**Winter Applications of Ethephon for Annual Bluegrass Seedhead Suppression**

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**Objectives**

1. Do pre-snow and/or post-snow applications of Ethephon in winter improve annual bluegrass seedhead suppression on greens when compared to just a spring program?

**Materials and Methods**

The study was conducted from November 2015 until May 2016 on a putting green at Murphy's Creek Golf Course in Aurora, CO. The turf is a mixture of 70%-80% annual bluegrass (*Poa annua*) and 20%-30% creeping bentgrass (*Agrostis palustris*) mowed at 0.125 inch and grown on a sand rootzone. Proxy (Bayer CropScience, Research Triangle Park, NC) is the ethephon product used to manage seedheads at this course, and is tank-mixed with Primo MAXX (Syngenta Crop Protection, Greensboro, NC) in late-spring (April/May). In recent years, Proxy use has increased at this site as seedheads have become difficult to manage. Depending on the year (and seasonal weather patterns) applications have been made throughout summer, and sometimes in the fall.

This RMEGI supported research investigated Proxy applied at 5oz/1000 $ft^2$ in two winter timings of "pre-snow cover" on November 13, 2015, or "post-snow melt" on February 26, 2016. A combination treatment applying Proxy at both winter timings (pre+post-snow) was also tested, plus mixtures with Proxy made at both winter timings. The mixtures included Proxy+Primo at 5oz+0.125oz/1000 $ft^2$; Proxy+Fiata Stressgaurd (Bayer CropScience, Research Triangle Park, NC) at 5oz+4oz/1000 $ft^2$; and Proxy+Foursome Turf Pigment (MANA Inc., Raleigh, NC) at 5oz+0.5oz/1000 $ft^2$. Winter treatments were applied to replicated 4-foot by 6-foot randomized plots using a backpack sprayer operating at 40 psi and a boom with four TeeJet AI11002VS nozzles in 2 gallons of water/1000 $ft^2$ (87 Gal/acre). A fungicide (Instrata® at 9.6oz/1000 $ft^2$; Syngenta Crop Protection, Greensboro, NC) and pigment (Sarge at 0.64oz/1000 $ft^2$; Numerator Technologies Inc., Saratoga FL) were applied to the entire trial on November 16, 2015 for protection from snow molds. No other pesticides were applied during the study.

The standard spring program used at this course was the comparison treatment, and an untreated control was also included. A full treatment list including products, rates, and timings is listed in Table 1. Spring applications were made by the superintendent using a Toro 5500 sprayer operating at 30 psi and delivering 1.5 gallons/1000 $ft^2$. All winter treatments mentioned previously also received the spring program applications to compare the efficacy of the winter timings for seedhead suppression to just the spring program.

Snow melted on February 20, 2016. The first spring program application was made March 10, 2016 and included only Proxy at 5oz/1000 $ft^2$. Unfortunately, turf that was supposed to be covered, and remain untreated, was mistakenly sprayed. But, this turf was covered on April 6, 2016 and May 13, 2016 when Proxy+Primo late-spring applications were made. Proxy was applied at 5oz/1000 $ft^2$ on April 6, but only at 3.2oz/1000 $ft^2$ on May 13. Primo was applied at 0.125oz/1000 $ft^2$ on both late-spring dates.

The accidental Proxy application to "untreated" turf in March likely confounded the results. Without a true untreated comparison, the full benefit of seedhead suppression from the seasonal timing treatments is diminished – as Proxy probably suppressed some seedheads in the "untreated" turf. However, this information is still valuable and useful for future studies. For reference, the untreated will now be referred to as a "check" that received a single application of Proxy in spring.

Seedheads were not observed on the green until April 2016. Seedheads were visually assessed on May 20, 2016 on a 0%-100% scale, where 100= complete seedhead cover in the plots. Suppression (or control) was determined by calculations of seedhead means comparing those of treated-turf to the "check". Turf quality was rated at each winter application timing, and when seedheads were rated; on a 1-9 scale, where 6= the lowest acceptable quality. Any injury following the winter applications was rated on a 0%-100% scale, where 20= the highest acceptable discoloration to the turf. A chlorophyll meter was also used to quantify turf quality and plant injury by measuring leaf chlorophyll content on a 0-999 index scale. Three measurements were taken in each

plot and averaged for the plot mean – with higher numbers equaling darker green turf. All data was analyzed for differences using ARM (Gylling Data Management, Brookings SD) with means compared using Fishers' LSD at a 95% confidence interval. Data that was not homogeneous were subjected to transformations to normalize the data.

**Seedhead Suppression**

The treatments did not have significant effects on the suppression of annual bluegrass seedheads as determined by visual estimates (Table 2). Specific effects include:

- Seedheads covered half (50%) of the "check" turf in May. All turf receiving winter Proxy applications had fewer seedheads (numerically), but were not significantly different to the check (Table 2). The lack of statistical differences may have been influenced by the accidental March Proxy application. But, there was also some suppression variation across replicates. For example, a particular treatment may have had great suppression in some plots, but suppression was poor in others. This creates a larger spread of possible variables associated with a treatment mean. Future work will refine the methods and use more replications to try and lessen variation.
    - Turf receiving the spring program (3 spring Proxy applications) only suppressed 27% of seedheads compared to the "check" treatment (Figure 1). The poor suppression from the spring program is likely due to a warm February that caused heat units, or growing degree days, to accumulate rapidly when snow was melting. Based on ambient air temperatures from Murphy Creek's weather station, 183 $DD_{base32F}$ (degree-days, base 32°F low temperature threshold) had accumulated by February 20 when snow finally melted off (Table 3).
    - The post-snow application made on February 26 occurred at 215 $DD_{base32F}$, and was essentially useless as an "early" Proxy application. According to Michigan State's Growing Degree Day Tracker (the industry standard for seedhead degree-day models in the north), a suggested target range for initiating spring Proxy+Primo applications is 220-500 $DD_{base32F}$ – with better control typically observed the earlier you start. The relatively quick snow melt, and fast accumulation of heat units observed in this trial, highlight some of the challenges superintendents face in spring when trying to manage seedheads. In theory, the post-snow application should have been made 2-3 weeks earlier, but how do you spray snow covered greens? It is likely not practical to remove snow just to make an ethephon application to manage seedheads.
        - The first spring Proxy application in March occurred at 400 $DD_{base32F}$, which is almost out of effective range for seedhead suppression according to MSU's GDD Tracker. Keep in mind this model was developed in the upper Midwest region of the U.S., and may be accurate for all regions in the western U.S.
- Winter Proxy applications slightly improved seedhead suppression over the spring program (Figure 1). Applying Proxy at the pre-snow cover timing in November, or at the post-snow melt timing in February, suppressed 40% of seedheads. Interestingly, making both winter applications did not improve suppression over either single timing in this trial. Applying Proxy+Primo at both winter timings suppressed 37% of seedheads, and Proxy+Fiata applied at both timings suppressed 47% of seedheads. The best suppression seemed to be from Proxy+Foursome (53%) applied at both winter timings (Figure 2).

**Turf Quality and Color**

The treatments had significant effects on turf quality in February, but not on turf color on any date (Table 4). Specific effects include:

- Winter applications of Proxy or the Proxy mixtures did not negatively impact turf quality in early spring. Winter applications were safe to putting green turf as no visible discoloration (Table 4) or crown rising occurred in weeks following the November or February applications.
- Pre-snow applications of Proxy+Foursome and Proxy+Fiata significantly improved turf quality after snow melted in February (Table 4). Although not statistically different, higher leaf chlorophyll levels were also measured.
    - Pre-snow applications of Proxy also improved chlorophyll levels (numerically) supporting the safety of Proxy applied at this winter timing.
- There were no statistical differences for turf quality of color (chlorophyll) in May, but quality was a little better in turf receiving the winter treatments.

**Conclusion**

Applying ethephon (Proxy in this case) in seasonal winter timings had small improvements of annual bluegrass seedhead suppression over spring applications in this trial. The spring program suppressed 27% of seedheads, while including a winter application of Proxy (either pre-snow cover, or post-snow melt) boosted suppression near 40%. However, this level of suppression is still not good, but may be lower than what would have been calculated if untreated turf had not mistakenly been sprayed with Proxy in March. The best suppression came from applying Proxy with the Foursome pigment at both winter timings (53% suppression) and should be studied further. Making winter applications of Proxy+Fiata and Proxy+Primo did not improve suppression over just applying Proxy in winter, but did result in better quality and higher leaf chlorophyll later in spring. The winter Proxy programs were all safe to putting green turf and did not cause crown rising or scalping.

Although these results are somewhat inconclusive, it highlights the influence of spring weather when developing chemical programs to manage annual bluegrass seedheads. The concept of early ethephon applications has merit, and should improve seedhead suppression in most years. However, more work is needed to develop site-specific programs for winter, that are flexible, easy, and cost-effective. There will be new treatments tested in Colorado over the 2016-17 and 2017-18 winters. Stay tuned.

**Table 1.** Winter ethephon applications evaluated for annual bluegrass seedhead suppression on a bentgrass putting green compared to standard spring programs, CO, 2015-16.

| Treatment | Product/Rate (fl.oz/1000) | Application Date |
|---|---|---|
| Pre-Snow | Proxy/5 | Nov. 13, 2015 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Post-Snow | Proxy/5 | Feb. 26, 2016 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Pre-Snow | Proxy/5 | Nov. 13, 2015 |
| Post-Snow | Proxy/5 | Feb. 26, 2016 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Pre-Snow | Proxy/5+Primo/0.125 | Nov. 13, 2015 |
| Post-Snow | Proxy/5+Primo.0.125 | Feb. 26, 2016 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Pre-Snow | Proxy/5+Fiata/4 | Nov. 13, 2015 |
| Post-Snow | Proxy/5+Fiata/4 | Feb. 26, 2016 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Pre-Snow | Proxy/5+Foursome/0.5 | Nov. 13, 2015 |
| Post-Snow | Proxy/5+Foursome/0.5 | Feb. 26, 2016 |
| +Spring 1st app | Proxy/5 | Mar. 10, 2016 |
| +Spring 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| +Spring 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Spring only 1st app | Proxy/5 | Mar. 10, 2016 |
| Spring only 2nd app | Proxy/5+Primo/0.125 | Apr. 6, 2016 |
| Spring only 3rd app | Proxy/3.2+Primo/0.125 | May 13, 2016 |
| Check | Proxy/5 | Mar. 10, 2016 |

**Table 2**. Effect of winter Proxy applications on annual bluegrass seedheads, CO, 2015-16.

| Product/Rate (oz/1000) | Timing[X] | Seedheads[Y] |
|---|---|---|
| | | May 20, 2016 |
| | | (% of plot) |
| Check[V] | 1x spring | 50.0 a[Z] |
| Spring program[W] | 3x spring | 36.7 a |
| Proxy/5 | Pre&Post-snow | 35.0 a |
| Proxy/5+Primo/0.125 | Pre&Post-snow | 31.7 a |
| Proxy/5 | Pre-snow | 30.0 a |
| Proxy/5 | Post-snow | 30.0 a |
| Proxy/5+Fiata/4 | Pre&Post-snow | 26.7 a |
| Proxy/5+Foursome/0.5 | Pre&Post-snow | 23.3 a |
| **ANOVA** | **df** | |
| Treatment | 7 | ns |

[V]The "check" was supposed to be untreated turf, but was mistakenly sprayed with Proxy in March at label rates.
[W]Spring program applications included Proxy in March, and Proxy+Primo in April and May at label rates.
[X]Pre-snow=Nov. 13, 2015; Post-snow=Feb. 26, 2016; and these winter timings also received spring program applications.
[Y]Visual estimates of annual bluegrass seedheads: 0-100 cover scale.
[Z]Means within same column with the same letter are not different significantly (*P*=0.05)
*, **, ***, ns, significant at P≤0.05, 0.01, 0.001, or not significant respectively.

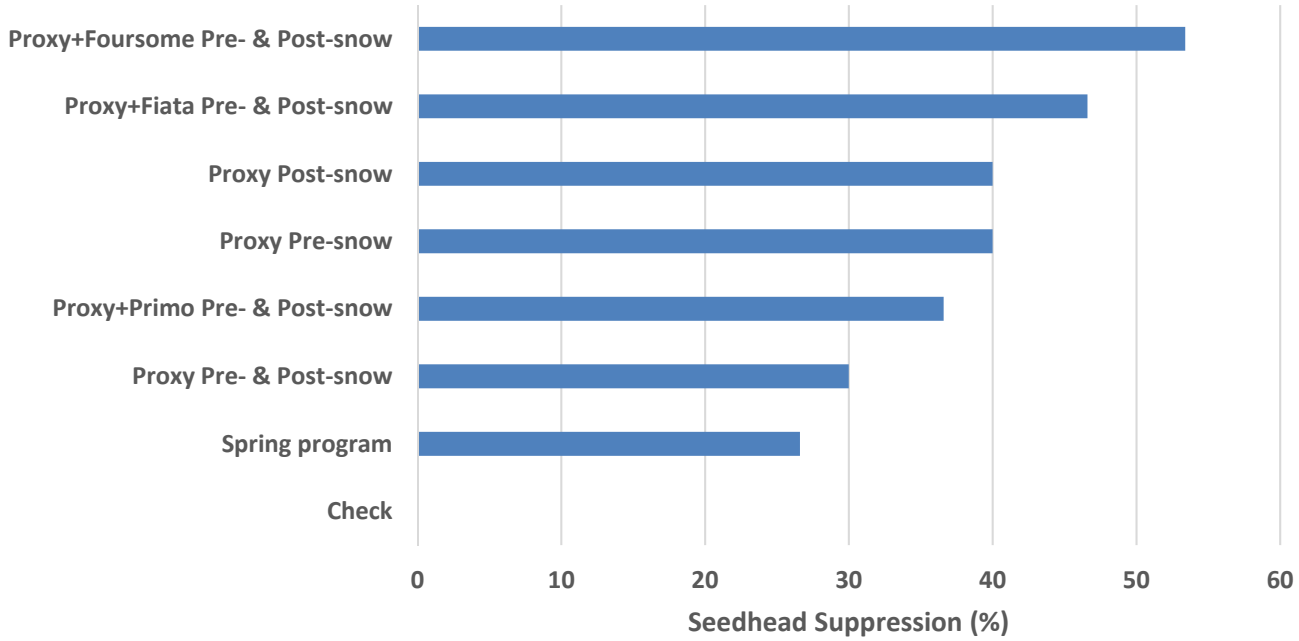


**Figure 1**. Seedhead suppression was improved when Proxy, or Proxy combinations, were applied in the winter compared to just a standard spring program at Murphy Creek Golf Course. The check was supposed to be untreated turf, but was mistakenly sprayed with Proxy in March. Suppression for winter and spring program treatments may have been higher had this turf not been sprayed, as suppression values are determined by calculating differences between treated and untreated means.

**Table 3**. Weekly temperatures and growing degree-day (DD) heat units at Murphy Creek Golf Course, Aurora, CO, 2015-16.

| **Week (2016)** (Date range) | **Days** (#) | **Temperature** Max | Min | Avg. | **DD** (wk) | **DD** (total) |
|---|---|---|---|---|---|---|
| | | | (°F) | | | (#) |
| 2-1 to 2-6 | 6 | 46 | 6 | 25 | 0 | *0* |
| 2-7 to 2-13 | 7 | 64 | 17 | 42 | 75 | *75* |
| 2-14 to 2-20 | 7 | 69 | 25 | 47 | 108 | *183* |
| 2-21 to 2-27 | 7 | 69 | 15 | 39 | 52 | *235* |
| 2-28 to 3-5 | 7 | 68 | 24 | 48 | 113 | *348* |
| 3-6 to 3-9 | 4 | 68 | 25 | 45 | 52 | *400* |

*Note* MSU's Growing Degree-Day Tracker suggests beginning Proxy+Primo applications in spring at approx. 220 $DD_{base32F}$ for best suppression of annual bluegrass seedheads. Snow melted off the green on Feb. 20, 2016 and 183 DD had already accumulated. The warm February likely influenced suppression effects in this trial, but pre-snow applications made in November did improve suppression over just a spring program that was initiated on March 10, 2016 when 400 DD had accumulated.

Winter Proxy+Foursome @ pre-snow timing in November

Winter Proxy+Foursome @ post-snow timing in February

Winter Proxy+Foursome (2 apps) plus Spring program in May with fewer seedheads.

**Figure 2**. Seedhead suppression was the best when Proxy was mixed with Foursome (a pigment) when applied at both winter timings compared to just the spring program (images below).

Spring program only @ pre-snow timing in November

Spring program only @ post-snow timing in February

Spring program only in May with seedheads

**Table 4.** Effect of winter Proxy applications on putting green quality and color, Aurora, CO, 2015-16.

| Product/Rate (oz/1000) | Timing[V] | Quality[W] | | | Injury[X] | | Chlorophyll[Y] | |
|---|---|---|---|---|---|---|---|---|
| | | 11-13-15 | 2-26-16 | 5-20-16 | 11-20-15 | 3-11-16 | 2-26-16 | 5-20-16 |
| | | | (#) | | (%) | | (index) | |
| Proxy/5+Foursome/0.5 | Pre&Post-snow | 6.0 a[Z] | 6.3 a | 6.7 a | 0.0 a | 0.0 a | 149 a | 244 a |
| Proxy/5+Fiata Stressgaurd/4 | Pre&Post-snow | 6.0 a | 6.0 ab | 6.3 a | 0.0 a | 0.0 a | 151 a | 240 a |
| Proxy/5 | Pre&Post-snow | 6.0 a | 5.7 abc | 6.0 a | 0.0 a | 0.0 a | 146 a | 254 a |
| Proxy/5 | Pre-snow | 6.0 a | 5.3 bc | 6.3 a | 0.0 a | 0.0 a | 143 a | 250 a |
| Proxy/5 | Post-snow | 6.0 a | 5.3 bc | 6.3 a | 0.0 a | 0.0 a | 138 a | 240 a |
| Check[T] | 1x spring | 6.0 a | 5.0 c | 5.3 a | 0.0 a | 0.0 a | 138 a | 245 a |
| Proxy/5+Primo/0.125 | Pre&Post-snow | 6.0 a | 5.0 c | 6.3 a | 0.0 a | 0.0 a | 142 a | 261 a |
| Spring program[U] | 3x spring | 6.0 a | 5.0 c | 6.0 a | 0.0 a | 0.0 a | 139 a | 245 a |
| **ANOVA** | **df** | | | | | | | |
| Treatment | 7 | ns | * | ns | ns | ns | ns | ns |

[T]The "check" was supposed to be untreated turf, but mistakenly sprayed with Proxy in March at label rates.

[U]Spring program applications included Proxy in March, and Proxy+Primo in April and May at label rates.

[V]Pre-snow=Nov. 13, 2015; Post-snow=Feb. 26, 2016; and these winter timings also received spring program applications.

[W]Turf quality rating scale: 1-9; 9=best, 6=acceptable, 1=worst.

[X]Turf phytotoxicity rating scale: 0-100; 20=highest acceptable discoloration injury.

[Y]Chlorophyll measured with a CM-1000 chlorophyll meter on a 0-999 scale, where higher numbers equal darker green turf.

[Z]Means within same column with the same letter are not different significantly (*P*=0.05)

*, **, ***, ns, significant at P≤0.05, 0.01, 0.001, or not significant respectively.