The Impact of Chemical Control Strategies on Mitigating *Poa annua* Encroachment in a Mature Kentucky Bluegrass *(Poa pratensis)* Stand

Tyler Seidel, John Inguagiato and Jason Henderson

Department of Plant Science and Landscape Architecture, University of Connecticut

Introduction

Annual bluegrass *(Poa annua)* (ABG) is a significant weed impacting golf courses, sports fields, and other high quality turfgrass areas. This species is lighter in color, shallower rooted, less drought tolerant, less disease tolerant, less wear tolerant and very difficult to manage in the hot summer months compared to desirable turfgrasses (Branham, 1991). Annual bluegrass creates a nonuniform, mottled sward that drastically reduces aesthetics and playing surface quality. Given the poor attributes of ABG, infested turfgrass stands often require more intensive management to maintain acceptable quality leading to more inputs and higher costs (McCullough et al., 2010). This aggressive, highly adaptive species has proven to be an extreme challenge for turfgrass managers to mitigate and/or control. Therefore, utilizing an approach that encompasses pre-emergent (PRE) and post-emergent (POST) herbicides individually and in combination with each other, may be the best way to give the desirable species a competitive, long-term advantage.

Application timing of PRE products to control ABG can be complicated because the germination period is highly dependent upon temperature and photoperiod (McElroy et. al., 2004). The annual taxa *(Poa annua* var. *annua)*, germinates predominately in the fall, around September and October in the northeast. One of the difficulties associated with applying PRE control products for ABG in the fall, is that it usually overlaps with the ideal timing to overseed desirable cool-season turfgrasses. Most PRE herbicide products may persist in soil for several weeks or months following application and could inhibit desirable turfgrasses from germinating and developing (Juska and Hanson, 1967). Consequently, turfgrass managers struggle in the fall to effectively maintain good turfgrass density through overseeding while attempting to control ABG with PRE herbicides. In Arizona, it is common practice to apply prodiamine mid to late August, followed by overseeding in October (Kopec and Umeda, 2004). This practice generally provides acceptable ABG control, but can still affect the establishment of perennial ryegrass *(Lolium perenne)* (PRG) seedlings because applications need to be made no less than 8 wks after overseeding to avoid PRG injury (Kopec and Umeda, 2004; Yelverton and McCarty, 2001). Prodiamine has also been shown to be much more effective at controlling ABG when applied PRE in August or September, but is not as effective if applied in October (Dernoeden, 1998).

Regardless of the PRE herbicide mode of action, some research indicates that PRE herbicides alone may not provide acceptable ABG control in the long term without a following POST application (Reicher et. al., 2017). ABG is more commonly managed with both PRE and POST herbicides throughout the fall (Toler et. al., 2007).

Control of ABG with POST herbicides is often inconsistent due to limited efficacy of selective herbicides (Elmore et. al., 2021; Reicher et. al., 2012). The variability in efficacy can be attributed to many factors like ABG biotype, application rate, environmental conditions, and frequency of applications (Wehtje and Walker, 2002; Gonçalves et. al., 2021; Reicher et. al., 2017; Skelton et. al., 2012). Additionally, some POST herbicides can be phytotoxic to cool-season turfgrasses (Skelton et. al., 2012; Elmore et. al., 2021).

Mesotrione is an herbicide registered for PRE ABG suppression, but there is research evaluating its POST efficacy using sequential applications (Reicher et. al., 2012; Reicher et. al., 2011). Mesotrione prevents the plant from harvesting sunlight because of the damaged plastoquinone and in turn, shuts down chlorophyll and is unable to limit the creation of reactive oxygen species leading to the disassembly of photosynthesis and the destruction of leaf pigments (Beaudegnies et. al., 2009).

Mesotrione alone will provide satisfactory ABG control when utilized during PRG seeding (Park et. al., 2019). Excellent control of ABG was achieved when glyphosate is applied prior to seeding and then followed by 5 sequential applications of mesotrione (Park et. al., 2019). Mesotrione seems to be effective, but labor intensive because of how often it needs to be applied in order to be effective. For example, mesotrione rates of 56g ha^{-1} applied two or three times per week for a total of 10 applications or 84g ha^{-1} applied two times per week for a total of seven applications provided consistent control of ABG when applied in October (Skelton et. al., 2012). Slight discoloration can be expected with mesotrione, as some bleaching or whitening of desirable species such as Kentucky bluegrass *(Poa pratensis)* (KBG) can occur (Skelton et. al., 2012).

Amicarbazone is a POST herbicide used to control ABG in cool-season turfgrass species, that works by inhibiting the photosystem II (PSII) electron transport and interrupting oxygen evolution (Dayan et. al., 2009). Generally, amicarbazone works well to control ABG, and has been reported to be effective at controlling ABG in bermudagrass *(Cynodon dactylon)* overseeded with PRG (Leon et. al., 2014). Temperature can increase phytotoxicity in some species such as KBG, PRG and tall fescue *(Festuca arundinacea)* (TF) when utilizing amicarbazone (McCullough et. al., 2010; Leon et. al., 2014; Yu et. al., 2014). For example, TF seems to be more tolerant to amicarbazone at moderate temperatures (25ºC) compared to high temperatures (40ºC) (Yu et. al., 2014).

Research has shown that sequential amicarbazone applications in the spring, might be the best timing because it can effectively control ABG and cause less than 20% injury compared to 50% injury reported from fall applications to KBG (McCullough et. al., 2010). Fall applications can also inhibit turfgrass seedlings from establishing and pose a challenge for turf practitioners who plan to overseed in the fall. Research conducted in Florida and South Carolina reported PRG injury due to amicarbazone up to 12 weeks after overseeding in the fall (Leon et. al., 2014). Whereas in the spring, amicarbazone can be safely applied 2 weeks prior to PRG or TF overseeding (McCullough et. al., 2011).

Methiozolin is a new isooxazoline herbicide that is readily absorbed by both leaves and roots, that is safe to use on KBG and controls ABG well (Koo and Askewand., 2012; Rana and Askew, 2016; Han and Kaminski, 2011). Methiozolin translocates upward in the plant with little to no basipetal translocation (Flessner et. al., 2013). Methiozolin controlled ABG at various stages of maturity from early (2 leaf) to late (8 leaf) stages in a greenhouse setting, but seemed to work best when applied to earlier growth stages in the field (Koo and Askewand, 2012; Flessner et. al., 2013). Methiozolin was also effective at reducing the number of panicles by 50% (Koo et. al., 2013) Methiozolin applied at high rates twice in the fall controlled ABG up to 94% in KBG and a single application in the spring controlled ABG up to 60% on a creeping bentgrass *(Agrostis stolonifera)* (CBG) green (McNulty and Askew, 2011; Koo and Askewand., 2012).

Ethofumesate has been used to control ABG since the 1980’s (Johnson, 1983). Ethofumesate is a rapidly metabolized herbicide absorbed by foliage (Kohler and Branham, 2002). Efficacy of ethofumesate has been shown to be inconsistent and may injure desirable species (Meyer and Branham, 2006). Ethofumesate can be applied as single or sequential applications to control ABG. Single applications of various rates have mixed results in controlling ABG (Shearman, 1986; Dernoeden and Turner, 1988; Meyer and Branham, 2006). Ethofumesate is recommended to be applied up to 3 times in the fall and can be followed up with 1 or 2 applications in the spring if needed (Meyer and Branham, 2006). Research has also confirmed that three applications in the fall, as well as other sequential application regimes provide good ABG control in KBG and Bermudagrass (Reicher et. al., 2017, Shearman, 1986; Park et. al., 2019; Dickens, 1979). Whether individual or sequential applications, ethofumesate is generally a safe POST herbicide to apply to PRG or KBG (McElroy et. al., 2011; Coats and Krans, 1986; Lee, 1981; Sousek and Reicher, 2019).

Flurprimidol is a plant growth regulator (PGR) that is generally applied POST to reduce ABG infestation in CBG/ABG mixed stands (Miller, 2016). Research regarding flurprimidol suppressing ABG in KBG is limited. Flurprimidol is root absorbed and suppresses plant growth by inhibiting gibberellin biosynthesis, which in turn reduces cell elongation (Peteliwicz et. al., 2021). Suppression of ABG by flurprimidol in past research seems to be mixed. For example, flurprimidol applied multiple times throughout 1 yr resulted in a 22% to 27% reduction in ABG 1 mo after the final treatment, but no suppression was noted 2 months after the final treatment (Johnson and Murphy, 1995). Conversely, another report observed a 75% reduction in ABG cover over the course of 4 yrs (Reicher et. al., 2015). However, when flurprimidol is applied in the fall and is then followed by a different PGR, such as paclobutrazol in the spring, ABG control seems to drastically improve compared to flurprimidol applied alone (Johnson and Murphy, 2017; Johnson and Murphy, 1995). Apart from ABG suppression, flurprimidol has been shown to suppress vertical growth in both ABG and CBG, but can cause some damage in CBG (Bigelow et. al., 2007; Johnson and Murphy, 2017; Petelewicz et. al., 2021; Johnson and Murphy, 1995). In CBG, stolons are not suppressed by flurprimdol and continue to spread into areas occupied by regulated ABG and begin to crowd it out (Bigelow et. al., 2007).

Much of the previous literature related to chemical control of ABG, looks at chemical control regimes applied to desirable turfgrass stands that have considerable ABG infestation. When ABG infestation is high, a common strategy is to slowly suppress the ABG over multiple seasons and allowing the desirable species to compete with the injured ABG. Much of the previous related literature seems to evaluate 2 or 3 combinations of PRE and POST herbicides. This research evaluates 1 PRE herbicide and 5 POST herbicides individually and in combination with each other at rates and timing to control minor ABG infestations quickly before becoming a serious infestation. This research was designed to assess the impact of PRE and POST herbicides on percent ABG cover in an established KBG stand. The objective of this research is to determine if there are individual PRE or POST herbicides or combinations, that will effectively control ABG.

Materials and Methods

This field study was conducted at the University of Connecticut Plant Science Research and Education Facility in Storrs CT (41° 47’ 44.9268” N, 72° 13’ 46.8156” W). The study was sodded on 8 Sept 2020, over an area that was previously maintained as a *Poa annua* putting green on a Paxton, fine sandy loam soil (coarse-loamy, mixed, active, mesic Oxyaquic Dystrudepts). Glyphosate was applied to the *Poa annua* putting green and 7d later, a blec machine was then used to prepare the area. The sod was a Kentucky bluegrass *(Poa pratensis)* blend of ‘Bluenote’ 25%, ‘Legend’ 25%, ‘Ginney II’ 20%, ‘Princeton P-105’ 20%, and ‘Bolt’ 10%, that was originally seeded in Sept 2019 at Tuckahoe Farms (Hammonton, NJ).

The study was arranged in a randomized complete block design arranged as a 2×6 factorial with three replicates. Individual plots measured 3’×6’. The first factor, pre-emergent (PRE), had two treatment levels: 1.) prodiamine and 2.) no prodiamine. The second factor post-emergent (POST), had six treatment levels: 1.) Ethofumesate, 2.) Mesotrione, 3.) Amicarbazone, 4.) Methiozolin, 5.) Flurprimdol and 6.) No POST treatment.

The PRE treatment was applied on 14 Sep 2022 at a rate of 0.5oz 1000ft $^{-2}$ using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles. The POST treatments were as follows; Ethofumesate applied at a 1.5oz 1000ft $^{-2}$ rate using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles, 2x at a 21d interval on 20 Sep 2022 and 18 Oct 2022. Mesotrione applied at a 0.036oz 1000ft $^{-2}$ rate with 0.2oz of a non-ionic surfactant (Intake 1-0-0, Brandt Co., Tampa FL) using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles, 5x consecutively on a M/Th/M/Th/M (23 May, 26 May, 30 May, 2 June, 6 June 2022) schedule (Skelton et al., 2012). Amicarbazone applied at a 0.14oz 1000ft $^{-2}$ rate using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles, 2x at a 14d interval on 22 Apr 2022 and 6 May 2022. Methiozolin applied at a 1.2oz 1000ft $^{-2}$ rate using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles, 2x at a 14d interval on 20 Sep 2022 and 6 Oct 2022. Flurprimidol applied at a 1.1oz 1000ft $^{-2}$

rate using a CO_2 backpack sprayer with 1gal 1000ft $^{-2}$ nozzles, 2x, once in the spring (22 Apr 22) and once in the fall (20 Sep 22).

The sod was originally maintained at 7.6cm at the time of installation, but was maintained at 3.2cm for the study. Mowing occurred 2x to 3x per week to simulate sports turf conditions. The research area was core cultivated at a depth of 3" and 1.5" spacing with 5/8" diameter tines on 11 Oct 2020. In 2020, a starter fertilizer (16-25-12) (Lebanon Turf, Lebanon, PA) was applied at a rate of 0.5 lb N 1000ft $^{-2}$ using a broadcast spreader on 29 Sept and 24 Oct 2020, for a total of 1.6 lbs P_2O_5 1000ft $^{-2}$ and 0.8 lbs K_2O 1000ft $^{-2}$. The starter fertilizer contained 3.3% slowly available N from methylene urea. In 2021, the same 16-25-12 fertilizer was applied again at the same rates on 12 May and a complete fertilizer (15-2-8) (Lebanon Turf, Lebanon, PA) with 8.5% slowly available N from methylene urea and biosolids was applied at a rate of 1 lb N 1000ft $^{-2}$ and 0.5 lb K_2O 1000ft $^{-2}$ was applied on 10 June, 9 Aug, 17 Sept and 17 Oct. A combination of 1.44g a.i. azoystrobin and 0.03g a.i. acibenzolar S-methyl was applied on 16 Sept 2020 at a rate of 2.88oz 1000ft $^{-2}$. Fungicide was applied using a bike sprayer (custom fabricated) with 1 gal 1000ft $^{-2}$ nozzles at 40 psi. The entire research area was subjected to simulated athletic field traffic using a Brinkman Traffic Simulator (BTS) 2x week^{-1} April through November 2021. One traffic event consisted of two passes with BTS varying the direction for each pass. Traffic simulation frequency increased to 3x week^{-1} beginning in May 2022.

Percent *Poa annua* cover was collected 5 May 2022 and 11 Nov 2023. Turfgrass quality was qualitatively assessed on a bi-weekly basis based on a visual rating scale (1=brown dead turfgrass plants; 9=darkest green densest turfgrass stand). Percent *Poa annua* cover was quantified using the line intersect method using two grids measuring 0.6m×1.7m with 240 intersections on each grid (480 intersections total) and each intersection spaced 6.3cm apart (Hoyle et. al, 2013). Percent *Poa annua* cover was calculated by dividing the sum of intersections aligning with *Poa annua* in the canopy by the total number of intersections and multiplying by 100. Percent green cover was analyzed on a bi-weekly basis in 2021 and 2022. Digital image analysis (DIA) (Karcher and Richardson, 2005; Richardson et. al, 2001) was used to calculate percent cover and dark green color index (DGCI) based on a digital image taken in a controlled light environment (Karcher and Richardson, 2003).

An analysis of variance was completed to test for significant treatment effects ($P \leq 0.05$) using the glimmix procedure in SAS statistical software 9.4 (SAS Institute, 2013). When significant source effects were obtained, means were separated using Fisher's least significant difference test. Data were tested for violations of assumptions for parametric analyses (normality of residuals, homogeneity of variance and non-additivity). Most dependent variables violated assumptions of the additive model and normality. Percent *Poa annua* cover, percent cover and quality were either transformed by the arcsine, square root or $\log_{10}$ transformation, if necessary, prior to statistical analysis. The analysis of variance and Fisher's means separations test were based on the transformed data, and the means were converted back to original scale for the results.

Results

Percent Poa annua Cover

2022 and 2023

Significant differences in percent *Poa annua* cover were observed in pre-emergent (PRE) and post-emergent (POST) main effects (Table 1). There was also significant interaction between PRE and POST on 21 November 2023 (Table 1).

In 2023, the PRE × POST interaction revealed combinations of pre and post emergent herbicides as well as pre-emergent herbicides alone, resulted in low ABG cover (Figure 1 and 2). Methiozolin and ethofumesate were effective at reducing percent ABG cover, regardless of fall applied prodiamine (Figure 2). Flurprimidol reduced ABG, however, efficacy improved with fall applied prodiamine (Figure 2). Mesotrione and Amicarbazone resulted in the highest ABG cover (Figure 1). Methiozolin alone or in combination with fall applied prodiamine, had low ABG cover (Figure 1 and 2).

Turfgrass Quality

2021

Significant differences in turfgrass quality were observed in PRE and POST emergent main effects (Table 2). There was also a significant interaction between PRE and POST on 13 Sep (Table 2).

The PRE × POST interaction revealed that generally, PRE and POST herbicides individually or in combination with each other did not affect turfgrass quality (Figure 3). However, mesotrione combined with prodiamine lowered turfgrass quality compared to mesotrione alone (Figure 3). Conversely, methiozolin combined with prodiamine increased turfgrass quality compared to methiozolin alone (Figure 3).

Tables

Table 1. Effect of pre-emergent and post-emergent herbicides on percent *Poa annua* cover 2022 and 2023.

	Date	
Main Effects	20 May 22	21 Nov 23
Pre-Emergent	-Percent Poa annua Cover-	
Yes	1.1 a[a]	2.5 b
No	1.1 a	14.6 a
Post-Emergent		
Ethofumesate	1.2 ab	7.1 bc
Mesotrione	0 b	9.5 ab
Amicarbazone	0 b	15 a
Methiozolin	0 b	1.7 c
Flurprimidol	1.1 ab	5.6 bc
None	1.4 a	12.3 ab
Variation Source	-ANOVA-	
Pre-Emergent (Pre)	NS	***
Post-Emergent (Post)	NS	**
Pre × Post	NS	*

Note: Comparison is based on quantitative weed counts with 2 grids with 240 intersections each (480 intersections in total)

[a]Means in columns followed by the same letter, within each main effect, are not significantly different according to Fishers LSD *($P<0.05$)*

Table 2. Effect of pre-emergent and post-emergent herbicides on turfgrass quality 2021.

	Date											
Main Effects	6 June	16 June	23 June	30 June	7 July	16 July	1 Aug	13 Aug	25 Aug	13 Sep	1 Oct	16 Nov
Pre-Emergent	-----------------------------------Quality Rating---------------------------------											
Yes	7.8 b[a]	5.4 b	5.3 a	5.5 a	5.7 a	5.5 a	5.3 a	5.2 a	5.1 a	5.4 a	5.4 a	4.5 a
No	8.1 a	5.8 a	5.7 a	5.8 a	6.0 a	5.6 a	5.5 a	5.6 a	5.3 a	5.6 a	5.6 a	4.7 a
Post-Emergent												
Ethofumesate	8.1 ab	5.6 a	5.5 a	5.8 a	6.1 a	5.6 a	5.5 a	5.3 a	5.1 a	5.6 a	5.3 ab	4.1 c
Mesotrione	8.1 ab	5.8 a	6.0 a	6.0 a	6.1 a	5.8 a	5.8 a	5.5 a	5.5 a	5.5 a	5.6 a	4.8 ab
Amicarbazone	8.3 a	5.3 a	4.3 b	4.1 b	4.6 b	5.1 b	4.3 b	5.0 a	5.3 a	5.6 a	5.8 a	4.6 ab
Methiozolin	8.1 ab	5.8 a	6.1 a	6.0 a	6.3 a	5.1 b	5.5 a	5.5 a	5.0 a	5.1 a	5.0 b	4.5 bc
Flurprimidol	7.7 b	5.6 a	5.6 a	6.0 a	6.0 a	5.6 a	5.8 a	5.6 a	5.1 a	5.6 a	5.6 a	4.6 ab
None	7.7 b	5.6 a	5.6 a	6.1 a	6.1 a	6.0 a	5.5 a	5.5 a	5.1 a	5.5 a	5.8 a	5.0a
Variation Source	--------------------ANOVA----------------------											
Pre-Emergent (Pre)	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Post-Emergent (Post)	NS	NS	**	***	***	**	**	NS	NS	NS	*	*
Pre × Post	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS

Note: Quality Ratings: 1, dead and/or brown turf, high weed cover; 6, minimum acceptable quality; 9, optimum quality

[a]Means in columns followed by the same letter, within each main effect, are not significantly different according to Fishers LSD *($P<0.05$)*

UCONN TURFGRASS

Figures

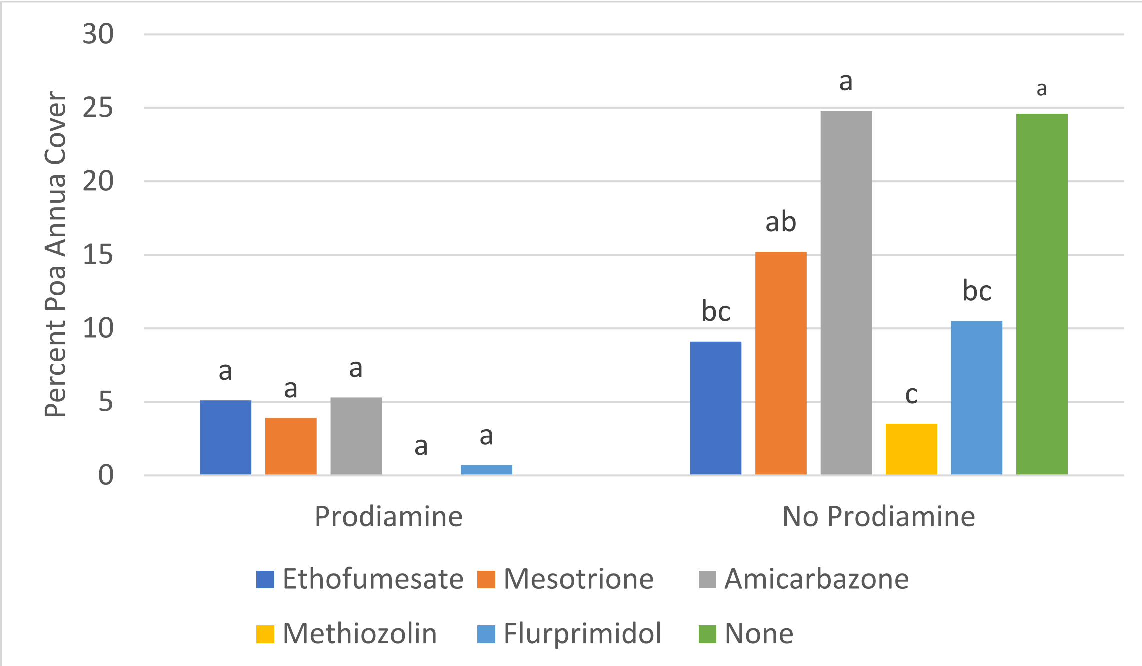

Figure 1. Interaction of pre and post emergent herbicides on percent *Poa annua* cover on 21 November 23.

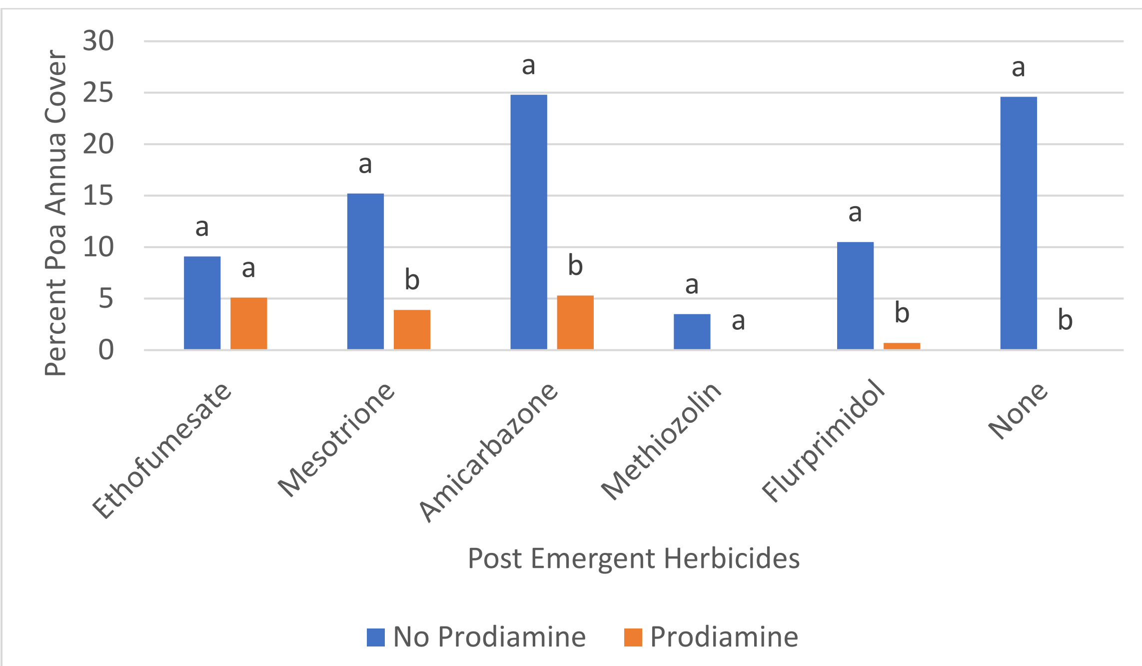

Figure 2. Interaction of pre and post emergent herbicides on percent *Poa annua* cover on 21 November 23.

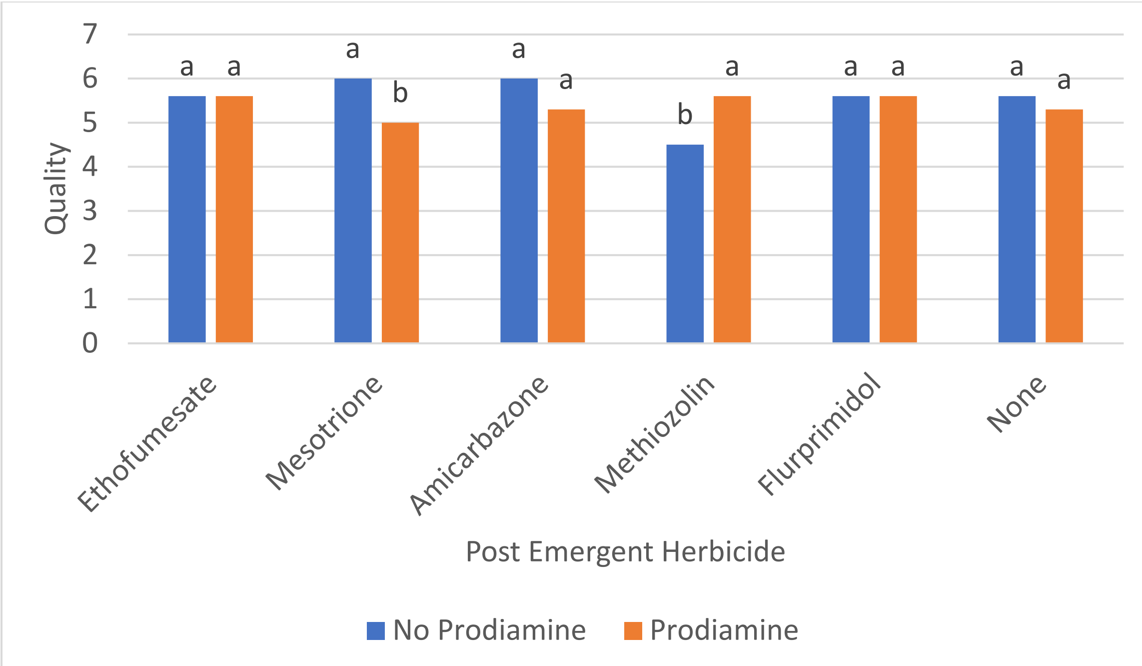

Figure 3. Interaction of pre and post herbicides on turfgrass quality 13 September 2021.

Discussion and Conclusion

The use of pre and post herbicides is an effective strategy to control minor infestations of ABG or to prevent the establishment of ABG in a predominantly desirable turfgrass stand. The primary objective of this research was to identify if individual or combination treatments of pre and post herbicides, could be implemented by turfgrass managers to minimize ABG encroachment in Kentucky bluegrass.

The data indicates that greater ABG control can be obtained with some combinations of pre and post herbicides. For example, prodiamine significantly reduced ABG infestation regardless of the post emergent product used, with the exception of ethofumesate and methiozolin. This indicates that these post products were effective when utilized alone and were therefore not necessarily enhanced when used in combination with prodiamine. Comparatively, ethofumesate and methiozolin were effective at reducing ABG cover with or without prodiamine.

The data also indicates that some individual treatments including prodiamine, ethofumesate and methiozolin when applied alone, provide good control of ABG infestation.

Previous research findings related to the efficacy of prodiamine against ABG are consistent with this research (Bhowmik and Bingham, 1990; Couderchet et. al., 1997; Dernoeden and Krouse, 1994). Fall applied prodiamine provided excellent control of ABG and should be considered when ABG infestations are minor. However, turf managers should consider the reseeding limitations and risk of resistance associated with prodiamine. Turf managers may have difficulty in the fall maintaining good turfgrass density while trying to control ABG with pre-emergent herbicides because perennial ryegrass *(Lolium perenne)* (PRG), requires 8wks after overseeding to avoid injury from prodiamine (Kopec and Umeda, 2004; Yelverton and McCarty, 2001). To avoid PRG injury, turf managers may consider applying prodiamine in August and overseeding in October. Good control of ABG can be achieved when pordiamine is applied in August and still leaves a window of opportunity to seed in October (Dernoeden, 1998). Another consideration when using prodiamine is the risk of resistance. The continued use of this herbicide across many years, has resulted in some resistant ABG phenotypes in Tennessee and North Carolina (Breeden et. Al., 2017; Isgrigg et. al., 2002).

Mesotrione has provided satisfactory control with sequential applications (Skelton et al., 2012). However, mesotrione did not result in acceptable control of ABG in this research. Mesotrione efficacy did improve when combined with prodiamine and no phytotoxicity to desirable turfgrass species was observed.

Amicarbazone treatments did not provide good control of ABG and had the highest percent ABG cover. Previous research has reported Amicarbazone treatments can be phytotoxic to desirable KBG, which was also observed in this research (McCullough et. al., 2010). Some turfgrass species seem to have higher tolerance to amicarbazone when applied at moderate temperatures (25C) compared to high temperatures (40C) (Yu et al., 2014). Amicarbazone efficacy improved when combined with prodiamine.

Methiozolin treatments were the most effective at controlling ABG and was not phytotoxic to KBG. Annual bluegrass cover was further reduced when combined with prodiamine. However, was not statistically significant. These results are consistent with previous research that also report good control of ABG with this herbicide (Koo et. al., 2013; Rana and Askew, 2016; Han and Kaminski, 2011).

Ethofumesate treatments were also very effective at controlling ABG and not phytotoxic to KBG. However, previous research has reported mixed results. Some research has reported mixed efficacy with single applications of ethofumesate, while sequential applications in the fall provided good ABG control (Dernoeden and Turner, 1988; Meyer and Branham, 2006; Reicher et al., 2017). In general, ethofumesate is a safe herbicide to apply to KBG (McElroy et. al., 2011; Coats and Krans, 1986; Lee, 1981; Sousek and Reicher, 2019).

Control of ABG with flurprimidol was acceptable and was not phytotoxic to KBG. Flurprimidol efficacy was improved when combined with prodiamine. Research regarding flurprimidol suppressing ABG in KBG is limited. Most research has been focused on suppressing ABG in creeping bentgrass *(Agrostis stolonifera)* (CBG). However, results are mixed (Johnson and Murphy, 19955; Reicher et al., 2015).

Based upon the results of this research, turf managers desiring minimal ABG infestation in a mature KBG stand have various chemical control options that are not labor intensive and will provide good control of minor ABG infestations. The herbicides with the greatest efficacy were methiozolin, ethofumesate and flurprimidol. Two fall treatments of methiozolin or ethofumesate were very effective, regardless of fall applied prodiamine. Flurprimidol applied once in the fall and spring resulted in some control of ABG. However, efficacy was improved when combined with fall applied prodiamine. Avoid using amicarbazone and mesotrione since results indicated poor ABG control as well as phytotoxicity associated with amicarbazone.

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