Noncrop and Invasive Vegetation Management Weed Science

2017 Annual Research Report

UNIVERSITY
OF KENTUCKY

College of Agriculture
Department of Plant and Soil Sciences

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INFORMATION NOTES 2017 NCVM-1

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The information provided in this document represents a collaborative effort between the Roadside Environment Branch of the Kentucky Transportation Cabinet and the Department of Plant and Soil Sciences in the College of Agriculture at the University of Kentucky. The main priority of this project was to collect and disseminate information to the KTC REB to increase the efficiency of operations aimed at roadside environment management.

This report contains a summary of research conducted during the 2017 season. This document is primarily for the use of the Kentucky Transportation Cabinet. Other use is allowable if proper credit is given to the authors.

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Acknowledgements

The Kentucky Transportation Cabinet funded the majority of the research conducted during the 2017 season. A special recognition must go to P. David Cornett, Mike Smith, and others at the Central Office in Frankfort for supporting this research effort. Special acknowledgement must also go to the twelve district roadside environment managers and their crews for contribution of ideas and land to conduct part of this research.

Other personnel in the Weed Science group who also aided in this project in terms of labor, equipment, and ideas include Charlie Slack, Sara Carter, and Dr. J.D. Green. Appreciation is also given to the farm crews at Spindletop Research Station for equipment and plot maintenance.

The research could not have been accomplished if not for the generous contributions of product. Contributors of product used include:

BASF Corporation
Bayer Crop Science
Dow AgroSciences
DuPont
Nufarm
PBI Gordon

External funding for research projects was received from Bayer Crop Science. The financial support of this organization is greatly appreciated.

We sincerely appreciate the effort and continued support of all our cooperators and look forward to future endeavors.

Species List

The following is a list of plant species discussed in the following document.

Scientific Name	Common Name
Ambrosia artemisiifolia L.	Common Ragweed
Aralia spinosa L.	Devil's Walking Stick
Arundo donax L.	Giant Reed
Coreopsis lancelata L.	Lance-leaved Coreopsis
Cyndon dactylon (L.) Pers.	Bermuda Grass
Daucus carota L.	Wild Carrot
Digitaria sanguinalis (L.) Scop.	Large Crabgrass
Festuca arundinaceum (Schreb.) S.J. Darbyshire	Tall Fescue
Liquidambar styraciflua L.	Sweetgum
Liriodendron tulipifera L.	Tulip Poplar
Lonicera japonica Thunb.	Japanese Honeysuckle
Medicago lupulina L.	Black Medic
Muhlenbergia schreberi J.F.Gmel.	Nimblewill
Plantago lanceolata L.	Buckhorn Plantain
Poa pratensis L.	Kentucky Bluegrass
Polygonum cuspidatum Siebold & Zucc.	Japanese Knotweed
Rubus allegheniensis	Blackberry
Rhus glabra L.	Smooth Sumac
Setaria faberi Herrm.	Giant Foxtail
Setaria pumila (Poir.) Roem. & Schult.	Yellow Foxtail
Sorghum halepense (L.) Pers.	Johnsongrass

Trifolium pretense L.	Red Clover
Ulmus alata Michx.	Winged Elm

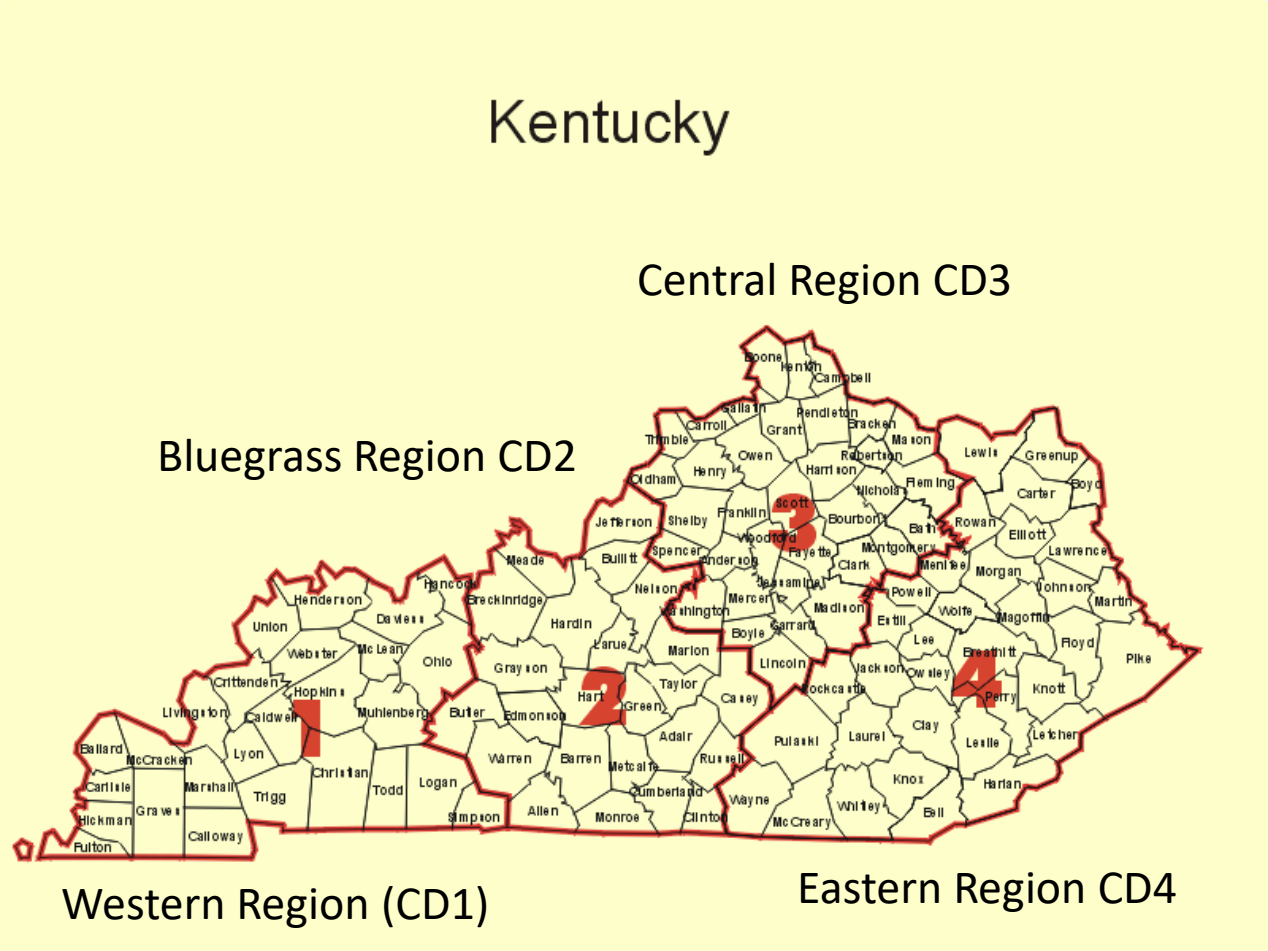
Herbicide List

The following is a list of herbicides discussed in the following document.

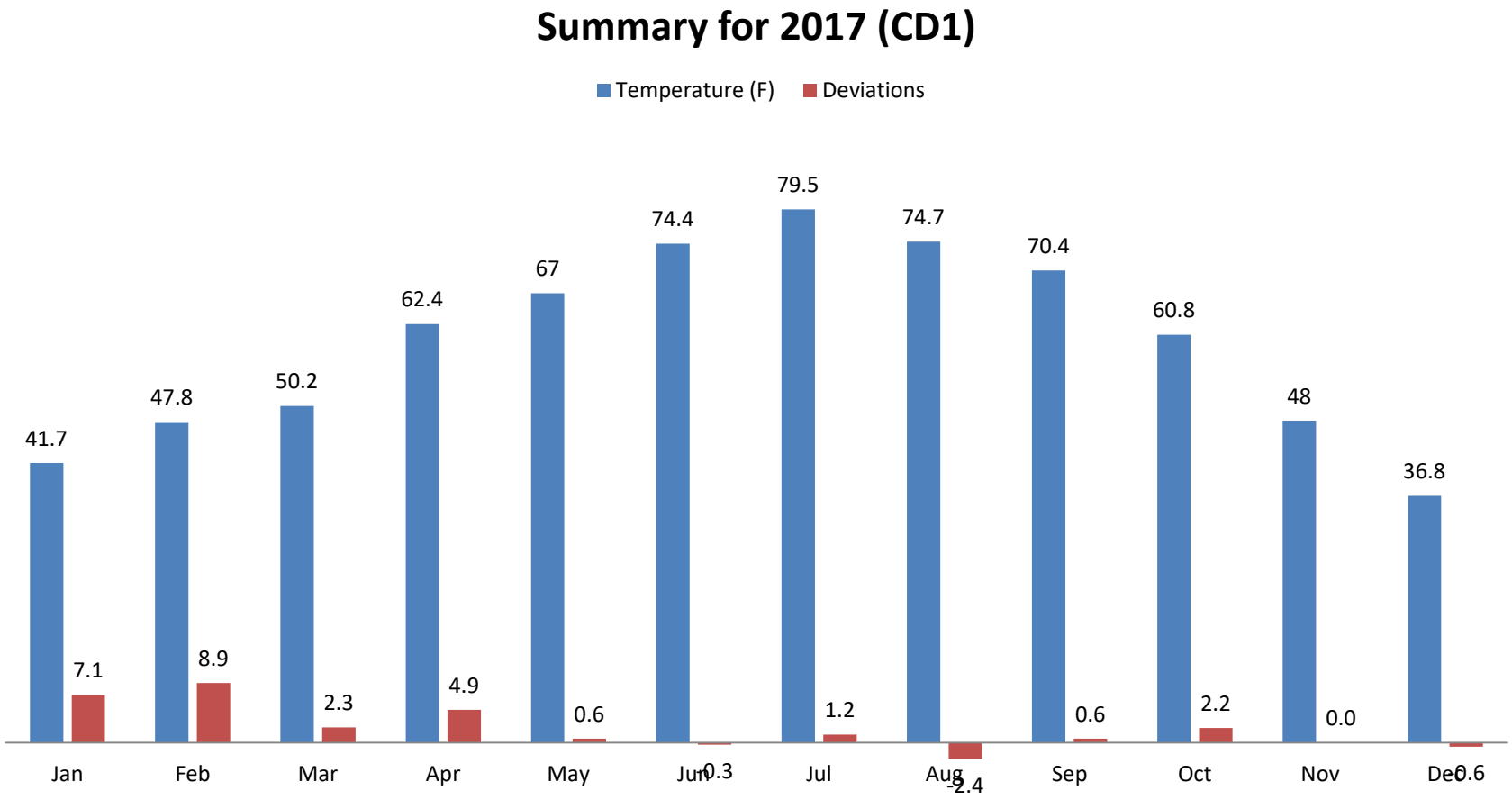
Product	Active Ingredient(s)	Concentration	Manufacturer
Acclaim Extra	fenoxaprop	0.57 lb per gallon	Bayer
Aim	carfentrazone-ethyl	2.0 lb per gallon	FMC
Aneuw	prohexadione calcium	27.5% w/w	Nufarm
BK 800	2,4-D + 2,4-DP + dicamba	1.89 lb ae + 0.94 lb ae + 0.47 lb ae per gallon	PBI Gordon
Cadet	fluthiacet-methyl	0.91 lb per gallon	FMC
Cleantraxx	penoxsulam + oxyfluorfen	0.083 lb + 3.93 lb per gallon	Dow AgroSciences
Clearcast	imazamox	1 lb ae per gallon	BASF
Command	clomazone	3.0 lb per gallon	FMC
Detail	saflufenacil	2.85 lb per gallon	BASF
Dual II Magnum	S-metolachlor	7.64 lb per gallon	Syngenta
Embark 2-S	mefluidide	2.0 lb ae per gallon	PBI Gordon
Escort XP	metsulfuron methyl	60% w/w	Dupont
Esplanade	indaziflam	1.67 lb per gallon	Bayer
Formula 40	2,4-D	3.67 lb ae per gallon	Nufarm
Fusilade II	fluazifop	2 lb per gallon	Syngenta
Fusion	fluazifop + fenoxaprop	2 lb + 0.56 lb per gallon	Syngenta
Gallery	isoxaben	75% w/w	Dow AgroSciences
Garlon 4 Ultra	triclopyr ester	4 lb ae per gallon	Dow AgroSciences
Hyvar X	bromacil	80% w/w	DuPont
Journey	imazapic + glyphosate	0.75 lb ae + 1.5 lb ae per gallon	BASF
Karmex	diuron	75% w/w	DuPont
Method	aminocyclopyrachlor	2 lb ae per gallon	Bayer
Milestone VM	aminopyralid	2 lb ae per gallon	Dow AgroSciences
Milestone VM Plus	aminopyralid + triclopyr	0.1 lb ae + 1.0 lb ae per gallon	Dow AgroSciences
MSMA	monosodium acid methanearsonate	6 lb per gallon	Drexel
Opensight	aminopyralid + metsulfuron	0.525 lb ae + 0.0945 lb ae per gallon	Dow AgroSciences
Oust XP	sulfometuron	75% w/w	DuPont
Oust Extra	sulfometuron + metsulfuron	56.25% + 15% w/w	DuPont
Outlook	dimethenamid-P	6.0 lb per gallon	BASF
Outrider	sulfosulfuron	75% w/w	Monsanto

Overdrive	diflufenzopyr + dicamba	0.2 lb ae + 0.5 lb ae per gallon	BASF
Patriot	metsulfuron	60% w/w	Nufarm
Patron 170	2.4-D + 2,4-DP	1.71 lb ae + 0.87 lb ae per gallon	Nufarm
Payload	flumioxazin	51% w/w	Valent
Pendulum AquaCap	pendimethalin	3.8 lb per gallon	BASF
Permit	halosulfuron-methyl	75% w/w	Gowan
Perspective	aminocyclopyrachlor + chlorsulfuron	39.5% + 15.8% w/w	DuPont
Polaris AC Complete	imazapyr	4 lb ae per gallon	Nufarm
Plateau	imazapic	2 lb ae per gallon	BASF
Poast Plus	sethoxydim	1 lb per gallon	BASF
Proclipse	prodiamine	65% w/w	Nufarm
Pyresta	2,4-D + pyraflufen-ethyl	3.5 lb ae + 0.0177 lb per gallon	Nichino America
Rodeo	glyphosate	4 lb ae per gallon	Dow AgroSciences
Roundup ProMax	glyphosate	4.5 lb ae per gallon	Monsanto
Sahara	diuron + imazapyr	62.22% + 7.78% w/w	BASF
Select Max	Clethodim	0.97 lb per gallon	Valent
Streamline	aminocyclopyrachlor + metsulfuron methyl	39.5% + 12.6% w/w	DuPont
Stronghold	mefluidide + imazethapyr + imazapyr	1.46 lb ae + 0.35 lb ae + 0.01 lb ae per gallon	PBI Gordon’s
Telar XP	chlorsulfuron	75% w/w	DuPont
Tenacity	mesotrione	4 lb per gallon	Syngenta
Vastlan	triclopyr	4 lb ae per gallon	Dow AgroSciences
Viewpoint	imazapyr + aminocyclopyrachlor + metsulfuron	31.6% + 22.8% + 7.3% w/w	DuPont

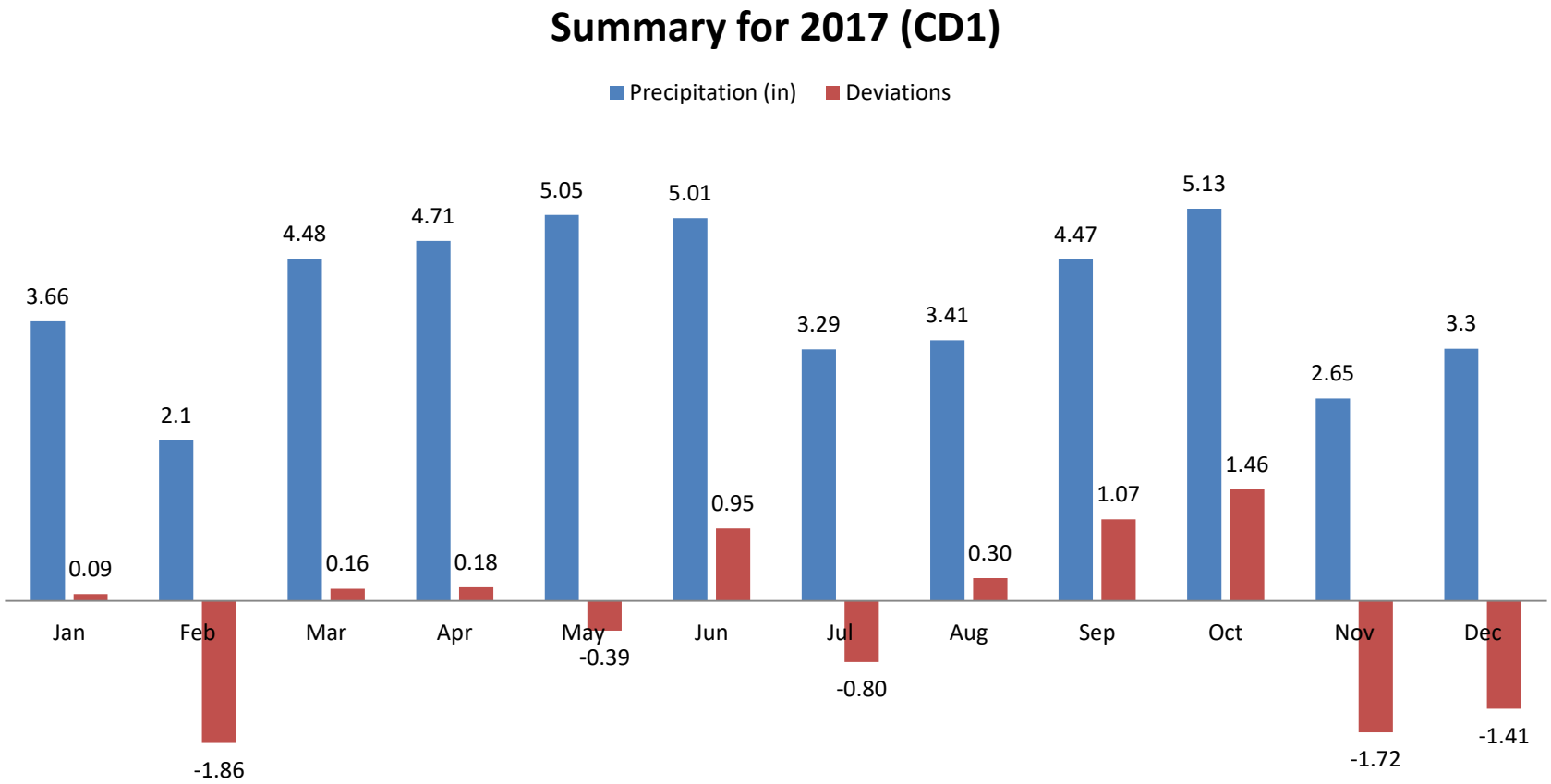
Map of Kentucky Climate Divisions



Western Region (CD1) Monthly Temperatures and Deviations from Normal (UKWAC)



Western Region (CD1) Monthly Precipitation and Deviations from Normal (UKWAC)



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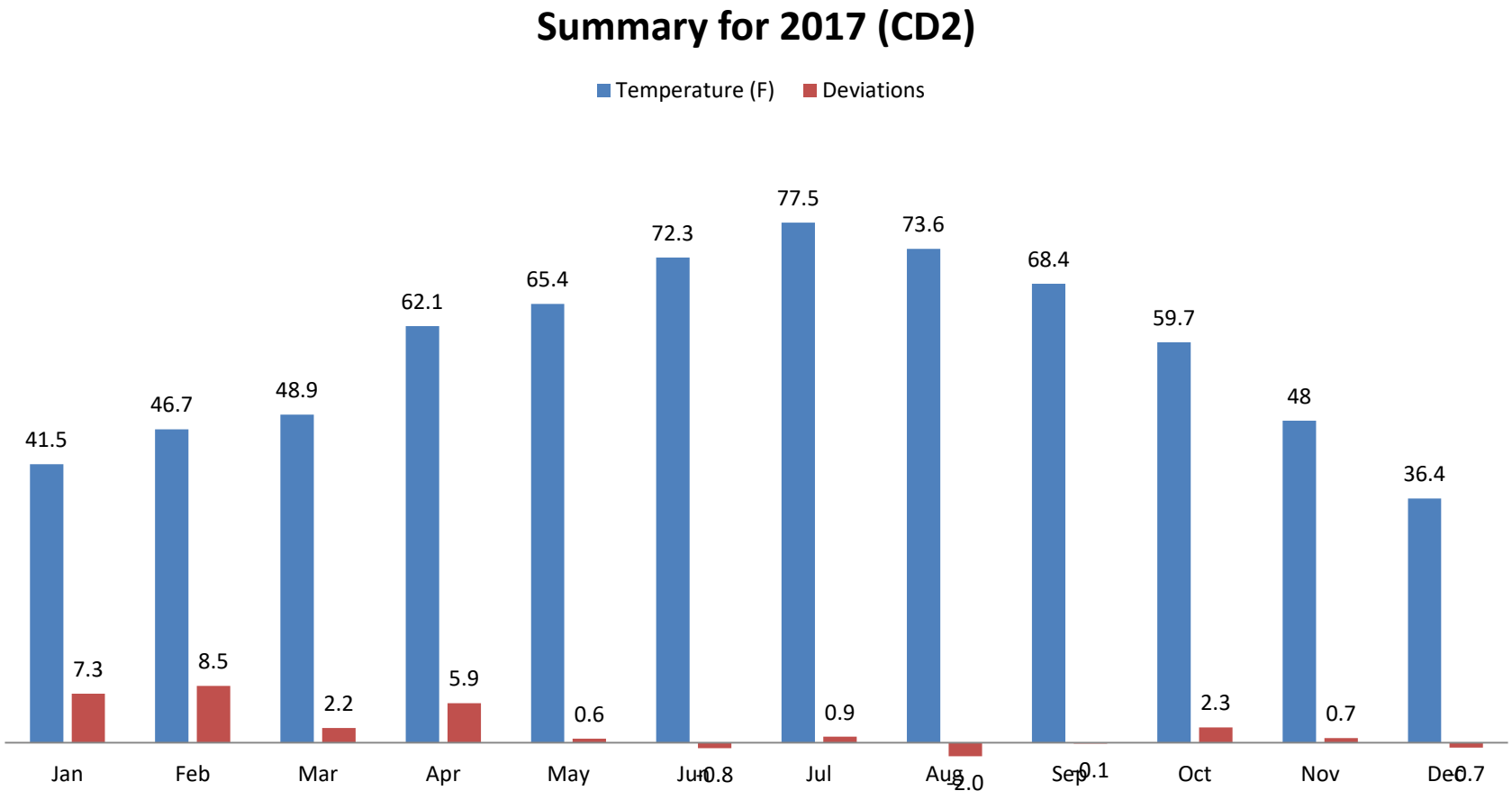

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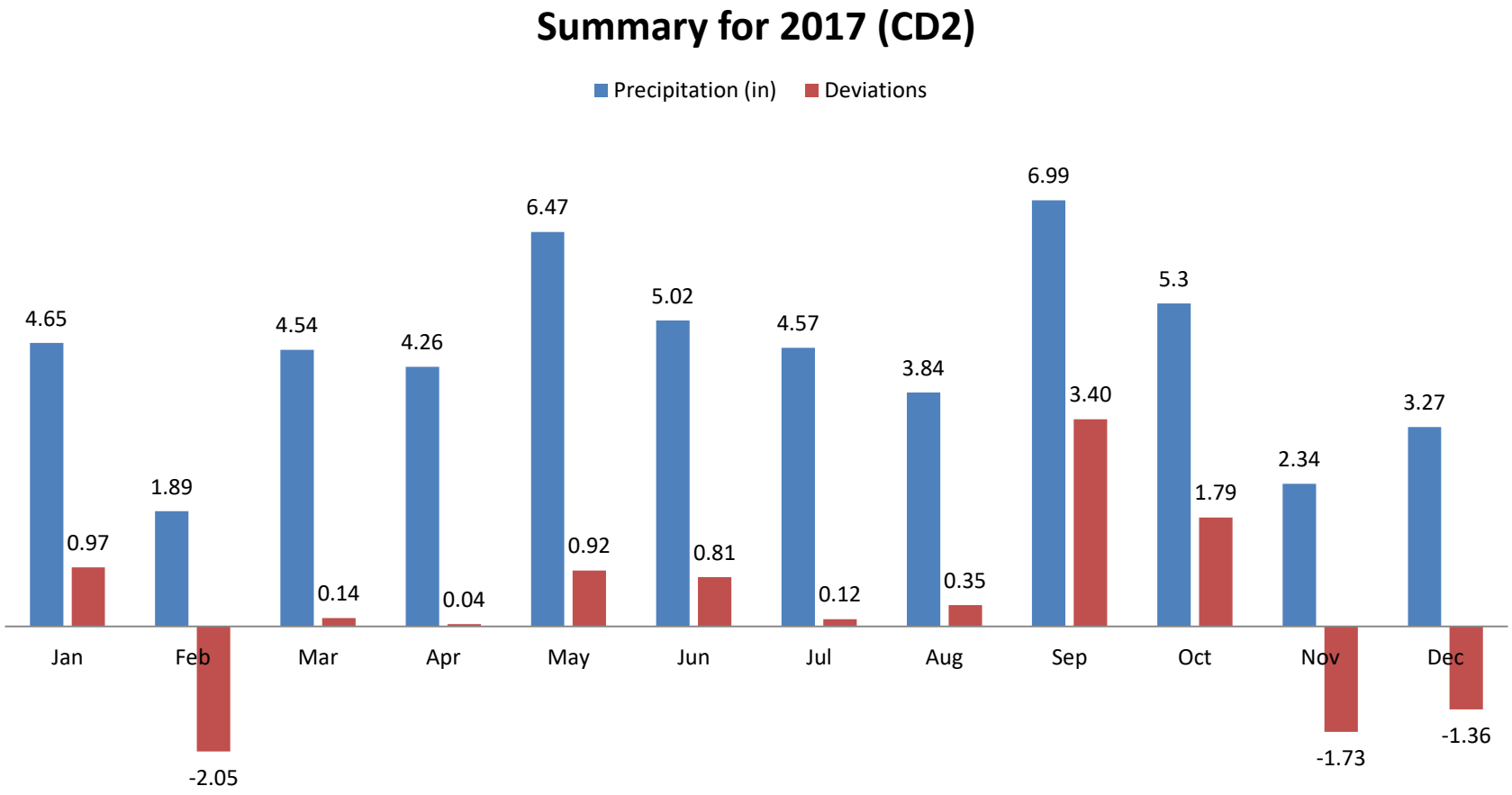

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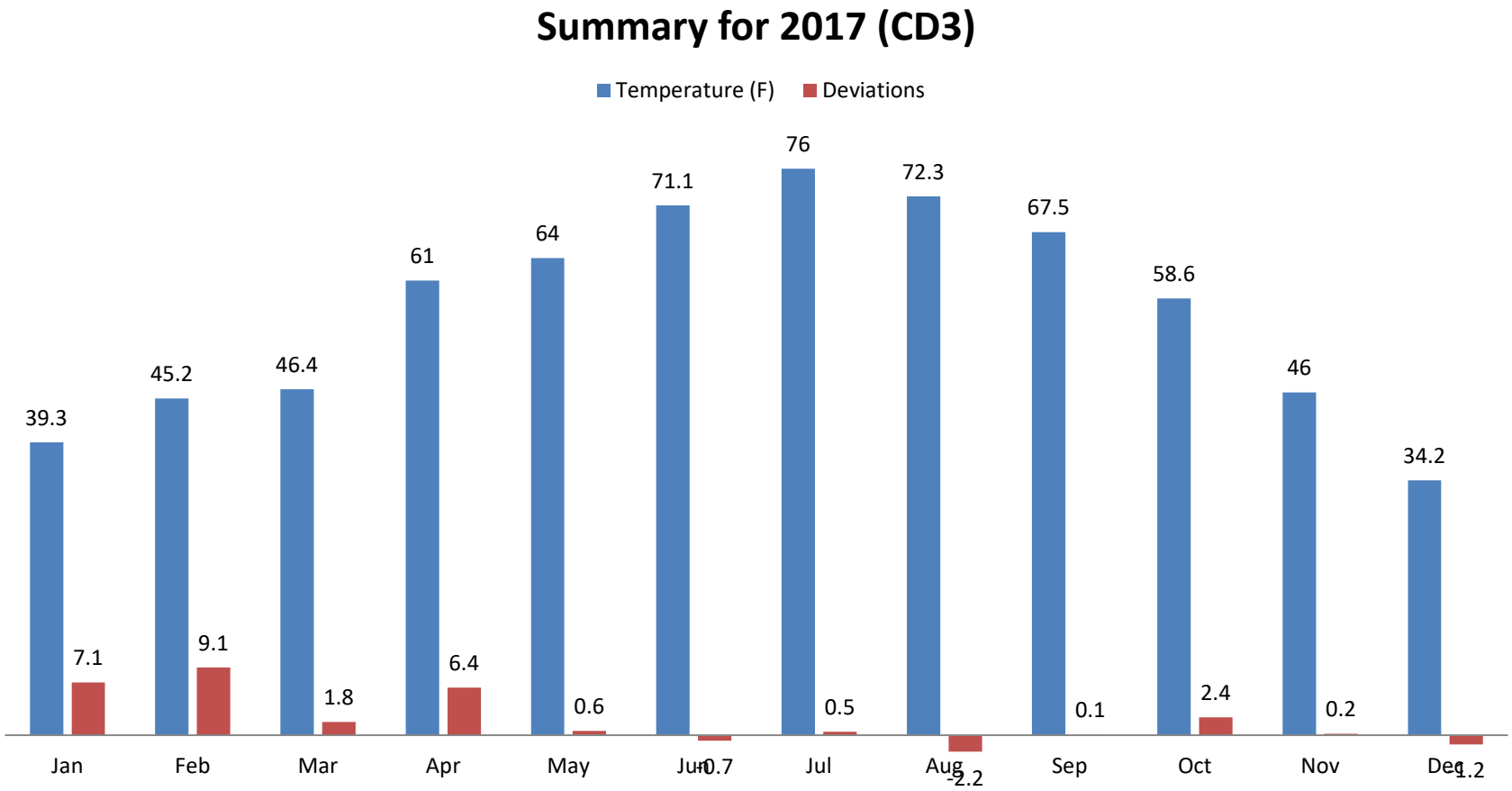

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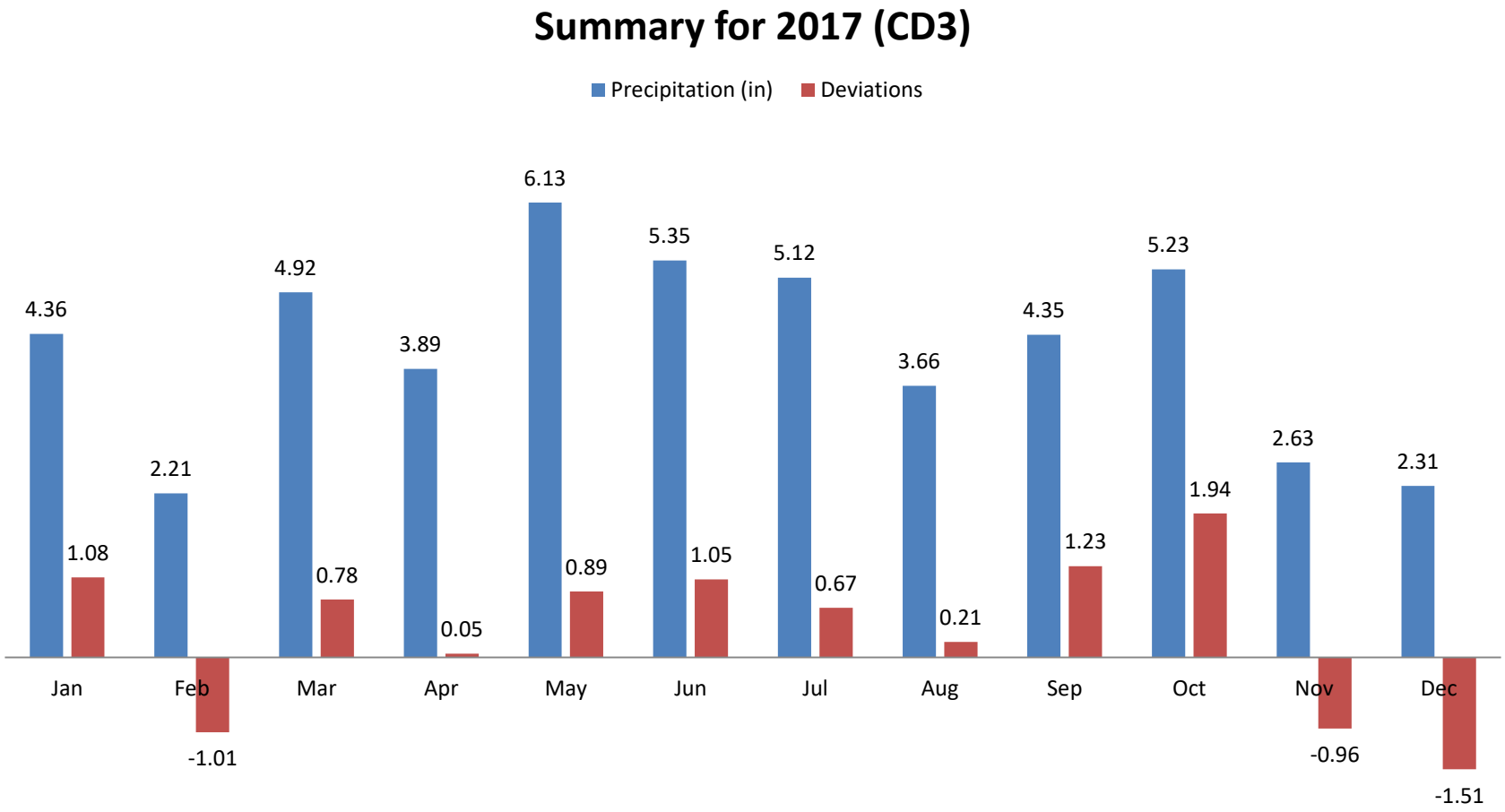

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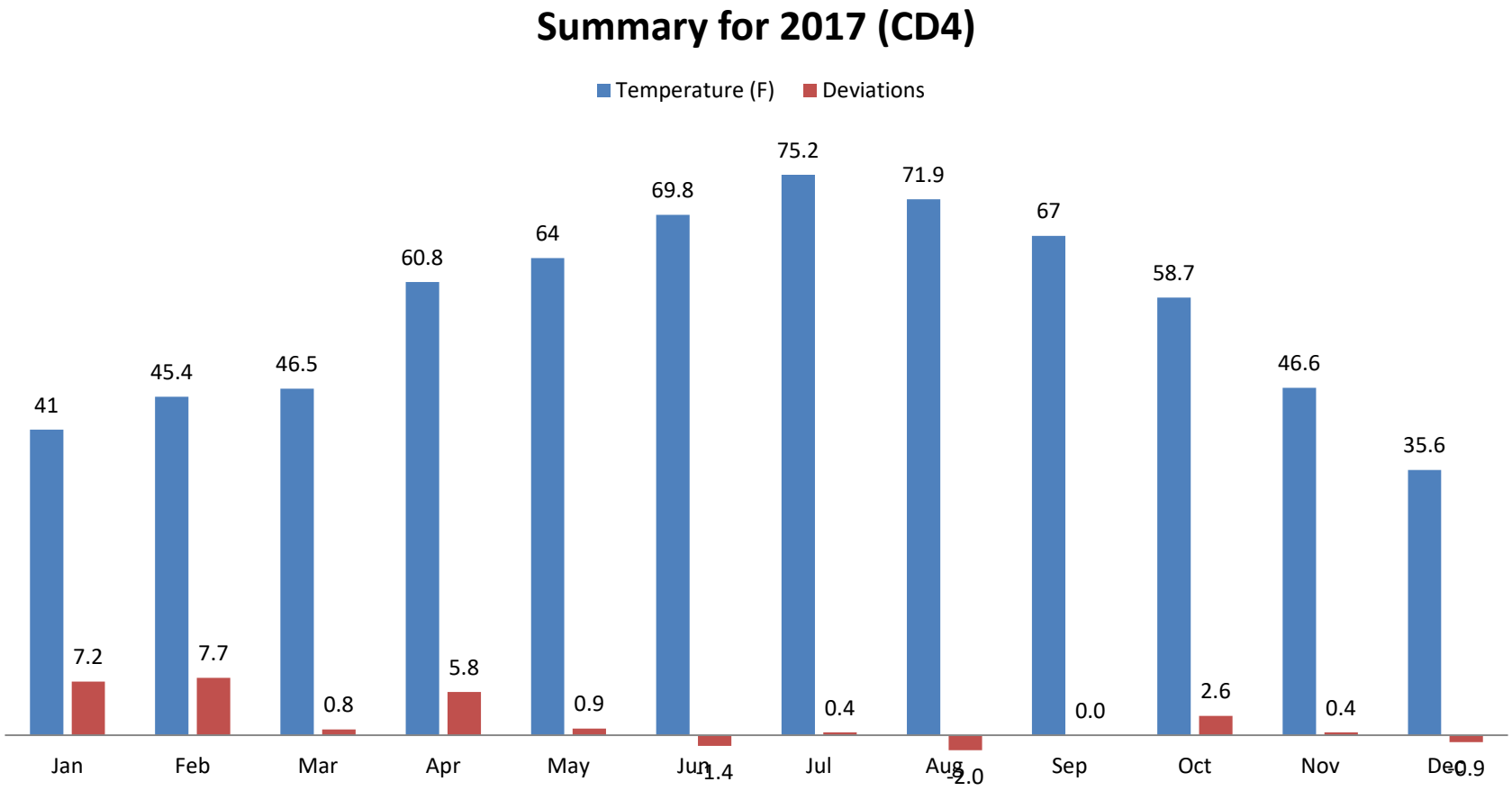

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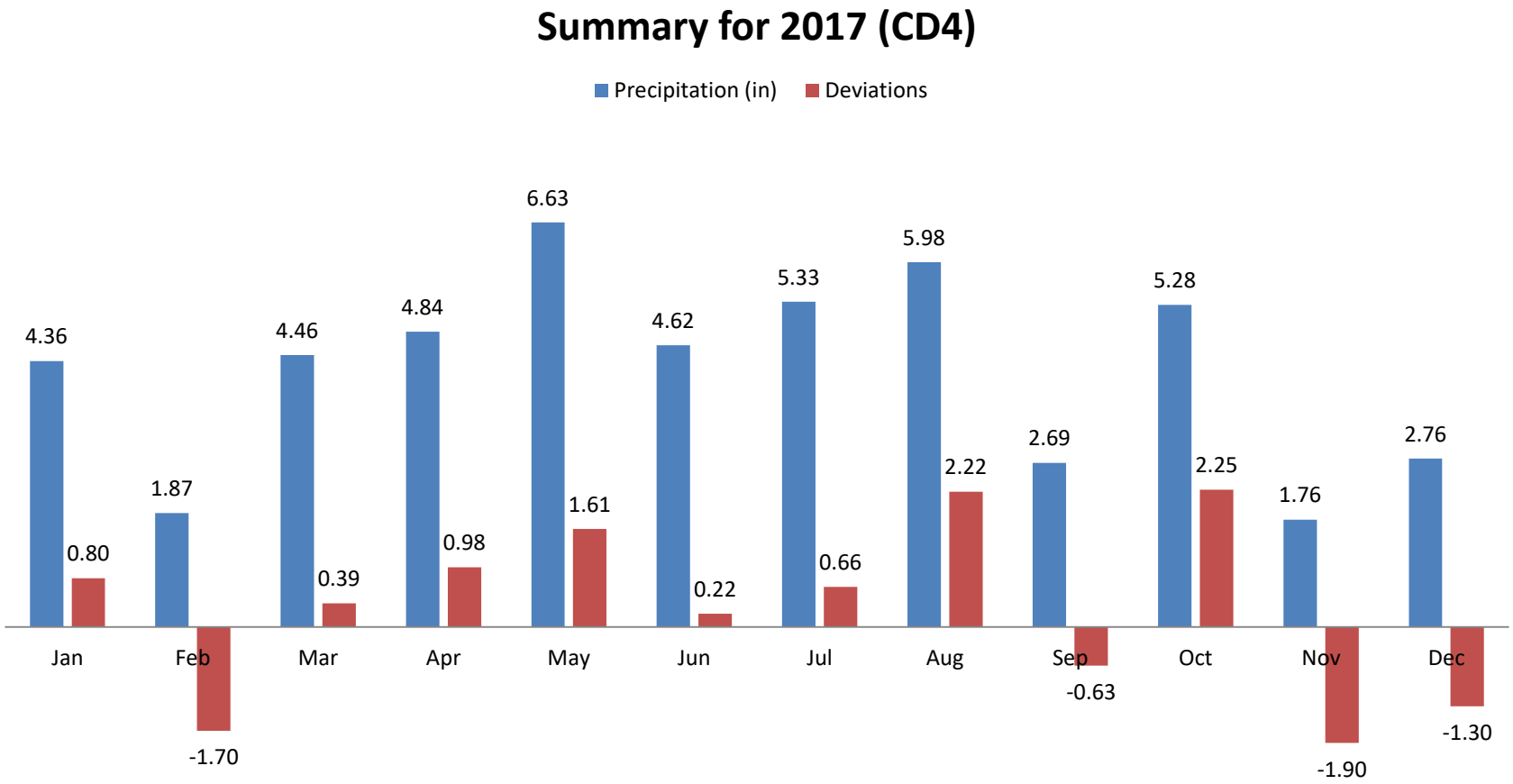


2016-2017 Dormant Stem Brush Control Trial

Introduction

One of the challenges of vegetation management on right-of-ways is the rapid growth of woody plants. While mechanical (mowing) and chemical options are available during the growing season to manage woody vegetation, dormant-stem herbicide applications are another option outside the growing season that extend the spray season. The herbicides are applied to brush vegetation while there are no leaves on the deciduous plants. The herbicide treatment is applied to the branches and trunks and the herbicide moves into the plant by penetrating the thin bark layer. The most effective timing is from about six weeks prior to bud break and up to the beginning of bud break. Applications must be made when the bark, stems, and branches are dry. This trial was established to compare the efficacy of some herbicide combinations for controlling brush species.

Materials and Methods

A trial was established in an area of mixed brush regrowth near Nortonville in western Kentucky along the Western KY Parkway. Four treatments plus a control, listed in Table 1, were applied on March 8, 2016 before bud break at 50 GPA using a TeeJet® Boomless tip mounted on the rear of an ATV. Plots were 40 ft long X 12 ft wide and were arranged as a RCBD with 4 replications. The woody vegetation was 5-6 ft high at application. The species in the plots included tulip poplar, sweet gum, winged elm, smooth sumac, devil's walking stick, and blackberry. There was also Japanese honey suckle, giant reed, and other herbaceous plants in the plots.

The same four herbicide treatments were applied along the Parkway in four large demonstration plots near the State Police station and salt dome on February 26, 2016. The shoulders of the east and westbound lanes from mile markers 38.7 to 42.1 were used. A roadside sprayer with an articulated boom was used to apply the products to the brush. However, we were unable to collect rating data on these as the Parkway was undergoing pavement grinding and resurfacing during the season and it was not safe to do so.

All the herbicide mixes included basal oil *(Low Odor Arborchem Basal Oil from Arborchem Products Co, Mechanicsburg, PA)* to help get the herbicide through the bark and surfactant to emulsify the oil with the water carrier. All the mixes also included different rates of Garlon 4 Ultra (triclopyr) which does not have residual soil activity. The components with some soil activity are the dicamba in BK800, aminopyralid in Milestone, aminocyclopyrachlor + imazapyr + metsulfuron in Viewpoint, and metsulfuron in Patriot (Table 1).

The small plots were rated visually 57 (5/3/2016), 72 (5/18/2016), 114 (6/29/2016), 205 (9/28/2016), and 422 (5/3/2017) days after treatment (DAT). Data collected were % woody stem leaf out and % herbaceous cover 57 DAT and % leaf out and % green cover from woody

vegetation which was split into lower and upper canopy cover 72 DAT. For the 114 and 205 DAT ratings, % bareground, % herbaceous cover, and % woody lower and upper canopy cover (overlapping canopy at this point) data were collected. The following spring at the 422 DAT rating, % herbaceous cover, % woody lower and upper canopy cover plus % woody stem leafout data were collected. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

The spray coverage or, rather, the lack of coverage was evident in the large and small plots after leaf out. This illustrated the importance of good coverage for the most efficacious control results.

At the first rating, 57 DAT, all the herbicide treatments had less % leaf out (2-7%) on the woody stems than the control plots (Table 2). In many of the plots, small seedlings were evident. At 72 DAT, all the herbicide treatments still had less leaf cover from the woody vegetation than control (Table 2).

Later in the season (114 DAT), the Garlon + Milestone and Patron + Garlon + Patriot treatments (Treatments 2 and 4) had more bare ground than the control (Table 3). At this time, the lower woody canopy cover was the same as the control for the BK800 + Garlon and Garlon + Viewpoint treatments (Treatments 1 and 3) while the upper canopy cover was the same as control for the Patron + Garlon + Patriot treatment (Treatment 4). By the time of the last assessment (205 DAT), the herbaceous cover, which was predominantly grasses, was greater than the control in the Garlon + Milestone and Garlon + Viewpoint treatments (Treatments 2 and 3) (Table 3). The Garlon + Milestone and Patron + Garlon + Patriot treatments (Treatments 2 and 4) still had more bareground than control and these treatments plus the Garlon + Viewpoint treatment (Treatment 3) still had less lower canopy cover than control.

Next spring (422 DAT) there were no differences in the herbaceous cover and the Garlon + Milestone, Garlon + Viewpoint, and Patron + Garlon + Patriot treatments (Treatments 2, 3, and 4) had less upper canopy cover than the control (Table 5). The treatment that stood out was Garlon + Milestone (Treatment 2) which provided less lower canopy cover and woody stem leafout than control. Many of these stems were dead and dry. It can take time for treatment differences to become evident with perennials.

All the treatments gave good initial results in brush suppression but many of the plants still leafed out from buds outside the spray pattern and continued to grow. Assessments the following season provided information on how many of these plants actually died and how efficacious the herbicide mixes were.

Table 1. Herbicide treatments, active ingredients and application rates for Dormant Stem Brush Control Trial.

Trt. No.	Product(s)	Rate per acre	Active Ingredient(s)	ai Application Rate (per acre)
1	BK800 Garlon 4 Ultra Basal Oil Surfactant	1.5 gal 0.5 gal 2 gal 1 gal	2,4-D + 2,4-DP + dicamba triclopyr	2.84 lb ae + 1.41 lb ae + 0.71 lb ae 2 lb ae
2	Garlon 4 Ultra Milestone Basal Oil Surfactant	2 gal 7 fl oz 2 gal 1 gal	triclopyr aminopyralid	8 lb ae 1.8 oz ae
3	Garlon 4 Ultra Viewpoint Basal Oil Surfactant	1 gal 12 oz 2 gal 1 gal	triclopyr aminocyclopyrachlor + imazapyr + metsulfuron	4 lb ae 2.7 oz + 3.8 oz + 0.9 oz
4	Patron 170 Garlon 4 Ultra Patriot Basal Oil Surfactant	6.9 pt 1 gal 3 oz 2 gal 1 gal	2,4-D + 2,4-DP triclopyr metsulfuron	1.47 lb ae + 0.75 lb ae 4 lb ae 1.8 oz
5	Untreated Control			

Table 2: Brush Control Trial Results in 2016 (part 1)

						Woody Vegetation Cover		
			% Leaf Out	% Herbaceous Cover	% Leaf Out	% Green Cover	% Lower Canopy	% Upper Canopy
Trt. No.	**Product(s)**	**Rate per acre**	**57 DAT[1]**		**72 DAT**			
1	BK800 Garlon 4 Ultra Basal Oil Surfactant	1.5 gal 0.5 gal 2 gal 1 gal	7 b[2]	3	9 b	20 b	11 b	9 b
2	Garlon 4 Ultra Milestone Basal Oil Surfactant	2 gal 7 fl oz 2 gal 1 gal	2 c	9	3 b	11 b	8 b	3 b
3	Garlon 4 Ultra Viewpoint Basal Oil Surfactant	1 gal 12 oz 2 gal 1 gal	5 bc	1	9 b	16 b	5 b	11 b
4	Patron 170 Garlon 4 Ultra Patriot Basal Oil Surfactant	6.9 pt 1 gal 3 oz 2 gal 1 gal	3 bc	2	8 b	14 b	6 b	8 b
5	Untreated Control		100 a	2	100 a	100 a	53 a	48 a

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3: Brush Control Trial Results in 2016 (part 2)

					Woody Vegetation Cover				Woody Vegetation Cover	
			% Herb[1] Cover	% Bare	% Lower Canopy	% Upper Canopy	% Herb Cover	% Bare	% Lower Canopy	% Upper Canopy
Trt. No.	**Product(s)**	**Rate per acre**	**114 DAT[2]**				**205 DAT**			
1	BK800 Garlon 4 Ultra Basal Oil Surfactant	1.5 gal 0.5 gal 2 gal 1 gal	39	4 b[3]	53 a	20 b	23 bc	4 b	53 ab	21
2	Garlon 4 Ultra Milestone Basal Oil Surfactant	2 gal 7 fl oz 2 gal 1 gal	35	15 a	23 b	26 b	36 ab	18 a	34 b	13
3	Garlon 4 Ultra Viewpoint Basal Oil Surfactant	1 gal 12 oz 2 gal 1 gal	29	3 b	38 ab	25 b	48 a	5 b	35 b	13
4	Patron 170 Garlon 4 Ultra Patriot Basal Oil Surfactant	6.9 pt 1 gal 3 oz 2 gal 1 gal	29	6 ab	29 b	34 ab	25 bc	8 ab	36 b	31
5	Untreated Control		11	0 b	54 a	58 a	13 c	4 b	56 a	28

[1] Herbaceous Cover

[2] *DAT = Days after treatment*

[3] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05*

Table 4: Brush Control Trial Results in 2017

				Woody Vegetation Cover		
			% Herbaceous Cover	% Lower Canopy	% Upper Canopy	% Woody Stem Leafout
Trt. No.	**Product(s)**	**Rate per acre**	**422 DAT[1] (May 3, 2017)**			
1	BK800 Garlon 4 Ultra Basal Oil Surfactant	1.5 gal 0.5 gal 2 gal 1 gal	41	56 a[2]	30 ab	69 a
2	Garlon 4 Ultra Milestone Basal Oil Surfactant	2 gal 7 fl oz 2 gal 1 gal	50	19 b	4 c	26 b
3	Garlon 4 Ultra Viewpoint Basal Oil Surfactant	1 gal 12 oz 2 gal 1 gal	49	39 ab	13 bc	69 a
4	Patron 170 Garlon 4 Ultra Patriot Basal Oil Surfactant	6.9 pt 1 gal 3 oz 2 gal 1 gal	66	43 ab	25 bc	75 a
5	Untreated Control		75	63 a	48 a	84 a

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05

2016 Mowing x PGR Trial (2017 Assessments)

Introduction

Tall fescue is a widely adapted cool-season grass that is a commonly used on roadsides and other turfed areas. Frequent mowing is the most common management regime for departments of transportation but reduced mowing schedules are being used to cut costs. To maintain highway safety, the zone next to the roadway (clear zone) might be mowed three times per season while the remaining right of way (selective zone) is only mowed once per season. Plant Growth Regulators (PGRs) could potentially reduce mowing while maintaining safe highway conditions. PGRs are currently classified into six categories, Classes A – F, based on their mechanism of action. This trial included examples of Class A, C, and D PGRs and was established to evaluate some PGR options for roadside management. Class A are late gibberellic acid (GA) synthesis blockers, Class C are mitotic/cell division inhibitors, and Class D are herbicidal. This trial was established to examine the interaction between different PGRs and mowing management regimes.

Seedhead suppression is an effective means to reduce mowing for the first cycle. PGRs for this are normally applied in the early spring but late fall applications can also suppress seedhead emergence and elongation.

Materials and Methods

This trial was established in 2016 at the Spindletop Research Farm in Lexington KY arranged as a split plot design with 3 mowing regimes, 16 PGR treatments, and three replications. Main plots were 20 ft wide and the three mowing regimes were: three times per season, once at the end of the season, and unmowed. Sub plots were 10 ft by 20 ft with running unsprayed checks (5 ft wide) between each of the plots. The treatments were five PGRs applied one to two weeks after each of the three mowings plus control. The plots with one mowing and no mowing also had the PGR applications at each of the three timings. Each set of plots only received one PGR application.

PGR products tested were Embark 2S (mefluidide [Class C]) at 24 fl oz/A, Plateau (imazapic) (Class D) at 12 fl oz/A*, Opensight (aminopyralid + metsulfuron methyl [Class D]) at 2.5 fl oz/A, Anuew (prohexadione calcium [Class A]) at 1 lb/A, and Perspective (aminocyclopyrachlor + clorsulfuron [Class D]) at 4.75 oz/A (Table 1). Growth regulator herbicides were included in the treatments, either as part of the product or added as 2,4-D, to act as “safeners” to reduce the fescue “yellowing” after application. However, it should be noted that application of even low volatility 2,4-D formulations later in the season carries the risk of damage to sensitive plants nearby. Plateau should have been applied at the recommended rate of 4 fl oz/A rather than the 12 fl/oz A rate that was actually applied, but the application error was not detected until after all the applications had been made. All applications were at 25 gallons per acre and included a non-ionic surfactant (Activator 90) at 0.25% v/v. Application dates were 5/24/2016, 7/19/2016, and 10/6/2016. Mowing dates were 5/16/2016, 7/11/2016, and 9/21/2016.

With the Plateau treatment rate error, it was decided to analyze the data for each mowing regime separately rather than as a split plot design. The plots were assessed for seedhead height and seedhead density (0 – 100%) the spring after all the PGR applications on three dates. These were 351 days after the first application (DAT1), 261 days after the third application (DAT3) on May 10, 2017 as well as 367 DAT1 (232 DAT3) (5/26/2017) and at 381 DAT1 (246 DAT3) (6/9/2017). Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

In 2016, the combination of three mowings plus treatments with either Embark, Plateau, or Perspective resulted in lower seedhead densities than the control (13 to 47%) 216, 232, and 246 DAT3 (Table 2). Although, these differences may not have been enough seedhead suppression to reduce the need for mowing. The height to seedhead was reduced with the Embark treatment applied after the third mowing 232 and 246 DAT3.

Plots that were mowed once in 2016 and that were treated with Embark, Plateau, or Perspective after the mowing had reduced heights to seedhead 216 DAT3 (Table 3). The Embark, Plateau, Anuew, and Perspective treatments had lower seedhead densities than the control 216 and 232 DAT3. Seedhead emergence was delayed in these treatments and, by 246 DAT3, only the Embark, Plateau* (note rate too high), and Perspective treatments still had lower seedhead densities than the control. The biological response in these plots (late season application after end of season mowing) may have delayed when the first mowing was necessary.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates.

Product (s)	Rate (per Acre)	Active Ingredient(s)	ai Rate (per Acre)
Embark 2S Formula 40	24 fl oz 2 qt	mefluidide 2,4-D amine	6 oz ae 1.84 lb ae
Plateau * Formula 40	12 fl oz 2 qt	imazapic 2,4-D amine	3 oz ae 1.84 lb ae
Opensight	2.5 oz	aminopyralid + metsulfuron methyl	1.3 oz ae + 0.24 oz
Anuew Formula 40	1 lb 2 qt	prohexadione calcium 2,4-D amine	4.4 oz 1.84 lb ae
Perspective	4.75 oz	aminocyclopyrachlor + chlorsulfuron	1.9 oz + 0.75 oz
Unsprayed Control			

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

* Rate should have been 4 fl oz per acre

Growth regulator herbicides included as “safeners”.

Table 2. Herbicide Treatments, Seedhead Height, and Seedhead Density for Plots with 3 Mowing Cycles per Year in 2016

Product (s)	Rate (per Acre)	Timing	May 10, 2017		May 26, 2017		June 9, 2017	
			Ht (in)	Seedhead Density (%)	Ht (in)	Seedhead Density (%)	Ht (in)	Seedhead Density (%)
			351 DAT1[1] (216 DAT3[2])		367 DAT1 (232 DAT3)		381 DAT1 (246 DAT3)	
Embark 2S	24 fl oz	after first mowing	27 bcd[3]	97 a	43 ab	100 a	45 abc	100 a
Formula 40	2 qt	after second mowing	31 ab	100 a	43 ab	100 a	48 a	100 a
		after third mowing	23 d	38 b	34 d	35 b	36 d	30 c
Plateau *	12 fl oz	after first mowing	29 abc	95 a	43 ab	93 a	47 abc	100 a
Formula 40	2 qt	after second mowing	32 a	100 a	41 abc	100 a	47 abc	100 a
		after third mowing	25 cd	13 c	38 cd	25 b	41 cd	18 c
Opensight	2.5 oz	after first mowing	27 bcd	95 a	39 abc	100 a	42 abcd	100 a
		after second mowing	30 bd	100 a	44 a	100 a	48 ab	100 a
		after third mowing	29 abc	100 a	41 abc	92 a	44 abc	93 a
Anuew	1 lb	after first mowing	29 abc	92 a	39 bcd	100 a	41 cd	100 a
Formula 40	2 qt	after second mowing	28 abcd	100 a	39 abcd	100 a	41 cd	100 a
		after third mowing	29 abc	100 a	41 abc	100 a	42 bcd	100 a
Perspective	4.75 oz	after first mowing	29 abc	97 a	40 abc	100 a	44 abc	100 a
		after second mowing	29 abc	100 a	41 abc	100 a	47 abc	100 a
		after third mowing	24 d	42 b	37 cd	35 b	41 cd	47 b
Unsprayed Control			27 bcd	100 a	41 abc	97 a	45 abc	100 a

* Rate should have been 4 fl oz per acre

[1] DAT1 = Days after treatment after first mowing

[2] DAT3 = Days after application after third mowing

[3] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3. Herbicide Treatments, Seedhead Height, and Seedhead Density for Plots with 1 Mowing Cycle per Year in 2016

Product (s)	Rate (per Acre)	Timing	May 10, 2017		May 26, 2017		June 9, 2017	
			Ht (in)	Seedhead Density (%)	Ht (in)	Seedhead Density (%)	Ht (in)	Seedhead Density (%)
			351 DAT1[1] (216 DAT3[2])		367 DAT1 (232 DAT3)		381 DAT1 (246 DAT3)	
Embark 2S	24 fl oz	after first mowing	28 abcd	83 ab	40 ab	83 ab	42 abc	90 a
Formula 40	2 qt	after second mowing	30 ab	90 ab	40 ab	100 a	44 abc	100 a
		after third mowing	24 de	11 d	38 ab	28 cd	42 abc	58 b
Plateau *	12 fl oz	after first mowing	26 bcd	80 ab	39 ab	100 a	43 abc	100 a
Formula 40	2 qt	after second mowing	31 a	75 ab	41 ab	72 ab	45 abc	100 a
		after third mowing	24 de	7 d	42 a	17 d	42 abc	12 c
Opensight	2.5 oz	after first mowing	27 abcd	90 ab	39 ab	82 ab	41 bc	100 a
		after second mowing	30 abc	88 ab	39 ab	93 a	45 abc	100 a
		after third mowing	25 cde	75 ab	41 ab	80 ab	45 abc	100 a
Anuew	1 lb	after first mowing	27 abcd	70 bc	36 b	73 ab	42 abc	90 a
Formula 40	2 qt	after second mowing	28 abcd	77 ab	42 a	87 a	41 bc	83 ab
		after third mowing	25 cde	42 c	38 ab	53 bc	38 c	73 ab
Perspective	4.75 oz	after first mowing	27 abcd	73 ab	39 ab	87 a	46 ab	100 a
		after second mowing	29 abc	100 a	43 a	100 a	49 a	100 a
		after third mowing	21 e	10 d	38 ab	33 cd	40 bc	57 b
Unsprayed Control			30 abc	87 ab	43 a	90 a	45 abc	100 a

* Rate should have been 4 fl oz per acre

[1] *DAT1 = Days after treatment after first mowing*

[2] *DAT3 = Days after application after third mowing*

[3] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

2016 Knotweed Control Trial (near Smith's Grove)

Introduction

Japanese knotweed (*Polygonum cuspidatum* Siebold & Zucc.) is a problem for land managers and along roadsides due to its aggressive nature and reproductive potential. It is a tall perennial canelike shrub 3 to 12 feet (1 to 3.5 m) in height, freely branching and dense, with often clonal infestations. Hollow-jointed, reddish stems, similar to bamboos, survive only one season while rhizomes survive decades. Dead tops remain standing during winter. Japanese knotweed spreads along streams by stem and rhizome fragments and is also spread along roadsides by mowing (Miller, et al. 2010).

Materials and Methods

This trial was established beside guardrail along KY 80 (New Bowling Green Road) near Smith's Grove, KY. The trial had 5 treatments with 3 replications of each arranged in a randomized complete block design. On August 24, 2016, treatments were applied with a spray volume of 50 gallons/acre using a directed spray swath over the canopy beside the guardrail for a plot width of 5 ft and length of 12 ft (two areas between guardrail posts per plot). Canopy height was 4 to 5.5 ft. All herbicide treatments included Activator 90 at 0.25% v/v (Table 1). Milestone was applied at the broadcast rate (7 fl oz/ac) but the label allows for a spot treatment rate of 14 fl oz/ac if no more than 50% of the area is treated.

Visual assessments of percent knotweed control were done 26 (9/19/2016), 56 (10/19/2016), and 308 (6/28/2017) days after treatment (DAT) for the trial. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

All the treatments provided at least some control of knotweed either as leaf damage or leaf drop 26 DAT (Table 2). Rodeo had the greatest control (85%) while the broadcast rate of Milestone had the least (15%). A month later, the Milestone VM Plus, Polaris AC Complete, and Rodeo treatments had similar control ratings (88-95%) while the Milestone plots provided 65% control. Early the following summer, the Polaris AC Complete and Rodeo treatments gave the best control (88-90%) while the other treatments gave little control (7-12%). One of the advantages of the Rodeo treatment is there is no soil residual restricting seeding onto the site.

Literature Cited

Miller, J.H., S.T. Manning, and S.F. Enloe. 2010. A management guide for invasive plants in southern forests. USDA Forest Service Southern Research Station. GTR SRS-131.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates.

Trt. No.	Product Name	Rate	Rate Unit	Active Ingredient(s)	ai Rate per acre
1	Milestone	7	FL OZ/A	aminopyralid	1.8 oz ae
2	Milestone VM Plus	6	PT/A	aminopyralid + triclopyr	1.2 oz ae + 12 oz ae
3	Polaris AC Complete	2	PT/A	imazapyr	1 lb ae
4	Rodeo	8	QT/A	glyphosate	8 lb ae
5	Nontreated Check				

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

Table 2. Herbicide Treatments and % Control Data.

Trt. No.	Product Name	Rate	Rate Unit	% Control		
				26 DAT[1]	56 DAT	308 DAT
1	Milestone	7	FL OZ/A	15 *d*[2]	65 *b*	7 bc
2	Milestone VM Plus	6	PT/A	53 *b*	90 *a*	12 b
3	Polaris AC Complete	2	PT/A	37 *c*	88 *a*	88 a
4	Rodeo	8	QT/A	85 *a*	95 *a*	90 a
5	Nontreated Check			0 *d*	0 *c*	0 c

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *DAT = Days after treatment*

[2] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

2017 Greenhouse Screening of Potential Herbicides for Wildflower Plantings

Introduction

Successfully establishing and maintaining primarily perennial plant pollinator / wildflower plots is a challenge. The seed mix developed by Roundstone Native Seed for KYTC (Kentucky Transportation Cabinet) is a diverse mixture of plants and it can take 70 to 80 days for most of the seeds to germinate and establish. Good site preparation is important to reduce early competition from annual weeds and one of the management options could be the use of selective pre-and post-emergence herbicides. Annual weedy grasses, such as giant foxtail and yellow foxtail, can become dominant in newly planted pollinator plots. The objective of this study was find potential herbicides that could be used for establishing pollinator/wildflower plantings by screening in the greenhouse. This information would then be used to inform management decisions.

Materials and Methods

These tests were performed in a greenhouse at the University of Kentucky. The pre-emergent herbicide tests used a 1:1 mix of soil:sand in 10 inch square and 2 inch deep flats, with added Osmocote (3 grams per L) for fertility. High levels of clay and organic matter can bind herbicide molecules and reduce the efficacy of the pre-emergence treatment. The post-emergent herbicide tests used a soilless mix, ProMix, in 10 inch square x 9 inch deep fiber pots, with added Osmocote, for better plant growth, as the amount of organic matter was not a concern for these herbicide treatments. The Pollinator/Monarch Seed Mix (Tables 1 and 2) was sown at 20X field seeding rate (1 gram seed mix per flat or fiber pot) on the surface. Giant foxtail (*Setaria faberi*) seed (Azlin Seed Service, Leland, MS) was sown onto the same media as the Pollinator mix pre and post emergence trials but were in 4 inch square x 3.5 inch deep plastic pots. Because this was an initial screen for suitable herbicides, only a single replication of each treatment was done.

The herbicide treatments were applied at 26 gal/a using a spray chamber equipped with a single nozzle. All treatments contained the adjuvant Activator 90 at 0.25% v/v. The flats and pots were watered after the pre-emergence treatments were applied to “activate” the herbicide. The first set of pre-emerge treatments were sown January 6, 2017 with the second set sown April 11, 2017. Data for visual ratings taken 16 days after treatment (DAT) are presented in the tables (Tables 3b and 5b). The first set of post-emerge treatments were planted December 19, 2016 and sprayed January 17, 2017. The second set were planted April 11 and sprayed May 11, 2017. The ratings for taken 11 DAT for the first set and 26 DAT for the second set are presented in the tables (Tables 4b and 6b).

The treatments and rates for the first set of pre-emerge treatments (Table 3a) were selected as ones with potential utility for application at planting or used to control weeds after the pollinator plants were already established. The second set of treatments included different rates of Plateau and Pendulum Aquacap as well as Command and Outlook. All these herbicides have different mechanisms of action (Table 5a).

The treatments and rates for the first set of post-emerge treatments (Table 4a) were selected for their potential utility for selective control of broadleaves or grasses in pollinator plots. The second set of

treatments included more products and mechanisms of action plus a higher rate of Dual and the same rate of Pendulum as in the first set (Table 6a).

Results and Discussion

Pre-emergence herbicides are an important component of weed management. To be effective, they need to be applied at the correct rate on the soil surface and require rainfall or irrigation to be "activated". This is when the herbicides move into the soil layer where the weed seeds are. Most need to be applied before the weed seeds germinate to be effective. In many cases, emerged weeds are not affected by pre-emerge herbicides and will continue to grow. The most pre-emergence herbicides last in the soil for a period of time (soil residual activity) because weed seeds germinate over a period of time.

For the first set of pre-emerge treatments screened in this study(Table 3a), a series of products were included. Dual II Magnum (s-metolachlor) is used pre-emerge for early season control of annual grasses and small seeded broadleaf weeds in many agronomic and horticultural crops. Tenacity (turf label) or Callisto (agronomic label) (mesotrione) is used pre-and post-emerge for control of broadleaf weeds and some grasses in ornamental turfgrasses and in some agronomic crops. Pendulum Aquacap (pendimethalin) is used on established turf and horticultural plantings to prevent germination of many weeds. Plateau (imazapic) has pre-and post- emerge activity on a range of weed species. There are a number of plant species, especially prairie forbs and warm-season grasses, which are tolerant to this herbicide. The Pendulum label lists some wildflower species that are tolerant to an application of Pendulum + Plateau at planting. Esplanade (indaziflam) is used as a pre-emerge herbicide for control of annual grasses and broadleaf weeds in landscapes, horticultural crops and rights of way. Gallery (isoxaben) is also a pre-emerge herbicide used to control certain broadleaf weeds in established turf, ornamentals and non-cropland.

At 16 DAT, the pollinator mix in the Pendulum treatment had the highest emergence (90% emergence) (Table 3b) and a very low emergence of giant foxtail (5% emergence). However, as this was only a single replication, it cannot be tested statistically and many of the species in the mix had not emerged yet in the untreated control. Dual was effective against foxtail (only 2% emergence) but also reduced emergence of much of the pollinator mix. Tenacity was not effective against foxtail (95% emergence) and also reduced the pollinator mix emergence (only 10%). Plateau reduced emergence of both the pollinator mix and foxtail but not to the same extent as Milestone. Esplanade and Gallery had no or very little emergence of either the pollinator mix or foxtail.

For the first set of post-emergence treatments (Table 4a), the same products as the pre-emergence treatments were included plus Proclipse and a number of selective grass herbicides. Proclipse (prodiamine) has no post-emergence activity and is used on established turf and horticultural crops as well as rights of way to control annual grass and broadleaf weeds. Fusilade II (fluazifop), Select Max (clethodim), Poast Plus (sethoxydim) and Acclaim Extra (fenoxaprop) have good safety on broadleaf plants and are effective at selectively controlling grasses.

The grass herbicides had 70-85% damage on foxtail 11 DAT (Table 4b) with almost no damage to the pollinator mix broadleaf plants. Plateau damaged both the pollinator mix and foxtail. While Dual

controlled foxtail pre-emergence, it did not damage emerged foxtail. Milestone damaged the pollinator mix broadleaves (80%) far more than foxtail (10%). Pendulum, Gallery, and Proclipse showed little or no damage to either emerged pollinator or foxtail plants.

For the second set of pre-emergence treatments (Table 5a), different rates of Plateau and Pendulum were tested along with Command and Outlook. Command (clomazone) is a pre-emergence herbicide which taken up by roots that is used on tobacco and horticultural crops (soybeans, cotton too?). Outlook (dimethenamid) is a selective residual herbicide used to control annual grass and broadleaf weeds along with sedges. It is used on field and row crops, like corn and soybeans.

Plateau and Pendulum treatments reduced emergence of both the pollinator mix and foxtail plants. The reduction was greater with Plateau (Table 5b). There was little to no emergence of the pollinator mix or foxtail in the Command or Outlook treated flats.

For the second set of post-emergence treatments (Table 6a), the same rate of Pendulum and a higher rate of Dual than in the first set were used. Additions to the screen included Aim, Permit, Cadet and Clearcast. Aim (carfentrazone) is a contact herbicide used on a wide range of agronomic and horticultural crops. Permit (halosulfuron-methyl) is used to control broadleaf weeds and nutsedge in certain crops. Cadet (fluthiacet-methyl) is used as a burndown and post emerge control of broadleaf weeds in field crops. Clearcast (imazamox) can be used in and around aquatic areas and on non-cropland sites.

Clearcast was the only herbicide to injure foxtail (95%) 26 DAT but also injured (80%) the pollinator mix plants (Table 6b). Permit also injured (70%) the pollinator mix considerably. The other herbicides had less injury (5-10%).

We were unable to identify any ideal herbicide options for application at the time of seeding for the pollinator mix in this study. There are Plateau Safe seed mixes that are compatible with Plateau use that one may want to consider. There are a number of options for pre-emergence control of weeds after all the pollinator/wildflower species have emerged and established. These include Pendulum Aquacap, Proclipse, Esplanade, Gallery and, possibly, Dual II Magnum. For selective control of grasses in plots with established pollinator plants, which are predominantly broadleaves, one can use Fusilade II, Select Max, Poast Plus or Acclaim Extra.

Table 1. Pollinator/Monarch Seed Mix from Roundstone Seed for KYTC

Kind	Botanical Name	[1] PLS oz/ac	PLS lbs/ac	PLS lbs
Butterfly Milkweed	*Asclepias tuberosa*	18.91	1.182	1.182
Common Milkweed	*Asclepias syriaca*	17.92	1.12	1.12
Swamp Milkweed	*Asclepias incarnata*	10.00	0.625	0.625
Whorled Milkweed	*Asclepias verticillata*	1.15	0.072	0.072
Smooth Beardtongue	*Penstemon digitalis*	1.95	0.122	0.122
Lance Leaved Coreopsis	*Coreopsis lanceolata*	4.05	0.253	0.253
Blackeyed Susan	*Rudbeckia hirta*	3.35	0.209	0.209
Hoary Mountain Mint	*Pycnanthemum incanum*	1.25	0.078	0.078
Slender Mountain Mint	*Pycnanthemum tenuifolium*	1.25	0.078	0.078
Early Goldenrod	*Solidago juncea*	2.65	0.166	0.166
Bergamot	*Monarda fistulosa*	2.65	0.166	0.166
Spiked Blazing Star	*Liatris spicata*	3.35	0.209	0.209
Greyheaded Coneflower	*Ratibida pinnata*	3.00	0.188	0.188
Purple Coneflower	*Echinacea purpurea*	4.05	0.253	0.253
False Sunflower	*Heliopsis helianthoides*	3.00	0.188	0.188
Browneyed Susan	*Rudbeckia triloba*	3.00	0.188	0.188
Joe-Pye Weed	*Eupatorium fistulosum*	1.60	0.10	0.10
Iron Weed	*Vernonia altissima*	1.95	0.122	0.122
Sneezeweed	*Helenium autumnale*	1.95	0.122	0.122
Narrow-Leaved Sunflower	*Helianthus angustifolius*	1.95	0.122	0.122
New England Aster	*Aster novae-angliae*	2.30	0.144	0.144
White Wingstem	*Verbesina virginica*	2.65	0.166	0.166
Indian grass	*Sorghastrum nutans*	3.35	0.209	0.209
Little bluestem	*Schizachyrium scoparium*	6.85	0.428	0.428
Partridge Pea	*Cassia fasciculata*	1.25	0.078	0.078
Compass Plant	*Silphium laciniatum*	3.00	0.188	0.188
Cardinal Flower	*Lobelia cardinalis*	0.90	0.056	0.056
Lance-Leaved Goldenrod	*Euthamia graminifolia*	1.35	0.084	0.084
Boneset	*Eupatorium perfoliatum*	1.35	0.084	0.084
[2] Spring Oats	*Avena sativa*			20.0
Lbs/acre of Forbs				7.0
Total Lbs/ac.				27.0

[1] Pure Live Seed (PLS)
[2] Spring oats are for an early nurse crop

Table 2: Characteristics of seed mix

Species list for Pollinator / Monarch Seed Mix

Common Name	Species	Life Cycle	Flower Color
Swamp Milkweed	*Asclepias incarnata*	Perennial	Pink
Common Milkweed	*Asclepias syriaca*	Perennial	Pink
Butterfly Milkweed	*Asclepias tuberosa*	Perennial	Orange
Whorled Milkweed	*Asclepias verticillata*	Perennial	White
New England Aster	*Aster novae-angliae*	Perennial	Purple
Partridge Pea	*Cassia fasciculata*	Annual	Yellow
Lance Leaved Coreopsis	*Coreopsis lanceolata*	Perennial	Yellow
Purple Coneflower	*Echinacea purpurea*	Perennial	Lavender
Joe-Pye Weed	*Eupatorium fistulosum*	Perennial	Pink
Boneset	*Eupatorium perfoliatum*	Perennial	White
Lance-Leaved Goldenrod	*Euthamia graminifolia*	Perennial	Yellow
Sneezeweed	*Helenium autumnale*	Perennial	Yellow
Narrow-Leaved Sunflower	*Helianthus angustifolius*	Perennial	Yellow
False Sunflower	*Heliopsis helianthoides*	Perennial	Yellow
Spiked Blazing Star	*Liatris spicata*	Perennial	Pink
Cardinal Flower	*Lobelia cardinalis*	Perennial	Red
Bergamot	*Monarda fistulosa*	Perennial	Lavender
Smooth Beardtongue	*Penstemon digitalis*	Perennial	White
Hoary Mountain Mint	*Pycnanthemum incanum*	Perennial	White
Slender Mountain Mint	*Pycnanthemum tenuifolium*	Perennial	White
Greyheaded Coneflower	*Ratibida pinnata*	Perennial	Yellow
Blackeyed Susan	*Rudbeckia hirta*	Biennial	Yellow
Browneyed Susan	*Rudbeckia triloba*	Biennial	Yellow
Little bluestem	*Schizachyrium scoparium*	Perennial	Green
Compass Plant	*Silphium laciniatum*	Perennial	Yellow
Early Goldenrod	*Solidago juncea*	Perennial	Yellow
Indian grass	*Sorghastrum nutans*	Perennial	Green
White Windstem	*Verbesina virginica*	Perennial	White
Iron Weed	*Vernonia altissima*	Perennial	Purple

Table 3a: First Set of Pre-Emerge Treatments with Rates, Active Ingredients and Mechanisms of Action

Product (s)	Rate (per Acre)	Active Ingredient(s)	Mechanism of Action
Dual II Magnum	1.33 pt	metolachlor	Inhibitor of growth & division (Group 15)
Tenacity	5 fl oz	mesotrione	Inhibitor of pigment biosynthesis (Group 27)
Pendulum Aquacap	4 pt	pendimethalin	Inhibitor of microtubule assembly (Group 3)
Plateau	4 fl oz	imazapic	ALS Inhibitor (Group 2)
Milestone	5 fl oz	aminopyralid	Synthetic Auxin (Group 4)
Esplanade	3.5 fl oz	indaziflam	Cellulose Synthesis Inhibitor (Group 29)
Gallery	0.66 lb	isoxaben	Cell Wall Synthesis Inhibitor (Group 21)

Table 3b: First Set of Pre-Emerge Treatments with Rates, Active Ingredients and % Emergence of Pollinator Mix and Giant Foxtail 16 Days After Treatment (DAT)

Product (s)	Rate (per Acre)	Active Ingredient(s)	% Emergence (16 DAT)	% Emergence & Growth on Giant Foxtail (16 DAT)
Control			100	100
Dual II Magnum	1.33 pt	metolachlor	30	2
Tenacity	5 fl oz	mesotrione	10	95
Pendulum Aquacap	4 pt	pendimethalin	90	5
Plateau	4 fl oz	imazapic	40	50
Milestone	5 fl oz	aminopyralid	15	10
Esplanade	3.5 fl oz	indaziflam	0	0
Gallery	0.66 lb	isoxaben	0	2

Table 4a: First Set of Post-Emerge Treatments with Rates, Active Ingredients and Mechanisms of Action

Product (s)	Rate (per Acre)	Active Ingredient(s)	Mode of Action
Dual II Magnum	1.33 pt	metolachlor	Inhibit growth & division (Group 15)
Fusilade II	16 fl oz	fluazifop	ACC Inhibitor (Group 1)
Pendulum Aquacap	4 pt	pendimethalin	Inhibitor of microtubule assembly (Group 3)
Plateau	4 fl oz	imazapic	ALS Inhibitor (Group 2)
Milestone	5 fl oz	aminopyralid	Synthetic Auxin (Group 4)
Esplanade	3.5 fl oz	indaziflam	Cellulose Synthesis Inhibitor (Group 29)
Gallery*	0.66 lb	isoxaben	Cell Wall Synthesis Inhibitor (Group 21)
Select Max	12 fl oz	clethodim	ACC Inhibitor (Group 1)
Poast Plus	1.5 pt	sethoxydim	ACC Inhibitor (Group 1)
Acclaim Extra	20 fl oz	fenoxaprop	ACC Inhibitor (Group 1)
Proclipse	2 lb	prodiamine	Inhibitor of microtubule assembly (Group 3)

Note: Mistake with the sprayer resulted in 2X application for Gallery (1.32 lb/ac)

Table 4b: First Set of Post-Emerge Treatments with Rates, Active Ingredients and % Damage of Pollinator Mix and Giant Foxtail 11 Days After Treatment (DAT)

Product (s)	Rate (per Acre)	Active Ingredient(s)	Damage (%) 11 DAT	Injury Rating (%) on Giant Foxtail (11 DAT)
Control			0	0
Dual II Magnum	1.33 pt	metolachlor	5	0
Fusilade II	16 fl oz	fluazifop	1	70
Pendulum Aquacap	4 pt	pendimethalin	2	0
Plateau	4 fl oz	imazapic	40	50
Milestone	5 fl oz	aminopyralid	80	10
Esplanade	3.5 fl oz	indaziflam	20	10
Gallery*	0.66 lb	isoxaben	1	20
Select Max	12 fl oz	clethodim	0	80
Poast Plus	1.5 pt	sethoxydim	1	85
Acclaim Extra	20 fl oz	fenoxaprop	2	80
Proclipse	2 lb	prodiamine	5	0

Note: Mistake with the sprayer resulted in 2X application for Gallery (1.32 lb/ac)

Table 5a: Second Set of Pre-Emerge Treatments with Rates, Active Ingredients and Mechanisms of Action

Product (s)	Rate (per Acre)	Active Ingredient(s)	Mechanism of Action
Plateau	2 fl oz	imazapic	ALS Inhibitor (Group 2)
Plateau	4 fl oz		
Pendulum Aquacap	2 pt	pendimethalin	Inhibitor of microtubule assembly (Group 3)
Pendulum Aquacap	3 pt		
Pendulum Aquacap	4 pt		
Command	2 pt	clomazone	Inhibitor of DOXP synthase (Group 13)
Outlook	12 fl oz	dimethenamid	Inhibitor of VLCFA synthesis (Group 15)

Table 5b: Second Set of Pre-Emerge Treatments with Rates, Active Ingredients and % Emergence of Pollinator Mix and Giant Foxtail 16 Days After Treatment (DAT)

Product (s)	Rate (per Acre)	Active Ingredient(s)	% Emergence (16 DAT)	% Emergence & Growth on Giant Foxtail (16 DAT)
Control			100	100
Plateau	2 fl oz	imazapic	20	25
Plateau	4 fl oz		10	25
Pendulum Aquacap	2 pt	pendimethalin	40	50
Pendulum Aquacap	3 pt		50	50
Pendulum Aquacap	4 pt		40	50
Command	2 pt	clomazone	2	10
Outlook	12 fl oz	dimethenamid	5	0

Table 6a: Second Set of Post-Emerge Treatments with Rates, Active Ingredients and Mechanisms of Action

Product (s)	Rate (per Acre)	Active Ingredient(s)	Mode of Action
Aim	1 fl oz	carfentrazone	PPO Inhibitor (Group 14)
Permit	1 oz	halosulfuron-methyl	ALS Inhibitor (Group 2)
Cadet	0.6 fl oz	fluthiacet-methyl	PPO Inhibitor (Group 14)
Clearcast	32 fl oz	imazamox	ALS Inhibitor (Group 2)
Pendulum Aquacap	4 pt	pendimethalin	Inhibitor of microtubule assembly (Group 3)
Dual II Magnum	1.67 pt	metolachlor	Inhibit growth & division (Group 15)

Table 6b: Second Set of Post-Emerge Treatments with Rates, Active Ingredients and % Damage of Pollinator Mix and Giant Foxtail 26 Days After Treatment (DAT)

Product (s)	Rate (per Acre)	Active Ingredient(s)	Injury Rating (%) 26 DAT	Injury Rating (%) on Giant Foxtail
Control			0	0
Aim	1 fl oz	carfentrazone	10	0
Permit	1 oz	halosulfuron-methyl	70	0
Cadet	0.6 fl oz	fluthiacet-methyl	5	0
Clearcast	32 fl oz	imazamox	80	95
Pendulum Aquacap	4 pt	pendimethalin	20	0
Dual II Magnum	1.67 pt	metolachlor	10	0

2017 Cable Barrier Bareground Trial in Louisville

Introduction

Median cable barriers are designed to protect drivers from crossover accidents on interstates and other highways. However, the vegetation under and adjacent to them must be managed for safety and aesthetics. Usually this means using herbicides to maintain a vegetation free (bare ground) zone underneath the barriers. Broad-spectrum soil applied pre-emergence residual herbicides, in combination with a broad-spectrum post-emergence herbicide like glyphosate, are the mainstay for maintaining these bare ground zones. However, there may be turf adjacent to the bare ground zone that should be maintained. Ideally, the residual herbicides will last all season long and not move off-site by downward leaching or across the soil surface (erosive movement of soil particles with adsorbed herbicide).

This trial was part of an ongoing effort to evaluate the vegetation control efficacy and undesirable turf damage potential of a range of herbicides for use in vegetation management under cable barriers.

Materials and Methods

The trial was established under and beside cable barrier with a mixed species turf underneath it in the median of I-265 in Louisville, KY. The 16 treatments with 3 replications each were arranged in a randomized complete block design. Treatments were applied at 25 gallons per acre spray solution onto 6.5 ft wide by 20 ft long plots on June 21, 2017. This was somewhat late in the season. All herbicide treatments, except Roundup ProMax alone (Treatment 1), included Activator 90 at 0.25% v/v (Table 1). Roundup ProMax (glyphosate) has no residual activity so other herbicides were included in the combinations with it to provide residual and pre-emergent control for the bare ground treatments.

The Louisville weather station reported 0.43 inches of rain on June 22 which would have activated the soil applied pre-emergence herbicide treatments. Additional rainfall was recorded on June 23 (1.14 inches). These rainfall events may have contributed to the movement of some of the herbicides from where they were applied and damaged adjacent turf (Figure 1). Species present at application included Buckhorn plantain, which was flowering, plus tall fescue and Kentucky bluegrass both of which had mature seed heads.

Ratings of the proportion (%) of bare ground were taken 21 (7/12/2017) and 309 (4/26/2018) days after treatment (DAT). Visual assessments of the proportion (%) of bare ground, perennial grasses, annual grasses and broadleaf weeds were taken 48 (8/8/2017), 98 (9/27/2017), and 127 (10/26/2017) DAT. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

All the herbicide treatments (Treatments 1-15) had more bare ground than the control 21 DAT (Table 2). We noted turf damage beyond the sprayed area on some plots indicating movement of the herbicide after application (Figure 1). The extent of this was greatest with the Hyvar

treatment 21 DAT (Treatment 3), especially in rep 3. At the next assessment (48 DAT), turf damage was evident on more plots. At least one plot treated with Sahara, Hyvar, Oust, Viewpoint or AC Polaris Complete (Treatments 2, 3, 4, 7, and 8 respectively) showed damage.

Later in the season (48 DAT), treatments with soil active herbicides (Treatments 2-15) had more bare ground than Roundup ProMax by itself (Treatment 1) (Table 2). All the herbicide treatments had less perennial and annual grass cover than the control. Roundup ProMax by itself (Treatment 1) had a similar amount of broadleaf cover (12%) as the control (19%) while the other treatments ranged from 0 to 2%.

The best group of treatments 98 DAT with soil residual had 91 to 98% bare ground while the next group had 82 to 87% bare ground (Table 3) and were not different from Roundup ProMax by itself (82% bare ground). The best group included Sahara (Treatment 2), Oust (Treatment 4), Perspective + Esplanade (Treatment 5), Viewpoint + Espalande (Treatment 7), Polaris AC Complete (Treatment 8), Esplanade + Oust (Treatment 9), Streamline + Esplanade + Plateau (Treatment 10), Cleantraxx (Treatment 12) and Esplanade + Oust Extra (Treatment 15). The amount of perennial grass cover ranged from 0 to 18% in the herbicide treated plots but all of these had less cover than the untreated control (50%). Similarly, all herbicide treatments had less annual grass cover (0-4%) than control (30%). Some treatments had similar amounts of broadleaf cover (3-9%) as the control (5%) at this assessment. These included Roundup applied alone (Treatment 1), Oust (Treatment 4), Perspective + Proclipse (Treatment 6), Polaris AC Complete (Treatment 8), Cleantraxx + Milestone (Treatment 11) and Cleantraxx (Treatment 12).

By the end of the season (127 DAT), the best treatments still provided 83 to 97% bare ground (Table 4). The list of treatments not in this top group includes Roundup by itself (Treatment 1), Hyvar (Treatment 3), Perspective + Proclipse (Treatment 6) and Esplanade + Milestone (Treatment 14) with 70 to 80% bare ground. Some herbicide treatments had more perennial grass cover than others but all had less than the control (60%). These included Hyvar (Treatment 3), Perspective + Proclipse (Treatment 6), Method + Esplanade (Treatment 13), and Esplanade + Milestone (Treatment 14). The untreated control plots had the most annual grass cover (28%) but some herbicide treatments had more (0.3 – 7%) than others. These included Roundup alone (Treatment 1), Hyvar (Treatment 3), Oust (Treatment 4), Polaris AC Complete (Treatment 8), Cleantraxx + Milestone (Treatment 11), and Cleantraxx (Treatment 12). Most plots had buckhorn plantain but the ones with the most (2-12%), besides the control (5%), included Roundup alone (Treatment 1), Sahara (Treatment 2), Hyvar (Treatment 3), Oust (Treatment 4), Polaris AC Complete (Treatment 8), and Cleantraxx (Treatment 12). The broadleaf cover increased from the previous assessment and a number of treatments had similar cover as the control (7%). They ranged from 3 to 14% cover and included the treatments mentioned previously with plantain cover but also included Perspective + Proclipse (Treatment 6), Viewpoint + Esplanade (Treatment 7) and Cleantraxx + Milestone (Treatment 11).

At the beginning of the next season (309 DAT), all the herbicide treatments still had more bareground (53-97%) than the control (13%) (Table 5). Treatments in the top group (77-97%) included Roundup alone (Treatment 1), Sahara (Treatment 2), Perspective + Espalande (Treatment 5), Viewpoint + Esplanade (Treatment 7), Polaris AC Complete (Treatment 8), Esplanade + Oust (Treatment 9), Streamline + Esplanade + Plateau (Treatment 10), Cleantraxx + Milestone (Treatment 11), Cleantraxx (Treatment 12), Method + Esplanade (Treatment 13) and Esplanade + Oust Extra (Treatment 15).

The vegetation under the cable barrier in this location gave a good test of how well some of these bare ground herbicides can perform over a season and into the next year. It should be noted that the herbicides were applied somewhat late in the season and some of the earlier germinating species, such as some of the summer annual grasses, may have been controlled by the initial glyphosate application. These trials will be continued to provide additional information for roadside managers.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates for Cable Barrier Bareground Trial.

Trt. No.	Product Name	Rate	Rate Unit	Active Ingredient(s)	Application Rates
1	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
2	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Sahara	10	LB/A	diuron + imazapyr	6.2 LB + 12.4 OZ/A
3	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Hyvar	10	LB/A	bromacil	8 LB/A
4	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Oust XP	3	OZ/A	sulfometuron	2.3 OZ/A
5	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Perspective	9	OZ/A	aminocyclopyrachlor + chlorsulfuron	3.6 OZ + 1.4 OZ/A
	Esplanade	3.5	FL OZ/A	indaziflam	0.7 OZ/A
6	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Perspective	9	OZ/A	aminocyclopyrachlor + chlorsulfuron	3.6 OZ + 1.4 OZ/A
	Proclipse	2.3	LB/A	prodiamine	1.5 LB/A
7	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Viewpoint	18	OZ/A	aminocyclopyrachlor + imazapyr + metsulfuron	4.1 OZ + 5.7 OZ + 1.3 OZ/A
	Esplanade	3.5	FL OZ/A	indaziflam	0.7 OZ/A
8	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Polaris AC Complete	2	PT/A	imazapyr	16 OZ AE/A
9	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Esplanade	3.5	FL OZ/A	indaziflam	0.7 OZ/A
	Oust XP	3	OZ/A	sulfometuron	2.3 OZ/A
10	Roundup ProMax	1.3	QT/A	glyphosate	1.5 LB AE/A
	Streamline	8	OZ/A	aminocyclopyrachlor + metsulfuron	3.2 OZ + 1 OZ/A
	Esplanade	5	FL OZ/A	indaziflam	1 OZ/A
	Plateau	5	FL OZ/A	imazapic	1.3 OZ AE/A
11	Rodeo	1.5	QT/A	glyphosate	1.5 LB AE/A
	Cleantraxx	3	PT/A	penoxsulam + oxyfluorfen	0.5 OZ + 23.6 OZ/A
	Milestone VM	7	FL OZ/A	aminopyralid	1.8 OZ AE/A
12	Rodeo	1.5	QT/A	glyphosate	1.5 LB AE/A
	Cleantraxx	4.5	PT/A	penoxsulam + oxyfluorfen	0.7 OZ + 35.4 OZ/A
13	Rodeo	1.5	QT/A	glyphosate	1.5 LB AE/A
	Method	12	FL OZ/A	aminocyclopyrachlor	3 OZ AE/A
	Esplanade	5	FL OZ/A	indaziflam	1 OZ/A
14	Rodeo	1.5	QT/A	glyphosate	1.5 LB AE/A
	Esplanade	6	FL OZ/A	indaziflam	1.3 OZ/A
	Milestone VM	7	FL OZ/A	aminopyralid	1.8 OZ AE/A
15	Rodeo	1.5	QT/A	glyphosate	1.5 LB AE/A
	Esplanade	3.5	FL OZ/A	indaziflam	0.7 OZ/A
	Oust Extra	1.5	OZ/A	sulfometuron + metsulfuron	0.8 OZ + 0.2 OZ/A
16	Nontreated Check				

All herbicide treatments (except trt. #1) contained the adjuvant, Activator 90 at 0.25% v/v.

Table 2. Results for Cable Barrier Bareground Trial (21 and 48 DAT[1])(July 12 and August 8, 2017).

				% Bareground	% Bareground	% Perennial Grass	% Annual Grass	% Broadleaves
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**21 DAT**	**48 DAT**			
1	Roundup ProMax	1.3	QT/A	97 abc[2]	86 c	1.7 bc	0.7 b	12.0 b
2	Roundup ProMax	1.3	QT/A	97 abc	99 a	0.0 c	0.0 b	0.3 c
	Sahara	10	LB/A					
3	Roundup ProMax	1.3	QT/A	97 abcd	97 ab	1.3 bc	0.0 b	1.3 c
	Hyvar	10	LB/A					
4	Roundup ProMax	1.3	QT/A	99 a	99 a	0.0 c	0.0 b	0.5 c
	Oust XP	3	OZ/A					
5	Roundup ProMax	1.3	QT/A	97 abcd	98 ab	2.0 bc	0.0 b	0.0 c
	Perspective	9	OZ/A					
	Esplanade	3.5	FL OZ/A					
6	Roundup ProMax	1.3	QT/A	95 cd	98 ab	1.7 bc	0.0 b	0.7 c
	Perspective	9	OZ/A					
	Proclipse	2.3	LB/A					
7	Roundup ProMax	1.3	QT/A	98 ab	100 a	0.0 c	0.3 b	0.0 c
	Viewpoint	18	OZ/A					
	Esplanade	3.5	FL OZ/A					
8	Roundup ProMax	1.3	QT/A	99 a	99 a	0.0 c	0.0 b	1.3 c
	Polaris AC Complete	2	PT/A					
9	Roundup ProMax	1.3	QT/A	99 a	99 a	0.3 bc	0.0 b	1.0 c
	Esplanade	3.5	FL OZ/A					
	Oust XP	3	OZ/A					
10	Roundup ProMax	1.3	QT/A	97 abcd	99 a	0.3 bc	0.0 b	0.3 c
	Streamline	8	OZ/A					
	Esplanade	5	FL OZ/A					
	Plateau	5	FL OZ/A					
11	Rodeo	1.5	QT/A	95 cd	97 ab	1.2 bc	0.0 b	1.5 c
	Cleantraxx	3	PT/A					
	Milestone VM	7	FL OZ/A					
12	Rodeo	1.5	QT/A	98 ab	98 ab	0.0 c	0.3 b	1.7 c
	Cleantraxx	4.5	PT/A					
13	Rodeo	1.5	QT/A	96 bcd	94 ab	4.3 bc	0.7 b	0.0 c
	Method	12	FL OZ/A					
	Esplanade	5	FL OZ/A					
14	Rodeo	1.5	QT/A	95 d	93 b	7.0 b	0.0 b	0.0 c
	Esplanade	6	FL OZ/A					
	Milestone VM	7	FL OZ/A					
15	Rodeo	1.5	QT/A	97 abcd	97 ab	2.3 bc	0.0 b	0.7 c
	Esplanade	3.5	FL OZ/A					
	Oust Extra	1.5	OZ/A					
16	Nontreated Check			22 e	17 d	53.0 a	12 a	19.0 a

All herbicide treatments (except trt. #1) contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3. Results for Cable Barrier Bareground Trial (98 DAT[1])(September 27, 2017).

				% Bareground	% Perennial Grass	% Annual Grass	% Broadleaves
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**98 DAT**			
1	Roundup ProMax	1.3	QT/A	82 d[2]	5.7 b	4.0 b	8.7 a
2	Roundup ProMax Sahara	1.3 10	QT/A LB/A	91 abcd	7.3 b	1.7 b	0.3 b
3	Roundup ProMax Hyvar	1.3 10	QT/A LB/A	87 bcd	4.7 b	1.0 b	7.3 a
4	Roundup ProMax Oust XP	1.3 3	QT/A OZ/A	92 abc	0.3 b	0.7 b	3.8 ab
5	Roundup ProMax Perspective Esplanade	1.3 9 3.5	QT/A OZ/A FL OZ/A	98 a	2.3 b	0.0 b	0.0 b
6	Roundup ProMax Perspective Proclipse	1.3 9 2.3	QT/A OZ/A LB/A	83 cd	10.0 b	1.0 b	5.7 ab
7	Roundup ProMax Viewpoint Esplanade	1.3 18 3.5	QT/A OZ/A FL OZ/A	99 a	0.3 b	0.0 b	0.3 b
8	Roundup ProMax Polaris AC Complete	1.3 2	QT/A PT/A	93 ab	0.0 b	0.3 b	6.3 ab
9	Roundup ProMax Esplanade Oust XP	1.3 3.5 3	QT/A FL OZ/A OZ/A	98 a	1.0 b	0.0 b	0.7 b
10	Roundup ProMax Streamline Esplanade Plateau	1.3 8 5 5	QT/A OZ/A FL OZ/A FL OZ/A	99 a	1.0 b	0.0 b	0.0 b
11	Rodeo Cleantraxx Milestone VM	1.5 3 7	QT/A PT/A FL OZ/A	85 bcd	9.3 b	0.3 b	5.3 ab
12	Rodeo Cleantraxx	1.5 4.5	QT/A PT/A	94 ab	2.0 b	0.0 b	3.0 ab
13	Rodeo Method Esplanade	1.5 12 5	QT/A FL OZ/A FL OZ/A	83 cd	16.7 b	0.0 b	0.0 b
14	Rodeo Esplanade Milestone VM	1.5 6 7	QT/A FL OZ/A FL OZ/A	82 d	18.0 b	0.0 b	0.3 b
15	Rodeo Esplanade Oust Extra	1.5 3.5 1.5	QT/A FL OZ/A OZ/A	92 abc	7.3 b	0.2 b	0.2 b
16	Nontreated Check			12 e	50.0 a	30.0 a	5.0 ab

All herbicide treatments (except trt. #1) contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 4. Results for Cable Barrier Bareground Trial (127 DAT[1])(October 26, 2017).

				% Bareground	% Perennial Grass	% Annual Grass	% Plantain	% Broadleaves
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**127 DAT**				
1	Roundup ProMax	1.3	QT/A	75 cde	6.7 cdefg	6.7 b	6.0 ab	11.7 abc
2	Roundup ProMax	1.3	QT/A	88 abc	9.3 cdef	0.0 c	1.7 ab	2.3 abc
	Sahara	10	LB/A					
3	Roundup ProMax	1.3	QT/A	70 e	11.7 bcd	2.3 bc	11.7 a	16.0 a
	Hyvar	10	LB/A					
4	Roundup ProMax	1.3	QT/A	83 abcde	0.0 g	2.3 bc	5.0 ab	14.0ab
	Oust XP	3	OZ/A					
5	Roundup ProMax	1.3	QT/A	96 a	3.0 defg	0.0 c	0.0 b	1.3 bc
	Perspective	9	OZ/A					
	Esplanade	3.5	FL OZ/A					
6	Roundup ProMax	1.3	QT/A	72 de	15.0 bc	0.0 c	0.7 b	13.3 abc
	Perspective	9	OZ/A					
	Proclipse	2.3	LB/A					
7	Roundup ProMax	1.3	QT/A	97 a	0.0 g	0.0 c	0.0 b	4.0 abc
	Viewpoint	18	OZ/A					
	Esplanade	3.5	FL OZ/A					
8	Roundup ProMax	1.3	QT/A	85 abcd	0.7 fg	0.3 bc	10.0 ab	13.0 abc
	Polaris AC Complete	2	PT/A					
9	Roundup ProMax	1.3	QT/A	97 a	1.0 efg	0.0 c	0.3 b	1.7 bc
	Esplanade	3.5	FL OZ/A					
	Oust XP	3	OZ/A					
10	Roundup ProMax	1.3	QT/A	98 a	1.7 efg	0.0 c	0.0 b	0.7 bc
	Streamline	8	OZ/A					
	Esplanade	5	FL OZ/A					
	Plateau	5	FL OZ/A					
11	Rodeo	1.5	QT/A	83 abcde	10.0 cde	1.0 bc	0.0 b	5.7 abc
	Cleantraxx	3	PT/A					
	Milestone VM	7	FL OZ/A					
12	Rodeo	1.5	QT/A	92 ab	5.0 defg	0.7 bc	2.0 ab	3.0 abc
	Cleantraxx	4.5	PT/A					
13	Rodeo	1.5	QT/A	85 abcd	15.0 bc	0.0 c	0.0 b	0.0 c
	Method	12	FL OZ/A					
	Esplanade	5	FL OZ/A					
14	Rodeo	1.5	QT/A	80 bcde	19.3 b	0.0 c	0.0 b	0.7 bc
	Esplanade	6	FL OZ/A					
	Milestone VM	7	FL OZ/A					
15	Rodeo	1.5	QT/A	95 a	4.3 defg	0.0 c	0.0 b	0.3 bc
	Esplanade	3.5	FL OZ/A					
	Oust Extra	1.5	OZ/A					
16	Nontreated Check			8 f	60.0 a	28.3 a	5.0 ab	6.7 abc

All herbicide treatments (except trt. #1) contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 5. Results for Cable Barrier Bareground Trial (309 DAT[1])(April 26, 2018).

				% Bareground
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**309 DAT**
1	Roundup ProMax	1.3	QT/A	83 abc
2	Roundup ProMax	1.3	QT/A	78 abcd
	Sahara	10	LB/A	
3	Roundup ProMax	1.3	QT/A	57 de
	Hyvar	10	LB/A	
4	Roundup ProMax	1.3	QT/A	68 cde
	Oust XP	3	OZ/A	
5	Roundup ProMax	1.3	QT/A	91 ab
	Perspective	9	OZ/A	
	Esplanade	3.5	FL OZ/A	
6	Roundup ProMax	1.3	QT/A	53 e
	Perspective	9	OZ/A	
	Proclipse	2.3	LB/A	
7	Roundup ProMax	1.3	QT/A	95 ab
	Viewpoint	18	OZ/A	
	Esplanade	3.5	FL OZ/A	
8	Roundup ProMax	1.3	QT/A	81 abc
	Polaris AC Complete	2	PT/A	
9	Roundup ProMax	1.3	QT/A	97 a
	Esplanade	3.5	FL OZ/A	
	Oust XP	3	OZ/A	
10	Roundup ProMax	1.3	QT/A	95 ab
	Streamline	8	OZ/A	
	Esplanade	5	FL OZ/A	
	Plateau	5	FL OZ/A	
11	Rodeo	1.5	QT/A	78 abcd
	Cleantraxx	3	PT/A	
	Milestone VM	7	FL OZ/A	
12	Rodeo	1.5	QT/A	78 abcd
	Cleantraxx	4.5	PT/A	
13	Rodeo	1.5	QT/A	77 abcd
	Method	12	FL OZ/A	
	Esplanade	5	FL OZ/A	
14	Rodeo	1.5	QT/A	73 bcde
	Esplanade	6	FL OZ/A	
	Milestone VM	7	FL OZ/A	
15	Rodeo	1.5	QT/A	92 ab
	Esplanade	3.5	FL OZ/A	
	Oust Extra	1.5	OZ/A	
16	Nontreated Check			13 f

All herbicide treatments (except trt. #1) contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Figure 1: View of Plot Damage in the Cable Barrier Trial from Rep 3 on July 12, 2017 (21 Days After Treatment)

The plot in the foreground is Trt 3 (Hyvar) and movement of its active ingredient (bromacil) beyond the initial spray swath and subsequent damage to the turf is evident.

Supplement: Information on characteristics of some bareground chemistries

Information on the characteristics and behavior of some bareground herbicides should be useful to rights of way vegetation managers. The following tables (Tables 1a-g) present information on characteristics of some older and newer products. Only one product name is listed but the active ingredient may be included in multiple products and mixtures. The Mechanism of Action (MOA) Group(s) should be included on newer labels and is important information to manage and reduce the risk of selecting for resistant weed populations.

Summary of Herbicide Mechanism of Action (MOA) according to the Weed Science Society of America (WSSA) (Shaner, 2014)

MOA Group 2 Acetolactate Synthase (ALS) Inhibitors
These herbicides inhibit acetolactate synthase (ALS), a key enzyme in the biosynthesis of branched-chain amino acids isoleucine, leucine, and valine. Plant death results from events occurring in response to ALS inhibition and low branched-chain amino acid production, but the actual sequence of phytotoxic processes is unclear.

MOA Group 3 Inhibitors of microtubule assembly
These herbicides bind to tubulin, the major microtubule protein. The herbicide-tubulin complex inhibits polymerization of microtubules at the assembly end of the protein-based microtubule but has no effect on depolymerization of the tubule on the other end, leading to a loss of microtubule structure and function. As a result, the spindle apparatus is absent, thus preventing the alignment and separation of chromosomes during mitosis. In addition, the cell plate can be formed. Microtubules also function in cell wall formation. Herbicide-induced microtubule loss may cause the observed swelling of root tips as cells in this region neither divide nor elongate.

MOA Group 4 Synthetic Auxins
These herbicides act similar to that of endogenous auxin (IAA), although the true mechanism is not well understood. The specific cellular or molecular binding site relevant to the action of IAA and the auxin-mimicking herbicides has not been identified. Nevertheless, the primary action of these compounds appears to affect cell wall plasticity and nucleic acid metabolism. These compounds are thought to acidify the cell wall by stimulating the activity of a membrane-bound ATPase proton pump. The reduction in apoplastic pH induces cell elongation by increasing the activity of enzymes responsible for cell wall loosening. Low concentrations of auxin-mimicking herbicides also stimulate RNA polymerase, resulting in subsequent increases in RNA, DNA, and protein synthesis. Abnormal increases in these processes presumably lead to uncontrolled cell division and growth, which results in vascular tissue destruction. In contrast, high concentrations of these herbicides inhibit cell division and growth, usually in meristematic regions that accumulate photosynthate assimilates and herbicides from the phloem. Auxin-mimicking herbicides stimulate ethylene evolution which may in some cases produce the characteristic epinastic symptoms associated with exposure to these herbicides.

MOA Group 5 Inhibitors of photosynthesis at photosystem II site A
MOA Group 6 Inhibitors of photosynthesis at photosystem II site B
MOA Group 7 Inhibitors of photosynthesis at photosystem II site A; different binding behavior from group 5
All the herbicides that fall under these three classifications kill plants by inhibiting photosystem II. However, there often is not cross resistance from one class to another, hence the three classifications. These herbicides inhibit photosynthesis by binding to the Q_B-binding niche on the D1 protein of the photosystem II complex in chloroplast thylakoid membranes. Herbicide binding at this protein location blocks electron transport from Q_A to Q_B and stops CO_2 fixation and production of ATP and $NADPH_2$, which are needed for plant growth. However, plant death occurs by other processes in most cases. Inability to reoxidize Q_A promotes the formation of triplet state chlorophyll, which interacts with ground state oxygen to form singlet oxygen. Both triple chlorophyll and singlet oxygen can extract hydrogen from unsaturated lipids, producing a lipid radical and initiating a chain reaction of lipid peroxidation. Lipids and proteins are attacked and oxidized, resulting in loss of chlorophyll and carotenoids and in leaky membranes which allow cells and cell organelles to dry and disintegrate rapidly.

MOA Group 14 Inhibitors of protoporphyrinogen oxidase (Protox, PPO)
These herbicides appear to inhibit protoporphyrinogen oxidase (PPG oxidase or Protox), an enzyme of chlorophyll and heme synthesis catalyzing the oxidation of protoporphyrinogen IX (PPGIX) to protoporphyrin IX (PPIX). Protox inhibition leads to accumulation of PPIX, the first light-absorbing chlorophyll precursor. PPGIX accumulation apparently is transitory, as it overflows its normal environment in the thylakoid membrane and oxidizes to PPIX. PPIX formed outside its native environment probably is separated from Mg chetalase and other pathway enzymes that normally prevent accumulation of PPIX. Light absorption by PPIX apparently produces triplet state PPIX which interacts with ground state oxygen to form singlet oxygen. Both triplet PPIX and singlet oxygen can abstract hydrogen from unsaturated lipids, producing a lipid radical and initiating a chain reaction of lipid peroxidation. Lipids and proteins are attacked and oxidized, resulting in loss of chlorophyll and carotenoids and in leaking membranes which allows cells and cell organelles to dry and disintegrate rapidly.

MOA Group 29 Inhibitors of Cellulose biosynthesis
These herbicides inhibit cell wall biosynthesis (cellulose) in susceptible weeds.

The parameters extracted from the Herbicide Handbook (Shaner, 2014) for the tables include:

Water solubility: This is usually presented at 20 to 25 C and at known pH's as solubility can be quite different at different pH's (see Table 1f and penoxsulam). In general, as solubility increases, the compound's binding to soil particles and organic matter decreases which increases the likelihood of it moving deeper into the soil profile (leaching) or away from the site of application.

pKa: Some compounds have ionizable groups where they are neutral when protonated (with a hydrogen molecule) or with a negative charge when without a hydrogen. The proportion of molecules that are protonated or not depends on the pH of the environment. If the pH is at the

pKa then 50% of the groups are protonated and 50% are not. At a pH more basic than the pKa more than 50% of the groups are not protonated (negative charge). They are then less likely to bind to negatively charged clay and OM particles which would affect retention and movement in the soil.

Kow: This is the octanol-water coefficient, which represents a measure of the tendency of a compound to move from the aqueous phase into lipids (cell membranes). Octanol is non-polar and hydrophobic while water is polar and hydrophilic. Substances with high logKow values tend to adsorb more readily to organic matter in soils or sediments because of their low affinity for water.

Sorption: Koc measures the mobility of a substance in soil. A very high value means it is strongly adsorbed onto soil and organic matter and does not move throughout the soil. A very low value means it is highly mobile in soil.

Degradation: Some herbicides may degrade with light (photo degrade) and many are broken down by soil microbes.

Persistence: The longevity of a herbicide molecule is normally expressed in terms of half-life (t1/2) which is when half of the original amount remains. This is also a measure of the length of residual control.

Mobility: Summary of laboratory and field studies on mobility in the soil and the environment.

Literature Cited

Shaner, D.L. (2014) Herbicide Handbook. 10th Edition, Weed Science Society of America, Lawrence, 513 p.

Table 1a: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Hyvar	bromacil	5	815 mg/L (25 C)	9.1 (weak base)	NA	**Sorption:** Low to moderate adsorption to soil. Average K_{oc} is 32 mL/g
						Degradation: Microbial degradation apparently contributes to bromacil degradation.
						Persistence: Average field half-life is 60 days. When used at higher rates, phytotoxic residues persist for more than 1 yr.
						Mobility: Moderately mobile
Karmex	diuron	7	42 mg/L (25 C)	None (non-ionizable)	589	**Sorption:** Adsorbs to OM and clay. Average K_{oc} is 480 mL/g
						Degradation: Not strongly photodegraded but losses can be significant if diuron remains on the soil surface for several days or weeks. Microbial degradation if the primary means of diuron dissipation from soil.
						Persistence: Average field half life is 90 days. Phytotoxic residues dissipate within a season when applied at lower selective rates. At higher selective rates, residues may persist for more than 1 year.
						Mobility: Moderadely leachable; leaching not a problem except on soils low in OM and clay.

Table 1b: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Oust XP	sulfometuron	2	10 mg/L pH 5 (25 C) 300 mg/L pH 7 (25 C)	5.2 (weak acid)	NA	**Sorption:** Average K_{oc} is 78 mL/g at pH 7
						Degradation: Microbial breakdown occurs slowly. Non-microbial hydrolysis is moderately rapid at pH 6 but extremely slow at pH 8. Thus, degradation occurs most rapidly at lower soil pH values where rates are dominated by hydrolysis, whereas degradation rates are slowest at high pH and are dominated by microbial action.
						Persistence: Typical field half-life is 20-28 days at pH 6-7. Persistence is increased by cool temperatures, low soil moisture, and higher pH.
						Mobility: Generally greater at higher soil pH and lower OM content.
Polaris A/C Complete	imazapyr	2	11,272 mg/L pH 7 (25 C)	1.9, 3.6, 11.0 (weak acid)	1.3	**Sorption:** Generally weakly bound to soil, but adsorption increases as OM and clay increase.
						Degradation: micobial degradation is principal means of dissipation in soil.
						Persistence: Field half-life ranges from 25-142 days. Weed control efficacy persists from 3 mo to 2 yr, depending on application rate.
						Mobility: generally remains within top 50 cm of soil in field dissipation studies. In forest dissipation studies, it did not run off into streams and no evidence of lateral movement was observed.

Table 1c: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Plateau	imazapic	2	2200 mg/L (25 C)	2.0, 3.9, 11.1 (weak acid)	0.16 (pH 5) 0.01 (pH 7) 0.002 (pH 9)	**Sorption:** Weakly adsorbed in high pH soil, but adsorption increases with lower pH and increasing OM and clay content. **Degradation:** primarily degraded by microbes. Does not degrade appreciably under anaerobic conditions. **Persistence**: Average half-life is 120 days. **Mobility:** Field studies indicate that it remains in the top 30-45 cm of soil. Field studies do not indicate any potential for imazapic to move with surface water.
Pendulum Aquacap	pendimethalin	3	0.275 mg/L (25 C)	None (non-ionizable)	152,000	**Sorption:** Strongly absorbed by clay and OM. **Degradation:** Rapid degradation under anaerobic conditions. Aerobic biological degradation is slow. **Persistence**: Typical half-life in the field is 44 days, but varies with soil temperature and moisture. **Mobility:** Immobile, being strongly bound to OM and clay.

Table 1d: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Proclipse	prodiamine	3	0.013 mg/L (25 C)	None (non-ionizable)	12,672 ± 2,270 (25 C)	**Sorption:** Strongly absorbed to soil. Average K_{oc} is 13,000 mL/g
						Degradation: Photodegradation is a potential concern. Half-life was 57 days for aerobic metabolism and 30 days for anaerobic metabolism.
						Persistence: Half-life averages approx. 120 days when incorporated at recommended rates. Half-life was 69 days for a sandy loam in Georgia on a turf site.
						Mobility: Not readily leached
Milestone	aminopyralid	4	212 g/L pH 5	2.56	log K_{ow} = -1.75 pH 5	**Sorption:** weakly adsorbed to soil.
			205 g/L pH 7		log K_{ow} = -2.87 pH 7	**Degradation:** Primarily aerobic microbial degradation
			203 g/L pH 9		log K_{ow} = -2.96 pH 9	**Persistence**: under field conditions had half-lives from 6-74 days with a median half-life of 32 days
						Mobility: Field experiments show very limited mobility in soil profile.

Table 1e: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Method	aminocyclopyrachlor	4	4.2 g/L (25 C)	4.65	log K_{ow} = -1.12 pH 4 log K_{ow} = -2.48 pH 7	**Sorption:** K_{oc} ranged from 2.0 on sandly loam to 26 on clay loam (high potential for leaching) **Persistence**: slowly degrades by aerobic microbial metabolism with half-lives ranging from 114-433 days in different soils. **Mobility:** expected to be highly mobile in the environment
Payload	flumioxazin	14	1.79 mg/L (25 C)	none (non-ionizable)	log K_{ow} = 2.55 (20 C)	**Sorption:** NA **Degradation:** Primarily microbial, half-life in aerobic soil is 11.9 to 17.5 days **Persistence**: Not persistent in soil **Mobility:** Potential to leach in field agricultural soil is low

Table 1f: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Cleantraxx	penoxsulam	2	5.7 mg/L (pH 5, 19 C) 410 mg/L (pH 7, 19 C) 1460 mg/L (pH 9, 19 C)	NA	log K_{ow} = -0.354	**Sorption:** weakly adsorbed to soil.
						Degradation: Primarily microbial
						Persistence: rapidly degraded with half-lives of 5 to 16 days under flooded field conditions (is used in rice)
						Mobility: Potential for mobility in soil is high based on K_{oc} values between 50 and 150 mL/g
	oxyfluorfen	14	0.1 mg/L (20 C)	none (non-ionizable)	log K_{ow} = 4.47 (25 C)	**Sorption:** Strongly absorbed to soil
						Degradation: Photodegredation: half-life on dry soil generally is 20-30 days. Microbial degradation rates are slow.
						Persistence: Moderate residual with an average field half-life of 30 days
						Mobility: Immobile in most soils, but slightly mobile on extremely sandy soils

Table 1g: Summary of Properties of Some Bareground Chemistries

Product	Active Ingredient	MOA Group	Water Solubility	pKa	K_{ow}	Behavior in Soil
Detail	saflufenacil	14	0.003 g/100 mL (pH 5) 0.21 g/100 mL (pH 7)	4.41	log K_{ow} = 2.57	**Sorption:** K_{oc} = 9 to 56 (6 soils)
						Degradation: found to degrade rapidly in the environment
						Persistence: terrestrial dissipation DT_{50} = 1-36 days (7 sites)
						Mobility: Mobile to very mobile, hydrophilic
Esplanade	indaziflam	29	2040 mg/L pH 7 (25 C) 18,300 mg/L pH 9 (25 C)	weak acid	2.0 (pH 2) 2.8 (pH 4, pH7, pH 9)	**Sorption:** K_{oc} >1000 (strongly adsorbed onto soil and organic matter and does not move throughout the soil)
						Degradation: dissipates in environment primarily through biotic degradation and leaching.
						Persistence: long residual with an average half-life >150 days
						Mobility: NA

2017 Cable Barrier Selective Control Trial in Louisville

Introduction

Median cable barriers are designed to protect drivers from crossover accidents on interstates and highways. However, the vegetation under and adjacent to them must be managed for safety and aesthetics. In some areas, this means a combination of mechanical (mowing) and chemical control of the vegetation. There are a number of selective herbicides available for roadsides to control undesirable broadleaves, without harming grasses. The objective of this trial was to test a number of selective broadleaf control options.

Materials and Methods

The trial was established under and beside cable barrier with a mixed species turf underneath in the median of I-265 in Louisville, KY. The 9 treatments and 3 replications were arranged in a randomized complete block design. Treatments were applied at 25 gallons / acre onto 6.5 ft wide by 20 ft long plots on July 11, 2017, which was somewhat late in the season. All herbicide treatments included Activator 90 at 0.25% v/v (Table 1). This year treatments included aminocyclopyrachlor by itself (Method, Treatment 6) and mixtures with Vastlan, a new triclopyr formulation (Treatments 7 and 8). The tall fescue was at 5 inches and the black medic was at 3 inches at time of application.

Visual ratings of different parameters were taken 27 (8/8/2018), 77 (9/27/2017) and 106 (10/26/2017) days after treatment (DAT). Broadleaf control (%) was assessed 27 DAT while % broadleaf cover was assessed at all dates. Yellow foxtail cover (%) and total annual grass cover (%) were assessed 27 and 77 DAT. The foliage of these grasses was brown by the end of season assessment. Perennial grass cover (%) was rated 77 and 106 DAT while plantain cover (%) was assessed 106 DAT. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

Many of the plots had few broadleaf weeds remaining 27 DAT but the control had 22% broadleaf cover (Table 2). The top group of treatments had 55 to 85% broadleaf control while the lowest control was at 45% with Overdrive + Vastlan (Treatment 7). While not statistically different at this assessment the treatments with aminocyclopyrachlor (Treatments 3, 4, and 6) plus the Overdrive + Vastlan Treatment (#7), had the lowest yellow foxtail cover.

These same four treatments were in the lowest % cover group for yellow foxtail 77 DAT (Table 3). Would there have been even more yellow foxtail control if the application was earlier in the season? There was considerable variability in the proportion of perennial grass cover and none of the treatments were different from the control. This was also the case with total annual grass cover. All the herbicide treatments had lower broadleaf cover % than control (23%).

The summer annual grasses were brown at the season end rating 106 DAT and the treatment with the perennial grass cover greater than control was Perspective (Table 4). Treatments with the

same broadleaf cover as control included Milestone (mostly due to plantain) (Treatment 1), Pyresta + Proclipse (Treatment 5), and Overdrive + Vastlan (Treatment 7).

The broadleaf weed density along this section of cable barrier was relatively low. This may be due to past applications of soil residual herbicides and a smaller seed bank. We will find other sites with greater broadleaf pressure for future trials.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates for Cable Barrier Selective Control Trial.

Trt. No.	Product Name	Rate	Rate Unit	Active Ingredient(s)	Application Rates
1	Milestone VM	7	FL OZ/A	aminopyralid	1.8 OZ AE/A
2	Opensight	3.3	OZ/A	aminopyralid + metsulfuron	1.7 OZ AE + 0.3 OZ/A
3	Perspective	4.5	OZ/A	aminocyclopyrachlor + chlorsulfuron	1.8 OZ + 0.7 OZ/A
4	Streamline	4.5	OZ/A	aminocyclopyrachlor + metsulfuron	1.8 OZ + 0.6 OZ/A
5	Pyresta Proclipse	24 2	FL OZ/A LB/A	2,4-D + pyraflufen-ethyl prodiamine	0.66 LB AE + 0.05 OZ/A 1.3 LB/A
6	Method	4	FL OZ/A	aminocyclopyrachlor	1 OZ AE/A
7	Overdrive Vastlan	5 16	OZ/A FL OZ/A	diflufenzopyr + dicamba triclopyr	1 OZ AE + 2.5 OZ AE/A 8 OZ AE/A
8	Formula 40 Vastlan	48 32	FL OZ/A FL OZ/A	2,4-D triclopyr	22 OZ AE/A 16 OZ AE/A
9	Nontreated Check				

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

Table 2. Results for Cable Barrier Selective Control Trial (27 DAT[1])(August 8, 2017).

				Broadleaf Control (%)	Yellow Foxtail (% Cover)	Total Annual Grass (% Cover)	Broadleaf (% Cover)
Trt. No.	Product Name	Rate	Rate Unit	27 DAT			
1	Milestone VM	7	FL OZ/A	58 ab[2]	30 a	30	0 b
2	Opensight	3.3	OZ/A	55 ab	18 ab	18	0 b
3	Perspective	4.5	OZ/A	75 ab	5 ab	5	0 b
4	Streamline	4.5	OZ/A	85 a	3 ab	3	0 b
5	Pyresta Proclipse	24 2	FL OZ/A LB/A	75 ab	20 ab	20	0 b
6	Method	4	FL OZ/A	60 ab	3 ab	5	2 b
7	Overdrive Vastlan	5 16	OZ/A FL OZ/A	45 b	0.3 b	4	3 b
8	Formula 40 Vastlan	48 32	FL OZ/A FL OZ/A	85 a	19 ab	19	0 b
9	Nontreated Check			0 c	18 ab	18	22 a

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3. Results for Cable Barrier Selective Control Trial (77 DAT[1])(September 27, 2017).

				Perennial Grass (% Cover)	Yellow Foxtail (% Cover)	Total Annual Grass (% Cover)	Broadleaf (% Cover)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**77 DAT**			
1	Milestone VM	7	FL OZ/A	25 b	43 a	48 a	11 b
2	Opensight	3.3	OZ/A	45 ab	25 bc	35 ab	2 bc
3	Perspective	4.5	OZ/A	55 ab	2 e	23 bc	0 c
4	Streamline	4.5	OZ/A	72 a	2 e	17 bc	0 c
5	Pyresta Proclipse	24 2	FL OZ/A LB/A	42 ab	35 ab	37 ab	3 bc
6	Method	4	FL OZ/A	67 a	5 de	10 c	2 bc
7	Overdrive Vastlan	5 16	OZ/A FL OZ/A	60 a	15 cde	30 abc	0 c
8	Formula 40 Vastlan	48 32	FL OZ/A FL OZ/A	55 ab	22 bcd	25 abc	0 c
9	Nontreated Check			40 ab	20 bcd	27 abc	23 a

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 4. Results for Cable Barrier Selective Control Trial (106 DAT[1])(October 26, 2017).

				Perennial Grass (% Cover)	Plantain (% Cover)	Total Broadleaf (% Cover)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**106 DAT**		
1	Milestone VM	7	FL OZ/A	18 c	13	13 ab
2	Opensight	3.3	OZ/A	22 bc	2	2 bc
3	Perspective	4.5	OZ/A	62 a	0	0 c
4	Streamline	4.5	OZ/A	45 abc	0	2 bc
5	Pyresta Proclipse	24 2	FL OZ/A LB/A	48 ab	5	5 abc
6	Method	4	FL OZ/A	48 ab	0	0 c
7	Overdrive Vastlan	5 16	OZ/A FL OZ/A	40 abc	5	5 abc
8	Formula 40 Vastlan	48 32	FL OZ/A FL OZ/A	48 ab	0	0 c
9	Nontreated Check			32 bc	13	15 a

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] DAT = Days after treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

2017 PGR Options for Tall Fescue Management

Tall fescue is a widely adapted cool-season grass that is a commonly used on roadsides and other turfed areas. Frequent mowing is the most common management regime for this grass used by departments of transportation. Plant Growth Regulators (PGRs) are potential tools to reduce turf growth and aid in keeping our roadways safe for travelers. PGRs are currently classified into six categories, Classes A – F, based on their mechanism of action. This trial includes examples of Class A, C, and D PGRs and was established to evaluate some PGR options for roadside management of tall fescue. Class A are late GA synthesis blockers, Class C are mitotic/cell division inhibitors, and Class D are herbicidal. Tall fescue seedhead suppression is an effective means to reduce mowing for the first cycle. PGRs for this are normally applied in the early spring. This trial was established to evaluate some PGR options for roadside management of tall fescue.

Materials and Methods

A trial was established in 2017 at the Spindletop Research Farm in Lexington, KY. The trial was arranged as a complete block design with 21 PGR treatments and three replications of each. Plots were 7 ft by 20 ft with running unsprayed checks (3 ft wide) between each of the plots. The treatments were five PGRs applied before the first mowing and one to two weeks after each of the three mowings plus an untreated control. Products tested were Embark 2S (mefluidide) [Class C]), Plateau (imazapic) [Class D], Opensight (aminopyralid + metsulfuron methyl) [Class D], Anuew (prohexadione calcium) [Class A], and Perspective (aminocyclopyrachlor + clorsulfuron) [Class D] (Table 1). All applications were made at 25 gallons per acre spray solution and included a non-ionic surfactant (Activator 90) at 0.25% v/v. Application dates were 4/26/2017, 6/1/2017, 8/8/2017, and 10/6/2017. Mowing dates were 5/22/2017, 7/26/2017, and 9/26/2017.

Tall fescue color was assessed every two weeks by comparison to the running check strips. The color rating ranges from 0 (dead) to 9 (full green). The color of the check strips was set at 8. Heading (%) was assessed before the first mowing. Canopy heights were measured every two weeks as well. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

14 DAT1 the first applications, all the PGR treatments had shorter fescue than untreated control and most had lower heading density, except for Embark (Table 2). At this assessment, only fescue in Opensight and Perspective plots was less green than the control. By 26 DAT1, all fescue in all the treated plots was still shorter than that in the control and fescue in the Class D PGR treated plots had lower heading (%) (8-20%) (Figure 1) than the control . The Class D treatments were also less green than the control (?). Embark and Anuew only seem to have only slowed heading. After mowing, all the treatments, except Anuew, had less green color and shorter fescue heights at 36 DAT1. Figure 2 summarizes the effects of PGR treatments on green color over the course of the season. There was no effect on color beyond 36 DAT1. Figure 3 summarizes the effects on turf height over the course of the season. Plateau consistently reduced

fescue plant height across two mowings, until 136 DAT1. The other treatments had less consistent effects on fescue height. Fescue in the Anuew treated plots was not shorter than the fescue in control plots after the first mowing.

After the first mowing and the second PGR application, fescue in all the treated plots was not as green and was shorter than the control fescue 15 and 36 DAT2 (Table 3). The fescue in the Embark, Anuew, and Perspective treated plots was still less green and shorter 55 DAT2. Fescue color had recovered somewhat in Opensight treated plots but it was shorter. Twenty days after the second mowing (75 DAT2), fescue color was not different between treatments. Fescue in the Anuew treated plots was the only one shorter than that in the control plots 75 DAT2. Figure 4 summarizes the PGR effects on fescue color. Figure 5 summarizes the treatment effects on fescue height. Note that fescue in the Anuew plots was consistently shorter until 89 DAT2.

After the second mowing and the third PGR application (21 DAT3), fescue in the Plateau and Opensight treated plots had lower green color and lower fescue height than the other PGR treatments (Table 4). Anuew did reduce fescue color ratings 32 DAT3 while all the other treatments did. Fescue was shorter in all the treated plots except those treated with Embark. Fescue color increased in the Opensight and Anuew plots but it was still less than in the plots with the other treatments 47 DAT3. Fescue height was reduced by all the PGRs except for Opensight at that assessment date. After mowing only (59 DAT3), fescue in the Embark and Perspective plots was less green (Table 4) (Figure 6). Embark was the only PGR that reduced fescue height at that date. Plots treated with Embark consistently had shorter fescue until the end of the season (93 DAT3) (Figure 7). The height reductions were inconsistent with the other treatments, except that Plateau did not reduce fescue height beyond mowing (Figure 7).

After the third mowing and the fourth PGR application (16 DAT4), fescue treated with Plateau, Opensight or Perspective was less green. Fescue treated with any of the PGRs was still shorter (Table 5). At the last rating in the season, the only fescue in treated plots that did not have less color was that with Anuew treatment (Table 5, Figure 8). All the PGR treatments resulted in shorter fescue at both ratings (Figure 9).

The effects of the PGR treatments were variable throughout the season. The Class D PGRs (Plateau, Opensight and Perspective) reduced seedhead density and height after the first application timing. In general, many of the treatments reduced fescue height along with fescue color but the color recovered. Anuew had less effect on fescue color than the other PGRs at most of the evaluations. Fescue growth (height) reduction was observed to extend beyond mowing cycles, especially with in Plateau that were treated early in the season. Plots that were treated late in the season (October 6) will be evaluated in 2018 for spring seedhead suppression.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates.

Product (s)	Rate (per Acre)	Active Ingredient(s)	ai Rate (per Acre)
Embark 2S	24 fl oz	mefluidide	6 oz ae
Plateau	2 fl oz	imazapic	0.5 oz ae
Opensight	2.5 oz	aminopyralid + metsulfuron methyl	1.3 oz ae + 0.24 oz
Anuew	1 lb	prohexadione calcium	4.4 oz
Perspective	4.75 oz	aminocyclopyrachlor + chlorsulfuron	1.9 oz + 0.75 oz
Unsprayed Control			

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

Table 2. Herbicide Treatments, Turf Color, Fescue Heights and % Heading after First PGR Application

			May 10, 2017			May 22, 2017			June 1, 2017	
			Color (0-9)	Ht (in)	Heading (%)	Color (0-9)	Ht (in)	Heading (%)	Color (0-9)	Ht (in)
Product (s)	**Rate (per Acre)**	**Timing**	**14 DAT1[1]**			**26 DAT1**			**36 DAT1**	
Embark 2S	24 fl oz	before first mowing	7.9 a[2]	27 b	90 a	7.4 a	34 b	93 a	7.2 b	7.2 c
		after first mowing								
		after second mowing								
		after third mowing								
Plateau	2 fl oz	before first mowing	7.2 ab	20 c	15 c	6.2 b	18 d	10 bc	7.2 b	7.5 bc
		after first mowing								
		after second mowing								
		after third mowing								
Opensight	2.5 oz	before first mowing	6.5 b	19 c	9 c	6.2 b	21 d	8 c	7.3 b	7.7 bc
		after first mowing								
		after second mowing								
		after third mowing								
Anuew	1 lb	before first mowing	7.9 a	20 c	67 b	7.5 a	28 c	93 a	7.9 a	8.5 ab
		after first mowing								
		after second mowing								
		after third mowing								
Perspective	4.75 oz	before first mowing	6.8 b	22 c	12 c	6.2 b	20 d	20 b	7.3 b	7.3 bc
		after first mowing								
		after second mowing								
		after third mowing								
Unsprayed Control			8.0 a	31 a	100 a	8.0 a	39 a	100 a	8.0 a	9.0 a

[1] DAT1 = Days after treatment before first mowing

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3. Herbicide Treatments, Turf Color, and Fescue Heights after Second PGR Application

Product (s)	Rate (per Acre)	Timing	June 16, 2017		July 7, 2017		July 26, 2017		August 15, 2017	
			Color (0-9)	Ht (in)	Color (0-9)	Ht (in)	Color (0-9)	Ht (in)	Color (0-9)	Ht (in)
			51 DAT1[1] (15 DAT2[2])		72 DAT1 (36 DAT2)		91 DAT1 (55 DAT2)		111 DAT1 (75 DAT2)	
Embark 2S	24 fl oz	before first mowing	7.7 ab[3]	11 bcd	7.8 ab	13 bcd	7.8 ab	14 abc	7.9 cd	11 abc
		after first mowing	7.2 bc	12 bcd	5.7 d	12 cde	6.3 d	12 c	8.1 abc	11 ab
		after second mowing								
		after third mowing								
Plateau	2 fl oz	before first mowing	8.2 a	11 bcd	8.0 a	12 cde	7.9 a	13 bc	7.7 d	10 c
		after first mowing	6.7 cd	10 cd	6.7 c	12 cde	7.5 ab	14 ab	7.9 cd	11 abc
		after second mowing								
		after third mowing								
Opensight	2.5 oz	before first mowing	8.2 a	13 abc	8.0 a	14 a	8.1 a	14 ab	7.9 bcd	11 ab
		after first mowing	6.3 d	10 d	7.3 bc	11 ef	7.5 ab	13 bc	8.3 ab	12 a
		after second mowing								
		after third mowing								
Anuew	1 lb	before first mowing	8.0 a	13 ab	8.0 a	13 bc	8.0 a	14 ab	7.8 cd	11 abc
		after first mowing	7.2 bc	11 bcd	7.2 bc	10 f	7.2 bc	13 bc	7.9 cd	10 bc
		after second mowing								
		after third mowing								
Perspective	4.75 oz	before first mowing	7.8 a	12 abcd	7.9 ab	14 ab	8.0 a	13 abc	8.1 abc	12 a
		after first mowing	6.5 d	10 cd	5.7 d	12 de	6.8 cd	12 c	8.3 a	11 ab
		after second mowing								
		after third mowing								
Unsprayed Control			8.0 a	14 a	8.0 a	14 ab	8.0 a	15 a	8.0 abcd	12 a

[1] DAT1 = Days after treatment before first mowing

[2] DAT2 = Days after treatment after first mowing

[3] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 4. Herbicide Treatments, Turf Color, and Fescue Heights after Third PGR Application

Product (s)	Rate (per Acre)	Timing	August 29. 2017		September 9, 2017		September 24, 2017		October 6, 2017	
			Color (0-9)	Ht (in)	Color (0-9)	Ht (in)	Color (0-9)	Ht (in)	Color (0-9)	Ht (in)
			125 DAT1[1] (89 DAT2[2]) (21 DAT3[3])		136 DAT1 (100 DAT2) (32 DAT3)		151 DAT1 (115 DAT2) (47 DAT3)		163 DAT1 (127 DAT2) (59 DAT3)	
Embark 2S	24 fl oz	before first mowing	8.0 ab[4]	12 def	8.0 a	13 abcd	8.0 a	14 bcde	8.0 a	7 ab
		after first mowing	8.1 ab	12 defg	8.1 a	13 abcd	8.0 a	14 bcde	8.0 a	7 ab
		after second mowing	7.5 cd	11 fg	5.8 c	12 bcdef	6.5 d	11 f	7.3 c	6 b
		after third mowing								
Plateau	2 fl oz	before first mowing	7.9 abc	11 efg	8.0 a	11 def	7.9 ab	13 cdef	7.7 abc	8 ab
		after first mowing	8.0 abc	12 def	8.0 a	13 abc	8.0 a	14 bcde	8.1 a	8 ab
		after second mowing	6.8 e	11 efg	4.2 d	11 f	7.1 c	12 ef	8.0 ab	8 ab
		after third mowing								
Opensight	2.5 oz	before first mowing	8.0 abc	12 cde	8.0 a	13 abcd	8.0 a	16 ab	7.9 ab	8 ab
		after first mowing	8.1 ab	13 abc	8.0 a	14 a	8.0 a	15 abc	8.0 a	8 a
		after second mowing	7.3 de	11 efg	7.0 b	11 cdef	8.1 a	13 cde	7.7 abc	8 a
		after third mowing								
Anuew	1 lb	before first mowing	8.1 ab	14 ab	8.1 a	14 a	8.1 a	15 abcd	7.8 ab	8 a
		after first mowing	8.0 abc	12 defg	8.0 a	13 abcd	8.0 a	14 bcde	7.9 ab	8 ab
		after second mowing	8.0 abc	11 efg	7.8 a	11 ef	8.1 a	12 ef	7.7 abc	7 ab
		after third mowing								
Perspective	4.75 oz	before first mowing	8.0 abc	13 bcd	7.9 a	12 abcde	8.0 a	14 abcd	7.5 bc	7 ab
		after first mowing	8.4 a	11 efg	8.3 a	13 ab	8.1 a	17 a	7.8 abc	8 ab
		after second mowing	7.6 bcd	11 g	7.2 b	11 def	7.6 b	12 def	7.3 c	7 ab
		after third mowing								
Unsprayed Control			8.0 abc	14 a	8.0 a	13 ab	8.0 a	15 abc	8.0 a	8 a

[1] DAT1 = Days after treatment before first mowing *[2] DAT2 = Days after treatment after first mowing*

[3] DAT3 = Days after treatment after second mowing

[4] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 5. Herbicide Treatments, Turf Color, and Fescue Heights after Fourth PGR Application

Product (s)	Rate (per Acre)	Timing	October 22, 2017		November 9, 2017	
			Color (0-9)	Ht (in)	Color (0-9)	Ht (in)
			179 DAT1[1] (143 DAT2[2]) (75 DAT3[3]) (16 DAT4[4])		197 DAT1 (161 DAT2) (93 DAT3) (34 DAT4)	
Embark 2S	24 fl oz	before first mowing	8.0 a[5]	11 bcd	8.0 a	13 ab
		after first mowing	7.9 a	10 cdef	8.0 a	12 abcd
		after second mowing	8.1 a	10 cdef	8.0 a	11 bcde
		after third mowing	7.8 a	10 cdef	7.7 b	11 bcde
Plateau	2 fl oz	before first mowing	8.0 a	10 bcde	8.0 a	11 bcde
		after first mowing	8.0 a	11 bcd	8.0 a	12 abcd
		after second mowing	8.1 a	10 bcde	8.0 a	12 abc
		after third mowing	7.0 b	9 efg	7.2 c	10 efg
Opensight	2.5 oz	before first mowing	8.0 a	11 ab	8.0 a	12 abc
		after first mowing	8.0 a	11 abc	8.0 a	11 cde
		after second mowing	8.2 a	12 a	8.1 a	12 bcd
		after third mowing	7.0 b	9 fg	7.3 c	9 g
Anuew	1 lb	before first mowing	8.0 a	11 bcd	8.0 a	12 abcd
		after first mowing	8.0 a	11 bcd	8.0 a	11 bcde
		after second mowing	8.1 a	10 bcde	8.0 a	11 bcde
		after third mowing	7.9 a	10 defg	8.0 a	10 defg
Perspective	4.75 oz	before first mowing	8.0 a	10 bcde	8.0 a	12 bcd
		after first mowing	8.1 a	11 abc	8.0 a	11 bcde
		after second mowing	8.2 a	10 bcde	8.0 a	11 cdef
		after third mowing	7.1 b	9 g	7.3 c	9 fg
Unsprayed Control			8.0 a	11 ab	8.0 a	14 a

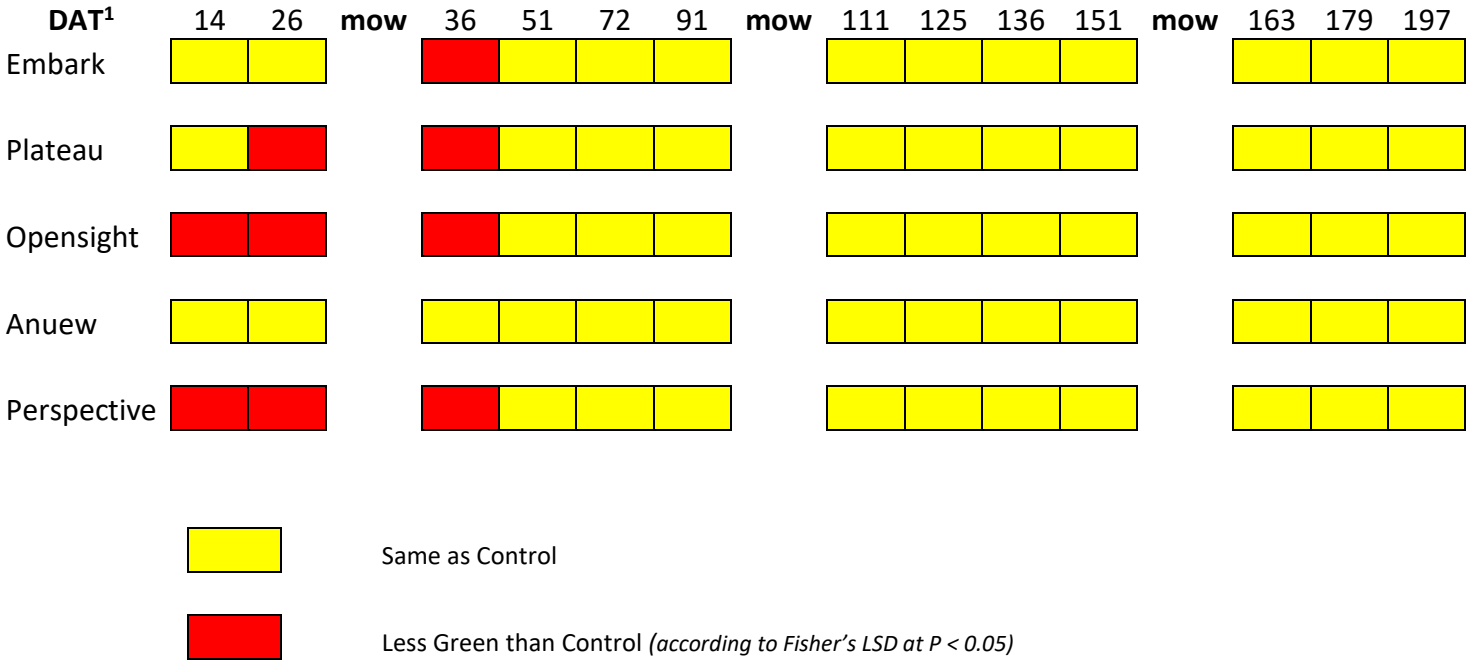
[1] DAT1 = Days after treatment before first mowing *[2] DAT2 = Days after treatment after first mowing*

[3] DAT3 = Days after treatment after second mowing *[4] DAT4 = Days after treatment after third mowing*

[5] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

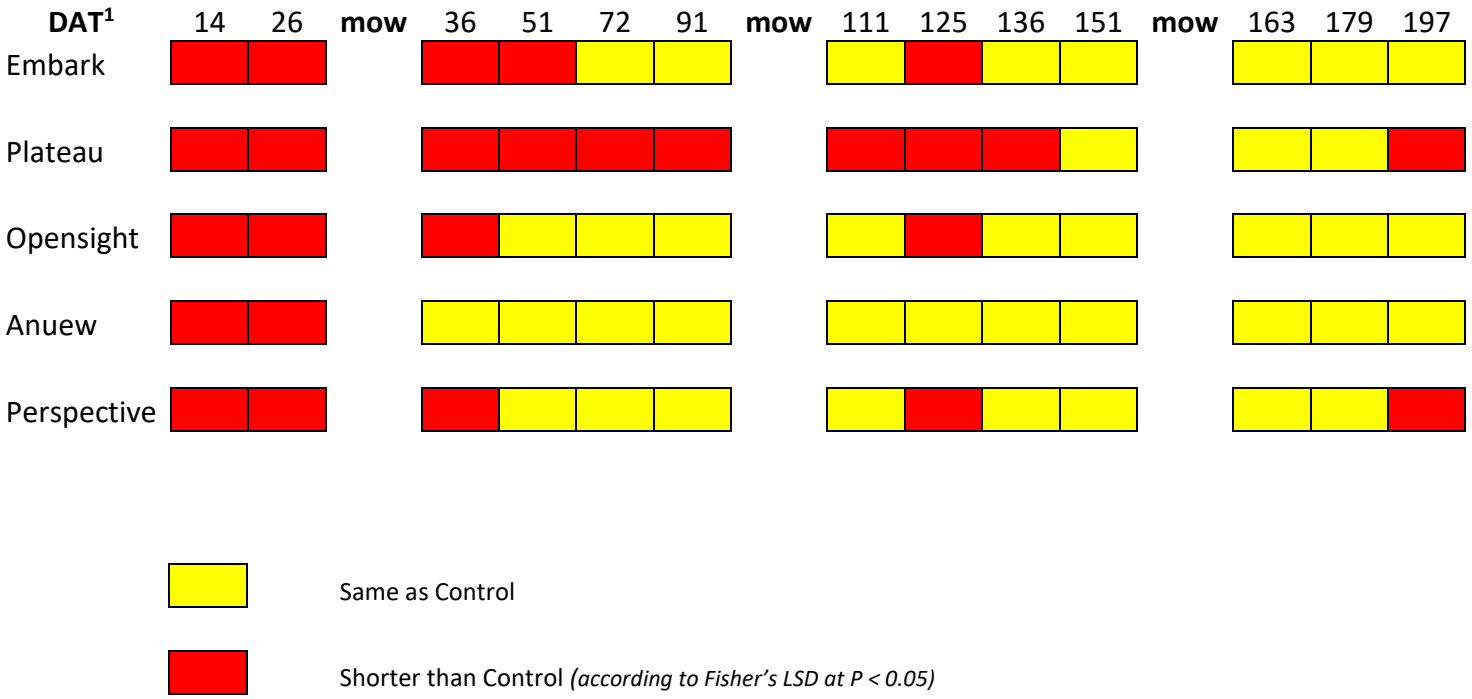
Figure 1. Example of plot with reduced tall fescue color, height, and seedhead density 26 days after the April 26 application.

Figure 2. Summary of Turf Color with PGR Application before First Mowing



[1] *DAT = Days after treatment*

Figure 3. Summary of Fescue Height with PGR Application before First Mowing

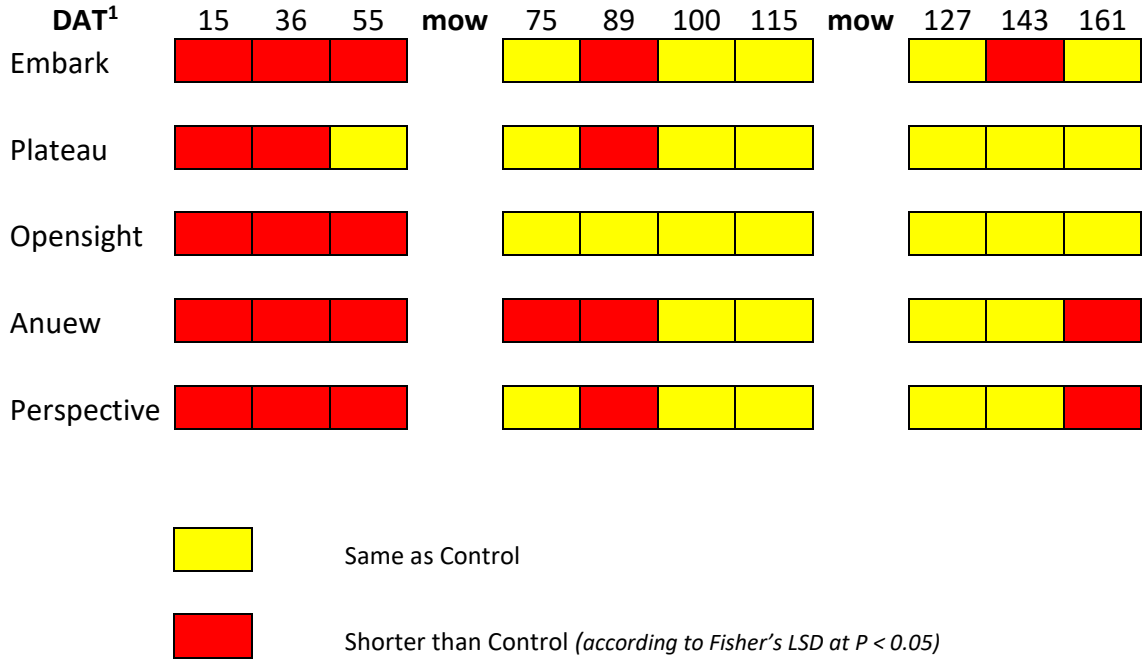


[1] *DAT = Days after treatment*

Figure 4. Summary of Turf Color with PGR Application after First Mowing

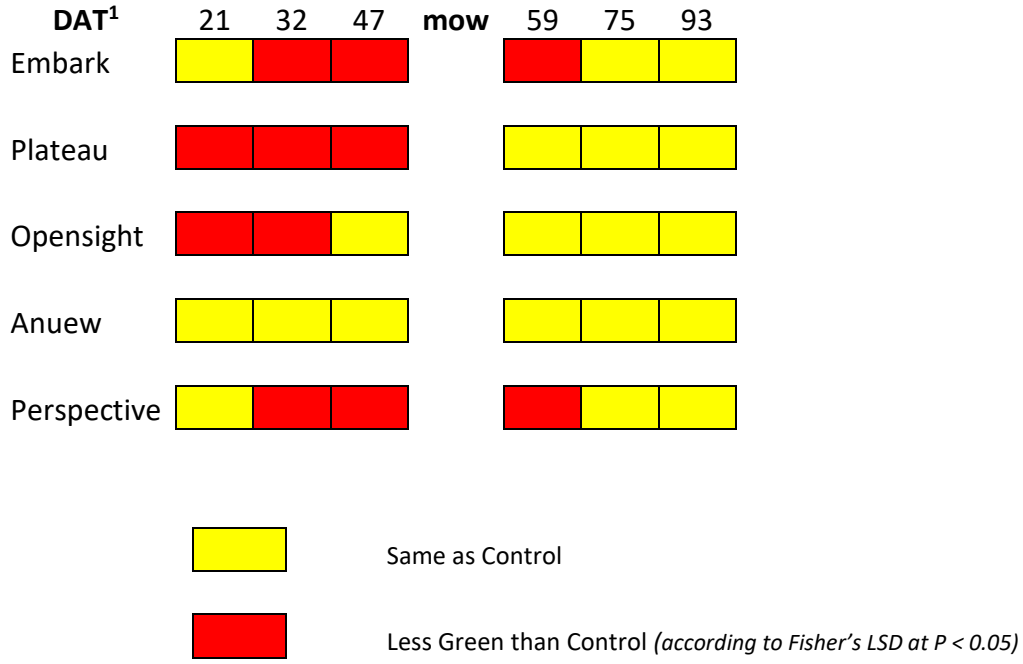
[1] *DAT = Days after treatment*

Figure 5. Summary of Fescue Height with PGR Application after First Mowing



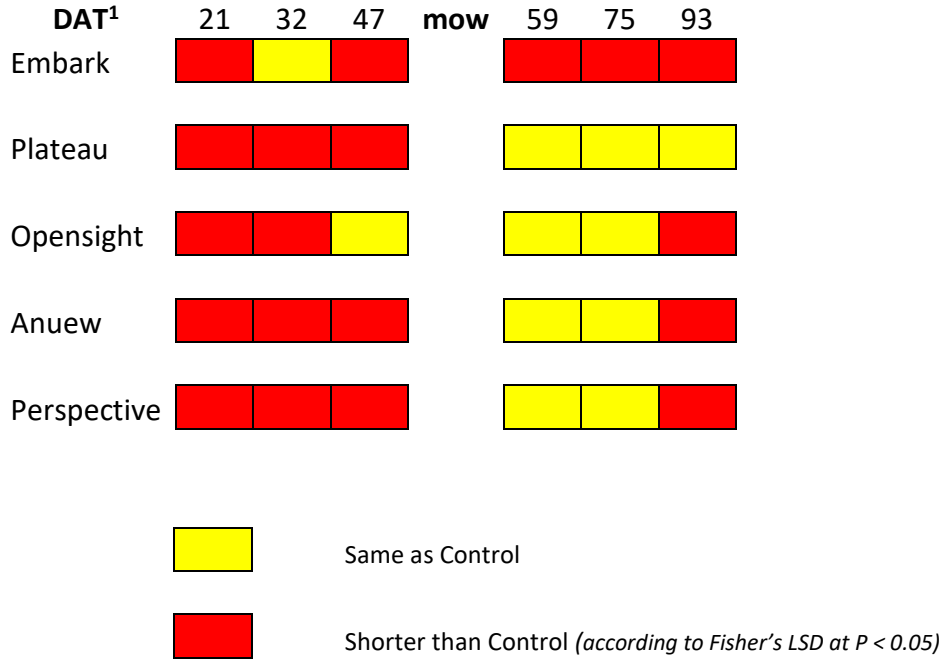
[1] *DAT = Days after treatment*

Figure 6. Summary of Turf Color with PGR Application after Second Mowing



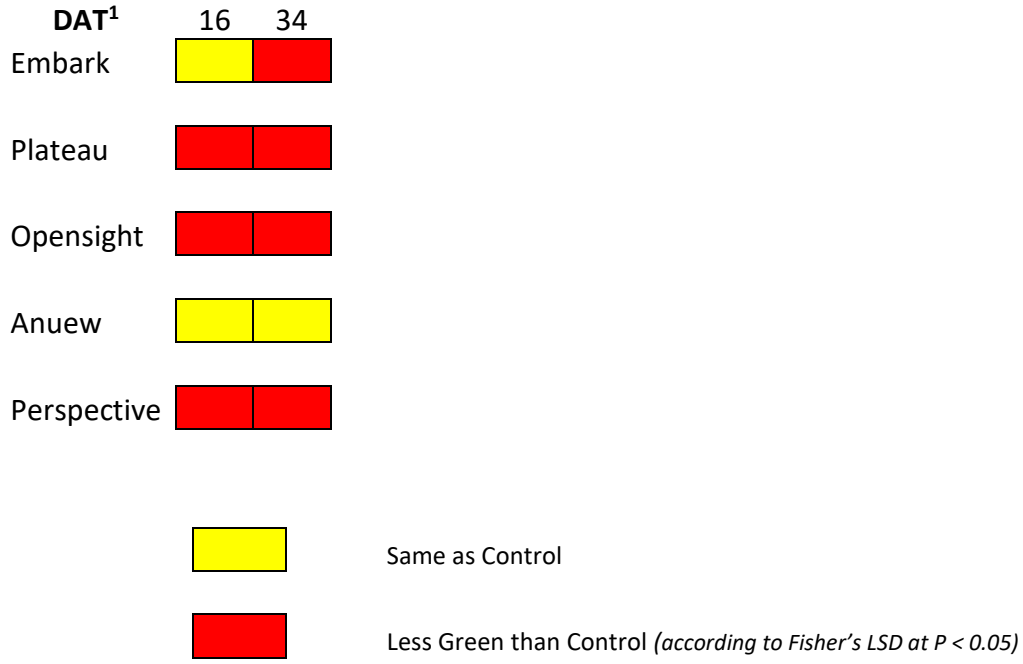
[1] *DAT = Days after treatment*

Figure 7. Summary of Fescue Height with PGR Application after Second Mowing



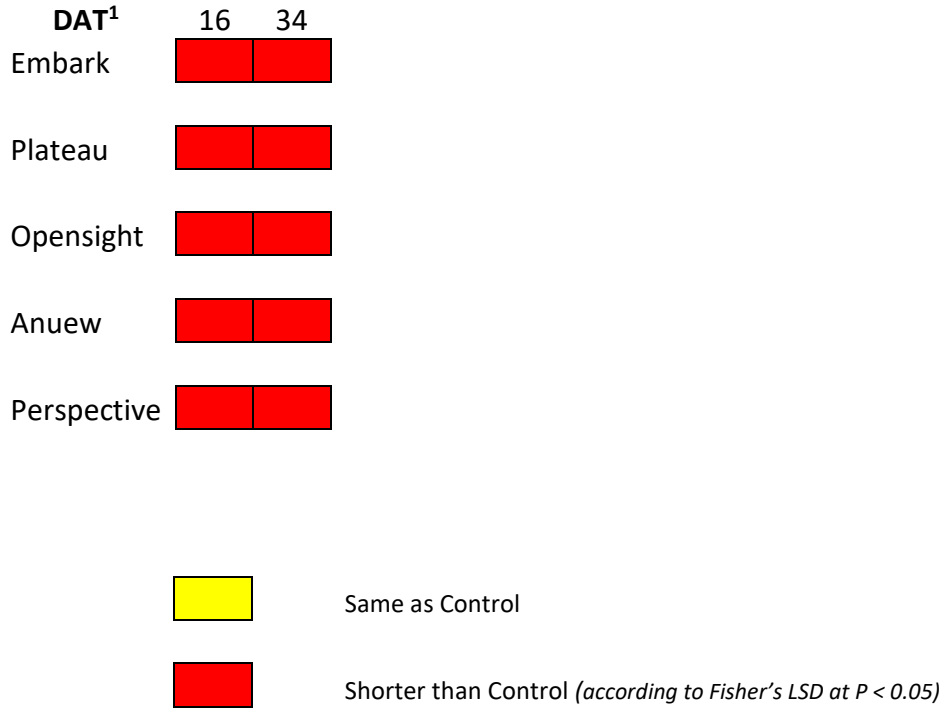
[1] *DAT = Days after treatment*

Figure 8. Summary of Turf Color with PGR Application after Third Mowing



[1] *DAT = Days after treatment*

Figure 9. Summary of Fescue Height with PGR Application after Third Mowing



[1] *DAT = Days after treatment*

2017 Weed Management Options in Coreopsis Plantings (Rowan County)

Introduction

It is a challenge to successfully establish and maintain pollinator / wildflower plots. Oftentimes, these plantings are primarily perennial plants and, due to establishment problems, sometimes these plantings fail. Questions of how to salvage or improve a previously established pollinator/wildflower stand are common. The objective of this study was to evaluate selective herbicides and herbicide combinations to help with establishing, salvaging or improving pollinator/wildflower plantings.

Materials and Methods

The study was established June 27, 2017 at an interchange near Morehead, KY on a planting of coreopsis. There were unusually dry and warm conditions in February at this location when the area was disked and the coreopsis seed was broadcast. This resulted in a poor and uneven stand with other plant species invading the open space. The recommended coreopsis planting time is in the spring (April or May) after a burndown treatment to control emerged weeds. The trial was established later than ideal. The trial had 10 treatments replicated 3 times each arranged in a randomized complete block design with 10 ft by 30 ft plots. Herbicide applications were made int 30 gallons per acre carrier volume and included a surfactant (Activator 90), except for Treatment 9 (Table 1). Some plants may suffer phytotoxicty from including a surfactant which is why Dual was tested with and without surfactant. At the time of first application, the coreopsis was 18 inches tall if flowering and 10 inches if not flowering. Red clover was flowering 15 inches tall, the foxtails were 6 inches tall and ragweed was 12 inches, tall and buckhorn plantain was 8 inches tall. The maximum height for good control of yellow foxtail is stated as 4 inches on the Plateau label. The second application of Fusilade (Treatments 2 and 5) was late and made on September 19, 2017.

The plots were mowed in the fall of 2017 and reseeded in 2018 with the KYTC pollinator mix. The stand was still very poor and the plots were rated once. Plots were rated for coreopsis and clover damage plus ragweed and yellow foxtail control 21 (7/18/2017) days after initial treatment (DAIT). They were assessed for % cover of coreopsis, clover, ragweed, wild carrot, and yellow foxtail 50 (8/16/2017), and 87 (9/22/2017) DAIT in 2017. The coreopsis plants had been damaged by frost before the last visit October 22 and the annual grasses were already brown so there was nothing left to rate. In 2018, they were rated for % cover of coreopsis, clover, wild carrot, and yellow foxtail 338 (5/31/2018) DAIT. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Results and Discussion

At the first rating there were a few coreopsis plants with foliar damage 21 DAIT (Table 2). Coreopsis plants treated with Plateau were smaller (stunted) than untreated plants (Figure 1). There was no damage from surfactant evident on the plants when comparing treatments 8 and 9 (Dual Magnum with and without surfactant). The Plateau treatments (3 – 5) were effective against red clover and ragweed (60-73% clover damage and 27-35% ragweed control).

Treatments 1 to 7 damaged yellow foxtail when applied post-emergence. Yellow foxtail emergence normally begins at the end of corn planting season (May 15). Using growing degree days (GDD) and a base temperature of 48F, one would expect 10% of final yellow foxtail total emergence at 250-400 GDD (*Weed Emergence Sequence: Knowledge to guide scouting and control, Iowa State University IPM-64*). Yellow foxtail has a medium length of germination period. Most foxtail plants would have already emerged by the first application so no benefit from pre-emerge herbicides would have been seen.

The vegetation composition varied between plots and was quite variable for the different species and, in many cases, were difficult to relate to treatments. Treatments 1 and 2 had both only received one application of Fusilade but had 30% and 10% clover cover and 10% vs 40% yellow foxtail cover 50 DAIT (Table 3). This is one of the challenges of conducting research in these situations.

Later in the season (87 DAIT), there was more coreopsis cover visible over other species (Table 4). There was less visible clover cover than earlier in the season as other species dominated. There were no evident treatment effects or benefits.

In the following spring after the plots were replanted (338 DAIT), the residual effects of the Plateau treatments were still evident (Table 5). There was less clover cover as well as less wild carrot with these treatments (3-5). These same treatments had lots of yellow foxtail cover. Treatments that would not harm established broadleaves (like clover) allowed them to compete more effectively against the annual grasses. There was more clover and wild carrot in those plots (Treatments 1 and 2 plus 6 to 9).

This trial gave us an opportunity to evaluate some options to “rescue” a planting that was a single species and was Plateau tolerant. However, timely (earlier, pre-emerge) treatments may have helped more than the ones applied. In short, rescue efforts did not appear to be effective.

Table 1. Herbicide treatments, active ingredients, and application rates.

Trt. No.	Product Name	Rate	Rate Unit	Application Time	Active Ingredient(s)	ai Application Rates
1	Fusilade II	24	FL OZ/A	A	fluazifop	6 OZ/A
2	Fusilade II	24	FL OZ/A	A	fluazifop	6 OZ/A
	Fusilade II	24	FL OZ/A	B	fluazifop	6 OZ/A
3	Plateau	4	FL OZ/A	A	imazapic	1 OZ AE/A
4	Plateau	4	FL OZ/A	A	imazapic	1 OZ AE/A
	Pendulum Aquacap	4	PT/A		pendimethalin	1.9 LB/A
5	Plateau	4	FL OZ/A	A	imazapic	1 OZ AE/A
	Pendulum Aquacap	4	PT/A		pendimethalin	1.9 LB/A
	Fusilade II	24	FL OZ/A	B	fluazifop	6 OZ/A
6	Fusilade II	24	FL OZ/A	A	fluazifop	6 OZ/A
	Pendulum Aquacap	4	PT/A		pendimethalin	1.9 LB/A
7	Fusilade II	24	FL OZ/A	A	fluazifop	6 OZ/A
	Dual Magnum	1.33	PT/A		s-metolachlor	1.3 LB/A
8	Dual Magnum	1.33	PT/A	A	s-metolachlor	1.3 LB/A
9*	Dual Magnum	1.33	PT/A	A	s-metolachlor	1.3 LB/A
10	Nontreated Check					

All herbicide treatments (except Trt. #9) contained the adjuvant, Activator 90 at 0.25% v/v.
Application dates: June 27 and September 19, 2017

Table 2. Herbicide treatments, application rates, and results 21 Days After Initial Treatment (DAIT[1]).

					Coreopsis Damage (%)	Clover Damage (%)	Ragweed Control (%)	Yellow Foxtail Control (%)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**Application Time**	**21 DAIT**			
1	Fusilade II	24	FL OZ/A	A	0 b[2]	10 b	10 bc	42 b
2	Fusilade II	24	FL OZ/A	A	0 b	10 b	10 bc	42 b
	Fusilade II	24	FL OZ/A	B				
3	Plateau	4	FL OZ/A	A	10 a	73 a	27 ab	53 ab
4	Plateau	4	FL OZ/A	A	0 b	60 a	30 a	65 a
	Pendulum Aquacap	4	PT/A					
5	Plateau	4	FL OZ/A	A	0 b	70 a	35 a	62 ab
	Pendulum Aquacap	4	PT/A					
	Fusilade II	24	FL OZ/A	B				
6	Fusilade II	24	FL OZ/A	A	0 b	0 b	3 c	57 ab
	Pendulum Aquacap	4	PT/A					
7	Fusilade II	24	FL OZ/A	A	0 b	0 b	3 c	60 ab
	Dual Magnum	1.33	PT/A					
8	Dual Magnum	1.33	PT/A	A	0 b	0 b	0 c	5 c
9*	Dual Magnum	1.33	PT/A	A	0 b	1 b	7 c	7 c
10	Nontreated Check				0 b	0 b	0 c	0 c

All herbicide treatments (except Trt. #9) contained the adjuvant, Activator 90 at 0.25% v/v.
Application dates: June 27 and September 19, 2017

[1] DAIT = Days after initial treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 3. Herbicide treatments, application rates, and results 50 Days After Initial Treatment (DAIT[1]).

					Coreopsis Cover (%)	Clover Cover (%)	Ragweed Cover (%)	Wild Carrot Cover (%)	Yellow Foxtail Cover (%)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**Application Time**	**50 DAIT**				
1	Fusilade II	24	FL OZ/A	A	17	30 a[2]	10 b	33 a	10 b
2	Fusilade II	24	FL OZ/A	A	7	10 b	26 ab	17 abc	40 ab
	Fusilade II	24	FL OZ/A	B					
3	Plateau	4	FL OZ/A	A	5	10 b	7 b	5 bc	73 a
4	Plateau	4	FL OZ/A	A	10	20 ab	16 ab	2 c	52 a
	Pendulum Aquacap	4	PT/A						
5	Plateau	4	FL OZ/A	A	17	9 b	13 b	23 abc	38 ab
	Pendulum Aquacap	4	PT/A						
	Fusilade II	24	FL OZ/A	B					
6	Fusilade II	24	FL OZ/A	A	15	17 ab	43 a	13 abc	12 b
	Pendulum Aquacap	4	PT/A						
7	Fusilade II	24	FL OZ/A	A	10	12 b	45 a	23 abc	13 b
	Dual Magnum	1.33	PT/A						
8	Dual Magnum	1.33	PT/A	A	3	12 b	12 b	17 abc	57 a
9*	Dual Magnum	1.33	PT/A	A	8	15 ab	7 b	17 abc	53 a
10	Nontreated Check				2	8 b	3 b	30 ab	57 a

All herbicide treatments (except Trt. #9) contained the adjuvant, Activator 90 at 0.25% v/v.
Application dates: June 27 and September 19, 2017

[1] DAIT = Days after initial treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 4. Herbicide treatments, application rates, and results 87 Days After Initial Treatment (DAIT[1]).

					Coreopsis Cover (%)	Clover Cover (%)	Ragweed Cover (%)	Wild Carrot Cover (%)	Yellow Foxtail Cover (%)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**Application Time**	**87 DAIT (3 DAT)**				
1	Fusilade II	24	FL OZ/A	A	30	10	22 bc[2]	35 a	3 d
2	Fusilade II	24	FL OZ/A	A	18	0	35 abc	15 bcd	32 abc
	Fusilade II	24	FL OZ/A	B					
3	Plateau	4	FL OZ/A	A	22	0	10 c	23 abc	37 abc
4	Plateau	4	FL OZ/A	A	23	10	23 abc	7 cd	37 abc
	Pendulum Aquacap	4	PT/A						
5	Plateau	4	FL OZ/A	A	28	3	17 bc	25 ab	27 bcd
	Pendulum Aquacap	4	PT/A						
	Fusilade II	24	FL OZ/A	B					
6	Fusilade II	24	FL OZ/A	A	18	7	53 a	5 d	13 cd
	Pendulum Aquacap	4	PT/A						
7	Fusilade II	24	FL OZ/A	A	18	3	47 ab	22 abcd	10 cd
	Dual Magnum	1.33	PT/A						
8	Dual Magnum	1.33	PT/A	A	8	0	33 abc	12 bcd	47 ab
9*	Dual Magnum	1.33	PT/A	A	22	0	12 c	10 bcd	57 a
10	Nontreated Check				27	7	12 c	23 abc	32 abc

All herbicide treatments (except Trt. #9) contained the adjuvant, Activator 90 at 0.25% v/v.
Application dates: June 27 and September 19, 2017

[1] DAIT = Days after initial treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Table 5. Herbicide treatments, application rates, and results 338 Days After Initial Treatment (DAIT[1]).

					Coreopsis Cover (%)	Clover Cover (%)	Wild Carrot Cover (%)	Yellow Foxtail Cover (%)
Trt. No.	**Product Name**	**Rate**	**Rate Unit**	**Application Code**	**338 DAIT (254 DAT)**			
1	Fusilade II	24	FL OZ/A	A	4 a[2]	27 ab	18 a	20 b
2	Fusilade II	24	FL OZ/A	A	3 ab	16 ab	11 ab	30 ab
	Fusilade II	24	FL OZ/A	B				
3	Plateau	4	FL OZ/A	A	0 c	2 b	3 b	60 a
4	Plateau	4	FL OZ/A	A	0 c	0 b	2 b	58 a
	Pendulum Aquacap	4	PT/A					
5	Plateau	4	FL OZ/A	A	0 c	1 b	3 b	58 a
	Pendulum Aquacap	4	PT/A					
	Fusilade II	24	FL OZ/A	B				
6	Fusilade II	24	FL OZ/A	A	1 bc	27 ab	7 ab	27 ab
	Pendulum Aquacap	4	PT/A					
7	Fusilade II	24	FL OZ/A	A	2 ab	40 a	8 ab	17 b
	Dual Magnum	1.33	PT/A					
8	Dual Magnum	1.33	PT/A	A	1 bc	47 a	12 ab	18 b
9*	Dual Magnum	1.33	PT/A	A	1 bc	28 ab	4 b	18 b
10	Nontreated Check				1 bc	42 a	13 ab	12 b

All herbicide treatments (except Trt. #9) contained the adjuvant, Activator 90 at 0.25% v/v.
Application dates: June 27 and September 19, 2017

[1] DAIT = Days after initial treatment

[2] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Figure 1. Examples of Plateau treated (stunted) (A) and untreated coreopsis (B) plants 21 Days After Treatment (DAT)

A

B

2017 PGR Options for Turf Management (Turf Research Center)

Introduction

Seasonal management of cool-season turf can include application of plant growth regulators (PGRs) to suppress growth and reduce the number of time consuming and costly mowings. PGRs may also be a good option on steep slopes where it is difficult to cut the grass safely. However, PGRs can cause turf discoloration, which is undesirable, but is temporary in many cases. We have tested PGRs for suppressing seedheads and growth in forage type tall fescue (see 2012 Research Report). We also tested a number of PGR treatments in combination with a synthetic auxin (2,4-D) as a "safener" to reduce damage to the grasses in 2015 at the Turf Research Center. There are concerns with using volatile growth regulator herbicides during hot conditions and in this current trial so in this trial we did not use any. Further, a number of older products (Embark and Stronghold) are no longer commercially available. The current question is, how do the available PGRs compare with each other for fescue growth reduction and safety?

There are a number of PGR products available for turf and the early classification of these placed them into two groups. Type I PGRs slow cellular division and include some herbicides. Our previous trials only included Type 1 PGRs. Type II PGRs are gibberellic acid (GA) inhibitors and slow cell elongation. The current classification has 6 groups, Classes A – F. This trial included a number of Type 1 PGRs which are now Class C (mitotic inhibitors) (cell division) (foliar absorbed) and Class D (herbicidal mode) PGRs. Mefluidide (in the products Envoy and Stronghold) is in Class C but is no longer commercially available. Imazethapyr + imazapyr (Stronghold), imazapic (Plateau), chlorsuluron (Telar and Perspective) and metsulfuron methyl (Escort and Opensight) are in Class D. Anuew (prohexadione calcium) is a Class A (late GA synthesis blocker) (foliar absorbed).

Materials and Methods

The trials were established at the Turfgrass Research Center at Spindletop Research Farm in Lexington KY with 10 treatments replicated 3 times arranged in a randomized complete block design on each of two turf types. They were part of a trial conducted by Kenneth Cropper (see reference) from 2013 to 2014. The turf type tall fescue plot was under high maintenance management during that time and the mixed species endemic polystand (endemic) plot was under low maintenance management. Since that trial ended, the only maintenance on these plots has been regular mowing at 3.5 inches. Plot sizes for the PGR trial were 3.5 ft by 20 ft with running unsprayed checks (1.5 ft) between each of the plots. Application was at 25 gallons per acre spray volume on July 8, 2017 and included a non-ionic surfactant (Activator 90) at 0.25% v/v. Table 1 lists the PGR treatments with their active ingredients and application rates. The Anuew label calls for the addition of AMS (ammonium sulfate) if the water has more than 40 ppm calcium. Table 2 lists the PGR treatments with their classification groups.

Turf color in the two sets of plots, turf fescue and endemic turf, was assessed by comparison to the running check strips 8 (7/16/2017), 16 (7/24/2017), 23 (7/31/2017), 32 (8/9/2017), 38 (8/15/2017), and 47 (8/24/2017) days after treatment (DAT). The color rating ranges from 0 (dead) to 9 (full green). The color of the check strips was set at 8. It should be noted that the

color and condition of the plots had decreased since the end of the 2014 season when all chemical and fertilizer inputs ceased. Canopy heights were measured at 8, 16, 23, 32, 38, and 47 DAT. Broadleaf weed (% control) ratings were taken on 8, 16, 23, and 32 DAT. A rating (0-4) of the density of crabgrass seedheads was taken on the turf type fescue plots 47 DAT. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at p = 0.05.

Results and Discussion

There was not much growth (height change) in the control turf fescue plots over the course of the trial (Tables 3, 4, and 5). The lack of inputs, such as nitrogen, may be why. However, 38 DAT almost all turf in all the PGR treated plots was shorter than that in the control plots (Table 5). With the slow fescue growth rate, it took longer for the PGR caused growth reductions to become evident. Plateau (Treatment 3) had the most consistent decrease in fescue height (Tables 3, 4, and 5) which is summarized in Figure 2.

The tall fescue in the turf plots fescue treated with Anuew had the same turf color as that in the control 16 DAT plots (Table 3). Embark and Escort reduced turf color less than the Stronghold and Plateau treatments. No PGR affected turf color 8 DAT (Table 3) but by 23 DAT (Table 4) fescue in all the PGRs plots except those for Anuew (Treatments 8 and 9) was less green than that in the control plots. Color had largely recovered by 47 DAT (Table 5) except fescue treated with Embark (Treatment 1). Color of fescue treated with Anuew Treatments 8 and 9) was consistently not different than that of the control fescue (Tables 3, 4, and 5) (Figure 1).

The Class A (Anuew) and Class C (Embark) PGRs did little to control broadleaves, as was expected. The lowest amount of broadleaves were found in plots treated with Telar, Escort, Perspective or Opensight (Treatments 4, 5, 6, and 7 respectively) 23 DAT (Table 4). By the end of the trial, crabgrass seedheads were evident in many of plots but were less than control in those treated with Plateau (Treatment 3) or Perspective (Treatment 6) (Table 5).

There was growth in the endemic turf plots (6 inches to 7.2 inches in the control plots) over the course of the trial (Tables 6 to 8) (Figure 4) than in the turf type tall fescue plots (Tables 3 to 5). A greater proportion of the canopy in the endemic turf plots was dominated by warm-season grasses such as bermudagrass and nimblewill. PGR effects on height in the endemic turf plots were sporadic but, by the end of the season (47 DAT), the Embark (Treatment 1), height of the turf in the Stronghold (Treatment 2) and Perspective (Treatment 6) treated plots was less than control (Table 8) (Figure 4). Perspective also had less nimblewill in the canopy than other plots at that time.

PGR effects on turf color were also sporadic (Figure 3) but turf in the Embark and Stronghold (Treatments 1 and 2) treated plots was less green 23 (Table 7) and 38 DAT (Table 8). The best

treatments for broadleaf control were Escort, Perspective and Opensight (Treatments 5, 6, and 7) 16 (Table 6), 23 and 32 DAT (Table 7).

There are a number of PGR options for use on cool season turf which will temporarily reduce **turf** height and color rating. These responses can vary depending on the level of inputs. These effects are reduced if the turf is not growing. Anuew did not affect turf color but still temporarily reduced turf height.

Cropper, Kenneth L., "INVESTIGATIONS INTO THE HOME LAWN CARBON BALANCE AND IMPROVING THE EFFICACY OF T-PHYLLOPLANINS FOR COMBATING TURFGRASS DISEASES" (2015).*Theses and Dissertations--Plant and Soil Sciences*. 63.
http://uknowledge.uky.edu/pss_etds/63

Table 1. PGR treatments, active ingredients, and application rates.

Treatment	Product Names	Rate (per Acre)	Rate Unit	Active Ingredient(s)	ai Rate (per acre)
1	Embark	24	fl oz/a	mefluidide	6 oz ae
2	Stronghold	12	fl oz/a	mefluidide + imazethapyr + imazapyr	2.20 oz ae + 0.53 oz ae + 0.01 oz ae
3	Plateau	2	fl oz/a	imazapic	0.5 oz ae
4	Telar	0.25	oz/a	chlorsulfuron	0.19 oz
5	Escort	0.5	oz/a	metsulfuron methyl	0.3 oz
6	Perspective	4.5	oz/a	aminocyclopyrachlor + chlorsulfuron	1.8 oz + 0.7 oz
7	Opensight	2.5	oz/a	aminopyralid + metsulfuron methyl	1.3 oz ae + 0.23 oz
8	Anuew AMS	8 8	oz/a oz/a	prohexadione calcium ammonium sulfate	2.2 oz
9	Anuew AMS	16 16	oz/a oz/a	prohexadione calcium ammonium sulfate	4.4 oz
10	Untreated Check				

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

Table 2. PGR treatments, active ingredients, and mechanism of action classification(s).

Treatment	Product Names	Active Ingredient(s)	Mechanism of PGR Action Classification(s)
1	Embark	mefluidide	Class C (mitotic/cell division inhibitor)
2	Stronghold	mefluidide + imazethapyr + imazapyr	Class F (PGR combination) (C + D + D)
3	Plateau	imazapic	Class D (herbicidal)
4	Telar	chlorsulfuron	Class D (herbicidal)
5	Escort	metsulfuron methyl	Class D (herbicidal)
6	Perspective	aminocyclopyrachlor + chlorsulfuron	Class D (herbicidal)
7	Opensight	aminopyralid + metsulfuron methyl	Class D (herbicidal)
8	Anuew AMS	prohexadione calcium ammonium sulfate	Class A (late GA synthesis blocker)
9	Anuew AMS	prohexadione calcium ammonium sulfate	Class A (late GA synthesis blocker)
10	Untreated Check		

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

Table 3. Results from Turf Fescue Plots (8 and 16 Days After Treatment (DAT))

				July 16, 2017			July 24, 2017		
				Color (0-9)	Ht (in)	Broadleaf Control (%)	Color (0-9)	Ht (in)	Broadleaf Control (%)
Treatment	Product Names	Rate (per Acre)	Rate Unit	8 DAT			16 DAT		
1	Embark	24	fl oz/a	7.8	3.8 abc[1]	2 c	7.2 cde	4.0	8 cd
2	Stronghold	12	fl oz/a	7.9	3.7 bc	5 bc	7.0 de	3.8	5 cd
3	Plateau	2	fl oz/a	7.8	3.5 c	13 bc	7.0 de	4.0	15 cd
4	Telar	0.25	oz/a	8.0	3.7 bc	8 bc	7.3 bcde	4.2	33 bc
5	Escort	0.5	oz/a	7.9	3.8 abc	12 bc	7.0 de	4.2	53 ab
6	Perspective	4.5	oz/a	7.8	3.8 abc	18 ab	7.7 abc	4.2	70 a
7	Opensight	2.5	oz/a	7.9	3.7 bc	28 a	6.8 e	4.3	60 ab
8	Anuew AMS	8 8	oz/a oz/a	8.0	4.0 ab	2 c	7.5 abcd	3.8	10 cd
9	Anuew AMS	16 16	oz/a oz/a	8.0	4.0 ab	0 c	7.8 ab	3.8	13 cd
10	Untreated Check			8.0	4.2 a	0 c	8.0 a	4.3	0 d

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

Table 4. Results from Turf Fescue Plots (23 and 32 Days After Treatment (DAT))

				July 31, 2017			August 9, 2017		
				Color (0-9)	Ht (in)	Broadleaf Control (%)	Color (0-9)	Ht (in)	Broadleaf Control (%)
Treatment	Product Names	Rate (per Acre)	Rate Unit	23 DAT			32 DAT		
1	Embark	24	fl oz/a	6.8 c[1]	4.0 ab	7 cd	6.3 d	3.7 bc	3 c
2	Stronghold	12	fl oz/a	6.8 c	3.8 ab	12 cd	7.0 cd	4.0 ab	2 c
3	Plateau	2	fl oz/a	6.6 c	3..5 b	33 bc	6.3 d	3.5 c	28 b
4	Telar	0.25	oz/a	7.2 bc	3.7 ab	60 ab	8.0 a	3.8 abc	15 bc
5	Escort	0.5	oz/a	6.8 c	4.0 ab	80 a	7.3 bc	3.8 abc	85 a
6	Perspective	4.5	oz/a	6.8 c	3.8 ab	73 a	7.2 bc	4.0 ab	77 a
7	Opensight	2.5	oz/a	7.0 c	3.8 ab	75 a	7.8 ab	4.0 ab	85 a
8	Anuew AMS	8 8	oz/a oz/a	7.8 ab	3.7 ab	25 cd	8.0 a	4.0 ab	5 c
9	Anuew AMS	16 16	oz/a oz/a	7.8 ab	4.0 ab	15 cd	8.0 a	3.7 bc	2 c
10	Untreated Check			8.0 a	4.2 a	0 d	8.0 a	4.2 a	0 c

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

Table 5. Results from Turf Fescue Plots (38 and 47 Days After Treatment (DAT))

				August 15, 2017		August 24, 2017		
				Color (0-9)	Ht (in)	Color (0-9)	Ht (in)	Crabgrass Seedheads (0-4)
Treatment	Product Names	Rate (per Acre)	Rate Unit	38 DAT		47 DAT		
1	Embark	24	fl oz/a	6.8 c[1]	3.5 de	6.7 b	3.5 c	2.0 ab
2	Stronghold	12	fl oz/a	7.4 abc	4.0 bc	7.3 ab	3.8 bc	1.7 ab
3	Plateau	2	fl oz/a	6.9 c	3.3 e	7.3 ab	3.5 c	0.3 c
4	Telar	0.25	oz/a	7.7 ab	4.0 bc	7.6 a	4.0 ab	2.7 a
5	Escort	0.5	oz/a	7.8 a	3.7 cde	7.7 a	4.3 a	2.3 a
6	Perspective	4.5	oz/a	7.2 bc	3.7 cde	7.3 ab	4.0 ab	1.0 bc
7	Opensight	2.5	oz/a	7.9 a	3.8 bcd	8.0 a	4.3 a	2.7 a
8	Anuew AMS	8 8	oz/a oz/a	8.0 a	4.0 bc	8.0 a	3.8 bc	2.0 ab
9	Anuew AMS	16 16	oz/a oz/a	8.0 a	4.2 ab	8.0 a	4.0 ab	2.0 ab
10	Untreated Check			8.0 a	4.5 a	8.0 a	4.3 a	2.0 ab

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

Table 6. Results from Endemic Turf Plots (8 and 16 Days After Treatment (DAT))

				July 16, 2017			July 24, 2017		
				Color (0-9)	Ht (in)	Broadleaf Control (%)	Color (0-9)	Ht (in)	Broadleaf Control (%)
Treatment	Product Names	Rate (per Acre)	Rate Unit	8 DAT			16 DAT		
1	Embark	24	fl oz/a	8.0 a[1]	5.7	2 bc	7.5 ab	5.8 ab	10 c
2	Stronghold	12	fl oz/a	7.9 b	5.7	3 bc	8.0 a	5.8 ab	8 c
3	Plateau	2	fl oz/a	8.0 a	5.8	5 bc	7.3 ab	6.0 ab	13 c
4	Telar	0.25	oz/a	8.0 a	5.8	2 bc	7.7 ab	6.7 a	8 c
5	Escort	0.5	oz/a	8.0 a	5.8	7 b	7.5 ab	6.3 a	37 b
6	Perspective	4.5	oz/a	8.0 a	5.8	20 a	7.7 ab	6.2 ab	62 a
7	Opensight	2.5	oz/a	8.0 a	5.8	15 a	7.0 b	6.5 a	67 a
8	Anuew AMS	8 8	oz/a oz/a	8.0 a	6.0	2 bc	7.8 a	6.3 a	13 c
9	Anuew AMS	16 16	oz/a oz/a	8.0 a	6.3	1 c	7.3 ab	5.2 b	5 c
10	Untreated Check			8.0 a	6.0	0 c	8.0 a	6.3 a	0 c

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

Table 7. Results from Endemic Turf Plots (23 and 32 Days After Treatment (DAT))

				July 31, 2017			August 9, 2017		
				Color (0-9)	Ht (in)	Broadleaf Control (%)	Color (0-9)	Ht (in)	Broadleaf Control (%)
Treatment	Product Names	Rate (per Acre)	Rate Unit	23 DAT			32 DAT		
1	Embark	24	fl oz/a	7.2 c[1]	6.3 ab	5 cd	7.3	5.0 d	10 c
2	Stronghold	12	fl oz/a	7.5 bc	6.0 b	8 cd	7.8	5.0 d	8 c
3	Plateau	2	fl oz/a	7.7 ab	6.0 b	18 c	7.9	6.0 c	15 c
4	Telar	0.25	oz/a	8.0 a	6.2 ab	10 cd	8.0	6.7 ab	5 c
5	Escort	0.5	oz/a	7.8 ab	6.3 ab	65 ab	7.8	6.0 c	55 ab
6	Perspective	4.5	oz/a	7.7 ab	6.3 ab	53 b	7.5	6.0 c	70 a
7	Opensight	2.5	oz/a	7.9 ab	7.2 a	68 a	8.0	6.8 a	51 b
8	Anuew AMS	8 8	oz/a oz/a	7.8 ab	6.7 ab	8 cd	7.8	6.3 abc	5 c
9	Anuew AMS	16 16	oz/a oz/a	7.7 ab	6.2 ab	10 cd	7.8	6.2 bc	5 c
10	Untreated Check			8.0 a	6.5 ab	0 d	8.0	6.3 abc	0 c

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

[1] *Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.*

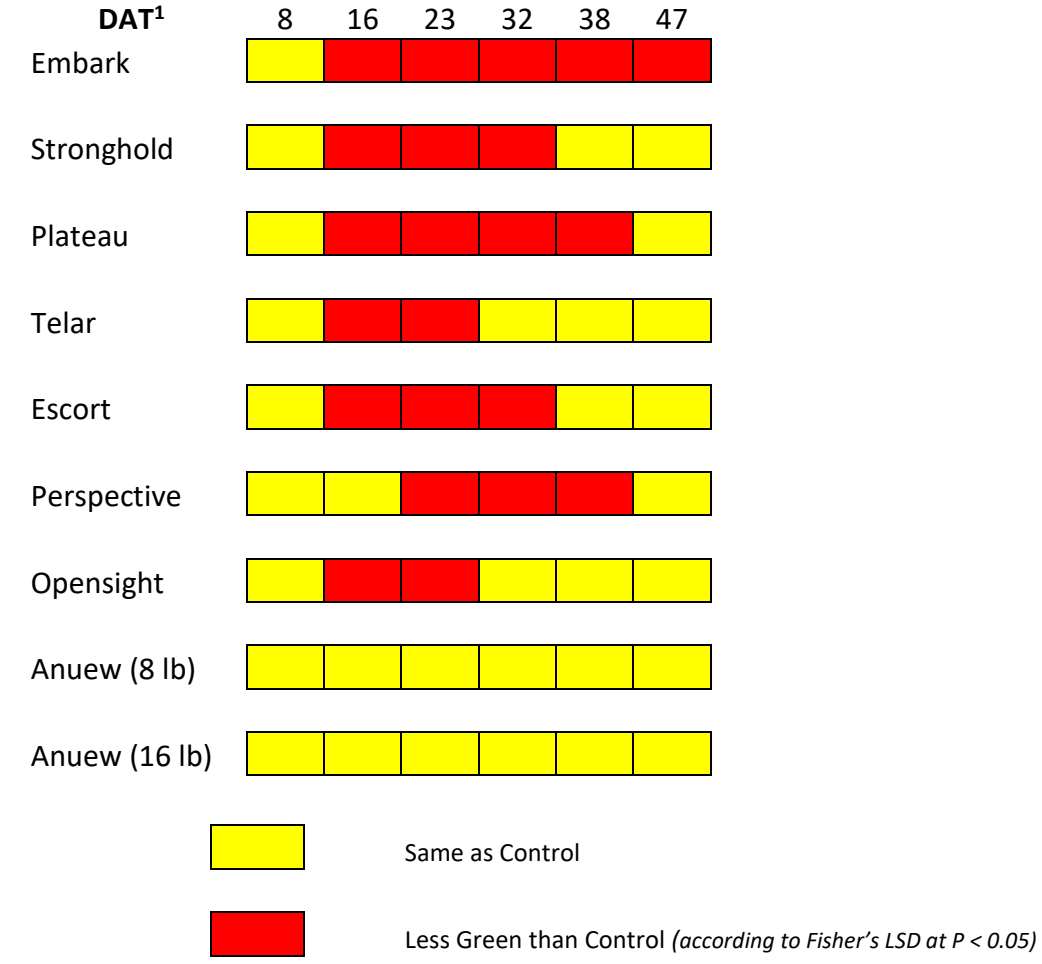
Table 8. Results from Endemic Turf Plots (38 and 47 Days After Treatment (DAT))

				August 15, 2017		August 24, 2017	
				Color (0-9)	Ht (in)	Color (0-9)	Ht (in)
Treatment	Product Names	Rate (per Acre)	Rate Unit	38 DAT		47 DAT	
1	Embark	24	fl oz/a	7.5 c	5.5 c	7.4 b	5.5 c
2	Stronghold	12	fl oz/a	7.8 b[1]	6.0 bc	7.7 ab	6.2 bc
3	Plateau	2	fl oz/a	8.0 a	6.7 ab	8.0 a	6.7 ab
4	Telar	0.25	oz/a	8.0 a	6.7 ab	8.0 a	7.0 ab
5	Escort	0.5	oz/a	8.0 a	7.0 ab	7.9 a	7.3 a
6	Perspective	4.5	oz/a	8.0 a	6.3 bc	7.9 a	6.2 bc
7	Opensight	2.5	oz/a	8.0 a	7.7 a	8.0 a	7.5 a
8	Anuew AMS	8 8	oz/a oz/a	7.9 ab	6.7 ab	8.0 a	6.7 ab
9	Anuew AMS	16 16	oz/a oz/a	7.9 ab	6.3 bc	7.8 ab	6.7 ab
10	Untreated Check			8.0 a	6.3 bc	8.0 a	7.2 a

All herbicide treatments contained the adjuvant, Activator 90 at 0.25% v/v.

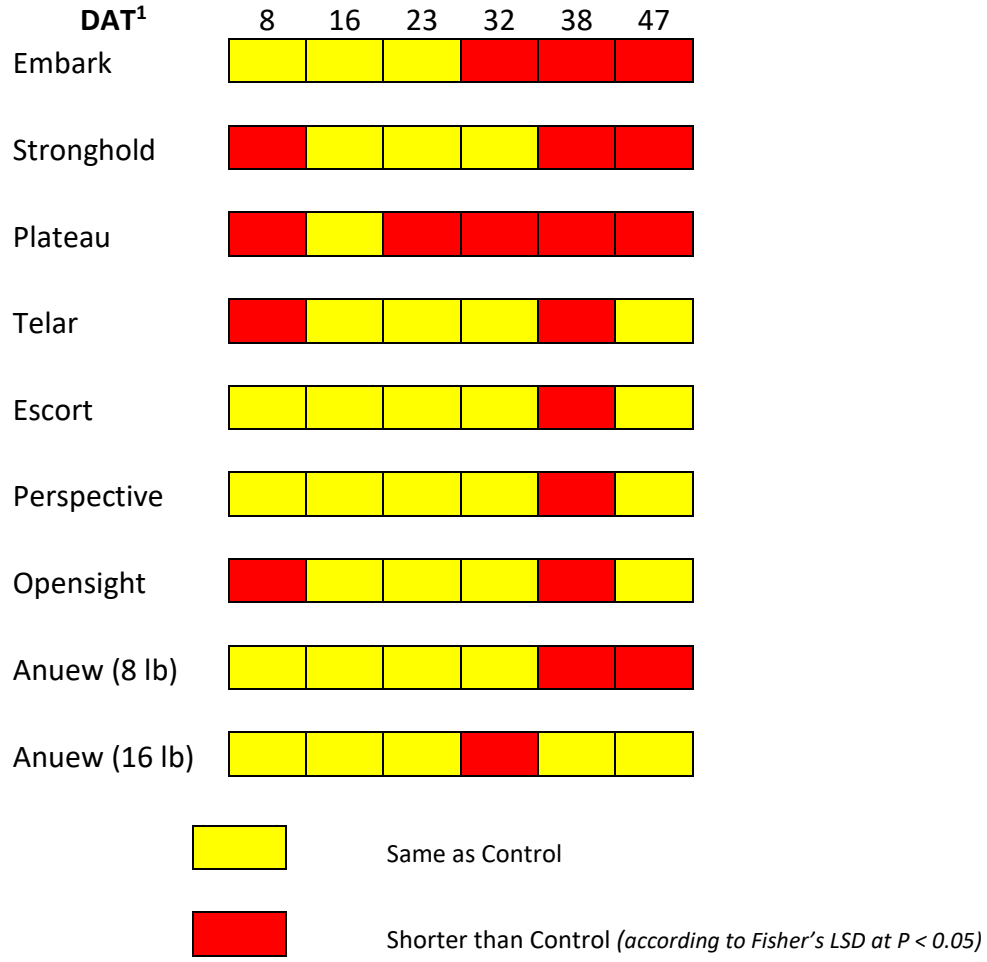
[1] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Figure 1. Summary of Turf Type Fescue Color



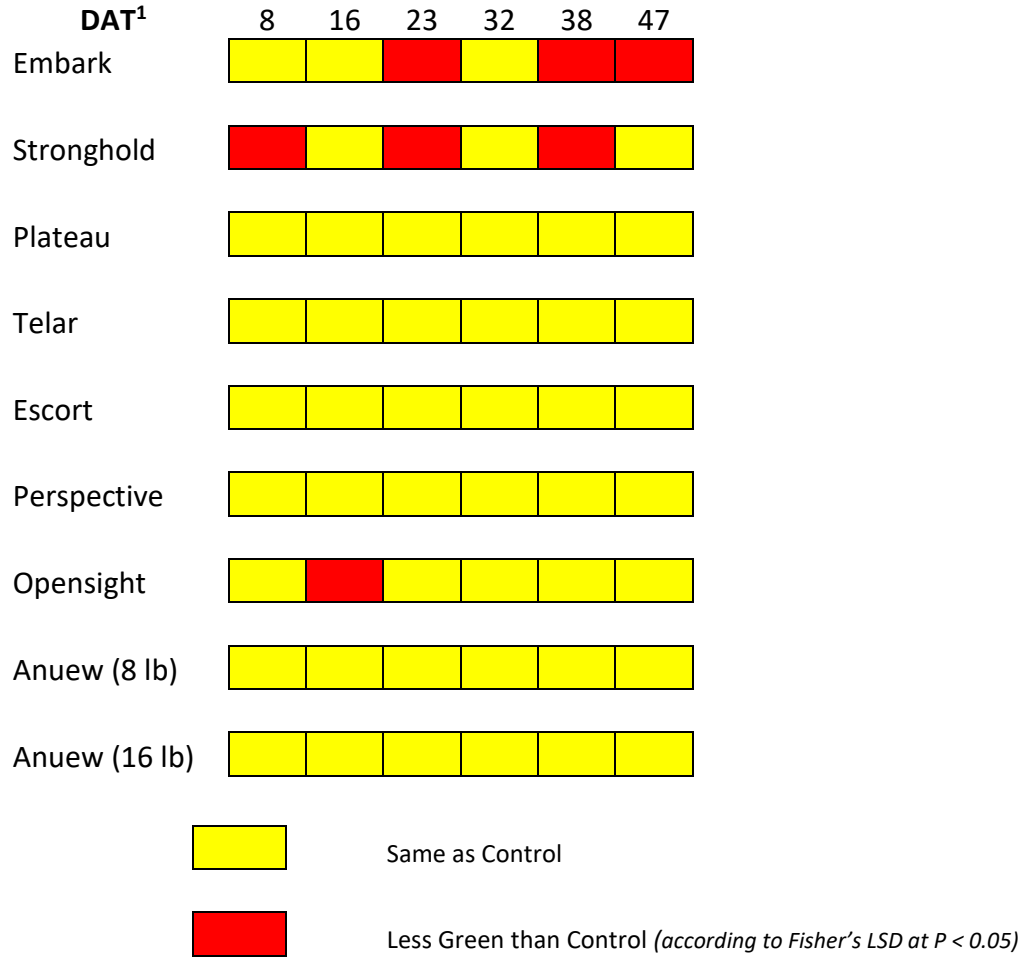
[1] *DAT = Days after treatment*

Figure 2. Summary of Turf Type Fescue Height



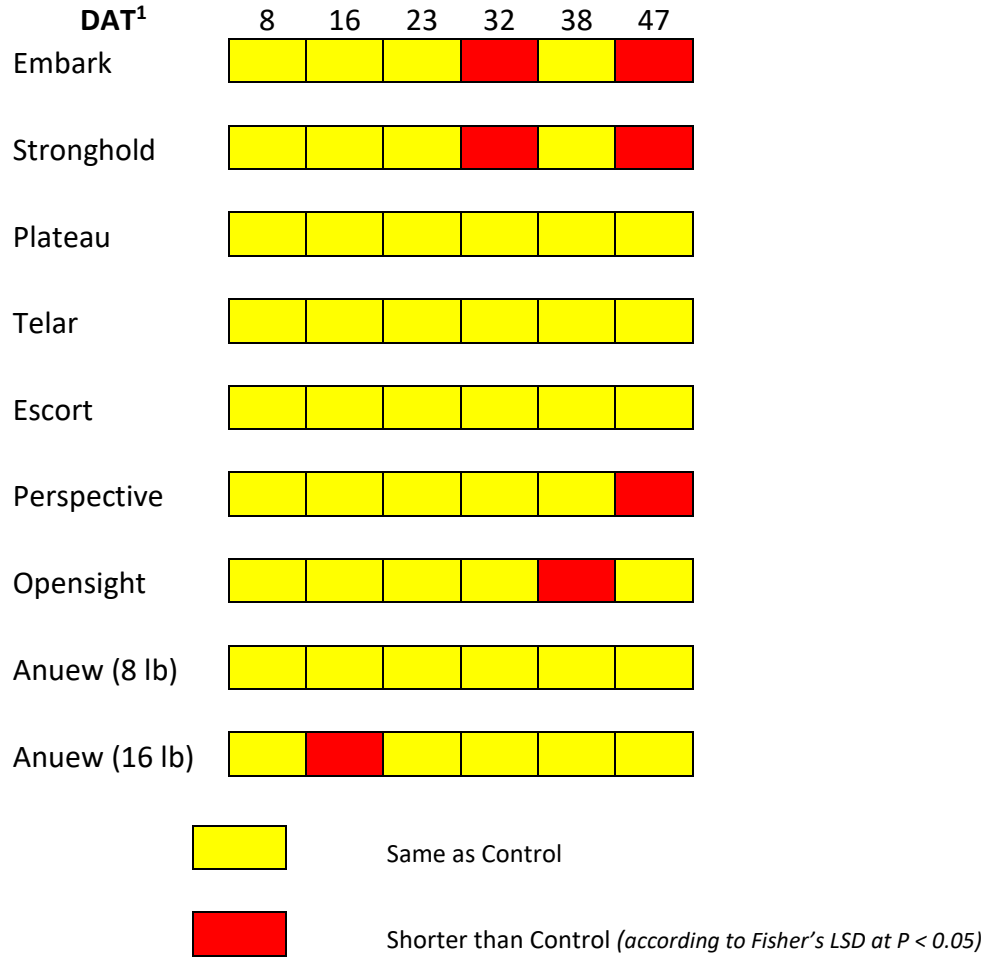
[1] *DAT = Days after treatment*

Figure 3. Summary of Endemic Turf Color



[1] *DAT = Days after treatment*

Figure 4. Summary of Endemic Turf Height



[1] *DAT = Days after treatment*

2017 Johnsongrass Control Trial in Rowan County

Introduction

Johnsongrass (*Sorghum halepense*) is a perennial warm-season grass, a noxious weed in Kentucky, and is a common problem on right-of-ways. There are a number of herbicides labeled and available to control johnsongrass on right-of-ways. However, some of these can damage desirable cool-season turf, such as tall fescue. One of the johnsongrass control herbicides that is safer to use on tall fescue is Fusion. However, a 2012 Fusion label change made it no longer available for use on right-of-way sites. This trial is a continuation of the evaluation of a range of alternative johnsongrass control/suppression options.

Materials and Methods

The site was along an entrance ramp along I64 in Rowan County KY. It was mowed July 25, 2017 and the johnsongrass regrowth treated August 30, 2017. The trial had 20 treatments with 3 replications of each arranged in a randomized complete block design with 7 ft by 20 ft plots. Application was at 30 gallons /acre carrier volume. The johnsongrass was 36 to 58 inches tall with an overall average canopy height of 48 inches. About 5% of plants had emerged seedheads. Johnsongrass control was assessed 23 (9/22/2017) and 53 (10/22/2017) days after treatment (DAT). Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Table 1 lists the treatments, active ingredients and application rates. The 2011 Fusion label rates for selective control of johnsongrass were 7 to 9 oz/A (Treatments 1 and 2). The rates on the label for Envoy are 16 and 32 fl oz/A (Treatments 3 and 4). Previous trials had used 13, 15, and 17 fl oz/A to find the best selective Envoy rate with the minimal fescue damage. The labeled Fusilade II rates are 16 to 24 oz/A (Treatments 5 and 6). The Acclaim Extra label lists 20 oz/A per acre to control seedling johnsongrass 12 – 24 inches tall (Treatment 7); 39 oz/A to control rhizome johnsongrass 24 to 60 inches tall (Trt. 8); and a combination of Acclaim Extra plus Fusilade (0.5 plus 3.5 oz/A), for improved turfgrass tolerance and to control rhizome johnsongrass 10 to 25 inches tall (Treatment 9). The Outrider label rates for selective johnsongrass control in tall fescue turf are 0.75 to 1 oz/A (Treatments 10 and 11). Treatment 12 is MSMA applied alone and Treatment 13 is MSMA applied in combination with Outrider at 0.75 oz/A. Clearcast (Treatment 14) has an aquatic label and may be used close to waterways. The high rate of Plateau used in Treatment 15 will severely damage tall fescue. Poast Plus is an herbicide option we have not tested recently and its label for this region of the U.S. lists control of rhizome johnsongrass up to 25 inches tall (Treatments 16 and 17). Roundup (Treatment 18) and Journey (Treatment 19) are non-selective.

Results and Discussion

The regrowth of the johnsongrass at this site was vigorous and the plants were quite large at the time of application. All the treatments controlled johnsongrass to some extent 23 and 53 days after treatment (DAT) (Table 2). The most effective treatments 23 DAT had 68 to 78% control. These included both rates of Envoy (Treatments 3 and 4), both rates of Fusilade II (Treatments 5 and 6), both rates of Acclaim Extra (Treatments 7 and 8), the combination of Acclaim + Fusilade (Treatment 9), both rates of Poast (Treatments 16 and 17) and Roundup ProMax (Treatment 18).

At 53 DAT, the top group of treatments had 83 to 93% control and were many of the same treatments as at 23 DAT. At the second rating, the best treatments were the high rate of Fusion (Treatment 2), both rates of Envoy (Treatments 3 and 4), both rates of Fusilade II (Treatments 5 and 6), the high rate of Acclaim Extra (Treatment 8), the combination of Acclaim + Fusilade (Treatment 9), Roundup ProMax (Treatment 18) and Journey (Treatment 19).

The herbicides that quickly injured the aboveground portion of the johnsongrass plants may not necessarily be the ones providing the best long-term control. Outrider has performed well in our trials but is slower to show foliar control. Long-term control ratings will be taken in spring 2018.

Table 1. Herbicide Treatments, Active Ingredients and Application Rates.

Trt. No.	Product Name	Rate	Rate Unit	Active Ingredient(s)	AI Rate (per acre)
1	Fusion Activator 90	7 0.25	FL OZ/A % V/V	fluazifop + fenoxaprop	1.75 oz + 0.49 oz
2	Fusion Activator 90	9 0.25	FL OZ/A % V/V	fluazifop + fenoxaprop	2.25 oz + 0.63 oz
3	Envoy COC	16 1	FL OZ/A % V/V	clethodim	1.9 oz
4	Envoy COC	32 1	FL OZ/A % V/V	clethodim	3.9 oz
5	Fusilade II Activator 90	16 0.25	FL OZ/A % V/V	fluazifop	4 oz
6	Fusilade II Activator 90	24 0.25	FL OZ/A % V/V	fluazifop	6 oz
7	Acclaim Extra Activator 90	20 0.25	FL OZ/A % V/V	fenoxaprop	1.4 oz
8	Acclaim Extra Activator 90	39 0.25	FL OZ/A % V/V	fenoxaprop	2.78 oz
9	Acclaim Extra Fusilade II COC	7 14 1	FL OZ/A FL OZ/A % V/V	fenoxaprop fluazifop	0.5 oz 3.5 oz
10	Outrider Activator 90	0.75 0.25	OZ/A % V/V	sulfosulfuron	0.563 oz
11	Outrider Activator 90	1 0.25	OZ/A % V/V	sulfosulfuron	0.75 oz
12	MSMA	32	FL OZ/A	monosodium acid methanearsonate	24 oz
13	Outrider MSMA	0.75 32	OZ/A FL OZ/A	sulfosulfuron monosodium acid methanearsonate	0.563 oz 24 oz
14	Clearcast MSO	32 1	FL OZ/A % V/V	imazamox	4 oz ae
15	Plateau MSO	8 1	FL OZ/A % V/V	imazapic	2 oz ae
16	Poast Plus MSO	2.25 1	PT/A % V/V	sethoxydim	4.5 oz
17	Poast Plus MSO	3.75 1	PT/A % V/V	sethoxydim	7.5 oz
18	Roundup ProMax	22	FL OZ/A	glyphosate	12.4 oz ae
19	Journey MSO	21.3 1	FL OZ/A % V/V	imazapic + glyphosate	2 oz ae + 4 oz ae
20	Nontreated Check				

Table 2. Herbicide Treatments and % Control 23 and 53 Days After Treatment (DAT)

Trt. No.	Product Name	Rate	Rate Unit	23 DAT	53 DAT
1	Fusion Activator 90	7 0.25	FL OZ/A % V/V	40 efg[1]	75 cde
2	Fusion Activator 90	9 0.25	FL OZ/A % V/V	60 bcde	88 ab
3	Envoy COC	16 1	FL OZ/A % V/V	70 abcd	87 abc
4	Envoy COC	32 1	FL OZ/A % V/V	77 ab	88 ab
5	Fusilade II Activator 90	16 0.25	FL OZ/A % V/V	72 abc	87 abc
6	Fusilade II Activator 90	24 0.25	FL OZ/A % V/V	75 ab	88 ab
7	Acclaim Extra Activator 90	20 0.25	FL OZ/A % V/V	85 a	73 de
8	Acclaim Extra Activator 90	39 0.25	FL OZ/A % V/V	68 abcd	85 abcd
9	Acclaim Extra Fusilade II COC	7 14 1	FL OZ/A FL OZ/A % V/V	78 ab	93 a
10	Outrider Activator 90	0.75 0.25	OZ/A % V/V	23 gh	72 e
11	Outrider Activator 90	1 0.25	OZ/A % V/V	32 fg	78 bcde
12	MSMA	32	FL OZ/A	43 efg	77 bcde
13	Outrider MSMA	0.75 32	OZ/A FL OZ/A	50 cdef	80 bcde
14	Clearcast MSO	32 1	FL OZ/A % V/V	27 fg	72 e
15	Plateau MSO	8 1	FL OZ/A % V/V	33 fg	80 bcde
16	Poast Plus MSO	2.25 1	PT/A % V/V	72 abc	52 f
17	Poast Plus MSO	3.75 1	PT/A % V/V	75 ab	75 cde
18	Roundup ProMax	22	FL OZ/A	75 ab	87 abc
19	Journey MSO	21.3 1	FL OZ/A % V/V	47 defg	83 abcde
20	Nontreated Check			0 h	0 g

[1] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

2017 Fescue Damage by Johnsongrass Control Options

Introduction

Johnsongrass (*Sorghum halepense*) is a perennial warm-season grass, a noxious weed in Kentucky, and is a common problem on right-of-ways. There are a number of herbicides labeled and available to control johnsongrass on right-of-ways. However, some of these can damage desirable cool-season turf, such as tall fescue. One of the johnsongrass control herbicides that is safer to use on tall fescue is Fusion. Hiowever, a 2012 Fusion label change made it no longer available for use on right-of-way sites. This trial is a continuation of the evaluation of a range of alternative johnsongrass control/suppression options.

Materials and Methods

The trial were established August 26, 2017 at Spindletop Research Farm on a tall fescue field when the plants were 10 inches high. The trial had 20 treatments with 3 replications of each arranged in a randomized complete block design with 3.5 ft by 10 ft plots and 1.5 ft wide unsprayed buffers between each of the plots. Application was at 30 gallons per acre carrier volume. Tall fescue color was assessed every two weeks by comparison to the running check strips. The color rating ranges from 0 (dead) to 9 (full green). The color of the check strips was set at 8. Plots were assessed 14 (9/9/2017), 29 (9/24/2017), 45 (10/10/2017), 57 (10/22/2017), and 75 (11/9/2017) days after treatment (DAT). Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$.

Table 1 lists the treatments, active ingredients and application rates. The 2011 Fusion label rates for selective control of johnsongrass were 7 to 9 oz/A (Treatments 1 and 2). The johnsongrass control rates on the label for Envoy are 16 and 32 fl oz/A (Treatments 3 and 4). Previous trials had used 13, 15, and 17 fl oz/A to find the best selective rate with less fescue damage. The labeled Fusilade II rates for johnsongrass control are 16 to 24 oz/A (Treatments 5 and 6). The Acclaim Extra label lists 20 oz/A per acre to control seedling johnsongrass 12 – 24 inches tall (Treatment 7); 39 oz/A to control rhizome johnsongrass 24 to 60 inches tall (Trt. 8); and a combination of Acclaim Extra plus Fusilade (0.5 plus 3.5 oz/A), for improved turfgrass tolerance and to control rhizome johnsongrass 10 to 25 inches tall (Treatment 9). The Outrider label rates for selective johnsongrass control in tall fescue turf are 0.75 to 1 oz/A (Treatments 10 and 11). Treatment 12 is MSMA applied alone and Treatment 13 is MSMA applied in combination with Outrider at 0.75 oz/A. Clearcast (Treatment 14) has an aquatic label and may be used close to waterways. The high rate of Plateau used in Treatment 15 will severely damage tall fescue. Poast Plus is an herbicide option we have not tested recently and its label for this region of the U.S. lists control of rhizome johnsongrass up to 25 inches tall (Treatments 16 and 17). Roundup (Treatment 18) and Journey (Treatment 19) are non-selective.

Results and Discussion

Some treatments showed good safety on tall fescue with color ratings that were not different from the nontreated check over all the ratings while others showed recovery of color following an initial decrease by the end of the season (Table 2). Treatments with color ratings unchanged from the control included both rates of Fusion (Treatments 1 and 2), both rates of Acclaim Extra (Treatments 7 and 8) and MSMA by itself (Treatment 12) plus in combination with Outrider (Treatment 13). Treatments that where color recovered by 75 DAT included the low rate of Envoy (Treatment 3), both rates of Fusilade (Treatments 5 and 6), the combination of Acclaim + Fusilade (Treatment 9), both rates of Outrider (Treatments 10 and 11), both rates of Poast (Treatments 16 and 17) and Roundup (Treatment 18). Fescue color in plots treated with the high rate of Envoy (Treatment 4), Clearcast (Treatment 14), Plateau (Treatment 15) or Journey (Treatment 19) did not recover before the end of the season. These treatments would be not be recommended if one wants to preserve existing fescue in the application area. Ratings of fescue density will be taken in spring 2018.

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Table 1. Herbicide Treatments, Active Ingredients and Application Rates.

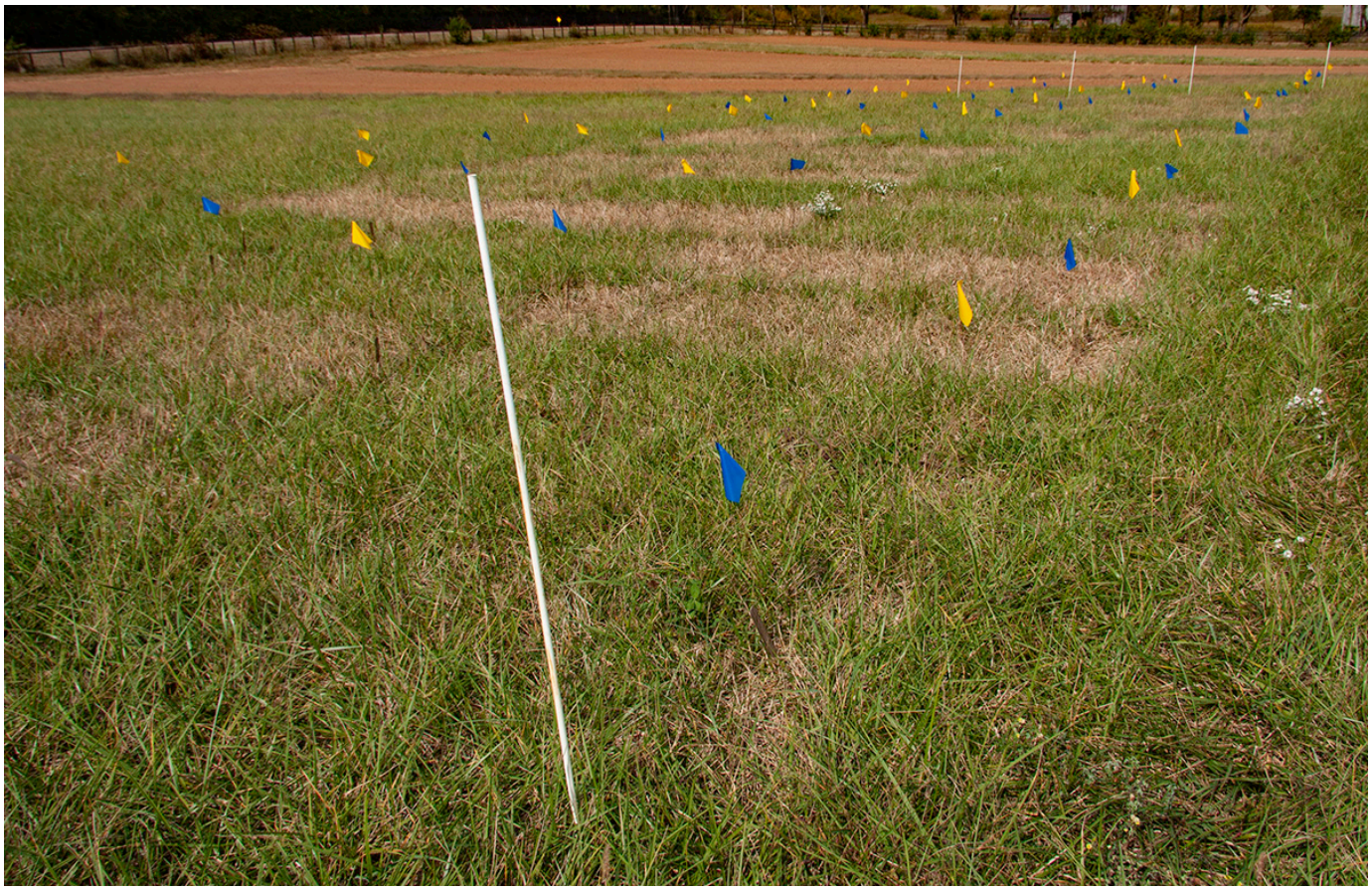
Trt. No.	Product Name	Rate	Rate Unit	Active Ingredient(s)	AI Rate (per acre)
1	Fusion Activator 90	7 0.25	FL OZ/A % V/V	fluazifop + fenoxaprop	1.75 oz + 0.49 oz
2	Fusion Activator 90	9 0.25	FL OZ/A % V/V	fluazifop + fenoxaprop	2.25 oz + 0.63 oz
3	Envoy COC	16 1	FL OZ/A % V/V	clethodim	1.9 oz
4	Envoy COC	32 1	FL OZ/A % V/V	clethodim	3.9 oz
5	Fusilade II Activator 90	16 0.25	FL OZ/A % V/V	fluazifop	4 oz
6	Fusilade II Activator 90	24 0.25	FL OZ/A % V/V	fluazifop	6 oz
7	Acclaim Extra Activator 90	20 0.25	FL OZ/A % V/V	fenoxaprop	1.4 oz
8	Acclaim Extra Activator 90	39 0.25	FL OZ/A % V/V	fenoxaprop	2.78 oz
9	Acclaim Extra Fusilade II COC	7 14 1	FL OZ/A FL OZ/A % V/V	fenoxaprop fluazifop	0.5 oz 3.5 oz
10	Outrider Activator 90	0.75 0.25	OZ/A % V/V	sulfosulfuron	0.563 oz
11	Outrider Activator 90	1 0.25	OZ/A % V/V	sulfosulfuron	0.75 oz
12	MSMA	32	FL OZ/A	monosodium acid methanearsonate	24 oz
13	Outrider MSMA	0.75 32	OZ/A FL OZ/A	sulfosulfuron monosodium acid methanearsonate	0.563 oz 24 oz
14	Clearcast MSO	32 1	FL OZ/A % V/V	imazamox	4 oz ae
15	Plateau MSO	8 1	FL OZ/A % V/V	imazapic	2 oz ae
16	Poast Plus MSO	2.25 1	PT/A % V/V	sethoxydim	4.5 oz
17	Poast Plus MSO	3.75 1	PT/A % V/V	sethoxydim	7.5 oz
18	Roundup ProMax	22	FL OZ/A	glyphosate	12.4 oz ae
19	Journey MSO	21.3 1	FL OZ/A % V/V	imazapic + glyphosate	2 oz ae + 4 oz ae
20	Nontreated Check				

Table 2. Herbicide Treatments and Fescue Color (0-9) 14, 29, 45, 57, and 75 Days After Treatment (DAT)

Trt. No.	Product Name	Rate	Rate Unit	14 DAT	29 DAT	45 DAT	57 DAT	75 DAT
1	Fusion Activator 90	7 0.25	FL OZ/A % V/V	7.8 ab[1]	7.9 a	7.7 ab	8.0 a	7.9 a
2	Fusion Activator 90	9 0.25	FL OZ/A % V/V	7.6 abc	7.5 ab	7.2 ab	7.5 abc	8.0 a
3	Envoy COC	16 1	FL OZ/A % V/V	6.2 e	2.7 fg	3.3 fg	5.2 e	7.0 ab
4	Envoy COC	32 1	FL OZ/A % V/V	6.3 e	1.3 h	0.8 i	3.2 f	3.8 d
5	Fusilade II Activator 90	16 0.25	FL OZ/A % V/V	7.5 abcd	6.3 bcd	6.5 bc	7.2 abc	7.9 a
6	Fusilade II Activator 90	24 0.25	FL OZ/A % V/V	7.0 d	4.7 e	3.8 ef	5.7 de	7.3 a
7	Acclaim Extra Activator 90	20 0.25	FL OZ/A % V/V	8.0 a	8.0 a	8.0 a	8.0 a	8.0 a
8	Acclaim Extra Activator 90	39 0.25	FL OZ/A % V/V	7.9 a	8.0 a	8.0 a	8.0 a	8.0 a
9	Acclaim Extra Fusilade II COC	7 14 1	FL OZ/A FL OZ/A % V/V	7.6 abc	6.2 cd	6.7 bc	7.3 abc	8.0 a
10	Outrider Activator 90	0.75 0.25	OZ/A % V/V	7.0 d	5.7 de	5.5 cd	6.7 bcd	7.8 a
11	Outrider Activator 90	1 0.25	OZ/A % V/V	7.2 cd	6.2 cd	4.7 de	6.3 cde	7.9 a
12	MSMA	32	FL OZ/A	8.0 a	8.0 a	8.0 a	8.0 a	8.0 a
13	Outrider MSMA	0.75 32	OZ/A FL OZ/A	7.8 a	7.3 abc	7.2 ab	7.7 ab	8.0 a
14	Clearcast MSO	32 1	FL OZ/A % V/V	7.0 d	3.3 f	0.5 i	1.5 g	2.8 d
15	Plateau MSO	8 1	FL OZ/A % V/V	7.2 bcd	5.5 de	1.0 i	2.7 fg	5.7 bc
16	Poast Plus MSO	2.25 1	PT/A % V/V	7.2 cd	3.2 f	4.5 def	5.3 e	6.7 ab
17	Poast Plus MSO	3.75 1	PT/A % V/V	6.3 e	2.5 fgh	1.5 hi	3.7 f	6.8 ab
18	Roundup ProMax	22	FL OZ/A	5.3 f	3.0 f	2.5 gh	5.7 de	7.2 ab
19	Journey MSO	21.3 1	FL OZ/A % V/V	6.2 e	1.7 gh	1.2 i	2.5 fg	4.2 cd
20	Nontreated Check			8.0 a	8.0 a	8.0 a	8.0 a	8.0 a

[1] Means within a column followed by the same letter are not different according to Fisher's LSD at P < 0.05.

Figure 1: Overall View of the Plots 45 DAT (Oct. 6, 2017)
The plots in the foreground were treated with Fusion (Treatments 1 and 2) and one can see the damaged fescue from other treatments as well as the unsprayed borders between plots.



Effect of Mowing Timing on Johnsongrass Herbicide Efficacy: Two Year Summary

Joe Omielan and Michael Barrett
University of Kentucky

INTRODUCTION

Johnsongrass (*Sorghum halepense*) is a perennial warm season grass, listed as a noxious weed, and a common problem on right-of-way sites. There are a number of herbicides labeled and available to control johnsongrass and most rely on translocation from the leaves to the rhizomes for greatest efficacy. However, mowing also is part of roadside management and one common question is: How long after herbicide application do we need to wait before mowing without reducing herbicide efficacy on johnsongrass control?

OBJECTIVE

The objective of this study was to evaluate the effect of the amount of time between herbicide application and mowing on johnsongrass control.

MATERIALS & METHODS

This study was initiated August 14, 2014 and repeated August 24, 2015 at an interchange near Bardstown KY. Four herbicide treatments were applied to 3 m x 18 m strips at 280 L/ha (Table 1). Average johnsongrass height was 75 cm. Six time of mowing treatments (Table 2) were applied as 3 m x 12 m strips across the herbicide treatments (Fig. 1) in a split block design, replicated three times (4 times in 2015). The mowing height was 13 cm. The herbicide treatments were Outrider (sulfosulfuron), Fusilade II (fluazifop), Acclaim Extra (fenoxaprop), and Fusilade + Acclaim. The time of mowing treatments were as follows: no mowing, same day as herbicide application, as well as 1 day, 2 days, 1week, and 2 weeks after application.

Visual assessments of percent johnsongrass control were done 34 (9/17/2014), 70 (10/23/2014), and 350 (7/30/2015) days after herbicide treatment (DAT) for the 2014 trial. Assessments were done 32 (9/25/2015), 45 (10/8/2015), 53 (10/16/2015), and 298 (6/17/2016) DAT for the 2015 trial. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at p = 0.05.

RESULTS & DISCUSSION

Differences in johnsongrass control among herbicide treatments with mowing within hours of application were evident 34 DAT in the 2014 trial (Table 3A) with Outrider providing greater control than other herbicide treatments with the same day mowing treatment. There may have been more soil uptake with Outrider than other herbicide treatments as well as faster translocation to the rhizomes. Acclaim Extra had less control than the other herbicide treatments at many of the shorter mowing intervals (Table 3A & B) (Fig. 2). By 350 DAT, control in the top set of treatment combinations ranged from 43 to 92% (Table 3C).

Regrowth of johnsongrass after mowing was slower in 2015 than in 2014. One reason may be the timing of rainfall. There was 16.1 cm in Aug. 2014 but only 7.1 cm in Aug. 2015 (long term average is 8.9 cm). We saw 89% johnsongrass control with the Outrider and Fusilade II treatments when mowed the same day 32 DAT and 81 to 85% control 53 DAT (Table 4A). Control for the other herbicide treatments mowed the same day ranged from 72 to 75% 53 DAT. At the final assessment in 2016 (298 DAT), the control varied considerably among treatments and ranged from 13 to 48% for plots mowed the same day in 2015, with the least control for the Acclaim Extra treatment (Table 4B).

Table 1. Herbicide treatments, application rates, and active ingredients used in this trial.

Trt. No.	Product(s)	Rate per acre	Active Ingredients
1	Outrider	1 oz	sulfosulfuron
	Activator 90	0.25% v/v	
2	Fusilade II	24 fl oz	fluazifop
	Activator 90	0.25% v/v	
3	Acclaim Extra	39 fl oz	fenoxaprop
	Activator 90	0.25% v/v	
4	Acclaim Extra	7 fl oz	fenoxaprop
	Fusilade II	14 fl oz	fluazifop
	COC	1%	

Table 2. Timing of mowing treatments used in this trial.

Trt No.	Timing of Mowing Treatments
1	Same day as herbicide application
2	1 Day after
3	2 Days after
4	1 Week after
5	2 Weeks after
6	No mowing

Table 3. Herbicide x mowing treatment combinations and % johnsongrass control 34 DAT **(A)**, 70 DAT **(B)** and 350 DAT **(C)** in 2014 trial.

(A) Mowing Time	Outrider	Fusilade II	Acclaim Extra	Acclaim + Fusilade
Same Day	83 *cd*	39 *gh*	45 *g*	30 *h*
1 Day After	97 *ab*	90 *abcd*	65 *f*	87 *bcd*
2 Days After	98 *a*	91 *abcd*	68 *f*	91 *abcd*
1 Week After	99 *a*	91 *abcd*	72 *ef*	93 *abc*
2 Weeks After	99 *a*	95 *ab*	83 *cd*	93 *abc*
No Mowing	70 *f*	87 *bcd*	82 *de*	87 *bcd*

(B) Mowing Time	Outrider	Fusilade II	Acclaim Extra	Acclaim + Fusilade
Same Day	88 *ab*	0 *f*	17 *ef*	14 *ef*
1 Day After	99 *a*	94 *a*	37 *de*	96 *a*
2 Days After	100 *a*	97 *a*	48 *cd*	98 *a*
1 Week After	100 *a*	97 *a*	67 *bc*	99 *a*
2 Weeks After	100 *a*	100 *a*	94 *a*	99 *a*
No Mowing	93 *a*	99 *a*	92 *a*	97 *a*

(C) Mowing Time	Outrider	Fusilade II	Acclaim Extra	Acclaim + Fusilade
Same Day	55 *a-h*	8 *h*	13 *gh*	40 *b-h*
1 Day After	75 *a-e*	78 *abc*	27 *e-h*	28 *d-h*
2 Days After	68 *a-f*	88 *ab*	35 *c-h*	50 *a-h*
1 Week After	72 *a-e*	92 *a*	43 *a-h*	55 *a-h*
2 Weeks After	72 *a-e*	33 *c-h*	20 *fgh*	38 *c-h*
No Mowing	62 *a-g*	76 *a-d*	58 *a-g*	61 *a-g*

Means within a rating time followed by the same letter are not different according to Fisher's Protected LSD at P < 0.05..

Figure 1. Mowing on day of application (August 14, 2014).

Figure 2. Overview of Rep 1 plots 34 DAT in 2014 trial. Red flags mark edge of block while yellow and blue flags mark center of herbicide strips.

Table 4. Herbicide x mowing treatment combinations and % johnsongrass control 53 DAT **(A)** and 298 DAT **(B)** in 2015 trial.

(A) Mowing Time	Outrider	Fusilade II	Acclaim Extra	Acclaim + Fusilade
Same Day	81 *abc*	85 *abc*	72 *c*	75 *bc*
1 Day After	83 *abc*	91 *a*	91 *a*	90 *ab*
2 Days After	93 *a*	89 *ab*	90 *ab*	87 *ab*
1 Week After	90 *ab*	86 *abc*	88 *ab*	93 *a*
2 Weeks After	87 *ab*	88 *ab*	89 *ab*	91 *a*
No Mowing	89 *ab*	87 *ab*	95 *a*	96 a

(B) Mowing Time	Outrider	Fusilade II	Acclaim Extra	Acclaim + Fusilade
Same Day	48 *a*	36 *ab*	13 *b*	21 *ab*
1 Day After	38 *ab*	41 *ab*	21 *ab*	24 *ab*
2 Days After	55 *a*	54 *a*	36 *ab*	48 *a*
1 Week After	55 *a*	51 *a*	29 *ab*	29 *ab*
2 Weeks After	51 *a*	50 *a*	36 *ab*	23 *ab*
No Mowing	50 *a*	38 *ab*	23 *ab*	23 *ab*

Means within a rating time followed by the same letter are not different according to Fisher's LSD at P < 0.05..

SUMMARY

Mowing timing did affect herbicide efficacy. The 2014 results suggest that mowing 1 or 2 days after application will not reduce the efficacy of Outrider, Fusilade, or Acclaim + Fusilade. However, one should wait 2 weeks before mowing if Acclaim Extra was applied. While there was less regrowth following the treatments in 2015 compared to 2014, the results support the same delay before mowing for these herbicides.

PGR Options for Roadside Tall Fescue Management

Joe Omielan and Michael Barrett
University of Kentucky

INTRODUCTION

Tall fescue is a widely adapted species and is commonly used on roadsides in the transition zone. Multiple mowings are the most common tall fescue management regime for transportation departments. Plant Growth Regulators (PGRs) could potentially reduce mowing while maintaining safe highway conditions. PGRs are currently classified into six categories, Classes A – F, based on their mechanism of action. This trial includes examples of Class A, C, and D PGRs and was established to evaluate some PGR options for roadside management. Class A are late GA synthesis blockers, Class C are mitotic/cell division inhibitors, and Class D are herbicidal.

OBJECTIVE

Evaluate the effect of effect of selected PGRs on tall fescue color, seedhead production, and growth.

MATERIALS & METHODS

The trial was established in 2017 at the Spindletop Research Farm in Lexington KY. It was arranged as a complete block design with 21 PGR treatments and three replications. Plots were 2 m by 6 m with running unsprayed checks between each of the plots. PGRs were applied before the first mowing and one to two weeks after each of the three mowings. The control had no PGR applied. Mowing was done May 22, July 26, and September 26 all in 2017.

Products tested were Embark 2S (mefluidide [Class C]) at 24 fl oz/A, Plateau (imazapic)(Class D) at 2 fl oz/A, Opensight (aminopyralid + metsulfuron methyl [Class D]) at 2.5 fl oz/A, Anuew (prohexadione calcium [Class A]) at 1 lb/A, and Perspective (aminocyclopyrachlor + clorsulfuron [Class D]) at 4.75 oz/A. All applications were at 234 L/ha and included a non-ionic surfactant at 0.25% v/v. Application dates were April 26, June 1, August 8, and October 6 in 2017.

Tall fescue color was assessed by comparison to the running check strips. The color rating ranges from 0 (dead) to 9 (full green). The color of the check strips was set at 8. Seedhead density was assessed before the first mowing. Canopy heights were measured every two weeks through the growing season. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at p = 0.05.

Figure 1. Example of plot with reduced tall fescue color, height, and seedhead density 26 days after the April 26 application.

RESULTS & DISCUSSION

Table 1. Tall fescue color and seedhead height/density 26 days after the April 26 application.

Product(s)	Color (0-9)	Ht to Seedhead (in)	Seedhead Density (%)
Embark 2S	7.4 *a*	34 *b*	93 *a*
Plateau	6.2 *b*	18 *d*	10 *bc*
Opensight	6.2 *b*	21 *d*	8 *c*
Anuew	7.5 *a*	28 *c*	93 *a*
Perspective	6.2 *b*	20 *d*	20 *b*
Control	8.0 *a*	39 *a*	100 *a*

Means followed by the same letter are not different according to Fisher's Protected LSD at P < 0.05.

Table 2. Tall fescue color and canopy height 36 days after the June 1 application.

Product(s)	Color (0-9)	Canopy Ht (in)
Embark 2S	5.7 *d*	12 *cde*
Plateau	6.7 *c*	12 *cde*
Opensight	7.2 *bc*	11 *ef*
Anuew	7.2 *bc*	10 *f*
Perspective	5.7 *d*	12 *de*
Control	8.0 *a*	14 *ab*

Means followed by the same letter are not different according to Fisher's Protected LSD at P < 0.05.

Table 3. Tall fescue color and canopy height 32 days after the August 8 application.

Product(s)	Color (0-9)	Canopy Ht (in)
Embark 2S	5.8 *c*	12 *bcdef*
Plateau	4.2 *d*	10 *f*
Opensight	7.0 *b*	11 *cdef*
Anuew	7.8 *a*	11 *ef*
Perspective	7.2 *b*	11 *def*
Control	8.0 *a*	13 *ab*

Means followed by the same letter are not different according to Fisher's Protected LSD at P < 0.05.

Table 4. Tall fescue color and canopy height 34 days after the October 6 application.

Product(s)	Color (0-9)	Canopy Ht (in)
Embark 2S	7.7 *b*	11 *bcde*
Plateau	7.2 *c*	10 *efg*
Opensight	7.3 *c*	9 *g*
Anuew	8.0 *ab*	10 *defg*
Perspective	7.2 *c*	9 *fg*
Control	8.0 *a*	14 *a*

Means followed by the same letter are not different according to Fisher's Protected LSD at P < 0.05.

Figure 2. Tall fescue color in plots treated with PGRs on April 26 through the season. Red cells indicate the tall fescue was less green than the control and yellow cells indicate color equal to the control (P < 0.05).

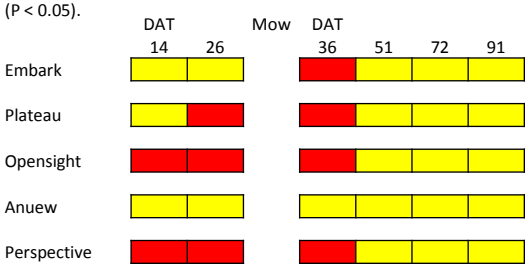
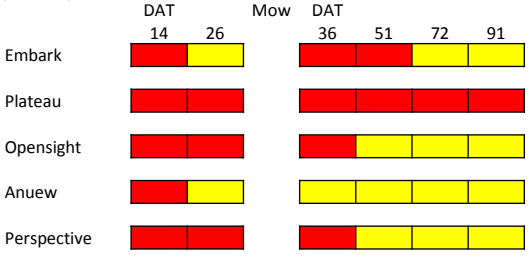


Figure 3. Tall fescue canopy height in plots treated with PGRs on April 26 through the season. Red cells indicate the tall fescue height was less than the control and yellow cells indicate height equal to the control (P < 0.05).



SUMMARY

The effects of the PGR treatments were variable. Plateau, Opensight and Perspective reduced seedhead density and height after the first application timing (Table 1 and Figure 1). Tables 1-4 show data for the plots at a similar time after all four application timings.

In general, many of the treatments reduced grass height along with turf color but color recovered (Figures 2 and 3). Anuew had less effect on color than the other treatments at most of the ratings.

Growth reduction was observed to extend beyond mowing cycles. The Plateau plots treated April 26 had shorter fescue for 136 days and they had been mowed twice in that time (Figure 3).

Plots that were treated late in the season (October 6) will be evaluated in 2018 for spring seedhead suppression.

2017 Roadside Environment Update (Agenda)
Tuesday April 4, 2017 at Frankfort KYTC Conference Center

Agenda

8:30 – 9:00 a.m. Coffee, Orange Juice & Muffins

9:00 – 9:50 a.m. Summary and discussion of Research Trials (part 1) (information on dormant stem, guardrail, kudzu, knotweed, and johnsongrass trials) (Cat. 3, 6, 10) (Dr. Joe Omielan)

9:50 – 10:40 a.m. Herbicide Resistance Management (MOA Groups, tank mixes and other management options) (General) (Dr. Michael Barrett)

10:40 – 11:00 a.m. Break

11:00 – 11:20 a.m. Monarch Butterfly programmatic agreement with US Fish and Wildlife Service (General) (Dave Harmon, KYTC Environmental Analysis)

11:20 – 12:10 p.m. Summary and discussion of Research Trials (part 2) (information on PGR, mowing, and wildflower trials plus knapweed biocontrol update) (Cat. 3, 6, 10) (Dr. Joe Omielan)

12:10 – 12:50 p.m. Lunch (Box Lunches)

12:50 – 1:10 p.m. Monarch Waystations (General) (Cindy Marquel, KYTC District 5)

1:10 – 1:30 p.m. Vegetation Removal Permitting Program (Staci Timol, KYTC)

1:30 – 2:30 p.m. KYTC Master Agreement Contract Update (Darrell Burks)

Pesticide CEUs approved: General (*2 CEU*)
Cat. 3, 6, 10 *(2 CEU*)

Attendance: 28 KYTC, 3 UK, 1 Industry

Breakdown of KYTC attendance: Central Office (8), Dept. Environ. Analysis (2)
D1 (1), D2 (2), D3 (2), D4 (4), D5 (1), D6 (2), D7 (1), D8 (2), D9 (1), D10 (1), D11 (1)

Vegetation Management for Highway Rights of Way Workshop
Tuesday July 25, 2017 at L.D. Brown Ag Expo Center, Bowling Green

Agenda

8:30 – 9:00 a.m. Registration (Rm 133-34, L.D. Brown Ag Expo Center, 406 Elrod Rd., Bowling Green, KY 42104)

9:00 – 10:00 a.m. Weed garden plus weed ID plus Hemp plots (Dr. Todd Willian) (Group A) & Herbicide Injury Demo plus New Soybean Herbicide Technologies (Dr. Joe Omielan and Dr. Mike Barrett) (Group B)

10:00 – 11:00 a.m. Weed garden plus weed ID plus Hemp plots (Dr. Todd Willian) (Group B) & Herbicide Injury Demo plus New Soybean Herbicide Technologies (Dr. Joe Omielan and Dr. Mike Barrett) (Group A)

11:00 – 12:00 p.m. Pollinator / Monarch Plots (discuss KYTC efforts in this and advice from Steve Kempf, KYTC) & KY31 vs Turf Type Fescue Establishment and Management (Dr. Paul Woosley)

12:00 – 1:00 p.m. Lunch

1:00 – 2:00 p.m. Pesticide Spill Response (Mike Smith & John Mucci, KYTC and Greg Ressler, Red River Specialties) with assistance of D3 Crew

2:00 – 3:00 p.m. Discussion and demonstration of the capabilities of the D3 Longboom truck with the crew plus Greg Ressler will present a drift control product demo and discuss some tips for successful applications.

CEU's in this workshop: 3 General and 2 Specific (Categories 3, 6, 10) (approved)

Dr. Todd Willian will provide information and practice in identifying crops and weeds at the weed garden and talk about the treatments applied to the hemp plots. (Cat. 3, 6, 10)

Dr. Joe Omielan and Dr. Mike Barrett will lead the group in an exercise examining herbicide injury symptoms on different crop species as well as talk about new soybean herbicide technologies and possible issues with them. (Cat. 3, 6, 10)

Steve Kempf will discuss pollinator / Monarch Waystation plots and provide advice on designing attractive gardens plus Dr. Paul Woosley will discuss fescue establishment and management. (General)

Mike Smith, John Mucci, and Greg Ressler will provide information on how to respond to and clean up pesticide spills with the assistance of the D3 crew. (General)

The District 3 crew will demo and discuss the Longboom truck while Greg will present a drift control product demo and provide some tips for successful applications. (General)

For more information contact Joe Omielan at 859-967-6205, e-mail joe.omielan@uky.edu

Attendance: 63 KYTC, 4 UK, 4 WKU, 2 Industry

Breakdown of KYTC attendance: Central Office (2)
D1 (2), D2 (8), D3 (24), D4 (9), D5 (5), D6 (6), D8 (6)

2017 KYTC Tree Management Workshop
Thursday September 21, 2017 at Robinson Center for Appalachian Resource Sustainability, Quicksand
176 Robinson Road, Jackson, KY 41339

Agenda

8:30 – 9:00 a.m. Registration along with coffee and donuts

9:00 – 10:00 a.m. Forest Pests and Forest Health Threats (Dr. Ellen Crocker, UK)

10:00 – 11:00 a.m. Selection and Care of Healthy Trees (Dr. Bill Fountain, UK)

11:00 – 12:00 p.m. An Overview of the International Society of Arboriculture Tree Risk Assessment Qualification. (Dr. Bill Fountain, UK)

12:00 – 1:00 p.m. Lunch

1:00 – 4:00 p.m. Outdoor Demonstrations (*please bring your hard hats and other safety gear*)

1:00 – 2:30 p.m. Chainsaw Maintenance, Safety & Ergonomics (Cody Dunkin from Bryan Equipment)

2:30 – 3:150 p.m. Demonstration of Sky Trim telescoping boom and saw-type cutter head from District 10 (District 10 crew)

3:15 – 4:00 p.m. Demonstration of Alamo Traxx remote mower (Tim Hardin from Limestone Equipment)

Pesticide CEU's for this workshop: 1 General and 1 Specific (Categories 3, 6, 10) (approved).

Arborist CEU's (5.25 CEUs) (approved).

Engineering PDH's (6 Hours) (approved).

For more information contact Joe Omielan at 859-967-6205, e-mail joe.omielan@uky.edu

Topics to be covered in the Workshop

Forest Pests and Forest Health Threats (Dr. Ellen Crocker, UK)

- An update on the current status of major forest pests and health threats including Emerald Ash Borer, Asian Longhorned Beetle, Hemlock Woolly Adelgid, and Thousand Cankers Disease. Ellen will also provide basic information on common invasive plant species in our forests.

Selection and Care of Healthy Trees (Dr. Bill Fountain, UK)

- Bill will present information on tree ID (both native and non-natives used in landscapes). It's important to pick the right tree for the location, plant it properly, and maintain it with proper pruning while avoiding mower damage and other hazards. He'll also suggest trees that are attractive and good for pollinators.

An Overview of the International Society of Arboriculture Tree Risk Assessment Qualification. (Dr. Bill Fountain, UK)

- TRAQ is an ISA qualification program that trains arborists how to use the methodologies outlined in the ISA Best Management Practices for Tree Risk Assessment. This qualification promotes the safety of people and property by providing a standardized and systematic process for assessing tree risk. The results of a tree risk assessment can provide tree owners and risk managers with the information to make informed decisions to enhance tree benefits, health, and longevity.

Outdoor Demonstrations and Hands-On Opportunities (*please bring your hard hats and other safety gear plus your chainsaws*)**:**

Chainsaw Maintenance, Safety & Ergonomics (Cody Dunkin from Bryan Equipment)

- Cody will discuss the safety features of a saw and proper PPE as well as proper starting and handling
- He will demonstrate an open face cut and notching, a plunge cut, felling a tree, and release of a tree under tension

Demonstration of Sky Trim telescoping boom and saw-type cutter head from District 10 (District 10 crew)

- See the saw cut and trim trees. Discuss its operation and maintenance.

Demonstration of Alamo Traxx remote mower (Tim Hardin from Limestone Equipment)

- See the remote mower in action. Discuss its operation and maintenance.

Attendance: 65 KYTC, 3 UK, 1 Industry

Breakdown of KYTC attendance: Central Office (2)
D6 (6), D7 (1), D8 (7), D9 (8), D10 (26), D11 (6), D12 (7)