EVALUATION OF NEW AND GENERIC HERBICIDES FOR ODOT ROADSIDE VEGETATION MANAGEMENT PROGRAMS

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MODERN METRIC CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
A	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	A
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
^oC	Celsius	1.8C+32	Fahrenheit	^oF
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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1.0 INTRODUCTION

A low-growing erosion-resistant ground cover such as bermudagrass is very beneficial in the clear or safety zone of the roadside right of way. Johnsongrass (*Sorghum halepense*) and other roadside weeds frequently exceed maximum vegetation heights (1) prescribed in the ODOT mowing manual. Additionally, when left unmowed or infrequently mowed, tall growing aggressive weeds can be very competitive with our beneficial roadside grasses yet provide less suitable soil stabilization. In recent years, in the national effort to manage invasive non-native weed species, roadsides are often singled out as a primary source of initial non-native weed establishment. This is not necessarily a reflection of anyone's roadside management program, but more a reflection on the nature of managing a state highway system right-of-way and the challenges of interstate travel. National needs dictate that highway roadside vegetation managers have an obligation to stay aware of any new exotic, non-native weed species that may occur on their roadsides.

While development of agrichemicals has slowed for agricultural crops, there is a sustained interest by the agrichemical manufacturers or marketers to expand herbicide label registrations on existing products into the industrial and roadside vegetation management market. The development of new herbicide products increases market competition and can result in reduced product prices to end users.

This report covers our research trials and demonstrations conducted during the 2011 growing season. These trials covered i) the continued development of the new active ingredient aminocyclopyrachlor/DPX-MAT28 found in Streamline™ and Perspective™ herbicides, (Chapters 2, 5, 6 and 7), ii) evaluation of herbicide tank mix combinations for control of weeds in the cable-barrier footprint (Chapter 2), iii) monitoring of successes and challenges of actual ODOT cable-barrier weed control treatments (Chapters 4 and 5) and iv) monitoring of a large scale ODOT herbicide treated areas containing the water conditioning adjuvant Request® (Chapter 8). The purpose of these trials was to improve and refine our weed control recommendations that are offered to ODOT for roadside vegetation management.

Streamline™ (2) and Perspective™ (3) herbicides received their federal EPA registration in 2011 and should provide increased kochia and field bindweed control for ODOT personnel across the state (4). This year's key research efforts also focused on initial herbicide screenings to develop long-term residual weed control treatments for the cable-barrier footprint. Developing a successful cable-barrier weed control treatment that meets ODOT divisional goals while also maintaining a sufficient degree of environmental sensitivity is a difficult challenge. In all likelihood a successful cable-barrier herbicide treatment will involve at least two seasonal herbicide applications to provide a season-long weed control program. This research will continue to develop the herbicide components necessary to provide ODOT field divisions with programs that provide acceptable levels of weed control for the wide variety of cable-barrier installations. Efforts were also conducted in 2011 to monitor current ODOT cable-barrier weed control programs that included prodiamine as a residual preemergence annual weed control component. Finally, a 2011 demonstration was also conducted in Grant

County to evaluate the ability of Request®, a water conditioning adjuvant from Helena Chemical Company, to increase johnsongrass control levels from glyphosate + sulfosulfuron herbicide treatments.

2.0 EVALUATION OF SELECTED HERBICIDE COMBINATIONS FOR THEIR ABILITY TO PROVIDE LONG-TERM RESIDUAL WEED CONTROL UNDER CABLE BARRIERS (4-H-7-11)

2.1 BACKGROUND

This study is an initial screening of herbicide combinations that were selected by the Oklahoma State University (OSU) Roadside Vegetation Management (RVM) team for their potential to provide acceptable long-term residual weed control as well as acceptable environmental risk when utilized for weed control in the footprint of the cable barrier system.

When early cable barrier systems were installed in Oklahoma it was common for many but not all ODOT vegetation managers to try to achieve total vegetation control (maintain bareground) under the barriers. The barriers might be located in the center median ditch bottom, or upslope from the center ditch bottom, with the barrier footprint located in asphalt millings or in the asphalt shoulder its self. Some personnel quickly found that on sloped sites where the footprint is principally soil or small diameter crushed rock, a bareground herbicide treatment often resulted in moderate to severe soil erosion under the cable barrier. Because of the erosion, many ODOT personnel began to see the benefit in maintaining common bermudagrass instead of bareground. Whether the goal is to maintain bareground or weed-free common bermudagrass under a cable barrier, these sites are subject to constant weed invasion.

The herbicides chosen for screening in this study were considered to be “soft” residual herbicides that provide potential for long-term weed control in either a bareground or common bermudagrass system. The herbicides/rates utilized have not been associated with high runoff potential or down slope movement and denuding of vegetation. The purpose of investigation of these particular treatments was to determine if they provided season-long annual weed control when applied in a late-winter/early-spring time frame.

2.2 OBJECTIVES

The objective of this study was to evaluate 15 herbicide treatments for weed control during the course of the 2011 growing season.

2.3 MATERIALS AND METHODS

This study was located at the Oklahoma State University Cimarron Valley Research Station in Perkins, Oklahoma. The soil type on the test site is a Teller series loam (5). Herbicide treatments were applied on March 8 (Table 1). At that time winter annual weeds present were as follows: annual ryegrass [*Lolium multiflora*] (2-5 inches tall), henbit [*Lamium amplexicaule*](1-3 inches tall), sheperdspurse [*Capsella bursa pastoris*](1-2 inch rosettes),

and hairy vetch [*Vicia villosa*](1-2 inches tall). Because of the emergence of winter annual weeds we added glyphosate (6) at 0.98 lb. active ingredient (a.i.) /A to each treatment in order to provide early postemergence control of winter annual weeds. The addition of the glyphosate component is critical for those herbicide treatments that have only preemergence activity such as Gallery® (a.i. isoxaben) (7), Prodiamine 65WDG (a.i. prodiamine) (8), and Pendulum® (a.i. pendimethalin) (9). Postemergence weed control data was collected for each of these weed species through 3 months after treatment (MAT).

No summer annual weed species were emerged at the time of treatment. Preemergence weed control evaluations were taken on the summer annual weeds, Palmer amaranth (*Amaranthus palmeri*) and large crabgrass (*Digitaria sanguinalis*). Preemergence weed control data was collected for each of these weed species through 8 months after treatment (MAT).

It should be noted that this study was conducted under very droughty conditions. All residual herbicides need adequate rainfall after their application to activate the product. In addition to the initial activating rainfall, it is also important to have enough soil moisture present to suspend herbicides in the soil solution within the soil matrix allowing them to remain available and active for plant uptake. Within 10 days of the March 3 treatment date this study received two rain events that totaled 0.47 inches of rainfall (10). This should have provided most of the necessary rainfall to initially activate all herbicides in this study. Following the initial rainfall the study received little to no rain for an extended 5 week period. During the summer months this study site, along with most of Oklahoma, was under moderate to severe drought and high temperature stress. Even under these extreme conditions there were still several herbicide treatments that were able to produce and maintain very good levels of annual weed control.

2.4 RESULTS & DISCUSSION

As a reminder, all treatments received an addition of glyphosate at 0.98 lb. a.i./A, to increase control of existing winter annual broadleaf and grassy weeds. At 61 days-after-application (DAA) & 92 DAA all treatments, excluding either Gallery™, Prodiamine 65 WDG, or Pendulum® alone, provided good to excellent postemergence control of cutleaf evening primrose. Control ranged from 90-100% (Table 2). The glyphosate component applied with the preemergence-only products Gallery™, Prodiamine 65WDG, or Pendulum® provided poor to good postemergence control of cutleaf evening primrose ranging from 33-85%. At 61 DAA & 92 DAA all treatments excluding Frequency™ (a.i. topramezone) (11), a.i. indaziflam alone, and Prodiamine 65WDG provided good to excellent postemergence control of henbit, which ranged from 82-100%. The herbicides Frequency™, indaziflam alone, and Prodiamine 65WDG, when combined with glyphosate provided moderate to excellent postemergence control of henbit (range 55-91% control).

Preemergence control of henbit was evaluated on November 11, 2011 (244 DAA). Because of the rates used and residual nature of the products in this study, most treatments were providing good to excellent long-term preemergence control of henbit. All treatments, excluding Frequency™, were providing 76-96% preemergence control of henbit at 244 DAA.

At 61 & 92 DAA all treatments were producing good to excellent postemergence control of annual ryegrass that ranged from 82-100% (Table 3). Preemergence control of annual ryegrass was also evaluated on November 11, 2011 (244 DAA). At that time all treatments, excluding Frequency™, were producing 83-97% preemergence control of annual ryegrass.

Preemergence control evaluations for sheperdspurse and hairy vetch were also collected at 244 DAA. Preemergence sheperdspurse and hairy vetch control were very similar with respect to individual treatment results. All treatments, excluding Oust® Extra (12) alone, Prodiamine 65WDG, Pendulum®, Frequency™, were producing good to excellent preemergence control of both species that ranged from 83-97%. Overall postemergence control of winter annual weeds was good with the addition of the glyphosate component and any additional activity from the residual herbicide component, however, in the future it may be better to use Landmaster® BW (13) at 4 pts./A as an alternative glyphosate source. The Landmaster® BW product, including the additional active ingredient 2, 4-D, would also likely increase the level of postemergence broadleaf weed control. Several of these treatments stood out as far as having the ability to provide long-term preemergence control of winter annual weeds resulting from applications made the previous winter/spring. This is a very desirable treatment characteristic that would help maintain a bareground area or control winter annual weeds in a bermudagrasss cable barrier footprint. Treatments of Diuron + Oust® Extra, Gallery® + Oust® Extra, Plainview™ + Oust® XP, Streamline™ + Oust® XP, and Perspective™ + Oust® XP (14, 15) showed very good potential at providing both short-term postemergence control and long-term preemergence control of winter annual broadleaf and grassy weeds.

As treatments were applied on March 3 and activated by rainfall by March 10 the large crabgrass and palmer amaranth weed control data represents only preemergence control from the residual components of the various treatments. The addition of the glyphosate component had no affect on the control of the large crabgrass or palmer amaranth in this study. Large crabgrass and palmer amaranth preemergence weed control ratings were taken at 61, 92, 124, 153, 183, and 215 DAA. Treatments including Diuron alone, Diruon + Oust® Extra, Gallery® + Oust® Extra, indaziflam + Oust® Extra, Plainview™ + Oust® XP, Streamline + Oust® XP, and Perspective™ + Oust® XP provided excellent season-long control of large crabgrass that ranged in control from 90-100% (Table 4). This level of control lasted through the final 215 DAA. Treatments of Oust® Extra alone, Milestone® VM + Oust® Extra, and indaziflam alone produced moderate to good levels of large crabgrass up to 124 DAA, however, control fell to moderately unacceptable levels by late summer and early fall. Loss of control by late summer (Aug.-Sept.) could necessitate the need for additional touch-up herbicide treatments. Treatments of Prodiamine and Pendulum® likely failed because of the dry conditions that could not keep these specific dinitroaniline herbicides suspended in the soil solution. They should have provided excellent season-long large crabgrass control in this study due to the rates that were used.

With respect to preemergence control of Palmer amaranth the results were very similar to those of large crabgrass control with one exception. Treatments including Diuron alone, Diruon + Oust® Extra, Gallery® + Oust® Extra, Milestone® VM (16) + Oust® Extra, indaziflam + Oust® Extra, Plainview™ + Oust® XP, Streamline™ + Oust® XP, and Perspective™ + Oust® XP provided good to excellent season-long control of large crabgrass that ranged in control from 78-100% (Table 5). This level of control lasted through the final 215 DAA. The treatments of Gallery® + Oust® Extra, Plainview™ + Oust® XP, Streamline™ + Oust® XP, and Perspective™ + Oust® XP maintained near complete control of Palmer amaranth throughout the duration of this study. Treatments of Oust® Extra alone produced moderate to good levels of Palmer amaranth control up to 124 DAA, however, control fell to unacceptable levels by late summer and early fall. Loss of control by late summer (Aug.-Sept.) could likely necessitate the need for additional touch-up herbicide treatments. In all likelihood treatments of Prodiamine 65WDG and Pendulum®, which should have provided good to excellent Palmer amaranth control in this study, failed because of the dry conditions that did not allow these specific dinitroaniline herbicides to remain suspended in soil solution and available for plant uptake.

2.5 CONCLUSIONS

In this initial screening, treatments of Diruon + Oust® Extra, Gallery® + Oust® Extra, indaziflam + Oust® Extra, Plainview® + Oust® XP, Streamline™ + Oust® XP, and Perspective™ + Oust® XP showed the ability to provide good to excellent season-long control of large crabgrass and Palmer amaranth. It is important to note that these treatments were able to produce and sustain these weed control levels under less than favorable environmental conditions. Currently these treatment combinations show the greatest promise in providing for consistent long-term residual annual weed control for ODOT cable-barrier systems

2.6 RECOMMENDATIONS

We recommend the continuation of research and development of these herbicides that were investigated in this first year of the trial. We feel that one or more treatment combinations, with supplemental additions as needed, may provide satisfactory weed control in the cable barrier footprint for the 9 -11 month long growing season. All of the herbicides evaluated in this initial screening study have been in OSU RVM development trials in the past (4, 17). Much is known about their activity, however, there are a few of the herbicides in this study that are new and the weed control spectrum resulting from tank mix combinations is currently unknown. We recommend continued screening of these herbicide treatment combinations to determine if consistent, cost effective weed control options can be developed. No changes are recommended to interim cable barrier treatments at this time.

Table 1. Herbicide application specifics for experiment 4-H-7-11.

Application Factor	**Measurement**
Application Date:	Mar-3-2011
Time of Day:	9:27 a.m.
Application Method:	Broadcast spray
Application Timing:	Preemergence & Postemergence
Application Placement:	Soil & foliar
Air Temperature:	63 F
Relative Humidity:	33 %
Wind Velocity:	4 MPH
Wind Direction:	NW
Dew Presence (Y/N):	No
Soil Temperature:	43 F
Soil Moisture:	Good
Cloud Cover:	0 %
Appl. Equipment:	4-wheel ATV
Operating Pressure:	25 PSI
Nozzle Type:	Teejet
Nozzle Size:	V8004
Nozzle Spacing, Unit:	20 inches
Nozzles/Row:	3
Boom Height:	20 inches
Ground Speed:	2.5 MPH
Carrier:	Water
Spray Volume:	30 gallons per acre
Mix Size:	1.8 liters
Propellant:	CO2

Table 2. Comparison of cable barrier combinations for postemergence control of cutleaf evening primrose and postemergence and preemergence control of henbit. Study 4-H-7-11.

Pest Name				cutleaf evening primrose				henbit					
Rating Date				5/10/2011		6/10/2011		5/10/2011		6/10/2011		11/9/2011	
Rating Type				Control		Control		Control		Control		Control	
Rating Unit				%		%		%		%		%	
Trt-Eval Interval				61 DAA		92 DAA		61 DAA		92 DAA		244 DAA	
Trt No.	Treatment Name[1]	Rate	Rate Unit	(POST)		(POST)		(POST)		(POST)		(PRE)	
1	Untreated Check			0		0		0		0		0	
2	Oust Extra	3.66	oz ai/a	100	a	100	a	100	a	100	a	76	d
3	Diuron	6.4	lb ai/a	100	a	100	a	100	a	100	a	94	a
4	Diuron Oust Extra	4 2.85	lb ai/a oz ai/a	100	a	100	a	100	a	100	a	90	abc
5	Gallery	1	lb ai/a	85	abc	63	bc	82	bc	96	abc	88	abc
6	Gallery Oust Extra	0.75 2.85	lb ai/a oz ai/a	100	a	100	a	100	a	100	a	95	a
7	Milestone VM	1.75	oz ai/a	100	a	97	a	100	a	97	ab	80	cd
8	Milestone VM Oust Extra	1.25 2.85	oz ai/a oz ai/a	100	a	100	a	100	a	100	a	88	abc
9	indaziflam	0.0625	lb ai/a	90	ab	95	ab	91	ab	66	bcd	91	ab
10	indaziflam Oust Extra	0.0625 2.85	lb ai/a oz ai/a	100	a	100	a	100	a	100	a	86	a-d
11	Prodiamine	1.5	lb ai/a	78	bc	33	c	83	bc	65	cd	82	bcd
12	Pendulum Aquacap	4.56	lb ai/a	73	c	63	bc	99	a	99	a	85	a-d
13	Frequency	1.4	oz ai/a	96	a	94	ab	70	c	55	d	48	e
14	(Plainview 10 oz.) MAT28 Oust XP Telar XP	 3.12 1.88 0.94	 oz ai/a oz ai/a oz ai/a	100	a	100	a	100	a	100	a	96	a
15	(Streamline 8 oz.) MAT28 Escort XP Oust XP	 3.16 1.008 2.25	 oz ai/a oz ai/a oz ai/a	100	a	100	a	100	a	100	a	96	a
16	(Perspective 8 oz.) MAT28 Telar XP Oust XP	 3.16 1.264 2.25	 oz ai/a oz ai/a oz ai/a	100	a	100	a	100	a	100	a	94	a
LSD (P=.10)				16.4		33.3		13.3		31.8		11.2	
Standard Deviation				11.8		24		9.6		22.8		8	
CV				12.48		26.74		10.1		24.86		9.34	
Replicate F				3.341		2.697		2.341		3.553		1.272	
Replicate Prob(F)				0.0505		0.0855		0.1155		0.0427		0.2966	
Treatment F				1.769		2.137		2.833		1.414		6.797	
Treatment Prob(F)				0.0989		0.044		0.0098		0.2133		0.0001	

[1]Glyphosate included at 0.98 lb. a.i./A for initial control of winter annual weeds. Plainview, Perspective and Streamline components are listed below the product name. LSD = least significant difference. Means with a common letter do not significantly differ at p = 0.10.NS = no significantly different.

Table 3. Comparison of cable barrier combinations for postemergence & preemergence control of annual ryegrass and preemergence control of shepardspurse (Shprdsprs) and hairy vetch. Study 4-H-7-11.

Pest Name				Annual Ryegrass			Shprdsprs	Vetch
Rating Date				5/10/2011	6/10/2011	11/9/2011	11/9/2011	11/9/2011
Rating Type				Control	Control	Control	Control	Control
Rating Unit				%	%	%	%	%
Trt-Eval Interval				61 DAA	92 DAA	244 DAA	244 DAA	244 DAA
Trt No.	Treatment Name[1]	Rate	Rate Unit	(POST)	(POST)	(PRE)	(PRE)	(PRE)
1	Untreated Check			0	0	0	0	0
2	Oust Extra	3.66	oz ai/a	88 def	91 a-e	90 a-d	78 e	68 bc
3	Diuron	6.4	lb ai/a	91 b-e	96 abc	97 a	96 a	85 ab
4	Diuron Oust Extra	4 2.85	lb ai/a oz ai/a	100 a	100 a	95 abc	91 abc	88 a
5	Gallery	1	lb ai/a	85 ef	86 de	92 a-d	88 a-d	90 a
6	Gallery Oust Extra	0.75 2.85	lb ai/a oz ai/a	98 ab	97 a	97 ab	95 ab	95 a
7	Milestone VM	1.75	oz ai/a	94 a-d	88 b-e	88 bcd	85 cde	90 a
8	Milestone VM Oust Extra	1.25 2.85	oz ai/a oz ai/a	99 ab	99 a	89 a-d	86 b-e	93 a
9	indaziflam	0.0625	lb ai/a	91 b-e	95 a-d	94 abc	92 abc	88 a
10	indaziflam Oust Extra	0.0625 2.85	lb ai/a oz ai/a	100 a	100 a	96 abc	86 b-e	83 ab
11	Prodiamine	1.5	lb ai/a	88 def	92 a-e	83 d	79 de	82 ab
12	Pendulum Aquacap	4.56	lb ai/a	82 f	83 e	87 cd	77 e	80 ab
13	Frequency	1.4	oz ai/a	90 cde	87 cde	73 e	57 f	58 c
14	(Plainview 10 oz.) MAT28 Oust XP Telar XP	 3.12 1.88 0.94	 oz ai/a oz ai/a oz ai/a	95 a-d	97 a	97 ab	92 abc	97 a
15	(Streamline 8 oz.) MAT28 Escort XP Oust XP	 3.16 1.008 2.25	 oz ai/a oz ai/a oz ai/a	97 abc	96 ab	97 ab	91 abc	97 a
16	(Perspective 8 oz.) MAT28 Telar XP Oust XP	 3.16 1.264 2.25	 oz ai/a oz ai/a oz ai/a	100 a	97 a	94 abc	88 a-d	97 a
LSD (P=.10)				8.2	9.5	9.5	9.4	18.8
Standard Deviation				5.9	6.8	6.8	6.8	13.2
CV				6.35	7.29	7.5	7.93	15.41
Replicate F				0.794	2.775	1.704	4.308	0.988
Replicate Prob(F)				0.4622	0.0802	0.2009	0.0238	0.3916
Treatment F				3.024	1.923	2.795	6.327	2.07
Treatment Prob(F)				0.0066	0.0704	0.0106	0.0001	0.0738

[1]Glyphosate included at 0.98 lb. a.i./A for initial control of winter annual weeds. Plainview, Perspective and Streamline components are listed below the product name. LSD = least significant difference. Means with a common letter do not significantly differ at p = 0.10.NS = no significantly different.

Table 4. Comparison of cable barrier combinations for preemergence control of large crabgrass. Study 4-H-7-11.

Pest Name				large crabgrass											
Rating Date				5/10/2011		6/10/2011		7/12/2011		8/10/2011		9/9/2011		10/11/2011	
Rating Type				Control		Control		Control		Control		Control		Control	
Rating Unit				%		%		%		%		%		%	
Trt-Eval Interval				61 DAA		92 DAA		124 DAA		153 DAA		183 DAA		215 DAA	
Trt No.	Treatment Name[1]	Rate	Rate Unit	(PRE)		(PRE)		(PRE)		(PRE)		(PRE)		(PRE)	
1	Untreated Check			0		0		0		0		0		0	
2	Oust Extra	3.66	oz ai/a	78	a	97	ab	93	abc	83	abc	75	a-d	76	ab
3	Diuron	6.4	lb ai/a	99	a	99	a	97	ab	97	a	96	a	97	a
4	Diuron Oust Extra	4 2.85	lb ai/a oz ai/a	99	a	100	a	99	a	99	a	99	a	98	a
5	Gallery	1	lb ai/a	82	a	59	c	30	ef	37	d	18	fg	20	de
6	Gallery Oust Extra	0.75 2.85	lb ai/a oz ai/a	99	a	98	a	97	ab	92	ab	90	abc	91	ab
7	Milestone VM	1.75	oz ai/a	45	b	37	d	13	f	5	e	0	g	0	e
8	Milestone VM Oust Extra	1.25 2.85	oz ai/a oz ai/a	92	a	89	ab	74	bcd	69	bc	63	cd	63	bc
9	indaziflam	0.0625	lb ai/a	89	a	88	ab	81	abc	79	abc	68	bcd	67	abc
10	indaziflam Oust Extra	0.0625 2.85	lb ai/a oz ai/a	99	a	100	a	98	ab	97	a	98	a	91	ab
11	Prodiamine	1.5	lb ai/a	94	a	80	b	53	de	35	d	27	ef	13	de
12	Pendulum Aquacap	4.56	lb ai/a	89	a	92	ab	71	cd	64	c	52	de	36	cd
13	Frequency	1.4	oz ai/a	30	b	17	e	12	f	7	e	5	fg	0	e
14	(Plainview 10 oz.) MAT28 Oust XP Telar XP	3.12 1.88 0.94	oz ai/a oz ai/a oz ai/a	94	a	99	a	97	ab	94	ab	94	ab	91	ab
15	(Streamline 8 oz.) MAT28 Escort XP Oust XP	3.16 1.008 2.25	oz ai/a oz ai/a oz ai/a	94	a	99	a	99	a	97	a	95	ab	95	ab
16	(Perspective 8 oz.) MAT28 Telar XP Oust XP	3.16 1.264 2.25	oz ai/a oz ai/a oz ai/a	88	a	100	a	99	a	99	a	99	a	99	a
LSD (P=.10)				26.8		17.8		23.8		25.7		26.5		32.1	
Standard Deviation				19.3		12.8		17.2		18.5		19.1		23.1	
CV				22.73		15.28		23.12		26.3		29.25		36.91	
Replicate F				0.699		0.866		0.427		0.208		0.344		0.066	
Replicate Prob(F)				0.5056		0.4318		0.6569		0.8136		0.7122		0.9366	
Treatment F				3.348		12.315		10.54		9.915		10.853		8.146	
Treatment Prob(F)				0.0034		0.0001		0.0001		0.0001		0.0001		0.0001	

[1]Glyphosate included at 0.98 lb. a.i./A for initial control of winter annual weeds. Plainview, Perspective and Streamline components are listed below the product name. LSD = least significant difference. Means with a common letter do not significantly differ at p = 0.10.NS = no significantly different.

Table 5. Comparison of cable barrier combinations for preemergence control of Palmer amaranth. Study 4-H-7-11.

Pest Name				**Palmer amaranth**											
Rating Date				**5/10/2011**		**6/10/2011**		**7/12/2011**		**8/10/2011**		**9/9/2011**		**10/11/2011**	
Rating Type				**Control**		**Control**		**Control**		**Control**		**Control**		**Control**	
Rating Unit				**%**		**%**		**%**		**%**		**%**		**%**	
Trt-Eval Interval				**61 DAA**		**92 DAA**		**124 DAA**		**153 DAA**		**183 DAA**		**215 DAA**	
Trt No.	**Treatment Name[1]**	**Rate**	**Rate Unit**	**(PRE)**		**(PRE)**		**(PRE)**		**(PRE)**		**(PRE)**		**(PRE)**	
1	Untreated Check			0		0		0		0		0		0	
2	Oust Extra	3.66	oz ai/a	99	a	98	a	92	a	75	ab	80	a	73	ab
3	Diuron	6.4	lb ai/a	99	a	96	a	95	a	88	a	87	a	95	ab
4	Diuron Oust Extra	4 2.85	lb ai/a oz ai/a	99	a	100	a	100	a	100	a	98	a	98	a
5	Gallery	1	lb ai/a	66	bc	35	b	38	b	37	cd	32	bc	18	d
6	Gallery Oust Extra	0.75 2.85	lb ai/a oz ai/a	99	a	100	a	98	a	82	ab	78	a	84	ab
7	Milestone VM	1.75	oz ai/a	95	ab	28	bc	25	bc	55	bc	88	a	63	bc
8	Milestone VM Oust Extra	1.25 2.85	oz ai/a oz ai/a	99	a	93	a	82	a	93	a	95	a	94	ab
9	indaziflam	0.0625	lb ai/a	99	a	37	b	25	bc	10	de	12	bc	12	d
10	indaziflam Oust Extra	0.0625 2.85	lb ai/a oz ai/a	99	a	100	a	100	a	100	a	98	a	94	ab
11	Prodiamine	1.5	lb ai/a	53	c	0	c	0	c	0	e	0	c	0	d
12	Pendulum Aquacap	4.56	lb ai/a	96	ab	32	bc	32	bc	27	cde	32	bc	32	cd
13	Frequency	1.4	oz ai/a	65	bc	0	c	0	c	18	de	42	b	33	cd
14	(Plainview 10 oz.) MAT28 Oust XP Telar XP	3.12 1.88 0.94	oz ai/a oz ai/a oz ai/a	99	a	100	a	100	a	100	a	100	a	99	a
15	(Streamline 8 oz.) MAT28 Escort XP Oust XP	3.16 1.008 2.25	oz ai/a oz ai/a oz ai/a	99	a	99	a	100	a	100	a	100	a	98	a
16	(Perspective 8 oz.) MAT28 Telar XP Oust XP	3.16 1.264 2.25	oz ai/a oz ai/a oz ai/a	99	a	100	a	100	a	100	a	99	a	98	a
LSD (P=.10)				31.4		33.7		34		33.1		35.7		33.5	
Standard Deviation				22.6		24.2		24.4		23.8		25.7		24.1	
CV				24.79		35.75		37.14		36.22		37.06		36.47	
Replicate F				3.533		1.09		1.44		0.021		0.133		1.594	
Replicate Prob(F)				0.0434		0.3506		0.2545		0.9796		0.8762		0.2217	
Treatment F				1.449		8.272		8.107		7.439		5.733		6.943	
Treatment Prob(F)				0.1978		0.0001		0.0001		0.0001		0.0001		0.0001	

[1]Glyphosate included at 0.98 lb. a.i./A for initial control of winter annual weeds. Plainview, Perspective and Streamline components are listed below the product name. LSD = least significant difference. Means with a common letter do not significantly differ at p = 0.10.NS = no significantly different.

3.0 EVALUATION OF 2011 DIVISION FIVE CABLE BARRIER HERBICIDE APPLICATION (4-H-8-11)

3.1 BACKGROUND

Over the past several years most ODOT field divisions have continued to install cable barrier systems on one or both sides of center medians. The base of the cable barrier installations varies from installation to installation. Generally the base material is either small rock or asphalt millings. The footprint of the base varies significantly between installations. It can be as narrow as 3-4 feet or as wide 12-14 feet and even wider in transition areas. Regardless of the installation one of the challenges in utilization of the cable barriers continues to be a need for long-term weed control. The cable barrier presents physical impediment to mowing and weed eating. We are currently screening herbicide combinations that may provide for long-term residual weed control in cable barrier systems. Interim recommendations have been developed for weed control in these areas while research proceeds.

Interim recommendations were made for ODOT to apply Prodiamine 65 WDG herbicide at a maximum labeled rate of 2.3 lb. product/A for pre-emergence weed control. Prodiamine 65 WDG is a preemergence herbicide that when applied at the recommended rates prior to weed emergence should provide for good to excellent control of many summer & winter annual weeds. Suitable activity is generally contingent upon receiving a minimum of 0.5 inches of rainfall at least 3 weeks prior to the germination of target weeds so that this pre-emergent herbicide can be moved into the soil. Division Five personnel chose to pursue our interim pre-emergent herbicide recommendation of 2.3 lb of Prodiamine 65WDG product per acre for the cable barrier pre-emergence weed control treatment.

3.2 OBJECTIVES

To evaluate weed control achieved by a 2.3 lb product per acre application of Prodiamine 65WDG applied pre-emergence to the cable barrier foot print by Division 5 spray crews.

3.3 MATERIALS AND METHODS

Arrangements were made for the I-40 West/Elk City crew to make a Prodiamine 65 WDG application at 2.3 lbs product/ A to the 10-12 wide foot cable barrier footprint. The area treated was between the eastbound mile marker 10 to mile marker 50; as well as westbound from mile marker 50 to exit 25. All cable barriers in these stretches of interstate were treated on February 17, 2011. An activating rainfall is very important following a prodiamine application. Rainfall data indicates that the western two-thirds of this site received approximately 0.17 inches of rainfall and the eastern one-third 0.48 inches of rainfall within the first 18 days after treatment (10). Because of the very low rainfall amounts in the western two-thirds of the treatment area it is unlikely that the prodiamine was properly activated until much later in the spring. Additionally, photo degradation of the prodiamine could have occurred since the materials sat on the vegetation canopy in strong sunlight for a long period of time. Under the very dry conditions there was still enough rainfall for kochia (*Kochia scoparia*) germination. This likely created a situation where kochia was able to germinate before the prodiamine was activated. Since prodiamine is strictly a pre-emergence herbicide, it had no activity on kochia that had emerged prior to the pre-emergence herbicide treatment.

A meeting was held with the I-40 West/Elk City crew members Alex Aranda and Jim Shepard in which their Prodiamine 65 WDG application was discussed and subsequently the site was toured. During the tour 5 sites were selected within the treatment area. We visited these sites every 5-6 weeks throughout the 2011 growing season. The sites were visited and evaluated on April 11 (53 days-after-application [DAA]), May 24 (96 DAA), July 6 (139 DAA), August 16 (180 DAA), September 27 (222 DAA), and November 15 (271 DAA). Visual observations were made at each site for annual weed species present and weed densities as compared to adjacent non-treated areas.

3.4 RESULTS & DISCUSSION

At 53 DAA the treated area continued to be very dry but at 3 of 5 sites kochia had and was continuing to emerge in the non-treated area. Areas outside of the treated areas (non-treated areas) were treated as pair-wise, non-treated controls. Within the 12 foot treated zone kochia had and was continuing to emerge at 2 of 5 sites. Also at 53 DAA large crabgrass was found within the treated area in 1 of the 5 sites and at very low density. At 96 DAA the treated area continued to be dry. However some soil moisture was present at the east end of the treated area. At this time very few kochia, or large crabgrass, had emerged at each of the 4 eastern sites. However, the western-most site had a very dense stand of small kochia (0.25-0.5 inch) infesting a large part of the cable barrier footprint. From the size of this kochia it appeared to have emerged at the same time.

At 96 DAA there was also early evidence of spray application pattern shadowing behind the cable barrier poles. Pattern shadowing occurs when a physical impediment intercepts spray droplets from one direction and the intended target area behind the physical impediment does not receive spray droplets. The target area is “shadowed or shielded” due to the physical interception of particles by the impediment. Consequently, the areas shielded from spray droplets receive a lower rate of herbicide than areas that were targets of the spray pattern but which were not shadowed by a physical impediment. These shadowed areas are an environment where weeds can germinate and develop. Depending upon the severity of the spray pattern shadows, structures can sometimes require application angles from two directions or from a more efficient direction.

At 139 DAA the eastern most site was showing low levels of scattered kochia that had grown to 6-10 inches in height. The rest of the sites remained clean of kochia within the treated footprint. The western most site, which had small kochia present at 96 DAA, was also free of kochia within the footprint at 139 DAA. The small emerged kochia had apparently either succumbed to the extreme heat and dry conditions during the past month or a delayed uptake of prodiamine herbicide had occurred. At 139 DAA it was also documented that between mile markers 46-50 eastbound, a low to moderate level of scattered kochia was present within the treated footprint. At 180 DAA 2 of 5 sites were showing low levels of newly emerged kochia. Much of this kochia was associated with pattern shadowing around cable barrier poles. The western most site continued to show new releases of kochia and pigweed at this time. A low to moderate, uniform, flush of kochia had emerged as a result of a couple of light early August rain events. Because of the erratic kochia control in some sections of the prodiamine test area, ODOT I-40/Elk City maintenance personnel made a broadcast clean-up application of Roundup Pro Concentrate at 1.5 quarts/A on August 24 (188 DAA).

At 222 DAA all of the sites looked very good and clean of all or nearly all kochia. The Roundup Pro Concentrate cleanup treatment applied by ODOT approximately one month prior to this evaluation was successful at controlling the scattered kochia plants within the treated footprint. As with all long-term residual herbicide treatments applicators should be prepared, if necessary, to make some type of cleanup treatment late in the season to control escaped weeds. Because of the treatment obstacles created by spraying in and around structures and very droughty conditions, herbicide results and performance may be less than desired or expected.

AT 271 DAA all sites were very clean of kochia and large crabgrass with the exception of the western most site. The western most site continued to have patchy flushes of kochia emergence. At this time the western most site was showing a new flush of 0.25 to 1 inch tall kochia that will likely be controlled with the next hard freeze. As a result of the earlier application of the prodiamine there were very few winter annual weeds emerging in the cable barrier footprint at any of the sites at 271 DAA. In 2 of 5 sites there was a very low density of very small winter annual grasses (probably downy brome) emerging. However, adjacent untreated areas were showing low to moderate uniform populations of several winter annual broadleaf and grassy weed species at all sites.

The long-term residual weed control resulting from the application of Prodiamine 65 WDG at 2.3 lb. /A to the I-40 cable barrier had both positive and negative results this season. Probably the biggest problem this past year was the lack of adequate rainfall to provide for initial activation of the prodiamine. This allowed for a window of kochia emergence before the herbicide could be properly activated, and since prodiamine has no postemergence capabilities in some areas it never had a chance to provide any activity. Lack of rainfall during the season also hurt prodiamine by not maintaining a minimal amount of soil moisture to keep the prodiamine molecules suspended and available for activity on germinating weed seed. Even under the very dry conditions the application of prodiamine was still able to produce and maintain good control of kochia and large crabgrass over most of the test area. As final observations indicated the residual nature of prodiamine, especially at maximum rates, can also provide preemergence control of winter annual weeds that are germinating 7-9 months after application. While the cable barrier test site did require a late summer broadcast cleanup treatment of Roundup Pro Concentrate the treatment was necessary because of kochia only. No other weeds escaped the prodiamine application to any extent.

Efforts are under way to find additional herbicides and herbicide treatment combinations to provide addition activity on weeds such as kochia. Hopefully additional herbicide treatments may be found that may be less affected by extreme climatic conditions as well.

3.5 CONCLUSIONS

The Prodiamine 65 WDG herbicide treatment applied to the cable-barrier footprint produced a reduction in summer and winter annual weed pressure in most areas treated. However, kochia control was somewhat erratic throughout the growing season and seemed to be directly correlated to local rainfall levels. With 2011 being a record year for drought, no areas received average rainfall levels. However, in those areas that did receive some 2011 rainfall, Prodiamine 65 WDG produced acceptable kochia control levels. Because of the low and erratic nature of the rainfall in 2011, some kochia did escape this treatment and it required a late summer application of glyphosate to maintain a weed free cable-barrier.

3.6 RECOMMENDATIONS

Please see section *4.5 RECOMMENDATIONS.*

4.0 EVALUATION OF 2011 DIVISION EIGHT CABLE BARRIER HERBICIDE APPLICATION (4-H-9-11)

4.1 BACKGROUND

We are currently screening herbicides and herbicide combinations that should provide for the necessary long-term weed control under cable barriers in the future. As this screening effort will take time, temporary recommendations were made by the OSU RVM program to ODOT in the fall of 2010. Recommendations were made to ODOT Field Division Eight personnel to modify regularly scheduled winter annual weed control treatments of Landmaster® BW at 3.3 pints/A + ammonium sulfate at 12 pounds/100 gallons of water (18) to include Prodiamine 65 WDG and Banvel®. Treatments that included the addition of Prodiamine 65 WDG and Banvel® were to be targeted for roadsides that included cable barriers only. The addition of the Prodiamine 65 WDG and Banvel® was to provide a long-term residual component as well as increase the level of postemergent broadleaf weed control from the standard treatment. Prodiamine 65 WDG was recommended for use at the maximum labeled rate of 2.3 lb. product/A while the recommended rate for Banvel® was 2 oz./A. Prodiamine 65 WDG is a preemergence herbicide that when applied at the recommended rates prior to weed emergence and given sufficient activating rainfall should provide for good to excellent control of many summer & winter annual weeds in the cable barrier foot print. This chapter covers our findings from monitoring for weed control in the cable barrier footprint treated by Division 8 spray crews in 2011.

4.2 OBJECTIVES

To evaluate weed control achieved by a Landmaster® BW + Banvel® + Prodiamine 65 WDG + ammonium sulfate application to the cable barrier foot print by Division 8 spray crews.

4.3 MATERIALS AND METHODS

The Division Eight Pawnee County herbicide application crew applied a Landmaster® BW + Banvel® + Prodiamine 65 WDG + ammonium sulfate application (at recommended rates listed in section 4.1) to an area on US-412 that included the cable barrier systems between the west end of the Cimarron Turnpike and east to the Keystone Lake bridge (Diamond Head Road crossover). All cable barriers in this stretch of highway were treated on March 2. An activating rainfall is very important following a prodiamine application and rainfall data indicates that the treated area received approximately 0.65 inches within 17 days of treatment. While these rainfall totals were low they should have been adequate to activate the prodiamine. The treated area did remain much dryer than normal throughout the duration of the weed control observations. The goal of this particular research effort was to select sites within the treated stretch of cable barrier and monitor the absence or presence of all vegetation types over the growing season. A meeting was held with the Pawnee County crew members Willard Wilkins and Peggy Ryan in which the Prodiamine 65 WDG application was discussed and subsequently the site was toured. During the tour 6 sites were selected within the treatment area with the goal of visiting these same sites every 5-6 weeks throughout the growing season. The sites were visited and evaluated on April 5 (34 DAA (days-after-application)), May 26 (75 DAA), July 11 (121 DAA), August 18 (159 DAA), September 29 (201 DAA), and November 10 (243 DAA). Visual observations were made at each site for weed species present and weed densities as compared to adjacent untreated areas.

4.4 RESULTS & DISCUSSION

It became apparent during the monitoring of this test site that there was a definitive difference between the western portion (east end of Cimarron Turnpike eastbound to W. 41st St. N.) and the eastern portion (W. 41st St. N. eastbound to Diamond Head Road). The primary differences noticed were the overall level of weed pressure as far as species and density was much higher in the western portion of the site than in the eastern portion. The reasons for these differences are unknown but are likely linked to weed pressures present prior to cable barrier installation in each portion and to the level of site disturbance when cable barriers were installed.

At 34 DAA the six evaluation sites were just beginning to show signs of winter and summer annual vegetation infestation and growth. At that time most sites were very clean of winter annual weeds with only a small amount of actively growing annual ryegrass and daisy fleabane (*Erigeron strigosus*) within the cable barrier footprint at 2 of 6 sites. At 75 DAA the differences between the western and eastern portions of the site became very evident. At 75 DAA the western portion was showing poor control of annual ryegrass, emergence of a low population of annual sowthistle (*Sonchus oleraceus*), and continued growth and development of daisy fleabane. Along with these winter annual weeds new emergence was evident from the summer annual weeds prostrate spurge (*Euphorbia supina*), marestail (*Conyza canadensis*), and nodding spurge (*Chamaesyce nutans*). While most of these weeds were relatively small (less than 6 inches tall) they did give the appearance of a weedy cable barrier footprint. The eastern portion had significantly less weed emergence with only a low erratic emergence of annual ryegrass, prostrate spurge, nodding spurge, Illinois bundleflower (*Desmanthus illinoensis*), and daisy fleabane.

By 121 DAA the roadsides in and around the entire test site had been mowed by ODOT crews and were showing signs of both high temperature and drought stress. The early summer mowing was very beneficial by removing remnants of the winter annual species, such as annual ryegrass and sowthistle that were previously not controlled by the treatment. At 121 DAA the western portion continued to show increased emergence and growth of prostrate spurge and nodding spurge. Marestail continued to emerge in 1 of 3 sites in the western portion but was beginning to succumb to summer heat and drought. As with the 75 DAA evaluations with the continued growth and development of prostrate spurge, nodding spurge, and marestail, this stretch of cable barrier did not meet the goal of a clean weed-free footprint. In the eastern portion of the monitored area, cable barrier footprints continued to look very good and were clean of most summer annual weeds. Prostrate spurge along with a low population of marestail was beginning to emerge in the eastern portion.

Evaluations taken at 159 DAA were very similar to those taken at 121 DAA. At that time weed escapes included prostrate spurge, nodding spurge, daisy fleabane, and Illinois bundleflower. At that time in the western portion of the monitored area, the various weed species were producing 30-60% groundcover, resulting in a very weedy appearance. The eastern portion of the area continued to be much more weed-free with the exception that prostrate spurge, nodding spurge, and Illinois bundleflower were increasing in the area east of Keystone Lake.

At 201 DAA the western portion continued to show increasing growth and development of prostrate and nodding spurge, daisy fleabane and low populations of other summer annuals. At this point total groundcover for all weed species in the western portion ranged from 50-80%. At that time the eastern portion continued to look very good and after a late summer mowing looked very clean as the mowers removed some existing stands of nodding spurge and Illinois bundleflower. It should also be noted that low populations of large crabgrass were found in adjacent untreated areas of roadsides throughout the growing season; however, within the treated portions of this test site large crabgrass was successfully controlled for the entire growing season.

Final evaluations took place at 243 DAA (November 10, 2011) and primarily focused on preemergence control of winter annual weeds resulting from the previous March application of Prodiamine 65 WDG. At that time treated cable barrier footprints were showing scattered low populations of emerging winter annual grasses (such as downy brome [*Bromus tectorum*] and/or annual ryegrass), Carolina geranium (*Geranium carolinianum*), annual sowthistle, and plantain spp (*Plantago spps*). When compared to adjacent untreated roadsides, the populations of winter annuals emerging in the treated footprint were significantly lower. This suggests that the Prodiamine 65 WDG component, applied at the 2.3 lb /A rate, is sufficient to provide long-term residual control of fall germinating winter annual weeds when applied as a single late winter preemergence application the previous spring.

The success of the test treatment of Landmaster® BW at 3.3 pints/A + Prodiamine 65 WDG at 2.3 pounds/A + Banvel® at 2 ounces/A + ammonium sulfate at 12 pounds/100 gallons of water applied on March 2, 2011 was very dependent on the weed species present throughout the test area. While the test treatment provided additional weed control in the western portion of the test area it was not capable of controlling prostrate spurge, nodding spurge, marestail, and daisy fleabane to an acceptable level. We are uncertain as to whether this was due in part to inadequate moisture to activate the pre-emergent component prodiamine. In defense of usage of the Prodiamine 65WDG application, there are very few herbicides that have pre-emergence activity on spurge species; plus, daisy species can have both annual and biennial forms. However, prodiamine's lack of pre-emergent activity on marestail was surprising. Future treatments to this site should take these specific weed species into consideration making sure the spectrum of control of selected herbicides will include these specific species.

4.5 CONCLUSIONS

The Landmaster® BW + Banvel® + Prodiamine 65 WDG + ammonium sulfate herbicide treatment applied to the cable-barrier footprint produced variable weed control, depending upon the specific weed species present. While the Prodiamine 65 WDG showed good ability to control large crabgrass and winter annual weeds, weed species such as prostrate spurge, nodding spurge, marestail, and daisy fleabane were not controlled successfully. Areas of the cable barrier system that contained these species were not maintained in a weed-free state and would have required a follow-up postemergence herbicide treatment in early to mid summer to maintain bareground underneath the cable-barrier.

4.6 RECOMMENDATIONS

The first year of observing field testing of cable barrier weed control treatments yield both successes and areas where a single program needs supplementation from additional herbicide components and follow-up treatments. Season-long success from a single application, regardless of components, may not be realistic. A supplemental summer addition or additions will likely be necessary in many cases. The cable barrier its self introduces an additional level of complexity since it is a continuous running barrier that can cause herbicide spray pattern shadowing. A list of suggested interim cable barrier treatments are being prepared and will be presented to ODOT for review in the first quarter of calendar year 2012.

5.0 EVALUATION OF AMINOCYCLOPYRACHLOR COMBINATION TREATMENTS FOR CONTROL OF PALMER AMARANTHPALMER AMARANTH AND JOHNSONGRASS AND COMMON BERMUDAGRASS TOLERANCE (STUDY 4-H-10-11)

5.1 BACKGROUND

This trial continues research on aminocyclopyrachlor (DPX-MAT28) herbicide blends for their ability to provide postemergence control of Palmer amaranth, johnsongrass, and large crabgrass as well as in determining common bermudagrass tolerance to these blends. The DuPont herbicide products Streamline™ (ingredients aminocyclopyrachlor plus metsulfuron methyl) and Perspective™ (ingredients aminocyclopyrachlor plus chlorsulfuron), received their federal EPA registration in 2011 and were added to the ODOT Approved Herbicide and Adjuvant List (AHAL) in 2011 (20). Additionally, these products will be added to the 2012 ODOT Herbicide Contract List. However, exact recommendations on aminocyclopyrachlor containing products have not been added to OSU Publication E-958: *Suggested Herbicides for Roadside Weed and Brush Problems* (18), pending additional research on use of the products and review of new pending label restrictions. This work focuses on further recommendation development for ODOT managed roadsides.

5.2 OBJECTIVES

The objectives of this trial were i) to evaluate 11 herbicide treatments for their effectiveness in controlling Palmer amaranth, johnsongrass, and large crabgrass over the 2011 growing season, and ii) to assess the phytotoxic effect of these herbicide treatments on common bermudagrass (*Cynodon dactylon*).

5.3 MATERIALS AND METHODS

Treatments were applied on June 7 to actively growing common bermudagrass as well as Palmer amaranth (*Amaranth palmeri*) 2-9 inches, johnsongrass (*Sorghum halepense*) 12-28 inches, and large crabgrass (*Digitaria sanguinalis*) 3-5 inches in height (Table 6.). At treatment time common bermudagrass was 2-8 inches in height and actively growing. Growing conditions were good during the first 30-45 days of this study; however by 63 DAA (days-after-application) the study site was under severe high temperature and drought stress. The level of stress at 63 DAA can clearly be seen in the common bermudagrass injury data at this time (Table 9.). Percent Palmer amaranth, large crabgrass, johnsongrass control and common bermudagrass injury were visually evaluated at 15, 30, 63, 91, and 121 days-after-application (DAA).

5.4 RESULTS & DISCUSSION

5.4.1 Soil Moisture Effects on Treatment Performance

Due to the drought conditions that most of Oklahoma has experienced during the past year the growing conditions at this site were erratic over the duration of this study. At the time of treatment application, conditions were dry but normal bermudagrass and weed growth was present. Three days after application a 1.0+ inch rain fell giving ample opportunity for all soil-residual components to become activated as well as provide good early growing conditions for grass and weed development. Evaluations at 15 DAA (days-after-application) showed the research area was dry but no signs of moisture or heat stress were present on existing plants.

Evaluations at 30 DAA showed the research area continued to become more dry and plant materials were beginning to show signs of moderate to severe drought stress in the form of leaf firing on large crabgrass and low levels of firing on common bermudagrass due to the lack of moisture and high temperatures. At that time Palmer amaranth and johnsongrass showed normal growth and development. Due to the beginning signs of environmental stress this trial was irrigated on July 29 (52 DAT) by the ODOT Grant County crew. Irrigation was applied using a Boombuster 437-R tip and applying approximately 1500 gallons of water over the research site. This resulted in an estimated 0.5-0.6 inches of water applied to the experimental area.

Evaluations at 63 DAA showed the research area was under moderate to severe drought and temperature stress. At that time common bermudagrass was at near complete brownout in the untreated checks and large crabgrass was at complete brownout. Also at that time johnsongrass and Palmer amaranth were showing signs of moderate to severe stress. Due to moderate rainfall and more normal temperatures in late August and September, growing conditions were more favorable at 91 and 121 DAA as signs of new plant growth were evident.

5.4.2 Palmer Amaranth Control

At 15 DAA all treatments were showing signs of Palmer amaranth growth suppression. At that early evaluation the treatment including Roundup Pro Concentrate was producing the best control of Palmer amaranth (76%). All other treatments were producing low (17-45%) to moderate levels (55-69%) of Palmer amaranth control & growth suppression. There was an early, clear MAT28 rate response of Palmer amaranth to higher rates producing higher levels of Palmer amaranth control & growth suppression. At 30 DAA the treatment including Roundup Pro® Concentrate continued to produce good Palmer amaranth control (85%). At that time all other treatments showed increased levels of Palmer amaranth control ranging from 23-77% control. Treatments including higher rates of DPX-MAT28 combined with Escort® (21) and Matrix® (a.i. rimsulfuron) (22) were producing Palmer amaranth control of 72-77%. Treatments including the low DPX-MAT28 rates were producing low levels of Palmer amaranth control (23-47%).

At 63 DAA the level of Palmer amaranth control remained similar to those levels at 30 DAA. This was no doubt due to the moderate to extreme drought conditions during this period. As irrigation was supplied to the research site on July 29, followed by moderate rainfall in August, it became apparent, at 91 DAA evaluations, that the Palmer amaranth that were not successfully controlled would eventually resume normal growth and seedhead development. As moderate weed growth resumed, by 91 DAA the control of

Palmer amaranth density had decreased for most treatments. The treatment including Roundup Pro® Concentrate continued to maintain acceptable levels (80% or greater) of Palmer amaranth control. All other treatments were showing decreased levels of Palmer amaranth control as weeds that were previously under moderate to severe levels of suppression were now showing signs of new growth and development, which included new leaf and seedhead development. At the final 121 DAA evaluations Palmer amaranth that had not been killed was continuing to development and produce seedheads in all treatments. The treatment including Roundup Pro® Concentrate, while not maintaining an 80% control level, did produce a final Palmer amaranth control level of 75%. This level of control would likely be considered acceptable to many roadside managers whom have difficulty in achieving this level of season long control (considered limited success with currently available herbicides). Treatments that included the 2.98 or 3.76 oz /A rate of DPX-MAT28, combined with either Telar®XP or Escort®, produced 57-62% season-long control of Palmer amaranth. This is a consistent level of control, maybe slightly higher, than the levels documented in past OSU roadside research trials with similar treatments. The slight increase may be due to some weed necrosis as a result of harsh July growing conditions. Treatments that included lower rates of DPX-MAT28 did not produce acceptable Palmer amaranth control throughout the duration of this study.

5.4.3 Johnsongrass Control

At 15 DAA all treatments were producing low to moderate levels of early johnsongrass control (15-50%). At that time johnsongrass control was primarily in the form of growth suppression, with only the treatments including Roundup Pro Concentrate and DPX-MAT28 at 4.0 oz./A plus Matrix® at 4.0 oz./A producing small amounts of chlorosis. By 30 DAA johnsongrass control had increased slightly for some treatments and decreased slightly for others with all treatments producing johnsongrass suppression in the range of 15-38%. At that time none of the treatments were producing any johnsongrass chlorosis, only growth height suppression. At 63 DAA johnsongrass growth suppression had decreased for all treatments and due to the dry conditions present, most treatments were very similar to the untreated checks. There were no treatment affects present on johnsongrass at either 91 or 121 DAA evaluations. While there has been johnsongrass control reported with DPX-MAT28 products by other researchers, in this trial there was no evidence that any of the treatment combinations evaluated are showing the ability to produce acceptable levels of johnsongrass control, short or long term. It will likely be necessary to include higher rates of glyphosate (closer to 0.5 lb a.i. /A) and/or combinations with sulfometuron or nicosulfuron to achieve acceptable levels of johnsongrass control along Oklahoma roadsides.

5.4.4 Crabgrass Control

At 15 DAA treatments including Roundup Pro® Concentrate and DPX-MAT28 at 4.0 oz./A plus Matrix® at 4.0 oz./A were producing large crabgrass control of 50 and 58%, respectively. All other treatments were producing lower amounts of large crabgrass control that ranged from 10-28%. At 30 DAA large crabgrass was beginning to show signs of firing in the untreated check plots as a result of dry conditions and high temperatures. As a result of the herbicide treatments effects, and crabgrass firing, all treatments showed significant increases in large crabgrass control at 30 DAA. By 60 DAA large crabgrass had completely burned up in the test area due the severe conditions and control data were not taken. As documented in past OSU roadside studies with DPX-MAT28 combination treatments, these products have shown the ability to provide very good 1-2 month postemergence control of large crabgrass, however, due to this year's drought conditions this data could not be replicated.

5.4.5 Bermudagrass Response

At 15 DAA there was very little effect from any of the herbicide treatment combinations on common bermudagrass growth and development. At that time only the treatment including Roundup Pro® Concentrate produced a small amount of common bermudagrass chlorosis and growth suppression (18%). All other treatments were producing very low levels, 6-13%, of common bermudagrass growth suppression with no apparent chlorosis. At 30 DAA common bermudagrass injury, primarily in the form of growth suppression and low levels of chlorosis, increased for all treatments. At that time the untreated check was also showing signs of growth suppression and low levels of chlorosis due to the drought conditions. At 30 DAA there were very little noticeable differences between common bermudagrass growth and development in treated plots and the untreated checks. At 63 DAA the common bermudagrass in the test area had succumbed to the drought and was at near complete brownout (92-95%). This level of brownout was due to the extreme drought conditions during the month of July. With milder temperatures and moderate rainfall during August (and a 0.5" irrigation), common bermudagrass in all plots had made a complete recovery by 91 DAA, having achieved 100% greenup. While much shorter in height, it had recovered from most drought affects.

At 121 DAA there appeared to be very low levels of common bermudagrass growth suppression (5-7%) in all DPX-MAT28 treatments as compared to the untreated checks. The common bermudagrass injury that resulted in this trail from postemergence DPX-MAT28 treatment combinations continues to be very consistent compared to past OSU roadside research trials. Common bermudagrass, along Oklahoma roadsides, appears to be more tolerant to 3.76 oz./A rates of DPX-MAT28 than do Cynodon spp. in SE states. Regardless of whether chlorsulfuron, metsulfuron, or rimsulfuron is mixed with DPX-MAT28, common bermudagrass appears to be very tolerant whether these products are applied on dormant or actively growing common bermudagrass in Oklahoma.

5.5 CONCLUSIONS

The highest rates of the aminocyclopyrachlor combination treatments showed the ability to produce moderate levels (40-75%) of post-emergent Palmer amaranth control and sustain the control throughout the season. Along Oklahoma roadsides that have infestations of Palmer amaranth this level of control may be able to supply some relief from this particular hard-to-control annual weed. The aminocyclopyrachlor combination treatments will also provide a low volatile alternative that has a much lower drift risk potential for ODOT summer broadleaf weed control programs. It is also very important that ODOT maintain a competitive stand of common bermudagrass or low-growing native grass to fill in voids created when Palmer amaranth is controlled. A competitive stand of common bermudagrass in itself will reduce future Palmer amaranth competition.

5.6 RECOMMENDATIONS

Once OSU RVM personnel review new pending Perspective™ and Streamline™ label changes, OSU personnel will be making final recommendations on the use of each of these herbicides. These final use recommendations are not expected to be affected by pending label changes but this cannot be confirmed until the final drafts of the labels are reviewed. Both of these new herbicides have shown the ability to provide very good broadleaf weed control in OSU roadside weed control trials for the past 4 years. The Perspective™ product, expected to be priced more economically for the roadside market segment, should provide a new standard for preemergence and postemergence kochia control and postemergence field bindweed control. Several research trials have been designed to determine whether Perspective™ and Streamline™ herbicides will control Palmer amaranth. Data from this study, along with previous studies, suggests that each of these herbicides will provide for moderate suppression (30-50%) of Palmer amaranth when applied as an early summer postemergence treatment at a rate of 4.75 ounces of product per acre. This level of control or suppression is not acceptable for a roadside that has a problem with Palmer amaranth. While these products can provide for good broadleaf weed control of some species, they will need to be tank-mixed with other broadleaf herbicides to provide for control of Palmer amaranth.

Table 6. Herbicide application specifics for experiment 4-H-10-11.	
Application Factor	**Measurement**
Application Date:	June-7-2011
Time of Day:	6:50 a.m.
Application Method:	Broadcast spray
Application Timing:	Postemergence
Application Placement:	Foliar
Air Temperature:	78 F
Relative Humidity:	68 %
Wind Velocity:	6 MPH
Wind Direction:	S
Dew Presence (Y/N):	No
Soil Temperature:	75 F
Soil Moisture:	dry
Cloud Cover:	0 %
Appl. Equipment:	Bicycle sprayer
Operating Pressure:	26 PSI
Nozzle Type:	XR Tee jet
Nozzle Size:	XR 8004VS
Nozzle Spacing, Unit:	20 inches
Nozzles/Row:	3
Boom Height:	24 inches
Ground Speed:	2.5 MPH
Carrier:	Water
Spray Volume:	30 gallons per acre
Mix Size:	1.8 liters
Propellant:	CO2

Table 7. Comparison of DPX-MAT28 treatment combinations for postemergence Palmer amaranth control. Study 4-H-10-11.[1]

Pest Name				**Palmer amaranth**									
Rating Date				**6/22/2011**		**7/7/2011**		**8/9/2011**		**9/6/2011**		**10/6/2011**	
Rating Type				**Control**		**Control**		**Control**		**Control**		**Control**	
Rating Unit				**%**		**%**		**%**		**%**		**%**	
Trt-Eval Interval				**15 DAA**		**30 DAA**		**63 DAA**		**91 DAA**		**121 DAA**	
Trt No.	**Treatment** Name	Rate	Rate Unit										
1	DPX-MAT28 Telar XP	2.14 0.573	oz wt/a oz wt/a	22	E	28	f	41	ef	25	de	28	cd
2	DPX-MAT28 Telar XP	2.98 0.79	oz wt/a oz wt/a	37	D	62	cd	63	bcd	60	abc	58	ab
3	DPX-MAT28 Telar XP	3.76 1	oz wt/a oz wt/a	43	D	60	cd	66	bc	72	ab	58	ab
4	DPX-MAT28 Escort XP	2.14 0.583	oz wt/a oz wt/a	45	cd	47	e	47	def	43	cde	37	bcd
5	DPX-MAT28 Escort XP	2.98 0.78	oz wt/a oz wt/a	55	bc	72	bc	68	abc	63	abc	62	ab
6	DPX-MAT28 Escort XP	3.76 1	oz wt/a oz wt/a	57	B	77	ab	73	abc	64	abc	57	ab
7	DPX-MAT28 Oust XP Telar XP Roundup Pro Conc.	2.5 1 0.507 9	oz wt/a oz wt/a oz wt/a fl oz/a	76	A	85	a	85	a	80	a	75	a
8	DPX-MAT28 Matrix	2 2	oz wt/a oz wt/a	17	E	23	f	30	f	18	e	20	d
9	DPX-MAT28 Matrix	3 3	oz wt/a oz wt/a	42	D	50	de	33	f	29	de	25	cd
10	DPX-MAT28 Matrix	4 4	oz wt/a oz wt/a	69	A	75	ab	79	ab	67	abc	58	ab
11	Milestone VM Escort XP	7.44 0.467	fl oz/a oz wt/a	54	bc	52	de	58	cde	48	bcd	50	abc
12	Untreated Check			0		16		15		0		0	
LSD (P=.10)				10.7		11.9		18.7		27		25.3	
Standard Deviation				7.6		8.5		13.3		19.2		17.9	
CV				16.13		14.81		22.64		36.99		37.37	
Replicate F				4.512		1.232		0.59		0.6		0.736	
Replicate Prob(F)				0.0241		0.313		0.5634		0.5584		0.4915	
Treatment F				16.844		16.171		5.827		3.433		2.928	
Treatment Prob(F)				0.0001		0.0001		0.0004		0.0091		0.0196	

[1]All treatments included a non-ionic surfactant at a rate of 0.25% volume per volume. DAA = days after application. LSD = least significant difference test. Means sharing a common letter do not significantly differ at p = 0.10.NS = no significant differences present at p=0.10.

Table 8. Comparison of DPX-MAT28 treatment combinations for postemergence Johnsongrass and large crabgrass control. Study 4-H-10-11. [1]

Pest Name				johnsongrass						large crabgrass			
Rating Date				6/22/2011		7/7/2011		8/9/2011		6/22/2011		7/7/2011	
Rating Type				Control		Control		Control		Control		Control	
Rating Unit				%		%		%		%		%	
Trt-Eval Interval				15 DAA		30 DAA		63 DAA		15 DAA		30 DAA	
Trt No.	Treatment Name	Rate	Rate Unit										
1	DPX-MAT28	2.14	oz wt/a	18	cd	15	b	15	b	10	c	60	ab
	Telar XP	0.573	oz wt/a										
2	DPX-MAT28	2.98	oz wt/a	20	cd	23	ab	13	b	25	c	60	ab
	Telar XP	0.79	oz wt/a										
3	DPX-MAT28	3.76	oz wt/a	23	bcd	30	ab	18	b	10	c	73	ab
	Telar XP	1	oz wt/a										
4	DPX-MAT28	2.14	oz wt/a	15	cd	20	ab	15	b	20	c	57	ab
	Escort XP	0.583	oz wt/a										
5	DPX-MAT28	2.98	oz wt/a	17	cd	22	ab	13	b	27	bc	67	ab
	Escort XP	0.78	oz wt/a										
6	DPX-MAT28	3.76	oz wt/a	38	ab	38	a	20	ab	10	c	80	a
	Escort XP	1	oz wt/a										
7	DPX-MAT28	2.5	oz wt/a	43	a	33	ab	28	a	50	ab	77	a
	Oust XP	1	oz wt/a										
	Telar XP	0.507	oz wt/a										
	Roundup Pro Conc.	9	fl oz/a										
8	DPX-MAT28	2	oz wt/a	23	bc	27	ab	17	b	28	bc	57	ab
	Matrix	2	oz wt/a										
9	DPX-MAT28	3	oz wt/a	18	cd	25	ab	12	b	25	c	50	ab
	Matrix	3	oz wt/a										
10	DPX-MAT28	4	oz wt/a	50	a	30	ab	18	b	58	a	68	ab
	Matrix	4	oz wt/a										
11	Milestone VM	7.44	fl oz/a	7	d	15	b	12	b	13	c	43	b
	Escort XP	0.467	oz wt/a										
12	Untreated Check			0		0		15		0		70	
LSD (P=.10)				16.7		19.7		8.7		24.2		30.4	
Standard Deviation				11.7		13.8		6.1		17.2		21.6	
CV				47.48		54.98		37.25		68.4		34.29	
Replicate F				2.87		2.393		1.61		10.215		19.759	
Replicate Prob(F)				0.0861		0.1233		0.2326		0.0009		0.0001	
Treatment F				3.855		0.817		1.747		2.621		0.825	
Treatment Prob(F)				0.0082		0.6183		0.1593		0.0319		0.6102	

[1]All treatments included a non-ionic surfactant at a rate of 0.25% volume per volume. DAA = days after application. LSD = least significant difference test. Means sharing a common letter do not significantly differ at p = 0.10.NS = no significant differences present at p=0.10.

Table 9. Comparison of DPX-MAT28 treatment combinations for common bermudagrass tolerance. Study 4-H-10-11. [1]

Crop Name				common bermudagrass									
Rating Date				6/22/2011		7/7/2011		8/9/2011		9/6/2011		10/6/2011	
Rating Type				Injury		Injury		Injury		Injury		Injury	
Rating Unit				%		%		%		%		%	
Trt-Eval Interval				15 DAA		30 DAA		63 DAA		91 DAA		121 DAA	
Trt No.	Treatment Name	Other Rate	Other Rate Unit										
1	DPX-MAT28 Telar XP	2.14 0.573	oz wt/a oz wt/a	6	d	23	a	93	a	0	a	5	ab
2	DPX-MAT28 Telar XP	2.98 0.79	oz wt/a oz wt/a	9	c	23	a	93	a	0	a	5	ab
3	DPX-MAT28 Telar XP	3.76 1	oz wt/a oz wt/a	9	c	20	ab	93	a	0	a	7	a
4	DPX-MAT28 Escort XP	2.14 0.583	oz wt/a oz wt/a	8	cd	20	ab	93	a	0	a	5	ab
5	DPX-MAT28 Escort XP	2.98 0.78	oz wt/a oz wt/a	9	c	22	ab	92	a	0	a	5	ab
6	DPX-MAT28 Escort XP	3.76 1	oz wt/a oz wt/a	13	b	20	ab	92	a	0	a	7	a
7	DPX-MAT28 Oust XP Telar XP Roundup Pro Conc.	2.5 1 0.507 9	oz wt/a oz wt/a oz wt/a fl oz/a	18	a	24	a	93	a	0	a	7	a
8	DPX-MAT28 Matrix	2 2	oz wt/a oz wt/a	9	c	16	bc	93	a	0	a	5	ab
9	DPX-MAT28 Matrix	3 3	oz wt/a oz wt/a	9	c	20	ab	95	a	0	a	5	ab
10	DPX-MAT28 Matrix	4 4	oz wt/a oz wt/a	13	b	21	ab	93	a	0	a	5	ab
11	Milestone VM Escort XP	7.44 0.467	fl oz/a oz wt/a	8	cd	12	c	92	a	0	a	3	b
12	Untreated Check			0		23		93		0		0	
LSD (P=.10)				3		6.1		3.8		0		2.2	
Standard Deviation				2.1		4.4		2.7		0		1.5	
CV				20.6		21.63		2.91		0		28.9	
Replicate F				1.753		34.109		1.34		0		4.194	
Replicate Prob(F)				0.1988		0.0001		0.2843		1		0.0301	
Treatment F				7.132		2.06		0.412		0		1.29	
Treatment Prob(F)				0.0001		0.0812		0.9244		1		0.2999	

[1]All treatments included a non-ionic surfactant at a rate of 0.25% volume per volume. DAA = days after application. LSD = least significant difference test. Means sharing a common letter do not significantly differ at p = 0.10.NS = no significant differences present at p=0.10.

6.0 EVALUATION OF 2011 DIVISION FOUR GRANT COUNTY PERSPECTIVE HERBICIDE DEMONSTRATION TREATMENT

6.1 BACKGROUND

The OSU RVM team has been working with the new herbicide active ingredient aminocyclopyrachlor for the past several years (4, 17). This new DuPont herbicide active ingredient was developed and labeled as a blend with other DuPont sulfonyl urea herbicides in an effort to produce a wide spectrum product with both preemergence and postemergence activity on broadleaf weeds, grassy weeds, and brush species. DuPont has targeted the roadside market with two blended products. The first product, Perspective™ (3), is a blend of aminocyclopyrachlor (DPX-MAT28) + chlorsulfuron. Chlorsulfuron is the same a.i. as in Telar®. The second DuPont blended product that has been recently released is Streamline™ (2), which is a blend of aminocyclopyrachlor + metsulfuron. Metsulfuron-methyl is the a.i. found in Escort® herbicide. Both of these herbicide blends have performed very well in past OSU weed control studies. They have proven to have the ability to supply good preemergence control of kochia (*Kochia scoparia*) and other broadleaf weeds if applied as a late preemergence/early postemergence treatment (late Feb. or early March treatment) (4, 17). They also may provide good weed control when applied in late May/early June as these products have proven to have the ability to supply moderate levels of postemergence suppression of Palmer amaranth (*Amaranthus palmeri*) and excellent postemergence control of kochia and other broadleaf weeds. Both of these new herbicides have shown similar abilities in weed control as Milestone® VM with an advantage in providing significantly better control of kochia. With these new products ODOT has the additional option of applying them in early summer for postemergence control of broadleaf weeds. Applying Milestone® VM in early summer as a postemergence treatment did not produce the same benefits as when applications were made in March.

Late in 2010 OSU personnel approached the local DuPont representative (Mr. T.V. Smith) and inquired if DuPont would be interested in donating some Perspective™ herbicide so that it could be given to 2 to 3 ODOT maintenance crews for use in large scale demonstrations of the product. DuPont, and Mr. Smith, were very agreeable and they donated 21.25 lbs of Perspective™ herbicide. The Perspective™ was provided at 11.25 lbs to Division Four/Grant County and 10.0 lbs to Division Six/Alfalfa County. These counties were chosen as they have increased problems with both kochia and Palmer amaranth, documented through the Annual Herbicide Program Report and personal contact with OSU personnel. Results of the Division Six/Alfalfa County Perspective™ Demonstration Treatment are discussed in Section 7 of this report.

OSU RVM personnel met with Division Four/Grant County personnel on May 17, at which time the donated Perspective™ herbicide was delivered and the details of the Perspective™ Demonstration Treatment were planned. The remainder of this chapter covers the materials and methods as well as outcomes from the Grant County crew's use of Perspective™ herbicide as a tank mix in a large scale demonstration.

6.2 OBJECTIVES

The objective of this large scale Grant County Oklahoma demonstration was to assess the contribution in weed control achieved by addition of Perspective™ herbicide at 4.75 ounces/A to a tank mix of Ranger Pro® at 19 ounces/A + Outrider® at 1.3 ounces/A when applied in early June to common bermudagrass roadsides containing Palmer amaranth and kochia.

6.3 MATERIALS AND METHODS

Mr. Steve Zeman/Grant County Supervisor chose five areas within his county to utilize the Perspective™ herbicide tank mix component under test. Areas where he chose to conduct the comparison were those that had a history of infestation by kochia, Palmer amaranth, and other pigweed species (*Amaranthus species*). The herbicide tank mix treatments tested by the Grant county crew were i) Ranger Pro® at 19 ounces/A + Outrider at 1.3 ounces/A and ii) Perspective™ at 4.75 ounces/A + Ranger Pro® at 19 ounces/A + Outrider® at 1.3 ounces/A. The demonstrations were conducted as a pair-wise comparison where one side of the highway received the tank mix that contained Perspective™ and the opposite side of the highway received the same tank mix without the Perspective™ component. All herbicide treatments in this study were made on June 6, 2011.

We conducted monthly evaluations on weed control in 3 of the 5 Perspective™ Demonstration Treatment sites on July 7 (31 Days after herbicide application [DAA]), August 9 (64 DAA), and September 10 (96 DAA). As with all 2011 summer herbicide treatments it is important to note that summer climatic conditions were very harsh in Grant County. The Perspective™ demonstration treatment performance was likely affected by the high temperature and drought stress conditions. Attempts were made during evaluations to try and separate weed control as a result of the herbicides versus that produced by the harsh growing conditions.

6.4 RESULTS & DISCUSSION

The treatment of Ranger Pro® at 19 ounces/A + Outrider® at 1.3 ounces/A did not produce any control of kochia or Palmer amaranth throughout this study. Therefore, all following discussion in this RESULTS & DISCUSSION section of Chapter 6 are in reference to the levels of control offered by addition of Perspective™ to the Ranger Pro® and Outrider® tank mix unless otherwise specifically stated.

At 31 DAA moderate to excellent kochia control was being produced at 2 of the 3 sites, however control was erratic and seemed to be influenced by weed densities. At that time kochia control ranged from 60-90%. The 60% kochia control was evident in areas that had high densities of broadleaf weeds (kochia & Palmer amaranth) and 90% in areas that had moderate to low densities. Palmer amaranth control was more erratic with some areas showing poor control of 25-50%, while other areas showed 40-60% control. Palmer amaranth and kochia that was not controlled showed moderate to severe growth suppression. This type of erratic weed control results may be somewhat due to climatic conditions. However as noted during evaluation, it may be partially due to the difficulties in getting good herbicide coverage in areas with a high density of target weeds. Dense canopies of weeds can cause a shadow or shielding effect such that some areas of the weed canopy do not receive herbicide spray droplets due to shadowing by taller weeds. It was also noted that areas that had a competitive stand of common bermudagrass tended to have higher weed control results as the common bermudagrass played a role in suppressing weed growth and development. It was also documented at that time that the Perspective™ Demonstration Treatment was producing extremely high levels (95% or greater) of field bindweed control. There was no early visible injury to common bermudagrass at any of the demonstration sites.

At 64 DAA both kochia and Palmer amaranth weed control results continued to be somewhat erratic. There was substantial variation between and within each demonstration site. Palmer amaranth control was quite variable, ranging from 35-80% at the 3 test sites evaluated. Palmer amaranth control at that time was 50%. At that time many of the larger Palmer amaranth plants that were not controlled by the Perspective™ Demonstration tank mix treatment were developing and producing seedheads. Kochia control was much more consistent within and between sites. At the site that had the highest density of kochia, a low to moderate amount of kochia escaped the Perspective™ treatment and its growth was suppressed. These same plants were also developing seedheads. No common bermudagrass injury was noticed at any of the sites at 64DAA.

At the final evaluation date on September 10 2011 (96 DAA) both Palmer amaranth and kochia control continued to vary from site to site. Population density, the amount of relative plant growth, and developmental stage was also variable and proportional to the number of weeds escaping from initial application treatment. The site located north of Nash showed Palmer amaranth control levels of 50-60% where there was a moderate to high density of weeds and 80-90% control in nearby areas where there were lower levels of Palmer amaranth and competitive stands of common bermudagrass. At 96 DAA at Nash, adjacent roadsides that were not treated with the Perspective™ Demonstration tank mix treatment were showing very high densities of fully developed Palmer amaranth. At the site located west of the intersection of US-81 S and US-60/64, Palmer amaranth control produced by the Perspective™ Demonstration tank mix treatment ranged from 40-50% and kochia control was approximately 80%. Weed control along that 4 mile stretch of US-60/64 was somewhat erratic and again seemed to be tied directly to weed densities. That particular site had received some late summer rain and a small population of new Palmer amaranth seedlings and kochia seedlings were documented. That site also showed a late summer emergence of a small population of toothed spurge (*Poinsettia dentate)*. The site located on US-60 just east of Lamont was showing 50-60% control of Palmer amaranth at 96 DAA from the Perspective™ Demonstration tank mix treatment. Also at that site at 96 DAA a small population of new Palmer amaranth seedlings were emerging. The roadside adjacent to the Perspective™ tank mix treatment that did not receive any herbicide treatment whatsoever was showing a very high density of fully developed Palmer amaranth plants. This suggests that the Perspective™ tank mix treatment resulted in substantial control of Palmer amaranth.

6.5 CONCLUSIONS

The addition of Perspective™ herbicide to the scheduled summer johnsongrass control treatment of Ranger Pro® + Outrider® produced moderate, but erratic weed control results based on specific weed species. The addition of Perspective™ showed the ability to provide poor to moderate control of Palmer amaranth, moderate to good control of kochia, and good to excellent control of field bindweed. There is a high probability that weed control levels were influenced by the harsh droughty conditions as well as affected by weed densities at treatment time. Areas with lower weed densities and a competitive stand of common bermudagrass showed more consistent elevated levels of weed control.

6.6 RECOMMENDATIONS

See Section 7.6 for collective recommendations from Chapters 6 and 7 of this report.

7.0 EVALUATION OF 2011 DIVISION SIX ALFALFA COUNTY PERSPECTIVE™ HERBICIDE DEMONSTRATION TREATMENT

7.1 BACKGROUND

The OSU RVM team has been working with the new herbicide active ingredient aminocyclopyrachlor for the past several years (4, 17). This new DuPont herbicide active ingredient was developed and labeled as a blend with other DuPont sulfonyl urea herbicides in an effort to produce a wide spectrum product with both preemergence and postemergence activity on broadleaf weeds, grassy weeds, and brush species. DuPont has targeted the roadside market with two blended products. The first product, Perspective™ (3), is a blend of aminocyclopyrachlor (DPX-MAT28) + chlorsulfuron. Chlorsulfuron is the same a.i. as in Telar®. The second DuPont blended product that has been recently released is Streamline™ (2), which is a blend of aminocyclopyrachlor + metsulfuron. Metsulfuron-methyl is the a.i. found in Escort® herbicide. Both of these herbicide blends have performed very well in past OSU weed control studies. They have proven to have the ability to supply good preemergence control of kochia (*Kochia scoparia*) and other broadleaf weeds if applied as a late preemergence/early postemergence treatment (late Feb. or early March treatment) (4, 17). They also may provide good weed control when applied in late May/early June as these products have proven to have the ability to supply moderate levels of postemergence suppression of Palmer amaranth (*Amaranthus palmeri*) and excellent postemergence control of kochia and other broadleaf weeds. Both of these new herbicides have shown similar abilities in weed control as Milestone® VM with an advantage in providing significantly better control of kochia. With these new products ODOT has the additional option of applying them in early summer for postemergence control of broadleaf weeds. Applying Milestone® VM in early summer as a postemergence treatment did not produce the same benefits as when applications were made in March.

Late in 2010 OSU RVM personnel approached the local DuPont representative (Mr. T.V. Smith) and inquired if DuPont would be interested in donating enough Perspective™ herbicide so that it could be given to 2 to 3 ODOT maintenance crews allowing them to apply a tank load of the new herbicide. DuPont, and Mr. Smith, were very agreeable and donated 21.25 lbs of Perspective™ herbicide. The Perspective™ was divided with 11.25 lbs given to Division Four/Grant County and 10.0 lbs given to Division Six/Alfalfa County. These counties were chosen as they have documented problems with both kochia and Palmer amaranth. Results of the Division Four/Grant County Perspective™ Demonstration Treatment are discussed in Chapter 6 of this report.

A meeting between OSU personnel and Division Six/Alfalfa County personnel was not conducted prior to the Division Six/Alfalfa County Perspective™ demonstration treatment being applied on June 22. However, to assist Alfalfa County personnel prior to their application of the Perspective™, an herbicide treatment tank mixture protocol was developed by OSU. This protocol was sent to Alfalfa County Superintendent Mark King. Alfalfa County was in the process of beginning to make their scheduled summer johnsongrass control treatment of Honcho® Plus (a.i. glyphosate) at 16 ounces/A + Oust® Extra (a.i. sulfometuron + metsulfuron-methyl) at 1.5 ounces/A with the intent to include the Perspective™ product in one of their tank loads. The remainder of this chapter covers the materials and methods as well as outcomes from the Alfalfa County crew's use of Perspective™ herbicide as a tank mix in a large scale demonstration.

7.2 OBJECTIVES

The objective of this large scale demonstration in Alfalfa County Oklahoma was to assess the weed control achieved by using a tank mix of Perspective™ herbicide at 4.75 ounces/A + Honcho® Plus at 16 fl oz /A + Oust® Extra at 1.5 oz /A when applied in late June to common bermudagrass roadsides containing Palmer amaranth, kochia and other broadleaf weeds.

7.3 MATERIALS AND METHODS

The Alfalfa County Perspective™ Demonstration treatment consisted of Honcho® Plus at 16 fl oz /A + Oust® Extra at 1.5 oz /A + Perspective™ at 4.75 oz /A. As in Grant County the intent of the Alfalfa County demonstration was to mix one load, or partial load, of this treatment and target Alfalfa County roadsides that had infestations of kochia, Palmer amaranth, and other broadleaf weeds. Unlike the Grant County demonstration site, in Alfalfa County the weed control comparison was made to the non-treated area outside of the spray zone. The spray zone starts at the edge of the hard surface and extends 25-27 feet outward toward the end of the ODOT easement. The placement of the demonstration applications was left up to Mr. Mark King/Alfalfa County Supervisor and he subsequently chose 2 test sites.

OSU personnel conducted monthly evaluations on weed control at each of the Perspective™ Demonstration Treatment sites on July 22 (30 Days after application [DAA]), August 11 (61 DAA), and September 6, 2011 (87 DAA). It is important to note that summer climatic conditions were very harsh in Alfalfa County. The Perspective™

demonstration treatment performance was likely affected by the high temperature and drought stress conditions. Attempts were made during evaluations to separate weed control as a result of the herbicides used versus that produced by the harsh growing conditions.

7.4 RESULTS & DISCUSSION

Unlike the RESULTS & DISCUSSION section in Chapter 6, the weed control results discussed in this section are in reference to that achieved by a Honcho® Plus at 16 ounces/A + Oust® Extra at 1.5 oz /A + Perspective™ at 4.75 oz /A treatment relative to a non-treated (no herbicide what so ever) area of roadside that was just outside of the spray zone. The spray zone started at the edge of the hard surface and extended 25-27 feet outward toward the end of ODOT road-easement.

At 30 DAA each Perspective™ herbicide tank mix demonstration site exhibited good control of kochia, marestail, Palmer amaranth, lambs quarter (*Chenopodium album*), and field bindweed (*Convolvulus arvensis*). Control of each of these species was at least 75-80%. At 30 DAA no common bermudagrass injury was noticed in either area.

At 61 DAA, control levels for all weed species were sustained or had increased from the 30 DAA ratings. This increase in control occurred despite a stretch of very severe high temperature and drought stress. At 61 DAA Palmer amaranth control was 70-80%, marestail and kochia control was at 80-90%, and field bindweed control was at 95% or greater. Common bermudagrass was showing moderate to severe signs of stress; however, no noticeable differences were documented between treated and untreated common bermudagrass.

On September 6 (87 DAA) control levels had increased slightly since the 61 DAA ratings. At that time good to excellent control of kochia, marestail, and field bindweed was found. Surprisingly, Palmer amaranth control had increased to 90-92% by 87DAA. That level of Palmer amaranth control, 3 months after application, has not been achieved in any previous OSU aminocyclopyrachlor herbicide research trial.

It is important to point out the difference between the Alfalfa County scheduled summer johnsongrass control treatment (Chapter 7) and that used by the Grant County crew (Chapter 6). The Alfalfa County crew used Oust® Extra in addition to glyphosate whereas the Grant County Crew used Outrider® instead of Oust® Extra. The Oust® Extra utilized by the Alfalfa County crew has a much higher degree of broadleaf weed control due to the ability of both the sulfometuron and metsulfuron active ingredients to produce significantly higher levels of broadleaf weed control than the active ingredient sulfosulfuron found in Outrider® herbicide. This resulted in a welcome, but unexpected significant increase in Palmer amaranth and kochia control in the Alfalfa County demonstration. Of course the use of Oust® Extra component can in some cases result in increased phytotoxicity to common bermudagrass since bermudagrass is more tolerant of sulfosulfuron than sulfometuron herbicides at commonly used rates.

Factors that may have led to the very good, high level of Palmer amaranth control in Alfalfa County were i) the inclusion of Oust® Extra in the Perspective™ tank mix demonstration treatment, ii) possibly some weed mortality due to severe summer growing conditions and iii) the ODOT mowing program.

7.5 CONCLUSIONS

The addition of Perspective™ herbicide to the scheduled summer johnsongrass control treatment of Honcho Plus® + Oust® Extra produced good to excellent control of several summer annual and perennial weed species. The response was generally consistent throughout the treated area. The addition of Perspective™ showed the ability to produce and sustain good control of Palmer amaranth along with good to excellent control of field bindweed. The use of Oust® Extra + Perspective™ provided a very high level of summer broadleaf weed control as this treatment combination contains four separate active ingredients. All of these ingredients individually provide varying degrees of broadleaf weed control activity.

7.6 RECOMMENDATIONS

We recommend continuing with the final implementation of Perspective™ and Streamline™ herbicides into the ODOT herbicide program. Continued label changes may occur on these products based on requirements of the US EPA. This may result from legal action taken in a class action law suit against DuPont concerning the purported damage of certain tree species in other states via root uptake of the herbicide aminocyclopyrachlor in urban landscapes from the product named Imprelis®. Aminocyclopyrachlor is one of two ingredients in both Perspective™ and Streamline™ herbicides. ODOT applicators will need to be certain to read and follow all labeled directions, as always, for all products utilized.

While some 2011 weed control results from the Perspective™ Herbicide Demonstrations were less than desirable, the new herbicides still have potential to supply a summer broadleaf weed control alternative for ODOT to utilize with decreased volatility risk. Also, these products have shown the ability in 2011 OSU RVM trials to produce and maintain long-term residual annual weed control. This will be beneficial in cable-barrier weed control programs as well. These new herbicide products were added to the 2011 Approved Herbicide and Adjuvant List (AHAL) and are scheduled to be added to the current ODOT herbicide contract in early 2012. We have not, however, added these two products to OSU Publication E-958: *Suggested Maintenance Practices for Roadside Weed and Brush Problems* as we suggest that small scale demonstrations conducted by OSU RVM and ODOT cooperators continue in 2012 before more extensive use by ODOT occurs.

We recommend the continuation of herbicide screening research in 2012 for determination of both pre- and post-emergent herbicides and herbicide combination treatments that can supply the desired weed control for ODOT in safety zones including cable-barrier system footprints. Comments have been made during 2011 by ODOT Director Gary Ridley as to the unacceptable appearance of cable-barriers that became infested with tall growing weeds. Both ODOT maintenance personnel and OSU RVM personnel are in agreement that effective cable-barrier weed control programs are needed. This challenging task will require continued development work with both residual (long-term preemergence) and foliar (postemergence) components to provide season-long bareground weed control or season-long weed free common bermudagrass. It is highly unlikely that a single application of any single or combination mix can maintain weed-free conditions in an intended bare ground or common bermudagrass management program in the cable-barrier footprint. Most likely seasonal applications will be needed to manage weeds effectively in such areas. While research screening work can continue on the Oklahoma State University Cimarron Valley Research Station it is recommended that future screenings and demonstrations take place under actual ODOT cable-barriers. Conducting work on actual cable-barriers will add to the complexity of factors investigated as well as add difficulty in conducting the work. Additionally, our RVM team will require assistance from ODOT in providing the necessary traffic safety crew to conduct such research.

8.0 EVALUATION OF 2011 DIVISION FOUR GRANT COUNTY REQUEST® (ADJUVANT) JOHNSONGRASS CONTROL DEMONSTRATION TREATMENT

8.1 BACKGROUND

Over the past several years it has been documented by OSU personnel through personal contacts and observations that ODOT personnel in Division Four/Grant County have experienced problems in successfully controlling summer perennial johnsongrass. OSU personnel have worked closely with Grant County Supervisor Steve Zeman and Grant County spray crew members in an attempt to diagnose what may be causing the poor johnsongrass control results. Over the past several years different herbicide treatment combinations and rates were tried in an effort to find that special treatment combination that would produce the 3-4 month season-long control of johnsongrass in this specific county. Combination treatments of glyphosate + Oust® or glyphosate + Outrider®, that were successful in other counties, were not able to produce and sustain acceptable levels (80% or greater) of perennial johnsongrass control in Grant County. During that time Grant County personnel were interviewed, spray records were reviewed, and spray equipment was inspected. The findings were that no clear culprit surfaced that was responsible for poor herbicide program performance. In 2005 as part of project SPR 2156 OSU conducted a water quality analysis and survey of ODOT maintenance facility water sources. Data from this survey showed that the ODOT Grant County water source had high values for pH, water hardness, and electrical (23) conductivity. Because of these high values it was determined that it was a possibility that the poor water quality may be adversely affecting the performance of the glyphosate component used for summer johnsongrass control. In 2011 OSU personnel contacted Helena Chemical Company and arranged for the purchase of the adjuvant Request®.

Request® (24, 25) is a liquid water conditioner and ammonium sulfate (AMS) replacement agent that may help overcome problems with weed control created by reduced efficacy of herbicides when linked to water quality problems such as hard water. According to the Helena Products Company website Request® utilizes sequestering agents and ammoniacal nitrogen to prevent water quality problems and enhance plant uptake for better results from herbicide applications where spray tank water quality is inhibiting herbicide performance. Request® contains no surfactant nor drift control additive.

The water conditioner adjuvant Request® was tested by ODOT Grant County personnel in 2011 to determine if it can help improve performance of their herbicide program effectiveness. This chapter summarizes the conduct and findings of the ODOT Grant County test of Request® under field conditions.

8.2 OBJECTIVES

The objective of this research was to monitor the effectiveness of Request® water conditioning adjuvant when tankmixed with a Ranger Pro® and Outrider® combination herbicide treatment application made by ODOT herbicide applicators in Grant County, Oklahoma.

8.3 MATERIALS AND METHODS

In this demonstration, ODOT Grant County applicators treated the south side of highway SH-11, west of Deer Creek with the scheduled tank mix of Ranger Pro® herbicide at 19 ounces/A + Outrider® herbicide at 1.3 ounces/A and on the north side of this same stretch of highway apply the same tank mix but include Request® at 1 quart/100 gallons of water. This allowed for comparison of one side of the highway with the other and determination if the Request® could produce an increase in herbicide activity. Both sides of the highway were treated on June 6 with the appropriate treatments. Johnsongrass control evaluations were taken from both treatment sites on July 7 (31 DAA), August 9 (64 DAA), and September 9 (93 DAA).

8.4 RESULTS & DISCUSSION

Under normal conditions, the test treatment of Ranger Pro® (glyphosate) at 19 fl oz /A + Outrider® at 1.3 oz /A should produce 90% or greater control of both seedling and perennial johnsongrass by 30 days after application. At 31 DAA it was evident that the test area that included the Request® water conditioner was producing very erratic johnsongrass control. Johnsongrass control ranged from 40-75% in the Request® treated area. An estimation of the average johnsongrass control at this time would be approximately 50%. This is well below what is deemed acceptable (acceptable being 80% or greater). Observations of the johnsongrass control achieved on the south side of the highway that did not have the Request® addition, averaged between 25-50%. While the glyphosate + Outrider® + Request® treatment was not able to produce an acceptable level of johnsongrass control it did show a noticeable improvement over the treatment that did not receive the Request® water conditioning agent. It was also documented at this time that common bermudagrass injury was approximately 10% higher in the Request® treated area but this would be acceptable for roadside sites.

At 64 DAA johnsongrass populations in both areas were severely stunted. Unfortunately the stunting was likely due to the severe high temperature stress, severe drought, and late July mowing conducted by Grant County maintenance personnel. Even though the summer remained very hot and dry, by 93 DAA johnsongrass populations had rebounded and it was evident that the herbicide applications yielded little to no johnsongrass control on both sides of the treated highway, north and south test safety-zones. While the addition of the Request® water conditioning adjuvant did produce a positive response in increasing johnsongrass control it was a very minimal response and temporary. We will continue to work with Grant County and Division Four personnel in order to develop a solution to the johnsongrass control problems in their county.

8.5 CONCLUSIONS

The addition of Request® water conditioning agent to an herbicide tank mix provided a somewhat erratic johnsongrass control response. While in some areas of the test sites the addition of the Request® water conditioning adjuvant did produce a positive response in increasing johnsongrass control it was generally a very minimal response and it did not appear to improve longer term control of johnsongrass in the test areas.

8.6 RECOMMENDATIONS

Due to limited improvement in weed control provided by addition of Request® adjuvant, we cannot recommend that ODOT continue it use. We also cannot recommend that ODOT have OSU continue to research Request® at this time.

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