2004
Annual Research Report

Refinement of Roadside Vegetation Management Practices in Oklahoma

ODOT Project: 2157

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Introduction

The intent of this research report is to supply ODOT personnel with the latest evaluations of products being developed for use in roadside vegetation management programs. Each of these studies have products or treatments being evaluated that could potentially have an impact on ODOT roadside vegetation management programs. All of the research presented in this report has been conducted using today's most modern research techniques and procedures and every attempt has been made to minimize research error so that product performances may be evaluated. All research studies were conducted on state highway system roadsides and under normal roadside conditions. As with all herbicide research conducted under field conditions there are many variables that influence the effects of the various herbicide treatments other than the herbicides themselves. Every attempt has been made to evaluate both positive and negative treatment results taking into consideration the specific field conditions at each study site. All data collected from treated plots was compared to nearby untreated plots for comparison. All data collected was completely unbiased as to product and manufacturer.

Title: Preemergence Broadleaf Weed Control
Trial ID: 4-H-51-04
Date Treated: 3/19/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Garfield Co. **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-81, 3.7 miles north of Bison (center median)
Trial Objective: The objective of this study was to evaluate an experimental herbicide from Dow AgroSciences for preemergence weed control of various broadleaf weeds and grasses and common bermudagrass tolerance.

Results & Discussion:

This study was performed under a confidentiality agreement between OSU Roadside Vegetation Management personnel and Dow AgroSciences. Under the agreement OSU cannot publish or share any data or study information until it is released by Dow AgroSciences. Agreements of this nature are standard operating procedures when a herbicide is in the early stages of being developed by the manufacturer. While OSU cannot share the data with ODOT at this point OSU personnel will retain this data and at the earliest point possible will inform ODOT personnel of the performance of any and all products evaluated in this study. As of the writing of this report Dow AgroSciences may be releasing the information on their new herbicide in early 2005. The manufacturer is currently planning on continuing the research and development of the new product in 2005 roadside research trials.

Title: Annual Ryegrass Control Study
Trial ID: 4-H-52-04
Date Treated: 3/29/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Payne Co. **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: Trial was located on US-177, approximately 2.2 miles north of Lakeside Golf Course/Stillwater (west side of highway).
Trial Objective: The objective of this study was to evaluate the effectiveness of flazasulfuron for winter annual weed control and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	6 ft x 15 ft
Application Date:	3/29/04
Time of Day:	2:15 p.m.
Application Timing:	Postemergence
Air Temperature:	68 F
% Relative Humidity:	30
Wind Velocity:	3 mph
Dew Present:	No
Soil Temperature:	64 F
Soil Moisture:	Good
% Cloud Cover:	10
Application Equipment:	CO2 bicycle
Operating Pressure:	24 psi
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	2.3 mph
Carrier Rate:	20 gpa

Soil Description	
% Sand: 35	% OM: 2.27
% Silt: 52.5	pH: 8.0
% Clay: 22.5	
Soil Name: Kirkland silt loam	

Weed Stage At Each Application	
Weed 1:	Downy brome
Stage Scale:	2-5 inch
Weed 2:	Annual ryegrass
Stage Scale:	2-6 inch
Weed 3:	
Stage Scale:	
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion: (refer to Tables 1a & 1b)

AT the 14 DAT evaluation date the standard treatment of Roundup Pro Concentrate (RPC) was producing significantly better control of both downy brome and annual ryegrass than any of the flazasulfuron treatments. The RPC treatment was also producing significant bermudagrass phytotoxicity and greenup delay at this same time. By 28 DAT evaluations all flazasulfuron treatments were producing good control of downy brome (86.7 % to 90%) and annual ryegrass (80% - 85%). This is comparable to RPC at 94.7% and 91.3%, respectively. RPC treatments were continuing to produce a small amount of visible bermudagrass phytotoxicity and significant greenup delay at 28 DAT. No flazasulfuron treatments produced any bermudagrass injury or greenup delay throughout the duration of this trial. AT 42 DAT evaluations flazasulfuron treatments were maintaining good control of downy brome (85% - 97.7%) and annual ryegrass (81.7% - 90.7%). At the final 56 DAT evaluations it appeared that lower flazasulfuron rates were beginning to break. The low rate of flazasulfuron at 1.5 oz. prod./A (0.0234 lb.a.i./A) started showing releases of downy brome and annual ryegrass. All flazasulfuron rates of 3.0 oz. prod./A and higher while showing slight reductions in weed control were able to maintain acceptable levels (80% or greater) of both downy brome and annual ryegrass control. The RPC standard treatment produced 5-10% better annual ryegrass control than the flazasulfuron treatments throughout the duration of this study but at a price of early season bermudagrass injury and noticeable greenup delay of about 4-6 weeks. Treatments were applied to this study when roadside bermudagrass was at approximately 30% greenup on March 29, 2004. Flazasulfuron (Katana) was submitted to EPA for full registration in fall of 2004 and could see commercialization in 2005.

Table 1a. Control of Downy Brome (Brome) and Annual Ryegrass (Ryegrass) in the Annual Ryegrass Control Study.

Trial ID: 4-H-52-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Payne Co. **Date Treated: 3/29/04**

Weed Code				Brome	Brome	Brome	Brome	Ryegrass	Ryegrass	Ryegrass	Ryegrass
Rating Data Type				% Control	% Control	% Control	% Control	% Control	% Control	% Control	% Control
Rating Unit				0-100	0-100	0-100	0-100	0-100	0-100	0-100	0-100
Rating Date				4/4/2004	4/26/2004	5/10/2004	5/24/2004	4/4/2004	4/26/2004	5/10/2004	5/24/2004
Evaluation Interval				14 DAT	28 DAT	42 DAT	56 DAT	14 DAT	28 DAT	42 DAT	56 DAT
Trt No.	Treatment Name	Product Rate	Product Rate Unit								
1	Untreated Check			0	0	0	0	0	0	0	0
2	flazasulfuron SurfKing	0.0234	LB A/A	35 b	86.7 bc	85 c	78.3 b	21.7 b	80	81.7	70
3	flazasulfuron SurfKing	0.047	LB A/A	36.7 b	90 ab	94.7 ab	98.7 a	28.3 b	83.3	82.7	80
4	flazasulfuron SurfKing	0.07	LB A/A	40 b	88.3 bc	90 bc	91 a	30 b	85	85	84.3
5	flazasulfuron SurfKing	0.094	LB A/A	40 b	85 c	97.7 a	92.3 a	28.3 b	81.7	90.7	85
6	Roundup Pro Conc.	0.94	LB A/A	75 a	94.7 a	99 a	98.7 a	75 a	91.3	89	86.7
LSD (P=.10)				**12.86**	**4.92**	**6.91**	**11.52**	**10.14**	**10.82**	**8.2**	**12.03**
Standard Deviation				**8.47**	**3.24**	**4.55**	**7.59**	**6.68**	**7.12**	**5.4**	**7.92**
Coeff. Of Variation				**18.67**	**3.64**	**4.88**	**8.26**	**18.21**	**8.45**	**6.29**	**9.76**
Replicate Mean Square				**3.791**	**11.453**	**4.486**	**3.236**	**0.486**	**6.191**	**3.65**	**2.766**
Replicate Prob(F value)				**0.0695**	**0.0045**	**0.0494**	**0.0934**	**0.6321**	**0.0237**	**0.0747**	**0.1222**
Treatment Mean Square				**11.709**	**3.933**	**4.826**	**3.605**	**31.589**	**1.128**	**1.581**	**2.163**
Treatment Prob(F value)				**0.002**	**0.0471**	**0.0282**	**0.0579**	**0.0001**	**0.4082**	**0.269**	**0.164**

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.

Table 1b. Bermudagrass Injury and Percent Living Cover in the Annual Ryegrass Control Study

Trial ID: 4-H-52-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Payne Co. **Date Treated: 3/29/04**

Weed Code				**Bermuda**		**Bermuda**		**Bermuda**		**Bermuda**		**Bermuda**	
Rating Data Type				**% Injury**		**% Injury**		**% Cover**		**% Cover**		**% Cover**	
Rating Unit				**0-100**		**0-100**		**0-100**		**0-100**		**0-100**	
Rating Date				**4/4/2004**		**4/26/2004**		**4/4/2004**		**4/26/2004**		**5/10/2004**	
Evaluation Interval				**14 DAT**		**28 DAT**		**14 DAT**		**28 DAT**		**42 DAT**	
Trt No.	**Treatment Name**	**Product Rate**	**Product Rate Unit**										
1	Untreated Check			0		0		60		76.7		85	
2	flazasulfuron SurfKing	0.0234	LB A/A	0	b	0	b	61.7	a	83.3	a	90	a
3	flazasulfuron SurfKing	0.047	LB A/A	0	b	0	b	61.7	a	81.7	a	88.3	a
4	flazasulfuron SurfKing	0.07	LB A/A	0	b	0	b	58.3	a	83.3	a	93.3	a
5	flazasulfuron SurfKing	0.094	LB A/A	0	b	0	b	61.7	a	81.7	a	91.7	a
6	Roundup Pro Conc.	0.94	LB A/A	25	a	13.3	a	40	b	40	b	81	b
LSD (P=.10)				**5.88**		**3.92**		**7.47**		**7.14**		**5.67**	
Standard Deviation				**3.87**		**2.58**		**4.92**		**4.7**		**3.73**	
Coeff. Of Variation				**77.46**		**96.82**		**8.68**		**6.35**		**4.2**	
Replicate Mean Square				**1**		**1**		**0.483**		**4.302**		**0.522**	
Replicate Prob(F value)				**0.4096**		**0.4096**		**0.634**		**0.0539**		**0.6125**	
Treatment Mean Square				**25**		**16**		**11.034**		**49.17**		**4.911**	
Treatment Prob(F value)				**0.0001**		**0.0007**		**0.0024**		**0.0001**		**0.0269**	

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.

Title: Glyphosate Formulation Study
Trial ID: 4-H-53-04
Date Treated: 5-18-04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Noble Co. **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-60, 0.5 miles west of junction SH-156 (south side of highway)
Trial Objective: The objective of this study was to evaluate the effectiveness of several glyphosate formulations when used in combination with Outrider for johnsongrass control and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	5 ft x 15 ft
Application Date:	5/18/04
Time of Day:	7:15 a.m.
Application Timing:	Postemergence
Air Temperature:	73 F
% Relative Humidity:	82
Wind Velocity/Direction:	7 mph
Dew Present:	No
Soil Temperature:	70 F
Soil Moisture:	Good
% Cloud Cover:	30
Application Equipment:	CO2 bicycle
Operating Pressure:	24 psi
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	1.9
Carrier Rate:	30 gpa

Soil Description	
% Sand: 22.5	% OM: 7.34
% Silt: 55	pH: 6.5
% Clay: 22.5	
Soil Name: Tabler silt loam	

Weed Stage At Each Application	
Weed 1:	Johnsongrass
Stage Scale:	12-18 inch
Weed 2:	
Stage Scale:	
Weed 3:	
Stage Scale:	
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion: (refer to Table 2)

When the early 7 DAT evaluations were taken most treatments were producing moderate amounts of johnsongrass control (51-75%). The formulations MON 79528 and 79503 were producing the best control at the higher rate. At 14 DAT all treatments were providing increased levels of johnsongrass control. The higher rates of MON79528, 79688, 79503, and 79527 were all producing good (81 – 88%) control of johnsongrass with other rates and formulations producing moderate control levels. At 28 DAT johnsongrass control from treatments included in this study is normally going to be at or near its highest level. At 28 DAT all treatments were showing slight decreases in johnsongrass control which was probably due to the abundant rainfall during June. MON 79527, 79528, and 79688 formulations were still maintaining good johnsongrass control (80-81%) at this time. At 56 DAT the high rate of MON 79527 was the only treatment maintaining an 80% or greater level of johnsongrass control (84%). The formulations MON 79688 and 79503 were producing johnsongrass control levels of 78 and

79%. At the final 84 DAT evaluations only the MON 97527 was again maintaining johnsongrass control levels above 80% (83%). The formulations MON 79688 and 79503 were maintaining johnsongrass control levels of 78 and 76%. Any treatment able to maintain 80% or better johnsongrass control for this duration during a summer with plenty of rainfall should produce very positive results in a roadside weed control program. This study was conducted using a blind format where OSU did not know the chemical identity of the MON glyphosate formulations. During a September 2004 meeting the identities of the MON formulations were given to OSU personnel. Many of the formulations that performed well in the test were the experimental formulations that will likely be commercialized in the near future. When the manufacturer (Monsanto) decides to change the current Roundup Pro Concentrate product to better fit the market, ODOT will likely see a product that will produce as good if not better weed control results in weed control programs. It was also identified, at the aforementioned September 2004 meeting, that some of the new experimental MON formulations that are of the potassium salt types may have problems with drift control products. This scenario has already played itself out in the agricultural markets that were using the Roundup Ultra Weathermax formulation (potassium salt type of glyphosate). Tank-mix compatibility will be monitored very closely with regards to future studies and future ODOT Approved Herbicide and Adjuvant Listings.

Data was also collected on common bermudagrass injury throughout the duration of the study. Common bermudagrass injury ranged from 2-10% through the 28 DAT evaluations. This level of injury is acceptable for roadsides.

Table 2. Johnsongrass Control and Bermudagrass Injury in the Glyphosate Formulation Study.

Trial ID: 4-H-53-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Noble Co. **Date Treated: May-18-04**

Weed/Crop Code				Johnsongrass		Johnsongrass		Johnsongrass		Johnsongrass		Johnsongrass		Bermuda		Bermuda	Bermuda
Rating Data Type				% Control		% Control		% Control		% Control		% Control		% Injury		% Injury	% Injury
Rating Unit				0-100		0-100		0-100		0-100		0-100		0-100		0-100	0-100
Rating Date				May-10-04		Jun-01-04		Jun-15-04		Jul-13-04		Aug-10-04		May-10-04		Jun-01-04	Jun-15-04
Evaluation Interval				7 DAT		14 DAT		28 DAT		56 DAT		84 DAT		7 DAT		14 DAT	28 DAT
Trt No.	Treatment Name	Product Rate	Product Rate Unit														
1	MON 78754 +Outrider	10 1.33	FL OZ/A OZ WT/A	51.7	cd	68	d	67.7	b-e	68.3	bcd	60	b-f	1.7	b	6.7	5
2	MON 78754 +Outrider	13 1.33	FL OZ/A OZ WT/A	60	bcd	78	a-d	73.7	a-d	73	abc	58.3	c-f	5	a	8.3	5
3	MON 79688 +Outrider	8.25 1.33	FL OZ/A OZ WT/A	55	cd	74.3	cd	69.3	a-e	71.7	bcd	63.3	b-e	5	a	8.3	5
4	MON 79688 +Outrider	10.7 1.33	FL OZ/A OZ WT/A	63.3	abc	86	ab	79.7	ab	79	ab	78.3	ab	5	a	10	5
5	MON 79730 +Outrider	8.25 1.33	FL OZ/A OZ WT/A	51.7	cd	67	d	53.7	f	65.3	cd	48.3	def	5	a	8.3	5
6	MON 79730 +Outrider	10.7 1.33	FL OZ/A OZ WT/A	57.2	cd	69	d	60.8	def	65.4	cd	46.3	ef	5	a	8.3	6.7
7	MON 79503 +Outrider	7.4 1.33	FL OZ/A OZ WT/A	51.7	cd	76	bcd	67	b-f	78.3	ab	76	abc	5	a	6.7	5
8	MON 79503 +Outrider	9.6 1.33	FL OZ/A OZ WT/A	73.3	ab	83.7	abc	77.3	abc	73.3	abc	63.3	b-e	5	a	10	6.7
9	MON 79527 +Outrider	8.25 1.33	FL OZ/A OZ WT/A	46.7	d	67.3	d	64.3	c-f	69	bcd	61.7	b-e	5	a	6.7	5
10	MON 79527 +Outrider	10.7 1.33	FL OZ/A OZ WT/A	60	bcd	80.7	abc	81.3	a	83.7	a	82.7	a	5	a	10	6.7
11	MON 79528 +Outrider	8.25 1.33	FL OZ/A OZ WT/A	48.3	d	68.3	d	60	ef	60.7	d	41.7	f	5	a	6.7	5
12	MON 79528 +Outrider	10.7 1.33	FL OZ/A OZ WT/A	75	a	87.7	a	80	ab	72.7	abc	66	a-d	5	a	10	5
13	Untreated Check			0		0		0		0		0		0		0	0
LSD (P=.10)				**14.86**		**11.62**		**13.57**		**11.33**		**18.89**		**1.17**		**3.23**	**2.02**
Standard Deviation				**10.57**		**8.27**		**9.66**		**8.06**		**13.44**		**0.83**		**2.3**	**1.44**
Coeff. Of Variation				**18.28**		**10.95**		**13.88**		**11.25**		**21.63**		**17.65**		**27.63**	**26.65**
Replicate Mean Square				**7.223**		**0.702**		**2.636**		**7.021**		**9.223**		**1**		**1.571**	**1**
Replicate Prob(F value)				**0.0041**		**0.5069**		**0.0952**		**0.0046**		**0.0013**		**0.384**		**0.2302**	**0.384**
Treatment Mean Square				**2.226**		**2.586**		**2.589**		**1.956**		**2.676**		**4**		**1.143**	**0.818**
Treatment Prob(F value)				**0.0553**		**0.0295**		**0.0293**		**0.0897**		**0.0252**		**0.0027**		**0.3775**	**0.6237**

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.

Title: Overdrive Tank-mix Study
Trial ID: 4-H-54-04
Date Treated: 5/26/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Garfield County **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-81, 4.0 mile north of Bison (center median).

Trial Objective: The objectives of this study were to evaluate the effectiveness of various broadleaf weed control herbicides when combined with Overdrive and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	5 ft x 15 ft
Application Date:	5/26/04
Time of Day:	6:30 a.m.
Application Timing:	Postemergence
Air Temperature:	68 F
% Relative Humidity:	83
Wind Velocity/Direction:	2-3 mph/ ESE
Dew Present:	N
Soil Temperature:	71 F
Soil Moisture:	Dry
% Cloud Cover:	Overcast
Application Equipment:	CO2 Bicycle
Operating Pressure:	24 psi
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	2.2
Carrier Rate:	20 gpa

Soil Description	
% Sand: 22.5	% OM: 1.86
% Silt: 52.5	pH: 7.4
% Clay: 25.0	
Soil Name: Pond creek silt loam	

Weed Stage At Each Application	
Weed 1:	Marestail
Stage Scale:	2-4 inch
Weed 2:	Palmer amaranth
Stage Scale:	1-6 inch (10% flower)
Weed 3:	
Stage Scale:	
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion:

Before summarizing the weed control results from this study it needs to be pointed out that at the day-of-treatment all vegetation was actively growing but soil moisture conditions were dry. Soon after initial treatment untreated weeds began to show drought symptoms (13 DAT) and this persisted for another week to ten days before rainfall. Evaluations made at 55 and 84 DAT were made with ideal soil conditions as evidenced by increased weed control and subsequent rainfall. The early drought conditions during the first several weeks of this study were likely responsible for the slow weed control responses.

Evaluations made on marestail control at 13 DAT showed moderate levels of growth suppression from all treatments. Complete vertical growth suppression and a small amount of chlorosis at terminal growing point but no necrosis was evident from all treatments. At 27 DAT growth suppression increased from all treatments with increasing levels of chlorosis but still very little necrosis or actual control was being achieved (this slower than usual response was likely due to earlier drought conditions). Unfortunately by 55 DAT ratings large crabgrass had grown to about 14 inches in most plots and the small marestail plants were no longer visible and evaluations were not taken. However marestail plants did not outgrow the suppression as none were noticed above the canopy of crabgrass or bermudagrass for the duration of the study. Palmer amaranth was the most predominant broadleaf weed in the study. Again at early 13 DAT evaluations palmer amaranth control ranged from 35-58% with control increasing to 35-73% at 27 DAT. At 27 DAT all treatments, despite the slow activity from the dry conditions, were producing moderate to good control except treatments including Telar. At 55 DAT, after good rainfall, palmer amaranth control increased for all treatments. While Telar treatments were not producing acceptable control most other treatments were producing good to excellant control of palmer amaranth at this time. The combinations of 2,4-D/Overdrive looked particularly good. By the final 84 DAT evaluations, control for all treatments had increased again as late summer rains promoted palmer amaranth growth in untreated plots. All treatments, excluding Telar, were producing at least 80% control with treatments of Overdrive 6 & 8 oz. alone, 2,4-D, triclopyr 3A, and Vanquish producing excellant control. Very little to no common bermudagrass injury was noticed due to any of the treatments throughout the duration of this study. Many of the herbicides and rates used in this study would likely produce moderate levels of broadleaf weed control when used alone. However tank-mixing some of these products at the lower rates may have potential to produce acceptable broadleaf weed control while helping to reduce treatment costs.

Table 3. Marestail and Amaranth Control in the Overdrive/Tank Mix Broadleaf Weed Control Study

Trial ID: 4-H-54-04 **Study Dir.: Doug Montgomery/Craig Evans**

Location: Garfield Co. **Date Treated: 5/26/04**

Weed Code				Marestail	Marestail		P. amaranth	P. amaranth	P. amaranth		P. amaranth	
Rating Data Type				% Control	% Control		% Control	% Control	% Control		% Control	
Rating Unit				0-100	0-100		0-100	0-100	0-100		0-100	
Rating Date				6/8/2004	6/22/2004		6/8/2004	6/22/2004	7/20/2004		8/17/2004	
Evaluation Interval				13 DAT	27 DAT		13 DAT	27 DAT	55 DAT		84 DAT	
Trt No.	**Treatment Name**	**Product Rate**	**Product Rate Unit**									
1	Untreated Check			0	0		0	0	0		0	
2	Overdrive	4	OZ WT/A	26.7	28.3	e	43.3	48.3	71.7	bc	80	cde
3	Overdrive	6	OZ WT/A	25.3	41.7	b-e	46.7	43.3	81.7	abc	86.7	a-e
4	Overdrive	8	OZ WT/A	27.8	52.6	abc	46.7	60	85	ab	91	a-d
5	Overdrive + Escort	4 0.25	OZ WT/A OZ WT/A	25.3	57.6	ab	35	58.3	83.3	abc	91.7	a-d
6	Overdrive + Escort	4 0.5	OZ WT/A OZ WT/A	21.7	46.7	a-d	41.7	70	71.7	bc	79.3	de
7	Overdrive + Telar	4 0.25	OZ WT/A OZ WT/A	21.7	30.1	de	50	35	48.3	d	65	f
8	Overdrive + Telar	4 0.5	OZ WT/A OZ WT/A	30	37.6	cde	41.7	41.7	62.7	cd	77.7	ef
9	Overdrive + 2,4-D Amine	4 16	OZ WT/A FL OZ/A	24.5	37.6	cde	38.3	61.7	91.7	ab	97	ab
10	Overdrive + 2,4-D Amine	4 32	OZ WT/A FL OZ/A	27.8	36.7	cde	51.7	53.3	88.3	ab	92.7	abc
11	Overdrive + Microflo triclopyr 3A	4 8	OZ WT/A FL OZ/A	31.7	35	cde	43.3	55	85.7	ab	89.7	a-e
12	Overdrive + Microflo triclopyr 3A	4 16	OZ WT/A FL OZ/A	26.7	57.6	ab	36.7	63.3	74.3	abc	84.3	b-e
13	Overdrive + Vanquish	4 8	OZ WT/A FL OZ/A	33.3	56.7	ab	45	63.3	77.7	abc	95	ab
14	Overdrive + Vanquish	4 16	OZ WT/A FL OZ/A	33.3	62.6	a	58.3	73.3	94	a	98.3	a
LSD (P=.10)				**8.74**	**18.25**		**13.39**	**21.99**	**21.42**		**13.33**	
Standard Deviation				**6.19**	**12.85**		**9.58**	**15.74**	**15.33**		**9.54**	
Coeff. Of Variation				**22.62**	**28.75**		**21.54**	**28.17**	**19.62**		**10.99**	
Replicate Mean Square				**9.183**	**6.197**		**2.792**	**1.818**	**0.642**		**0.141**	
Replicate Prob(F value)				**0.0016**	**0.0095**		**0.0812**	**0.184**	**0.5348**		**0.8695**	
Treatment Mean Square				**1.172**	**2.443**		**1.337**	**1.544**	**2.029**		**2.899**	
Treatment Prob(F value)				**0.3667**	**0.0452**		**0.2622**	**0.1761**	**0.0677**		**0.0128**	

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.

Title: Overdrive Scotch Thistle Control Study
Trial ID: 4-H-55-04
Date Treated: 4/15/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Roger Mills County **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-33, 1.5 miles east of Strong City (north side of highway)
Trial Objective: The objective of this study was to evaluate the effectiveness of Overdrive for scotch thistle control and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	5 ft by 12 ft
Application Date:	4/15/04
Time of Day:	2:30 p.m.
Application Timing:	Postemergence
Air Temperature:	89 F
% Relative Humidity:	17%
Wind Velocity/Direction:	2-4 mph/SW
Dew Present:	N
Soil Temperature:	64 F
Soil Moisture:	Good
% Cloud Cover:	0%
Application Equipment:	CO2 hand-held
Operating Pressure:	25
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	2.3 mph
Carrier Rate:	20 gpa

Soil Description	
% Sand: NA	% OM: NA
% Silt: NA	pH: NA
% Clay: NA	
Soil Name: Reinach fine sandy loam	

Weed Stage At Each Application	
Weed 1:	Scotch thistle
Stage Scale:	4-18 inch rosettes
Weed 2:	
Stage Scale:	
Weed 3:	
Stage Scale:	
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion:

It should be noted that there was a low population of scotch thistle in the experimental area but observations were consistent between replications and final results were not likely affected by weed populations. All treatments included a non-ionic surfactant and were applied to actively growing scotch thistle plants just prior to bolting. Overdrive has proven to be very affective at sub-labeled low rates (2 oz. prod. /A) on musk thistle and one of the goals of this study was to determine if scotch thistle was also susceptible at lower rates. At the 27 DAT evaluation Overdrive at 6 oz/A was producing significantly better scotch thistle control when compared to the lowest rate of 2 oz. /A. At this time all thistles were showing complete growth suppression but thistles treated with the higher rates were also exhibiting severe chlorosis and some necrosis. Also at this time the thistle in the untreated check plots were completely bolted. By 61 DAT evaluations, scotch thistles treated with Overdrive at 6 oz. /A were completely controlled while the lower rates were showing mostly necrotic tissue with a small amount of chlorotic tissue within the rosettes. The lower Overdrive rate evaluated in the study was slower to produce its final level of scotch thistle control but it should be noted that all scotch thistles treated did not produce or even get close to producing flowers/seeds. The fact that a couple of the thistles may have had a small amount of chlorotic tissue remaining means that the Overdrive 2 oz./A rate is probably as low as one could go and retain actual control. Past research has shown that musk thistle control with Overdrive at 2 oz. /A (currently sub-labeled use rate) will nearly complete control but will likely take a little longer than higher use rates. The obvious advantages of lower use rates means that an applicator will have to be patient with respect to how quickly a targeted thistle turns from green to brown. The fact that it stops growing the day of treatment but takes 30 to 60 days to actually die should be manageable. It does appear that scotch thistle may be a little more tolerant to the Overdrive 2 oz. /A rate than musk thistle. It will be important to repeat this study next year to see if the scotch thistle control results can be duplicated. If results are duplicated, BASF the Overdrive manufacturer, could be requested to apply for an ODAFF 2-ee sub-labeled use rate for Overdrive use in the control of scotch thistle.

Table 4. Control of Scotch Thistle in the Overdrive Scotch Thistle Trial

Trial ID: 4-H-55-04 **Study Dir.: Doug Montgomery**
Location: Roger Mills County **Date Treated: 4/15/04**

Weed Code				**S. thistle**	**S. thistle**
Rating Data Type				**% Control**	**% Control**
Rating Unit				**0-100**	**0-100**
Rating Date				**5/27/2004**	**6/16/2004**
Evaluation Interval				**27 DAT**	**61 DAT**
Trt No.	**Treatment Name**	**Product Rate**	**Product Rate Unit**		
1	Untreated Check			0	0
2	Overdrive + Surf King	2 0.25	OZ WT/A % V/V	50 b	90
3	Overdrive + Surf King	4 0.25	OZ WT/A % V/V	70 ab	94.3
4	Overdrive + Surf King	6 0.25	OZ WT/A % V/V	80 a	100
LSD (P=.10)				**21.02**	**15.12**
Standard Deviation				**12.08**	**8.69**
Coeff. Of Variation				**18.11**	**9.16**
Replicate Mean Square				**3.486**	**2.856**
Replicate Prob(F value)				**0.1329**	**0.1697**
Treatment Mean Square				**4.8**	**1**
Treatment Prob(F value)				**0.0865**	**0.4444**

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.
Surf-King is a non-ionic surgactant.

Title: Postemergence Broadleaf Weed Control Study
Trial ID: 4-H-56-04
Date Treated: 5/25/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Garfield County **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-81, 4.0 miles north of Bison (center median)
Trial Objective: The objective of this study was to evaluate an experimental herbicide from Dow AgroSciences for postemergence weed control of various broadleaf weeds and grasses and common bermudagrass tolerance.

Results & Discussion:

This study was performed under a confidentiality agreement between OSU Roadside Vegetation Management personnel and Dow AgroSciences. Under the agreement OSU cannot publish or share any data or study information until it is released by Dow AgroSciences. Agreements of this nature are standard operating procedure when a herbicide is in the early stages of developement by the manufacturer. While OSU cannot share the data with ODOT at this point OSU personnel will retain this data and at the earliest point possible will inform ODOT personnel of the performance of any and all products evaluated in this study. As of the writing of this report Dow AgroSciences may be releasing the information on their new herbicide in early 2005. The manufacturer is currently planning on continuing the research and development of the new product in 2005 roadside research trials.

Title: Quicksilver Broadleaf Weed Control Study
Trial ID: 4-H-57-04
Date Treated: 5/26/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Garfield County **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-81, 4.0 miles north of Bison (center median)
Trial Objective: The objective of this study was to evaluate the effectiveness of the new herbicide Quicksilver (manufactured by FMC) for control of various broadleaf and grassy weeds and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	5 ft by 15 ft
Application Date:	5/26/04
Time of Day:	7:45 a.m.
Application Timing:	Postemergence
Air Temperature:	68 F
% Relative Humidity:	83
Wind Velocity/Direction:	3-4 mph/ESE
Dew Present:	N
Soil Temperature:	71 F
Soil Moisture:	Dry
% Cloud Cover:	100%
Application Equipment:	CO2 bicycle
Operating Pressure:	24
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	2.2
Carrier Rate:	20 gpa

Soil Description	
% Sand: 22.5	% OM: 1.86
% Silt: 52.5	pH: 7.4
% Clay: 25.0	
Soil Name: Pond creek silt loam	

Weed Stage At Each Application	
Weed 1:	Palmer amaranth
Stage Scale:	1-6 inch
Weed 2:	Large crabgrass
Stage Scale:	2-5 leaf, 1-3 inch
Weed 3:	Marestail
Stage Scale:	2-6 inch (low pop.)
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion: At the time of treatment there were small amounts of weeds that were beginning to show moisture stress in a few small distinct areas within the research area. The droughty conditions persisted from the day of treatment for approximately 2 more weeks at which point numerous rain events occurred. Basically this study was under minor drought stress in the first 2 weeks, moderate drought stress for the next 2 weeks, and no drought stress for the remaining last one-half of the studies duration. In my opinion this could be a reason why some of the treatments produced weed control results slower than expected.

The targeted weeds in this study were palmer amaranth, large crabgrass, and marestail. We were also looking closely at injury to common bermudagrass. At 2 DAT most of the treatments including Quicksilver were producing more injury to palmer amaranth than comparative treatments without Quicksilver. However, palmer amaranth control at this time was not acceptable (minimum of 80%) for any of the treatments. At 7 DAT palmer amaranth control had increased for all treatments except Quicksilver alone. Treatments including RPC+SFM 75, tank-mixed with either Vanquish or Quicksilver, were producing similar amounts of palmer amaranth control of 67-68%. Most other treatments showed slight increases in palmer amaranth control.

At 13 DAT palmer amaranth control continued to increase for both treatments of RPC+SFM 75 tank mixed with either Vanquish or Quicksilver. The tank mixture of RPC+SFM 75+Vanquish was showing slightly better palmer amaranth control than its Quicksilver comparative treatment. It is important to mention that after the 13 DAT evaluation the experimental area received a couple of rainfall events that pulled the study out of the moderate drought that it was experiencing at 13 DAT. At 27 DAT and 55 DAT all vegetation was actively growing and under no abnormal environmental stresses. At 27 DAT palmer amaranth control increased for all treatments except Quicksilver alone. This is no doubt due to increased weed growth/herbicide translocation due to adequate moisture. At 27 DAT treatments of RPC+SFM 75 combined with either Vanquish or Quicksilver, or treatments including Overdrive at 4 oz., and Vanquish were producing moderate to good control of palmer amaranth. At 55 DAT vegetation growth had completely resumed active growth and all treatments showed increases in palmer amaranth control. Treatments of RPC+SFM 75+Vanquish, Overdrive @ 4 oz., Quicksilver @ 2 oz.+ Overdrive @ 2 oz., Quicksilver @ 1 oz.+ Overdrive @ 4 oz., and Quicksilver+Vanquish were all producing good control of palmer amaranth. All other treatments, excluding Quicksilver alone, were producing moderate control at this time.

At 2 DAT no crabgrass control was evident for any of the treatments. At 7 DAT and 13 DAT treatments of RPC+SFM 75 tank mixed with either Vanquish or Quicksilver were producing 63% and 75% control of large crabgrass, respectively. No other treatments were having an affect on crabgrass at this time. At 27 DAT crabgrass control began to separate slightly between these two treatments with the Quicksilver tank mix producing slightly better control than the Vanquish mixture. This same trend was noticed at 55 DAT with the Quicksilver treatment producing significantly better crabgrass control than its comparative Vanquish treatment. Crabgrass control for both of these treatments was moderate at 27 DAT and began to drop at 55 DAT to unacceptable levels.

At 7 DAT and 13 DAT the treatment of RPC+SFM 75+Vanquish treatment was producing significantly better control of marestail than all other treatments at 55 and 82%, respectively. Marestail control at 7 DAT and 13 DAT was very low for all other treatments but with the rainfall control increased at 27 DAT. AT 27 DAT treatments of RPC+SFM 75 tank mixed with either Vanquish or Quicksilver, or Quicksilver @ 2 oz.+ Overdrive @ 2 oz. were producing moderate levels of marestail control. Marestail control was not available at 55 DAT as the large crabgrass, which was not controlled, reached heights of 14-18 inches and masked the lower growing suppressed marestail.

Common bermudagrass injury at 7 DAT was very slight ranging from 3-8% from all treatments. At 13 and 27 DAT both treatments of RPC+SFM 75 significantly increased common bermudagrass injury but the level of injury would be considered acceptable for roadside situations. No common bermudagrass injury was evident at later evaluations.

Table 5a. Control of Palmer Amaranth and Crabgrass in the Quicksilver Study

Trial ID: 4-H-57-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Garfield Co. **Date Treated: 5/26/04**

Weed Code				**P. amaranth**	**P. amaranth**	**P. amaranth**	**P. amaranth**	**P. amaranth**	**P. amaranth**	**crabgrass**	**crabgrass**	**crabgrass**	**crabgrass**
Rating Data Type				**% Control**	**% Control**	**% Control**	**% Control**	**% Control**	**% Control**	**% Control**	**% Control**	**% Control**	**% Control**
Rating Unit				**0-100**	**0-100**	**0-100**	**0-100**	**0-100**	**0-100**	**0-100**	**0-100**	**0-100**	**0-100**
Rating Date				**5/28/2004**	**6/2/2004**	**6/8/2004**	**6/22/2004**	**7/20/2004**	**8/17/2004**	**6/2/2004**	**6/8/2004**	**6/22/2004**	**7/20/2004**
Evaluation Interval				**2 DAT**	**7 DAT**	**13 DAT**	**27 DAT**	**55 DAT**	**84DAT**	**7 DAT**	**13 DAT**	**27 DAT**	**55 DAT**
Trt No.	**Treatment Name**	**Product Rate**	**Product Rate Unit**										
1	Roundup Pro Concentrate + SFM 75 + Vanquish	13 1 16	FL OZ/A OZ WT/A FL OZ/A	30 def	68.3 a	76.7 a	78.3 a	93.7 ab	95 a	63.3 a	75 a	66.7 b	48.3 b
2	Roundup Pro Concentrate + SFM 75 + QuickSilver	13 1 2	FL OZ/A OZ WT/A FL OZ/A	60 a	66.7 a	72.7 a	70 ab	75.7 ab	78.3 a	62.7 a	75 a	76 a	65 a
3	Overdrive + Surf King Surfactant	2 0.25	OZ WT/A % V/V	26.7 ef	36.7 de	26.7 cd	41.7 cd	73.3 b	70 a	0 b	0 b	0 c	0 c
4	Overdrive + Surf King Surfactant	4 0.25	OZ WT/A % V/V	20 f	36.7 de	31.7 bcd	54.3 bcd	87.7 ab	92.7 a	0 b	0 b	0 c	0 c
5	QuickSilver + Overdrive + Surf King Surfactant	2 2 0.25	FL OZ/A OZ WT/A % V/V	46.7 bc	54.3 b	33.3 bc	40 d	82.7 ab	86.7 a	1.7 b	0 b	0 c	0 c
6	QuickSilver + Overdrive + Surf King Surfactant	1 2 0.25	FL OZ/A OZ WT/A % V/V	36.7 cde	48.3 bc	35 bc	62.7 abc	74.3 ab	78.3 a	3.3 b	0 b	0 c	0 c
7	QuickSilver + Overdrive + Surf King Surfactant	1 4 0.25	FL OZ/A OZ WT/A % V/V	36.7 cde	51.7 b	46.7 b	78.3 a	93.7 ab	88.3 a	1.7 b	0 b	0 c	0 c
8	QuickSilver + Vanquish + Surf King Surfactant	1 16 0.25	FL OZ/A FL OZ/A % V/V	33.3 de	45 bcd	36.7 bc	82.7 a	94.7 a	93.3 a	0 b	0 b	0 c	0 c
9	QuickSilver + Surf King Surfactant	1 0.25	FL OZ/A % V/V	38.3 cd	35 e	15 d	6.7 e	10 c	16.7 b	3.3 b	0 b	0 c	0 c
10	QuickSilver + Surf King Surfactant	2 0.25	FL OZ/A % V/V	51.7 ab	40 cde	15 d	8.3 e	18.3 c	31.7 b	1.7 b	0 b	0 c	0 c
11	Untreated Check			0	0	0	0	0	10	0	0	0	0
LSD (P=.10)				**10.13**	**9.77**	**18.12**	**21.75**	**20.5**	**26.42**	**6.63**	**5.92**	**8.59**	**11.63**
Standard Deviation				**7.16**	**6.9**	**12.8**	**15.36**	**14.48**	**18.66**	**4.68**	**4.18**	**6.07**	**8.22**
Coeff. Of Variation				**18.83**	**14.29**	**32.87**	**29.38**	**20.57**	**25.53**	**34**	**27.89**	**42.52**	**72.49**
Replicate Mean Square				**8.251**	**2.273**	**7.192**	**3.205**	**2.599**	**4.773**	**1.101**	**1**	**1.091**	**1.123**
Replicate Prob(F value)				**0.0029**	**0.1318**	**0.0051**	**0.0645**	**0.102**	**0.0217**	**0.3538**	**0.3874**	**0.3572**	**0.3469**
Treatment Mean Square				**8.383**	**9.204**	**8.188**	**9.861**	**13.562**	**6.367**	**92.397**	**171.429**	**74.14**	**26.058**

Table 5b. Marestail Control and Bermuda Injury in the Quicksilver Study

Treatment Prob(F value)	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0004**	**0.0001**	**0.0001**	**0.0001**	**0.0001**

Means followed by same letter do not significantly differ (P=.10, LSD).

Control treatments excluded from analysis.

Trial ID: 4-H-57-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Garfield Co. **Date Treated: 5/26/04**

Weed Code				**Marestail**		**Marestail**		**Bermuda**		**Bermuda**		**Bermuda**	
Rating Data Type				**% Control**		**% Control**		**% Injury**		**% Injury**		**% Injury**	
Rating Unit				**0-100**		**0-100**		**0-100**		**0-100**		**0-100**	
Rating Date				**6/2/2004**		**6/8/2004**		**6/2/2004**		**6/8/2004**		**6/22/2004**	
Evaluation Interval				**7 DAT**		**13 DAT**		**7 DAT**		**13 DAT**		**27 DAT**	
Trt No.	**Treatment Name**	**Product Rate**	**Product Rate Unit**										
1	Roundup Pro Concentrate	13	FL OZ/A	31.7		81.7	a	3.3	bc	10	a	13.3	b
	+ SFM 75	1	OZ WT/A										
	+ Vanquish	16	FL OZ/A										
2	Roundup Pro Concentrate	13	FL OZ/A	36.7		20	cd	8.3	a	10	a	17.7	a
	+ SFM 75	1	OZ WT/A										
	+ QuickSilver	2	FL OZ/A										
3	Overdrive	2	OZ WT/A	30		25	bc	3.3	bc	0	b	0	c
	+ Surf King Surfactant	0.25	% V/V										
4	Overdrive	4	OZ WT/A	34.4		21.7	cd	0	c	0	b	0	c
	+ Surf King Surfactant	0.25	% V/V										
5	QuickSilver	2	FL OZ/A	31.7		20	cd	5	ab	0	b	0	c
	+ Overdrive	2	OZ WT/A										
	+ Surf King Surfactant	0.25	% V/V										
6	QuickSilver	1	FL OZ/A	31.7		25	bc	3.3	bc	0	b	0	c
	+ Overdrive	2	OZ WT/A										
	+ Surf King Surfactant	0.25	% V/V										
7	QuickSilver	1	FL OZ/A	34.4		38.2	b	6.7	ab	0	b	0	c
	+ Overdrive	4	OZ WT/A										
	+ Surf King Surfactant	0.25	% V/V										
8	QuickSilver	1	FL OZ/A	28.3		38.3	b	6.7	ab	0	b	0	c
	+ Vanquish	16	FL OZ/A										
	+ Surf King Surfactant	0.25	% V/V										
9	QuickSilver	1	FL OZ/A	16.7		5	e	5	ab	0	b	0	c
	+ Surf King Surfactant	0.25	% V/V										
10	QuickSilver	2	FL OZ/A	18.3		10	de	6.7	ab	0	b	0	c
	+ Surf King Surfactant	0.25	% V/V										
11	Untreated Check			0		0		0		0		0	
LSD (P=.10)				**18.15**		**13.44**		**3.58**		**2.24**		**3.73**	
Standard Deviation				**12.73**		**9.46**		**2.53**		**1.58**		**2.63**	
Coeff. Of Variation				**43.34**		**33.21**		**52.3**		**79.06**		**84.92**	
Replicate Mean Square				**1.322**		**2.202**		**0.13**		**1**		**0.188**	
Replicate Prob(F value)				**0.2942**		**0.1411**		**0.8785**		**0.3874**		**0.8305**	
Treatment Mean Square				**0.831**		**15.375**		**2.739**		**21.333**		**18.942**	
Treatment Prob(F value)				**0.5987**		**0.0001**		**0.0329**		**0.0001**		**0.0001**	

Control treatments excluded from analysis.

Title: Roundup Pro Dry Vrs. Roundup Pro Concentrate Study
Trial ID: 4-H-58-04
Date Treated: 5/18/04 **Study Directors:** Doug Montgomery/Craig Evans
Location: Kay County **Investigator:** OSU Roadside Vegetation Mgmt. Program
Directions: US-60, 0.5 miles west of junction SH-156 (south side of highway)
Trial Objective: The objectives of this study were to evaluate the comparative johnsongrass control achieved from similar treatments of Roundup Pro Dry and Roundup Pro Concentrate and common bermudagrass tolerance.

Application Description	
Number of Replications:	3
Plot Size:	5 ft by 15 ft
Application Date:	5/18/04
Time of Day:	8:15 a.m.
Application Timing:	Postemergence
Air Temperature:	73 F
% Relative Humidity:	82%
Wind Velocity/Direction:	7-9 mph/SE
Dew Present:	N
Soil Temperature:	70 F
Soil Moisture:	Good
% Cloud Cover:	40%
Application Equipment:	CO2 bicycle
Operating Pressure:	24
Nozzle Type:	Flat fan
Nozzle Size:	8002 VS
Ground Speed:	1.9
Carrier Rate:	30 gpa

Soil Description	
% Sand: 22.5	% OM: 7.34
% Silt: 55	pH: 6.5
% Clay: 22.5	
Soil Name: Tabler silt loam	

Weed Stage At Each Application	
Weed 1:	Johnsongrass
Stage Scale:	12-18 inch
Weed 2:	
Stage Scale:	
Weed 3:	
Stage Scale:	
Weed 4:	
Stage Scale:	
Weed 5:	
Stage Scale:	

Results & Discussion:

This study was conducted as a compliment to the Glyphosate Formulation Study (4-H-53-04). Both this study and the Glyphosate Formulation Study were being conducted by numerous university personnel in both fine turf and roadside weed control programs across the country. Monsanto, the manufacturer of all of the glyphosate formulations in both of these studies, is collecting data and trying to find out which of their glyphosate formulations will perform best on roadsides and fine turf areas. This is an example of where one of our name brand manufacturers is truly looking out for the industry in that they want to make sure that if they indeed change there current formulation of glyphosate that it will work and be accepted by their industry clientele. At recent Monsanto meetings OSU personnel were informed that recent Monsanto glyphosate formulation changes in the agricultural crop area were not met with positive results as the new formulations created numerous problems. Monsanto has since rectified the problems but in our case they are trying to prevent them before they happen.

At 7 DAT the Roundup Pro (RP) Dry at 0.063 lb. ai./A rate was producing significantly more johnsongrass control than all other treatments. This is no doubt due to the fact that the RP Dry formulation has a very high surfactant concentration. By 14 DAT the same higher rate of RP Dry was maintaining significantly better control of johnsongrass than all other treatments. At 28 DAT johnsongrass control declined slightly for all treatments, as late June rains promoted johnsongrass regrowth. At 56 and 84 DAT johnsongrass control continued to decline for all treatments to unacceptable levels. It should be pointed out that the glyphosate active ingredient rates in this study are less than what is recommended by OSU personnel and were specifically selected for this reason. Selecting low rates will allow for easier separation of treatment differences with respect to both johnsongrass control and common bermudagrass tolerance. Common bermudagrass injury was also evaluated throughout the duration of this study and it was found that no treatment produced any unacceptable injury. Some very slight chlorosis was noticed through the 28 DAT evaluations. Research will likely continue next year with the various glyphosate formulations as both the glyphosate salt source and surfactant package that is formulated in this product are all very critical variables that determine the weed control properties of the future “Roundup”. In all likelihood the future name brand (Monsanto) “Roundup” will be very different from the one we use today. The positive side is the one selected for future use will in all likelihood be better for ODOT than the one used in current programs. Since this is the single most important herbicide used by ODOT today this issue will be one that will be monitored as closely as possible.

Table 6. Johnsongrass Control and Bermudagrass Injury in the Roundup Pro Dry Vrs. Roundup Pro Conentrate Study

Trial ID: 4-H-58-04 **Study Dir.: Doug Montgomery/Craig Evans**
Location: Kay County **Date Treated: 5/18/04**

Weed Code				**Johnsongrass**		**Johnsongrass**		**Johnsongrass**	**Johnsongrass**	**Johnsongrass**	**Bermuda**	**Bermuda**		**Bermuda**
Rating Data Type				**% Control**		**% Control**		**% Control**	**% Control**	**% Control**	**% Injury**	**% Injury**		**% Injury**
Rating Unit				**0-100**		**0-100**		**0-100**	**0-100**	**0-100**	**0-100**	**0-100**		**0-100**
Rating Date				**5/25/2004**		**6/1/2004**		**6/15/2004**	**7/13/2004**	**8/10/2004**	**5/25/2004**	**6/1/2004**		**6/15/2004**
Evaluation Interval				**7 DAT**		**14 DAT**		**28 DAT**	**56 DAT**	**84 DAT**	**7 DAT**	**14 DAT**		**28 DAT**
Trt No.	**Treatment Name**	**Rate**	**Rate Unit**											
1	Roundup ProDry + Outrider	0.29 0.062	LB A/A LB A/A	35	c	75.3	b	66	57	34	3.3	10	a	5
2	Roundup ProDry + Outrider	0.377 0.062	LB A/A LB A/A	61.7	a	83.3	a	78.3	73.3	59	5	10	a	6.7
3	Roundup Pro Concentrate + Outrider	0.29 0.062	LB A/A LB A/A	30	d	68.7	b	61	58.7	51.7	0	10	a	5
4	Roundup Pro Concentrate + Outrider	0.377 0.062	LB A/A LB A/A	43.3	b	75.3	b	66.7	65.3	58.3	3.3	10	a	6.7
5	Untreated Check			0		0		0	0	0	0	0		0
LSD (P=.10)				**4.38**		**7.76**		**13.25**	**21.78**	**32.91**	**3.5**	**0**		**3.5**
Standard Deviation				**2.76**		**4.89**		**8.35**	**13.73**	**20.74**	**2.2**	**0**		**2.2**
Coeff. Of Variation				**6.5**		**6.46**		**12.29**	**21.59**	**40.87**	**75.59**	**0**		**37.8**
Replicate Mean Square				**5.727**		**0.024**		**0.978**	**1.897**	**4.897**	**0.429**	**0**		**0.429**
Replicate Prob(F value)				**0.0406**		**0.976**		**0.429**	**0.2299**	**0.0548**	**0.6699**	**1**		**0.6699**
Treatment Mean Square				**76**		**4.516**		**2.314**	**0.879**	**0.946**	**2.714**	**0**		**0.571**
Treatment Prob(F value)				**0.0001**		**0.0555**		**0.1756**	**0.5029**	**0.4755**	**0.1377**	**1**		**0.6542**

Means followed by same letter do not significantly differ (P=.10, LSD).
Control treatments excluded from analysis.

2004 Herbicide/Adjuvant Compatibility Study

Introduction

Compatibility of herbicides and adjuvants used in tank mixtures can be a concern of Oklahoma Department of Transportation (ODOT) roadside managers due to i) reduced weed control efficacy of an incompatible tank mix, ii) costs of chemical waste disposal if an incompatible mixture cannot be sprayed from a tank and iii) the inefficient use of labor hours when incompatible tank mixtures are unknowingly created.

The OSU RVM program performed drift control product compatibility testing for ODOT in 1995 (see Roadside Vegetation Management Final Report, September 1996). Several drift control products available at that time were found to have severe tank mix incompatibility. Results of incompatibility testing were implemented into ODOT vegetation management programs through continuing education workshops and publications dealing with herbicide tank mix suggestions. Research results from that earlier trial were valuable to ODOT personnel as it allowed them to avoid creating a tank mix that could not be effectively applied or one that would have been difficult to empty from the spray tank. If an incompatible tank mix were created, this may have led to the creation of a situation where hazardous waste would have been costly to remediate.

There has been no testing of herbicide/adjuvants tank mixes by our program since 1995 and no reports released by our program since 1996. Since that time, many new adjuvant products have been introduced into the roadside vegetation market and several previously untested (as yet not tested for compatibility) products are listed on the current ODOT Herbicide bid list. These products include new drift control agents, surfactants and herbicide treatment enhancers such as sprayable ammonium sulfate (AMS).

Research Objective

The objective of this research was to evaluate readily created herbicide/adjuvant tank mixes for visually detectable physical incompatibility using an industry standard jar test.

Materials & Methods

The adjuvants selected for testing were those adjuvants listed on the ODOT 2003/2004 herbicide contract along with those recently listed on past ODOT herbicide contracts. The herbicides and their use rates were those recommended by the OSU RVM program.

Six herbicides and fourteen herbicide combinations (Tables 7a-c) were tested with twelve adjuvant tank mix partners to identify any incompatibilities. Specific herbicide/adjuvant combinations depended upon recommendations from OSU publication

E-958, “Suggested Maintenance Practices for Roadside Weed and Brush Problems”, November 2003 (now updated to November 2004). The experiment was preformed twice and each experiment contained two replications of treatments. This experimental design resulted in 143 herbicide/adjuvant combinations per replication within experiments.

Industry standard spray carrier rates of 30 gallons per acre were simulated in each experiment. Clear, clean, unused 1-liter soda bottles were filled with 500 ml of deionized water. The appropriate herbicide amounts were added to each bottle to represent rates indicated in Tables 1a-c. Experimental conditions were maintained under reasonably controlled environmental conditions where air temperatures averaged 71.8^{o} F and deionized water temperatures averaged 72.3^{o} F. Air temperature fluctuations ranged from 70.3^{o}F to 74.9^{o}F. Deionized water temperature fluctuations ranged from 72.0^{o}F to 73.5^{o}F. Temperature readings were taken hourly throughout the course of the experiments using a mercury-in-glass thermometer (accuracy $\pm$0.2 F, precision $\pm$0.1 F).

Tank mix treatments were evaluated at three separate stages (see Appendix A) to determine if any incompatibility complexes were formed. Summarizing, once all herbicide/adjuvant components were placed in the plastic bottle, the bottle was inverted slowly 10 times to mix the components. Assessment was made immediately upon mixing. After 30 minutes the bottle was checked for any incompatibility complexes before being inverted slowly for 10 times. Upon this mixing attempt, a final evaluation was performed for incompatibility. Four questions were asked at each stage of the evaluation (see Appendix B) so as to assess the major visual incompatibilities that are commonly found. The visual physical incompatibilities for which the herbicide/adjuvant tank mixes were assessed included: formation of precipitates, layering, change in flocculation and excessive foaming. Bottles were backlit with strong light sources to make incompatibilities more evident if present. Digital images were recorded for all herbicide/adjuvant tank mix combinations during the third replication.

Results & Discussion

No major incompatibilities were observed in any of the 143 herbicide/adjuvant combinations. Results were also very consistent among replications. Very minor formation of flakes, globules, sludges, and layers were observed on a few combinations but these were very minor. Some formations were attributed to minimal amount of initial agitation of bottles, as called for in our protocol, when adjuvants were added. Still other very minor incompatibilities occurred due to prill size of the dry adjuvants. Our testing can be considered to represent a conservative approach. We are confident that this testing method would detect incompatible tank mix combinations that would be problematic to the ODOT RVM Manager. Incompatibility complexes formed were so trivial that the visual ratings are not shown in this report. We feel that none of the herbicide/adjuvant tank mixes were of an order that would present any problems to ODOT personnel in conducting their weed control programs. Certainly none of the very minor complexes that we witnessed in these experiments were anywhere near the magnitude of incompatibility found by tank mixes created using products that were on the market during the 1994-95 time period.

Summary and Recommendations

Our compatibility testing did not identify any visually detectable physical incompatibilities of concern when OSU-recommended combinations of herbicides and adjuvants were tested. The specific herbicide/adjuvant tank mixes at the specified rates indicated in Tables 7a – c would not be expected to create any tank mix combinations that would be unusable, nor create any hazardous waste requiring costly or special disposal measures for ODOT pesticide applicators. Our compatibility testing is only for physical incompatibility that can be detected via a visual test. Our physical incompatibility testing methodology does not include testing for effects on weed control efficacy.

We are formally recommending that adjuvants tested in this study be included in the next ODOT Approved Herbicide & Adjuvants List (AHAL). Furthermore, if valid compatibility data is not already available, we recommend that any new drift control products, adjuvants and new herbicides under consideration for inclusion on a future AHAL be tested for tank mix compatibility before being included on the AHAL.

Table 7a. Sixty-six selected herbicide/adjuvant combinations evaluated for tank mix compatibility. These treatments included NIS[1], aquatic NIS, liquid drift control, dry drift control + AMS[2].

Herbicide Components			Adjuvants Component				
Herbicide	**Formulation**	**Herbicide rate**	**Adjuvant**	**Adjuvant type**	**Formulation**	**Adjuvant concentration**	**Adjuvant distributor**
Atrazine	4 LB Dry Flowable	2.0 LB A/A	Surf King	NIS	Liquid	0.5 % v/v	Estes
MSMA	6 LB Soluble Liquid	3.0 LB A/A	AD-Spray 80	NIS	Liquid	0.5 % v/v	Helena
MSMA + Oust	6 LB Soluble Liquid 75 Wettable Granule	3.0 LB A/A 0.047 LB A/A	Red River 90	NIS & Aquatic NIS	Liquid	0.5 % v/v	Red River
MSMA + SFM 75	6 LB Soluble Liquid 75 Wettable Granule	3.0 LB A/A 0.047 LB A/A	Timberland 90	NIS & Aquatic NIS	Liquid	0.5 % v/v	UAP
MSMA + Outrider	6 LB Soluble Liquid 75 Wettable Granule	3.0 LB A/A 0.047 LB A/A	Induce	NIS Aquatic	Liquid	0.5 % v/v	Helena
Overdrive	70 Wettable Granular	4 OZ WT/A	Aqua King	NIS Aquatic	Liquid	0.5 % v/v	Estes
			ChemTrol	Liquid drift	Liquid	64 FL OZ/100 GAL	Helena
			Detain II	Liquid drift	Liquid	12 FL OZ/100 GAL	Estes
			Pointblank WM	Liquid drift	Liquid	4.0 FL OZ/100 GAL	Helena
			Array	Dry Drift + AMS	Granular	9 LB/100 GAL	Estes
			Dry Poly Wet	Dry Drift + AMS	Granular	9 LB/100 GAL	Red River

1.) Non-ionic surfactant
2.) Ammonium sulfate

Table 7b. Twenty-five selected herbicide/adjuvant combinations evaluated for tank mix compatibility. These treatments included liquid drift control and dry drift control agents + ammonium sulfate (AMS).

Herbicide Component			Adjuvant Component				
Herbicide	**Formulation**	**Herbicide rate**	**Adjuvant**	**Adjuvant type**	**Formulation**	**Adjuvant concentration**	**Adjuvant distributor**
Roundup Pro Concentrate	5 LB Soluble liquid	0.5 LB A/A	Detain II	Liquid drift	Liquid	12 FL OZ/100 GAL	Estes
Mirage	4 LB Soluble Liquid	0.5 LB A/A	ChemTrol	Liquid drift	Liquid	64 FL OZ/100 GAL	Helena
Honcho Plus	4 LB Soluble Liquid	0.5 LB A/A	Pointblank WM	Liquid drift	Liquid	4.0 FL OZ/100 GAL	Helena
Campaign + AMS	3.1 LB Soluble Liquid 99% Sprayable Grade	32 FL OZ/A 17 LB/100 GAL	Array	Dry Drift + AMS	Granular	9 LB/100 GAL	Estes
Campaign + AMS + Overdrive	3.1 LB Soluble Liquid 99% Sprayable Grade 70 Wettable Granule	32 FL OZ/A 17 LB/100 GAL 2.0 WT/A	Dry Poly Wet	Dry Drift + AMS	Granular	9 LB/100 GAL	Red River

Table 7c. Twenty-seven selected herbicide/adjuvant combinations evaluated for tank mix compatibility. These treatments included liquid drift control agents.

Herbicide Component			Adjuvant Component				
Herbicide	**Formulation**	**Herbicide rate**	**Adjuvant**	**Adjuvant type**	**Formulation**	**Adjuvant concentration**	**Adjuvant distributor**
Roundup Pro Concentrate + Oust	5 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A	Detain II	Liquid drift	Liquid	12 FL OZ/100 GAL	Estes
Mirage + Oust	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A	ChemTrol	Liquid drift	Liquid	64 FL OZ/100 GAL	Helena
Honcho Plus + Oust	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A	Pointblank WM	Liquid drift	Liquid	4.0 FL OZ/100 GAL	Helena
Roundup Pro Concentrate + SFM 75	5 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					
Mirage + SFM 75	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					
Honcho Plus + SFM 75	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					
Roundup Pro Concentrate + Outrider	5 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					
Mirage + Outrider	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					
Honcho Plus + Outrider	4 LB Soluble Liquid 75 Wettable Granule	0.5 LB A/A 0.047 LB A/A					

Appendix A: Procedures for Conducting Herbicide/Adjuvant Compatibility Testing

1. Mix all herbicides together in the simulated spray tank (bottle) first, before attempting to add any adjuvant. The mixing order of products should follow the guidelines given below.

Mixing order for herbicides:
a. Ammonium sulfate (AMS)
b. dry herbicides
c. liquid solubles
d. liquid emulsifiables

Mixing should occur by slowly inverting bottle 3 or 4 times after each product is added. This should be adequate to mix all liquids but dry herbicides will require repeating the inversion process several more times over a 1-3 minute period or until all dry herbicide prills are visibly dispersed. Inverting bottles should be performed to prevent excessive foaming if at all possible. All herbicides & AMS should be thoroughly mixed before attempting the addition of any adjuvants being tested.

2. Add the appropriate adjuvants to the herbicide mixture one at a time followed by slowly inverting the mixture 10 times. Evaluate the mixture immediately and move on to the next adjuvant, repeating the process. Once the first mixture is evaluated, make a note of the time on the score sheet. Once all evaluations are made with a particular herbicide treatment, allow the bottles to set undisturbed for 30 minutes (or as close as possible).

3. After 30 minutes evaluate each of the bottles for the 2nd time. It is acceptable to pick up the bottles, but this should be done carefully so as not to disturb the mixture. After evaluation, place each bottle down undisturbed. It might be helpful to hold the mixture with a bright light (light bulb, window) behind the bottle to backlight the mixture making possible incompatibilities more visible. When the last mixture is evaluated proceed immediately to the 3rd evaluation.

4. The 3rd and final evaluation occurs by slowly inverting the first bottle 10 times followed by evaluation.

5. Each herbicide treatment will have 3 evaluation sheets, one sheet for each evaluation timing. When evaluations are completed, staple the 3 evaluation sheets together.

Appendix B: Compatibility Study Data Collection Form

Herbicide Treatment: | Evaluation Step: 1st 2nd 3rd

Evaluator: | Study/Replication Number: | Date:

Adjuvant	Supplier	1. Were precipitates formed?					2. Were separate layers formed?			3. Did herbicide mixture flocculate?			4. Was there a change in foaming?			5. Other?
		No	flakes	colored globules	clear globules	sludges	No	suspend	settled	No	suspend	settled	No change	More	Less	
Surf King	Estes															
Aqua King	Estes															
Detain II	Estes															
Array	Estes															
Red River 90	Red River															
Dry Poly Wet	Red River															
Timberland 90	UAP															
ChemTrol	UAP															
AD-Spray 80	Helena															
Induce	Helena															
Pointblank WM	Helena															
Stikezone PPS	Helena															
check																