

Total Vegetation Control for Industrial Sites

Introduction

The need for total vegetation control (i.e. bareground) exists for non-crop and industrial sites such as highway rights-of-way, power substations, fencerows, industrial sites such as production plants, and storage facilities to name a few. Total vegetation control is an important management objective in terms of safety and maintenance. For example, vegetation growing in and around an electric substation is a fire hazard and can cause damage to vital components thus increasing maintenance costs. In terms of highways, maintaining a vegetative free zone along highways and underneath guardrails increases driver's line of sight, decreases the potential for fires along the highways due to accidents, and allows for a clear vehicle recovery zone. Vegetation growing along the highway is also a maintenance concern as vegetation can increase the amount of cracks along a paved surface that would allow for the penetration of water into the pavement. This water can create a further maintenance concern if the water is allowed to contract and expand through thawing and freezing cycles. These examples illustrate how the simple presence of vegetation in unwanted areas can create costly problems that could have been avoided.

Applications of broad spectrum residual herbicides have become the mainstay for bareground maintenance operations. Preemergent type herbicides work by inhibiting the germination of seeds present in the soil / strata or being translocated via the roots and/or seed shoots. Examples of these types of herbicides are those containing prodiamine, pendimethalin, bromacil, and oryzalin. If actively growing weeds are present, it is necessary to combine the preemergent compound with a postemergent herbicide such as glyphosate or imazapyr. Many compounds offer both pre and post emergent activity. Examples of these include flumioxazin, diuron, and sulfometuron. There is a balance in choosing the most effective compounds to create the desired results while minimizing off target damage and cost per acre.

A study was initiated in the spring of 2004 to examine several bareground products and combinations thereof for duration of control and cost efficacy.

Materials and Methods

A study was initiated in April of 2005 to compare flumioxazin, pendimethalin, and diuron as bareground products for length of control. The study site was an unused storage area along Interstate 75 in central Kentucky. The study site had areas completely covered with herbaceous vegetation while other areas completely void of vegetation. The substrate was a compacted gravel base with little to no soil present with essentially no slope differences within and between the study blocks. Twenty seven chemical treatments and one untreated control were utilized in a completely randomized block design with three replications (Table 1). Predominant vegetation included decumbent lespedeza, white and red clover, and tall fescue. Plots were 3.3' X 20' with 5' running checks in between plots. Applications were made on April 20th, 2004 using a CO₂ powered sprayer equipped with 2 TeeJet 8008 SS flat fan nozzles at 50 GPA. All

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treatments included a nonionic surfactant at 0.25 % v/v. Costs per acre are approximate and are for comparison purposes only.

Table 1: Treatment list for 2004 bareground trial

Treatment	Compound	Active Ingredient(s)	Rate per acre	Cost per acre
1	Payload + Arsenal	flumioxazin + imazapyr	8 oz + 12 fl oz	\$71.00
2	Payload + Arsenal	flumioxazin + imazapyr	8 oz + 16 fl oz	\$77.00
3	Payload + Arsenal	flumioxazin + imazapyr	8 oz + 32 fl oz	\$106.00
4	Payload + Arsenal	flumioxazin + imazapyr	10 oz + 12 fl oz	\$82.00
5	Payload + Arsenal	flumioxazin + imazapyr	10 oz + 16 fl oz	\$89.00
6	Payload + Arsenal	flumioxazin + imazapyr	10 oz + 32 fl oz	\$118.00
7	Payload + Arsenal	flumioxazin + imazapyr	12 oz + 12 fl oz	\$94.00
8	Payload + Arsenal	flumioxazin + imazapyr	12 oz + 16 fl oz	\$101.00
9	Payload + Arsenal	flumioxazin + imazapyr	12 oz + 32 fl oz	\$130.00
10	Payload	flumioxazin	8 oz	\$49.00
11	Payload	flumioxazin	10 oz	\$61.00
12	Payload	flumioxazin	12 oz	\$73.00
13	Payload + Oust	flumioxazin + sulfometuron	8 oz + 3 oz	\$81.00
14	Payload + Oust	flumioxazin + sulfometuron	10 oz + 3 oz	\$93.00
15	Payload + Oust	flumioxazin + sulfometuron	12 oz + 3 oz	\$105.00
16	Payload + RoundUp Pro	flumioxazin + glyphosate	8 oz + 64 fl oz	\$71.00
17	Payload + RoundUp Pro	flumioxazin + glyphosate	10 oz + 64 fl oz	\$83.00
18	Payload + RoundUp Pro	flumioxazin + glyphosate	12 oz + 64 fl oz	\$95.00
19	Pendulum AquaCap + Arsenal	pendimethalin + imazapyr	64 fl oz + 12 fl oz	\$46.00
20	Pendulum AquaCap + Arsenal	pendimethalin + imazapyr	64 fl oz + 16 fl oz	\$53.00
21	Pendulum AquaCap + Arsenal	pendimethalin + imazapyr	128 fl oz + 12 fl oz	\$70.00
22	Pendulum AquaCap + Arsenal	pendimethalin + imazapyr	128 fl oz + 16 fl oz	\$77.00
23	Sahara	diuron + imazapyr	12 lb	\$107.00
24	Sahara	diuron + imazapyr	16 lb	\$143.00
25	Sahara + RoundUp Pro	diuron + imazapyr + glyphosate	12 lb + 64 fl oz	\$130.00
26	Sahara + RoundUp Pro	diuron + imazapyr + glyphosate	16 lb + 64 fl oz	\$165.00
27	Endurance + Arsenal	prodiamine + imazapyr	2 lb + 12 fl oz	\$83.00
28	Untreated			

Data collection included pre-application measurement of cover by species, percent cover of dead vegetation, and percent cover bareground. Follow up measurements were taken at approximately two week intervals after treatment. Data were analyzed using analysis of covariance (pre-application data as the covariate) in SAS software and adjusted treatment means were compared at each time interval using

Tukey's Honest Significant Difference (HSD) method at $p = 0.05$. Percent cover by species by treatment at 18 WAT was calculated using SAS software and the least square means options to allow for an unbalanced data set.

Results

The treatments that provided the highest level of bareground were those that included sulfometuron or diuron in the tank mixes (treatments 13 – 15 and 23 – 26) (Table 2). The only treatment other than those containing sulfometuron (Oust) or diuron (Sahara) that provided a percent cover of bareground greater than 90 % at any time during the screen was the Payload @ 12 oz + Arsenal @ 32 oz. This occurred at both 8WAT and 10 WAT. A general trend exists that shows an increase in percent bareground up to approximately 8 – 10 WAT (depending on treatment and rates). The exception to this is the treatments containing diuron as these treatments show an increase of percent bareground through 12 WAT.

There was no statistically significant difference between any Payload treatments that contained Arsenal at any given time interval. However, the treatments that had the high rate of Arsenal (32 oz) generally had higher percentages of bareground. The Payload alone treatments never realized the same degree of bareground as the Payload tank mix treatments; however, the Payload @ 10 oz per acre treatment (# 11) does show comparable levels of bareground. These stand alone treatments show the need for tank mixing with flumioxazin. The Payload @ 12 oz + RoundUp Pro @ 64 fl oz treatment had a higher, although not statistically significantly different, percent cover of bareground at the 18 WAT interval than the Payload treatments incorporating Arsenal.

Treatments using Pendulum AquaCap generally had lower percentages of bareground cover as compared to treatments using Arsenal or Oust. There appears to be antagonism present in this study in the Pendulum AquaCap treatments as the lower rate tested, 64 fl oz, plus Arsenal at 16 fl oz, had higher, although not statistically significantly different, levels of bareground compared to the treatments using the high rate of Pendulum AquaCap.

Treatments using Sahara consistently provided excellent levels of bareground through the entire screen. As previously stated, these treatments along with those using Oust, provided consistent control of vegetation through 18 WAT. These treatments would be preferable if non target damage due to herbicide movement were not a concern. Herbicide movement has been known to occur for these two products at the rate tested if environmental conditions (slope of treated site, precipitation, etc) favor this type of activity.

The Endurance + Arsenal treatment never a percent cover of bareground greater than 80 % in this trial. This treatment provided levels of bareground that were higher than that of the untreated control yet was never significantly different than the untreated control at a given time period through the length of the trial.

Percent cover by species at the end of the trial (18 WAT) would provide some interesting information. Table 3 shows percent cover by species by treatment for those species that had an adjusted mean percent cover greater than 5 %. These data would allow one to see what species were not controlled, or being "let go", at this time. It is important to remember that this information can not be interpreted across all treatments.

For example, if buckhorn plantain was beginning to occur in the Sahara plots but not in the Payload plots, it does not necessarily mean that Payload is more effective in controlling buckhorn plantain than Sahara. This phenomenon could be because there simply was no buckhorn plantain or an equally high concentration of buckhorn plantain in the Payload plots as the Sahara plots. The percent cover by species values should also not be the focus of this information; the presence of a species is the critical information. These data were not analyzed statistically for significant difference by species across treatments. This would be inaccurate given the size of the study area, the distribution of the weed complex, and the differences of weed density and population across plots at the beginning of the trial. This information is provided simply to give the reader an idea of what species were beginning to occur in certain treatments at 18 WAT.

Future Research

The entire study will be reapplied over the same area in the spring of 2005. The treatments assigned to certain plots will be applied to the same plots. This will give an operational aspect to the study as bareground treatments are typically applied to the same areas every spring. This will also provide periodic data (annual) for these applications. The study site had a broad weed complex and uneven distribution across the site at installation in April 2004. Reapplication of the same treatments will give information on persistence and a compounds ability to “reclaim” a site after sequential annual applications.

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Table 2: Adjusted treatment means for percent cover bareground for entire bareground trial

	HSD		HSD		HSD		HSD		HSD		HSD		HSD		HSD	
Trt	2WAT*	55.25	5WAT*	40.23	6WAT*	43.21	8WAT*	35.78	10WAT*	40.33	12WAT*	58.56	14WAT*	66.18	18WAT*	61.5
1	52.9	a	62.6	ab	80.1	ab	88.5	ab	88.6	a-c	84.9	a-e	85.0	ab	63.1	a
2	30.0	a	50.2	ab	64.9	a-c	70.3	a-d	84.1	a-c	61.4	a-e	57.9	ab	47.9	a
3	51.3	a	65.3	ab	87.1	a	91.0	ab	91.4	ab	84.2	a-e	84.3	ab	72.3	a
4	45.6	a	63.3	ab	55.8	a-c	79.8	a-d	82.8	a-c	75.5	a-e	83.1	ab	71.7	a
5	27.7	a	48.5	ab	82.5	ab	74.0	a-d	63.2	a-e	49.6	b-e	67.0	ab	50.0	a
6	58.8	a	63.8	ab	77.4	a-c	84.3	a-c	89.4	ab	88.2	a-e	83.8	ab	71.5	a
7	40.6	a	52.0	ab	76.9	a-c	84.8	a-c	85.2	a-c	81.7	a-e	78.1	ab	53.9	a
8	45.9	a	66.0	ab	76.9	a-c	84.5	a-c	77.6	a-d	68.5	a-e	73.3	ab	58.7	a
9	53.9	a	62.4	ab	86.3	a	92.6	ab	97.2	ab	86.6	a-e	86.3	ab	64.4	a
10	21.0	a	18.5	b	28.5	bc	35.1	d	39.8	de	40.5	e	50.7	ab	48.6	a
11	47.1	a	67.3	ab	68.9	a-c	70.8	a-d	80.0	a-c	70.8	a-e	80.6	ab	71.8	a
12	48.2	a	32.3	ab	45.6	a-c	44.9	b-d	46.0	c-e	47.5	c-e	50.0	ab	50.4	a
13	43.3	a	62.8	ab	77.5	a-c	81.0	a-d	90.7	ab	91.4	a-d	88.1	ab	71.8	a
14	44.6	a	59.7	ab	77.0	a-c	87.0	a-c	96.1	ab	93.8	a-d	91.4	ab	87.5	a
15	33.1	a	62.1	ab	84.1	a	93.7	a	98.4	a	98.3	ab	98.2	a	89.7	a
16	54.5	a	63.4	ab	81.8	ab	72.0	a-d	68.8	a-e	64.5	a-e	82.8	ab	60.4	a
17	42.3	a	71.2	ab	68.6	a-c	72.8	a-d	72.0	a-d	66.7	a-e	66.1	ab	42.5	a
18	46.9	a	75.5	ab	89.9	a	79.7	a-d	84.0	a-c	80.0	a-e	84.4	ab	83.8	a
19	34.6	a	45.4	ab	55.2	a-c	55.3	a-d	57.4	b-e	53.1	a-e	63.3	ab	62.9	a
20	27.6	a	49.1	ab	81.6	ab	84.2	a-c	83.7	a-c	78.3	a-e	77.9	ab	69.1	a
21	33.6	a	45.2	ab	62.3	a-c	67.8	a-d	75.7	a-d	68.6	a-e	76.3	ab	62.6	a
22	35.7	a	45.3	ab	59.9	a-c	69.5	a-d	79.1	a-d	69.8	a-e	74.4	ab	64.8	a
23	37.5	a	70.8	ab	77.9	a-c	89.4	ab	97.3	a	93.3	a-d	93.1	ab	82.7	a
24	57.7	a	85.1	a	93.9	a	93.7	a	95.9	ab	95.8	a-c	95.7	a	89.7	a
25	48.9	a	59.2	ab	72.3	a-c	78.2	a-d	100.0	a	99.9	a	97.0	a	88.1	a
26	49.0	a	55.2	ab	75.3	a-c	88.0	ab	100.0	a	100.0	a	99.7	a	91.6	a
27	32.3	a	38.3	ab	61.9	a-c	79.2	a-d	65.9	a-e	64.8	a-e	50.1	ab	59.4	a
28	20.5	a	16.7	b	25.0	c	40.4	cd	32.0	e	45.3	de	45.2	b	55.3	a

Note: Treatment means followed by the same letter are not statistically different using Tukey's Honest Significant Difference Test at p = 0.05. An asterick (*) next to evaluation dates indicates statistically significant treatment effect at that evaluation date.

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Table 3: Adjusted mean percent cover by species by treatment at 18 WAT

Trt	Species	Cover	Trt	Species	Cover	Trt	Species	Cover	Trt	Species	Cover
1	Lespedeza	35.5	9	Crabgrass	35	16	Crabgrass	22.5	22	Marestail	21
	Crabgrass	7.5		Lespedeza	11.75		Tall fescue	10		Buckhorn plantain	21
2	Crabgrass	30		Yellow foxtail	10		Marestail	7.5		Lespedeza	10
	White clover	21		Marestail	10		White clover	6.25		White clover	10
	Yellow foxtail	15.8	10	White clover	50		Yellow foxtail	6.25		Tall fescue	6.25
	Tall fescue	10		Buckhorn plantain	14.8	17	Crabgrass	36.7		Yellow foxtail	6.25
	Lespedeza	10		Marestail	10		Marestail	19.5		Red Clover	6.25
3	Crabgrass	17.3	11	White clover	10	18	White clover	11.75	23	Crabgrass	10
	Marestail	7.5		Buckhorn plantain	10		Marestail	10		Lespedeza	10
4	Lespedeza	35		Crabgrass	10		Crabgrass	10		Tall fescue	10
	Marestail	10		Yellow foxtail	10		Yellow foxtail	6.25		Marestail	6.25
	Yellow foxtail	7.5		Marestail	6.25	19	Lespedeza	31		Buckhorn plantain	6.25
5	Crabgrass	32	12	White clover	36.7		Marestail	10		Buckhorn plantain	6.25
	Tall fescue	21		Dandelion	10		Yellow foxtail	7.5	24	Yellow foxtail	10
	Marestail	10		Marestail	7.25		Buckhorn plantain	6.25		Crabgrass	6.25
	Yellow foxtail	5		Tall fescue	6.25	20	Lespedeza	18.75	26	Broomsedge	10
6	Crabgrass	10	13	Crabgrass	21		Marestail	18.3		Buckhorn plantain	6.25
	Yellow foxtail	6.25		Yellow foxtail	15.8		Buckhorn plantain	6.25	27	Lespedeza	90
7	Yellow foxtail	33.7	14	Yellow foxtail	15.5	21	Lespedeza	28		Marestail	5
	Crabgrass	21		Lespedeza	10		Marestail	11.2	28	White clover	21
	White clover	10		Crabgrass	5		Carrot	10		Lespedeza	15.5
8	Lespedeza	21					Tall fescue	6.25		Crabgrass	10
	Crabgrass	19.5								Marestail	6.25
	Marestail	7.5								Buckhorn plantain	5