Control of Canada Thistle (*Cirsium arvense*)

Introduction

Canada thistle is a federally listed invasive species native to Europe, western Asia, and northern Africa. First introduced into North America as an impurity in imported crop seeds, it was seen as a problem weed in agricultural settings as early as the late 1700s (Anderson 1999). This perennial has now become established and / or naturalized in Canada and areas north of the 37th parallel in the United States (roughly the southern border of Virginia, Missouri, Colorado, Utah, and through the middle of California). This species can aggressively spread by wind carried seeds and sprouting rhizomes, making it troublesome to control. In Kentucky, Canada thistle is more common in the northern and central regions of the state but does occur throughout the state in selected areas. It is possible that the species was accidentally planted along side KTC rights-of-way through the use of contaminated straw during construction remediation.

Certain growth regulator type herbicides have been shown to be effective on Canada thistle. Donald (1993) showed that dicamba, clopyralid, and picloram were all effective in reducing Canada thistle stem density after annual fall applications repeated for three years. 2,4-D was less effective in this study indicating that not all growth regulator type herbicides are equally as effective. Beck and Sebastian (2000) showed similar results with picloram. Beck and Sebastian also showed that this efficacy is neither increased nor decreased when Canada thistle is mowed 5-6 weeks prior to herbicide application.

Two studies are presented here. The first focuses on growth regulator type herbicides (2,4-D, dicamba, etc) while the second focuses on PPO inhibitor herbicides.

Control of Canada thistle with growth regulator type herbicides

Methods and Materials

A randomized complete block design study with three replications was installed at Spindletop research farm in Lexington, KY in early July 2004. The study site was a field with a predominant tall fescue cover with an even distribution of Canada thistle across the site. Eight chemical treatments and one untreated control were evaluated at 20 GPA (Table 1) and all chemical treatments included a non-ionic surfactant at 0.25 % v/v. Stinger was used in lieu of Transline, the non-crop labeled clopyralid. Plots were 5' X 20' and treated with a CO_2 powered sprayer equipped with three TeeJet 8004 flat fan nozzles. Plots were evaluated 62 and 100 DAT for visual percent control of Canada thistle and data was analyzed using ARM software. Treatment means were compared using Fisher's LSD at the $p = 0.05$ level. Untreated control values were omitted during analysis to reduce variance.

Results

There was variation in the amount of control seen at 62 DAT (Table 2). Control ranged from 17 % for Overdrive at 6 oz / ac to 91 % for Overdrive + Stinger at 4 oz + 8 oz / ac. This variation in response decreases as the trial progressed to 100 DAT. All treatments including clopyralid controlled at least 90 % of the Canada thistle. There appears to be no added benefit from increasing the amount of clopyralid in the Overdrive + Stinger treatments as the control response seen between the two treatments is not significantly different at 62 or 100 DAT. Although not statistically significant, there does appear to be some benefit to adding clopyralid to the Overdrive treatments as the lower rate (4 oz) resulted in a higher response when tank mixed with clopyralid than Overdrive alone at 6 oz. Clopyralid alone resulted in high control percentages at 100 DAT; however, the addition of Overdrive at 4 oz to the lower rate of clopyralid (8 fl oz) resulted in high percent control sooner than clopyralid alone. There was no statistically significant difference between the Overdrive alone treatments, Overdrive + Stinger treatments, Stinger alone, and Overdrive + Redeem R&P treatment at 100 DAT. The Garlon 4 treatment showed satisfactory control at 100 DAT but never realized the level of control as the other treatments tested.

There is considerable cost per acre variation across the treatments (Table 1). Based on level of control at 100 DAT, cost per acre, and statistical comparisons of treatment means, Overdrive alone with a non-ionic surfactant provides an operationally satisfactory level of control. Higher levels of control are seen with clopyralid alone and when Overdrive is tank mixed with clopyralid. The need to add Overdrive to clopyralid will depend on site characteristics such as weed populations not controlled by clopyralid alone or presence of desirables that may be injured with Overdrive.

Table 1: Treatment list for growth regulator Canada thistle trial

Treatment	Compounds	Active Ingredients	Rate per acre	Cost per acre
1	Overdrive + COC	diflufenzopyr + dicamba	6 oz + 32 fl oz	$17.00
2	Overdrive + NIS	diflufenzopyr + dicamba	6 oz + 32 fl oz	$15.00
3	Overdrive + Garlon 4 + COC	diflufenzopyr + dicamba + triclopyr	4 oz + 16 fl oz + 32 fl oz	$23.00
4	Garlon 4 + COC	triclopyr	16 fl oz + 32 fl oz	$13.00
5	Overdrive + Stinger + COC	diflufenzopyr + dicamba + clopyralid	4 oz + 10.67 fl oz + 32 fl oz	$35.00
6	Overdrive + Stinger + COC	diflufenzopyr + dicamba + clopyralid	4 oz + 8 fl oz + 32 fl oz	$29.00
7	Stinger + COC	clopyralid	10.67 fl oz + 32 fl oz	$25.00
8	Overdrive + Redeem R&P + COC	diflufenzopyr + dicamba + clopyralid + triclopyr	4 oz + 32 fl oz + 32 fl oz	$38.00
9	Untreated			

Table 2: Summary results for growth regulator Canada thistle trial

Trt No.	Type	Treatment Name	Rate	Rate Unit	Percent Control 62 DAT		100 DAT	
1	HERB	Overdrive	6	oz/a	17	cd	88	ab
	ADJ	COC	32	fl oz/a				
2	HERB	Overdrive	6	oz/a	22	bc	87	ab
	ADJ	NIS	0.25	% v/v				
3	HERB	Overdrive	4	oz/a	35	bc	70	bc
	HERB	Garlon EC	16	fl oz/a				
	ADJ	COC	32	fl oz/a				
4	HERB	Garlon EC	16	fl oz/a	32	bc	67	c
	ADJ	COC	32	fl oz/a				
5	HERB	Overdrive	4	oz/a	88	a	90	a
	HERB	Stinger	10.67	fl oz/a				
	ADJ	COC	32	fl oz/a				
6	HERB	Overdrive	4	oz/a	91	a	93	a
	HERB	Stinger	8	fl oz/a				
	ADJ	COC	32	fl oz/a				
7	HERB	Stinger	10.67	fl oz/a	42	b	95	a
	ADJ	COC	32	fl oz/a				
8	HERB	Overdrive	4	oz/a	83	a	93	a
	HERB	Redeem R & P	32	fl oz/a				
	ADJ	COC	32	fl oz/a				
9	CHK	Untreated Check			0	d	0	d

Note: Values followed by the same letter at a given time interval are not statistically significantly different at the p = 0.05 level using Fisher's LSD.

Control of Canada thistle with protoporphyinogen oxidase (PPO) inhibitor herbicides

Materials and Methods

A study was installed in June 2004 to evaluate the efficacy of the PPO type herbicides for Canada thistle control. This family of herbicide chemistry has been historically been used strictly in agricultural settings. Examples include acifluorfen, fomesafen, lactofen, and oxyfluorfen. These herbicides are extremely effective in the controlling annuals but it is unclear if these chemistries could be a cost effective treatment for troublesome species such as Canada thistle at low rates. This trial examines the efficacy of this specific chemistry in controlling Canada thistle.

Sixteen chemical treatments and an untreated control where installed in a randomized complete block design with three replications on June 17th, 2004. Plots were 10' X 30' with a 5' running check between each plot. Treatments were applied using an ATV equipped with a CO_2 powered sprayer using TeeJet XP size 03 flat fan tips. Applications were made at 20 GPA. Table 1 shows the products and rates used and costs are included for comparison purposes only. All treatments except those containing MSMA included a nonionic surfactant at a rate of 0.25% v/v and add an approximate cost of $0.25 per acre.

Quicksilver, Speedzone, and Edict have active ingredients that are considered to be PPO inhibitors. Speedzone is a 4 way blend of cafentrazone ethyl, 2,4-D 2-ethylhexyl ester, mecoprop acid, and dicamba. Hi Dep is a 2,4-D formulation that includes dimethylamine salt of 2,4-D and a diethanolamine salt of 2,4-D.

Data were collected at 29 DAT and 78 DAT. Visual percent control of Canada thistle was recorded and the data analyzed using ARM analysis of variance and treatment means were compared using Fisher's LSD test at $p = 0.05$. Untreated values were omitted from analysis to reduce variance.

Results

The only treatments that provided control greater than 70 % at 29 DAT where those containing Telar, the Hi Dep alone treatment at 64 fl oz / ac, and Redeem R & P treatment (Table 2). These treatments all declined in percent control 78 DAT to less than 40 %. The treatments with the highest percent control 78 DAT were the Speedzone treatments at 64 and 96 fl oz / ac. This higher degree of control as compared to the Quicksilver and Edict treatments may be due to the 4 way blend mixture in Speedzone. The dicamba element in this product may aid in increasing levels of control. The Redeem R & P treatment decreased in control levels from 29 to 78 DAT. In the previous Canada thistle study, Redeem R & P was effective at a rate 2X that tested here and when mixed with Overdrive.

The inability of foliar applied PPO type herbicides to translocate hinders the efficacy of these compounds in controlling perennials such as Canada thistle. The two way formulation of 2,4-D in Hi Dep was ineffective in controlling Canada thistle which is consistent with results from other 2,4-D studies on Canada thistle. Overdrive, Redeem R & P, and Telar were ineffective in this study. This may be due to the low rates tested

in an effort to reduce cost as these chemistries, especially Overdrive, have been shown to be effective in controlling Canada thistle.

Table 1: Treatment list for PPO Canada thistle trial

Treatment	Compounds	Active ingredient(s)	Rate per acre	Cost per acre
1	Quicksilver	carfentrazone	1 fl oz	$5.00
2	Quicksilver	carfentrazone	2 fl oz	$10.00
3	Quicksilver + Hi Dep	carfentrazone + 2,4-D*	1 fl oz + 32 fl oz	$10.00
4	Speedzone	4 way blend**	64 fl oz	$25.00
5	Speedzone	4 way blend**	96 fl oz	$37.00
6	Speedzone + Telar	4 way blend** + chlorsulfuron	96 fl oz + 0.25 oz	$42.00
7	Hi Dep	2,4-D*	32 fl oz	$5.00
8	Hi Dep	2,4-D*	64 fl oz	$10.00
9	Hi Dep + MSMA	2,4-D* + MSMA	32 fl oz + 64 fl oz	$14.00
10	Hi Dep + Overdrive	2,4-D* + diflufenzopyr + dicamba	32 fl oz + 4 oz	$15.00
11	Hi Dep + Telar	2,4-D* + chlorsulfuron	32 fl oz + 0.25 fl oz	$10.00
12	Redeem R & P	clopyralid + triclopyr	16 fl oz	$14.00
13	Edict	pyraflufen	2.75 fl oz	$13.00
14	Edict + Overdrive	pyraflufen + diflufenzopyr + dicamba	2.75 fl oz + 4 oz	$23.00
15	Edict + MSMA	pyraflufen + MSMA	2.75 fl oz + 64 fl oz	$22.00
16	Edict + Telar	pyraflufen + chlorsulfuron	2.75 fl oz + 0.25 oz	$18.00
17	Untreated control			

Table 2: Results summary of PPO Canada thistle trial

Trt No.	Type	Treatment Name	Rate	Rate Unit	Percent Control 29 DAT		Percent Control 78 DAT	
1	HERB	Quicksilver	1	fl oz/a	2	g	28	ab
	ADJ	NIS	0.25	% v/v				
2	HERB	Quicksilver	2	fl oz/a	5	fg	37	ab
	ADJ	NIS	0.25	% v/v				
3	HERB	Quicksilver	1	fl oz/a	52	bcd	25	ab
	HERB	Hi Dep	32	fl oz/a				
	ADJ	NIS	0.25	% v/v				
4	HERB	Speedzone	64	fl oz/a	53	bcd	55	a
	ADJ	NIS	0.25	% v/v				
5	HERB	Speedzone	96	fl oz/a	23	efg	55	a
	ADJ	NIS	0.25	% v/v				
6	HERB	Speedzone	96	fl oz/a	73	ab	12	ab
	HERB	Telar	0.25	oz/a				
	ADJ	NIS	0.25	% v/v				
7	HERB	Hi Dep	32	fl oz/a	28	def	17	ab
	ADJ	NIS	0.25	% v/v				
8	HERB	Hi Dep	64	fl oz/a	77	ab	15	ab
	ADJ	NIS	0.25	% v/v				
9	HERB	Hi Dep	32	fl oz/a	40	cde	5	b
	HERB	MSMA	64	fl oz/a				
10	HERB	Hi Dep	32	fl oz/a	52	bcd	10	b
	HERB	Overdrive	4	oz/a				
	ADJ	NIS	0.25	% v/v				
11	HERB	Hi Dep	32	fl oz/a	87	a	38	ab
	HERB	Telar	0.25	oz/a				
	ADJ	NIS	0.25	% v/v				
12	HERB	Redeem R & P	16	fl oz/a	72	ab	18	ab
	ADJ	NIS	0.25	% v/v				
13	HERB	Edict	2.75	fl oz/a	10	fg	43	ab
	ADJ	NIS	0.25	% v/v				
14	HERB	Edict	2.75	fl oz/a	57	bc	40	ab
	HERB	Overdrive	4	oz/a				
	ADJ	NIS	0.25	% v/v				
15	HERB	Edict	2.75	fl oz/a	5	fg	22	ab
	HERB	MSMA	64	fl oz/a				
16	HERB	Edict	2.75	fl oz/a	73	ab	23	ab
	HERB	Telar	0.25	oz/a				
	ADJ	NIS	0.25	% v/v				
17	CHK	Untreated Check			0		0	

Note: Values followed by the same letter at a given time interval are not statistically significantly different at the p = 0.05 level using Fisher's LSD.

Literature Cited

Anderson, W.P., 1999. Perennial Weeds. Iowa State University Press. Ames, IA. Pp 105-114.

Beck, K.G. and J.R. Sebastian, 2000. *Combined Mowing and Fall-Applied Herbicides to Control Canada Thistle (Cirsium arvense).* Weed Technol. 14: 351-356.

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