

Efficacy of experimental herbicide products – 2015 summer trial

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The objective of this research project is to evaluate efficacy of various combinations of post-emergent herbicides formulations for broadleaf weed control in turfgrass.

MATERIALS / METHODS

Plots were located in turf research area at the Guelph Turfgrass Institute, Guelph, ON. The site was an area of established turf (predominantly Kentucky bluegrass and perennial ryegrass, infested with dandelion, clover and other lawn weeds). Turf was maintained with typical high maintenance turf regime: 1.5 kg actual N 100 m⁻² per year in 3 applications (spring, summer, dormant); P and K in a 4:1:4 ratio with N; irrigated to prevent stress prior to treatment application and to prevent dormancy thereafter; mowed at 3 inches.

The treatments were combinations of different rates and volumes of post-emergent herbicide, as well as controls for a total of 16 treatments (see Table 1). Each treatment was replicated four times in 1 x

2 m plots arranged in a randomized complete block design (Figure 1). Plots were separated by 0.5 m buffer strips. Treatments were applied in June 11, 2015, and reapplied June 13 (Treatments 10 and 13) and July 2 (all 3 week reapplications). Broadcast treatments were applied with a compressed air sprayer (Teejet 8001VS flat fan nozzles - 5 ml/sec/ nozzle at 20 psi). Spot treatments were applied with a Chapin Stand'n'spray compressed air sprayer: target weeds were counted and total application amount recorded to give average treatment rate (ml/weed) (Table 2).

An anecdotal photographic record of the experiment was kept.

Table 2. Spot treatment details.

Treatment	Application	Target weed count	Application rate (ml/weed)
6 (C7)	Jun 11	84.3±11.1	3.8±0.2
	Jul 02	94.5±11	3.8±0.2
7 (C10)	Jun 11	77.0±12.8	3.7±0.4
	Jul 02	77.5±6.0	4.8±0.4

Table 1. Treatments

Treatment	Broadcast rate	Application
1 VNT2015-C1, 2 apps 3 wks apart	187 ml m ⁻²	Broadcast
2 VNT2015-C5, 2 apps 3wks apart	187	Broadcast
3 VNT2015-C7, 2 apps 3 wks apart	187	Broadcast
4 VNT2015-C9, 2 apps 3 wks apart	187	Broadcast
5 VNT2015-C10, 2 apps 3wks apart	187	Broadcast
6 VNT2015-C7, 2 apps 3 wks apart	See Table 2	Spot ¹
7 VNT2015-C10, 2 apps 3wks apart	See Table 2	Spot
8 VNT2015-C7, 1 app	93.5	Broadcast
9 VNT2015-C7, 1 app	187	Broadcast
10 VNT2015-C7, 2 apps 2 days (48hr) apart	187	Broadcast
11 VNT2015-C10, 1 app	93.5	Broadcast
12 VNT2015-C10, 1 app	187	Broadcast
13 VNT2015-C10, 2 apps 2 days (48hr) apart	187	Broadcast
14 Scotts weed-b-gone (FeHEDTA), 1app	187	Broadcast
15 Scotts weed-b-gone (FeHEDTA), 2apps 3 wks apart	187	Broadcast
16 untreated control	—	—

¹thoroughly wet the weeds till lightly drip



All measurements were analysed by appropriate statistical analyses (general linear models).

Data Collection:

Plots were rated pre-treatment for weed presence by visual ratings of broadleaf weed density and point quadrat measurement of weed cover. Post-treatment measurements of weeds were taken at 2-3 weeks after treatment and later in the season. Plots were rated visually and using canopy reflectance (normalized-difference vegetation index) 2-3 days after treatment for phytotoxicity of treatments to broadleaf weeds and to grasses.

Environmental conditions were noted at treatment application and for 24 hours following.

RESULTS

Environmental data

Daily air temperatures, evapotranspiration demand, and rainfall data for summer 2015 are presented in Figures 2 - 4.

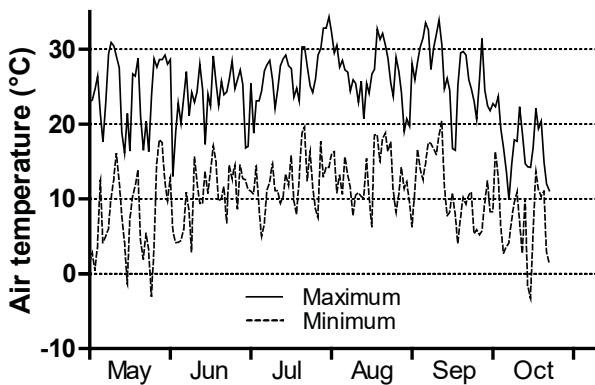


Figure 2. Daily air temperatures at GTI, summer 2015.

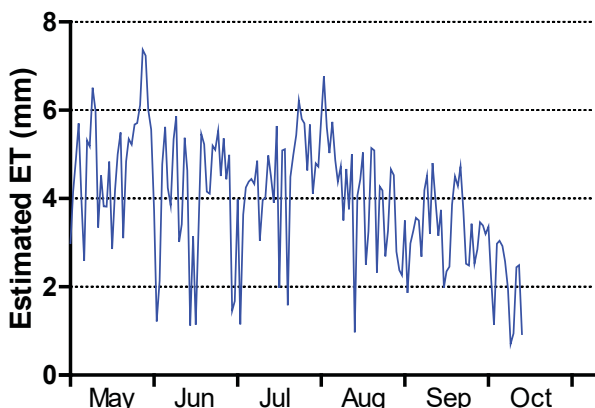


Figure 3. Daily estimated ET at GTI, summer 2015.

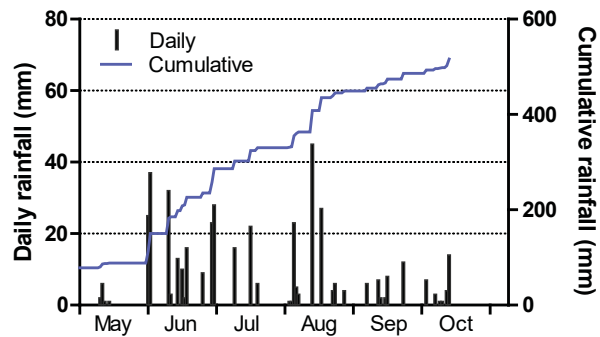


Figure 4. Daily and cumulative rainfall at GTI, summer 2015.

Visual ratings of phytotoxicity.

There was evidence on broadleaf weeds of oil-soaked leaves and necrosis within a few days after treatment (Table 3). There was little evidence of phytotoxicity on grasses for the first few days, but then phytotoxicity (slight browning of leaves) developed. Patterns of phytotoxic effects on weeds were statistically significant among herbicide treatments, but the differences were not large. Reduction of the broadleaf weed populations in some of the plots/treatments made interpretation of visual estimates of phytotoxicity difficult, as there were few weeds to exhibit the effects.

Canopy reflectance.

Canopy reflectance, which can be correlated with photosynthetic activity and plant health, was reduced by all treatments relative to the control, though the reduction was not statistically significant after the first application (Table 4). Some of the reduction will have been from phytotoxicity to the weed populations, and some from the effects of the treatments on the turfgrasses; because there was not regrowth in the weed populations generally, the recovery in canopy reflectance is mostly due to recovery in the turf. There were statistically significant differences among treatments on all dates, with the general pattern being similar to the visual phytotoxicity data (see Figure 5).

Broadleaf weed control.

Broadleaf weed infestation in the plot area before treatment (May 29) was about 40.8% of the area, as estimated by point-quadrat counts (Table 5). This is roughly equivalent to a visual rating of 6 (Figure 6 , Table 6). Most of the weed present



Table 3. Visual ratings of phytotoxicity in treated plots.

Treatment	Grass		Weed	
	5 DAT	19 DAT	5 DAT	19 DAT
C1	0.0 b	0.0 b	2.0 abc	2.0 abc
C5	0.0 b	0.3 ab	2.0 abc	1.8 a-d
C7- 1 app 0.5rate	0.0 b	0.5 ab	1.3 bc	2.0 abc
C7-1 app 1 rate	0.0 b	0.3 ab	2.5 ab	0.3 cd
C7-2 app	0.0 b	0.8 ab	1.5 bc	2.5 a
C7-48 hr	0.8 a	0.5 ab	3.0 ab	0.5 bcd
C7-spot	0.0 b	1.3 a	2.0 abc	1.8 a-d
C9	0.0 b	0.5 ab	1.5 bc	2.3 ab
C10-1 app 0.5rate	0.0 ¹ b	0.0 b	1.3 bc	1.8 a-d
C10-1 app 1 rate	0.0 b	0.3 ab	2.3 ab	0.5 bcd
C10-2 app	0.0 b	0.5 ab	2.0 abc	2.3 ab
C10-48 hr	0.0 b	0.0 b	4.0 a	1.0 a-d
C10-spot	0.0 b	1.0 ab	2.3 ab	2.0 abc
Control	0.0 b	0.0 b	0.0 c	0.0 d
WBG-1	0.0 b	0.0 b	3.0 ab	0.0 d
WBG-2	0.0 b	0.0 b	3.0 ab	2.8 a
msd p=0.05	0.3	1.1	2.1	1.9

¹ Visual ratings 0-10, 10 = most phytotoxicity. Means of 4 replicates. Means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 4. Canopy reflectance (NDVI) in treated plots.

Treatment	pre	0 DAT	4 DAT	13 DAT	14 DAT	18 DAT	27/6 DAT
C1	0.577 ¹	0.545	0.492 bcd	0.496 bc	0.480 cde	0.446 def	0.537 cde
C5	0.576	0.533	0.495 bcd	0.502 bc	0.476 cde	0.447 def	0.526 def
C7- 1 app 0.5rate	0.588	0.563	0.490 bcd	0.529 bc	0.503 b-e	0.442 ef	0.525 def
C7-1 app 1 rate	0.588	0.563	0.452 d	0.504 bc	0.515 bcd	0.527 bc	0.581 abc
C7-2 app	0.584	0.553	0.456 d	0.479 cd	0.449 e	0.369 g	0.476 f
C7-48 hr	0.591	0.540	0.380 e	0.431 d	0.447 e	0.460 def	0.535 cde
C7-spot	0.586	0.575	0.524 b	0.551 ab	0.532 bcd	0.481 cde	0.549 bcd
C9	0.582	0.546	0.473 cd	0.510 bc	0.491 b-e	0.436 ef	0.533 cde
C10-1 app 0.5rate	0.599	0.577	0.511 bc	0.548 ab	0.524 bcd	0.472 cde	0.552 bcd
C10-1 app 1 rate	0.575	0.541	0.461 cd	0.528 bc	0.537 bc	0.534 bc	0.594 ab
C10-2 app	0.592	0.556	0.481 bcd	0.508 bc	0.471 de	0.405 fg	0.490 ef
C10-48 hr	0.583	0.546	0.400 e	0.471 cd	0.483 cde	0.510 bcd	0.574 a-d
C10-spot	0.560	0.551	0.496 bcd	0.529 bc	0.508 b-e	0.456 def	0.527 def
Control	0.593	0.577	0.583 a	0.608 a	0.611 a	0.605 a	0.614 a
WBG-1	0.592	0.561	0.460 d	0.543 b	0.548 ab	0.560 ab	0.600 ab
WBG-2	0.577	0.560	0.466 cd	0.521 bc	0.470 de	0.447 def	0.522 def
msd p=0.05	NS	NS	0.050	0.064	0.064	0.065	0.054

¹ Normalized-difference vegetation index: mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 5. Total plot area (percent) covered by weed species pre-treatment (May 29, 2015) and post-treatment (July 15, 2015).

Treatment	Total weed			Dandelion		Clover		Narrowleaf plantain		Chickweed	
	05/29	07/15	Change	05/29	07/15	05/29	07/15	05/29	07/15	05/29	07/15
C1	39.3 ¹	12.7 a-d	-26.7 ab	24.3	4.0	9.7	8.3 ab	0.3	0.0	3.7	0.0 b
C5	42.0	9.0 bcd	-33.0 ab	19.7	1.3	14.7	7.0 ab	2.7	0.0	4.0	0.7 ab
C7- 1 app 0.5rate	40.0	21.7 a-d	-18.3 ab	14.0	3.7	21.3	17.7 a	0.0	0.0	4.3	0.0 b
C7-1 app 1 rate	37.7	24.7 abc	-13.0 ab	12.3	2.3	19.0	21.0 a	0.7	0.0	1.3	0.3 b
C7-2 app	40.0	8.7 bcd	-31.3 ab	15.7	1.3	20.0	7.3 ab	0.0	0.0	3.0	0.0 b
C7-48 hr	42.3	19.3 a-d	-23.0 ab	12.3	6.7	23.3	12.3 ab	0.0	0.0	5.3	0.0 b
C7-spot	41.7	16.0 a-d	-25.7 ab	16.7	2.0	21.7	14.0 ab	0.7	0.0	1.0	0.0 b
C9	42.7	12.7 a-d	-30.0 ab	12.3	1.7	20.3	10.7 ab	0.0	0.0	1.3	0.0 b
C10-1 app 0.5rate	39.7	14.3 a-d	-25.3 ab	19.0	1.0	17.7	13.0 ab	1.3	0.0	1.3	0.0 b
C10-1 app 1 rate	38.3	23.7 abc	-14.7 ab	20.0	4.0	13.0	18.0 a	0.3	1.0	2.0	0.0 b
C10-2 app	42.3	8.3 cd	-34.0 ab	16.0	1.7	18.0	6.7 ab	1.3	0.0	5.0	0.0 b
C10-48 hr	43.7	21.3 a-d	-22.3 ab	19.0	6.0	19.3	13.3 ab	1.3	0.0	3.7	0.3 b
C10-spot	31.0	11.7 bcd	-19.3 ab	11.0	2.0	12.7	9.3 ab	0.0	0.0	2.0	0.0 b
Control	38.3	29.3 a	-9.0 a	14.7	5.3	20.7	22.0 a	0.3	0.7	2.0	0.3 b
WBG-1	49.0	25.3 ab	-23.7 ab	14.3	5.3	29.0	18.0 a	1.7	0.3	2.7	1.7 a
WBG-2	44.0	5.7 d	-38.3 b	16.0	4.3	21.3	1.0 b	0.7	0.0	2.3	0.0 b
msd p=0.05	NS	16.9	26.1	NS	NS	NS	15.5	NS	NS	NS	1.2
	Birdsfoot trefoil		Broadleaf plantain		Black medic		Bindweed		Other		
	05/29	07/15	05/29	07/15	05/29	07/15	05/29	07/15	05/29	07/15	
C1	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
C5	0.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	
C7- 1 app 0.5rate	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
C7-1 app 1 rate	3.7	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.3	0.3	
C7-2 app	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
C7-48 hr	1.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
C7-spot	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
C9	5.7	0.0	2.7	0.0	0.3	0.0	0.0	0.0	0.0	0.3	
C10-1 app 0.5rate	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
C10-1 app 1 rate	2.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	
C10-2 app	1.3	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	
C10-48 hr	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.7	
C10-spot	5.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	
Control	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
WBG-1	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
WBG-2	3.0	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	

¹Percent cover area estimated by point-quadrat weed counts: 75 points per plot x 4 replicates.

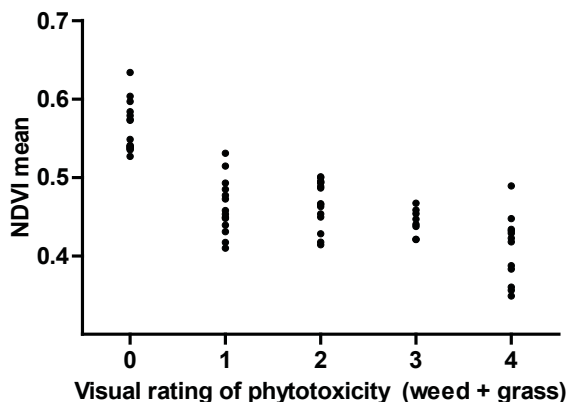


Figure 5. Association between canopy reflectance (NDVI) and visual phytotoxicity ratings (sum of weed + grass phytotoxicity), June 30, 2015 (19 DAT). Pearson r = 0.77.

was dandelion and clover, with smaller amounts of narrowleaf plantain and mouse-eared chickweed. Other sporadic weeds which were included in the total weed counts were birdsfoot trefoil, broadleaf plantain, black medick, and field bindweed. There was significant reduction in total broadleaf weed by 13 days after the first application in some treatments. By two weeks after the reapplication there were significant reductions in visual weed presence in many of the treatments, with the exception of some of the single application and low rate treatments. By 4 weeks after the reapplication most of the treatments had less weed than the control, but the reduction was significant only in the iron chelate repeat application (WBG-2).

Post-treatment point-quadrat weed counts taken 5 weeks after the first application (2 weeks



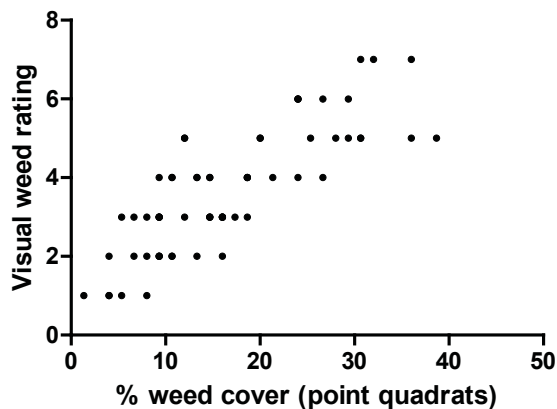


Figure 6. Association between point-quadrat weed cover estimates and visual weed ratings post-treatment. Pearson $r = 0.81$.

after reapplication) showed a decrease of about 24 percentage points, from 40% to 16.5% weed cover on average. All of the treatments showed a decline in weed cover when assessed as the difference between pretreatment cover and post-treatment (Table 5). The weed cover in the control plots declined by 9 percentage points; as with the visual ratings, only the repeat WeedBGone treatment showed a significant decline in weed cover compared to the control.

DISCUSSION AND CONCLUSIONS

All of the treatments showed some control effects. The best effects early (2 weeks after 1 application) were the two 48 hour repeat treatments, and later in the trial the 3 week repeat application treatments at full rate. Overall, only the iron chelate repeat application maintained a significantly lower weed presence than the control by the end of the trial, though most other treatments had less weed, numerically.

Table 6. Visual ratings of weed presence.

Treatment	Total weed				Dandelion		Clover		Narrowleaf plantain		Broadleaf plantain		Birdsfoot trefoil	
	13 DAT	19	35/14	67/46	35/14	67/46	35/14	67/46	35/14	67/46	67/46	67/46	67/46	67/46
C1	3.3 abc	1.8 cd	3.0 b-e	4.5 ab	1.3	2.3	2.5 ab	2.3 ab	0.0	0.0	0.0	0.0	0.0	0.0
C5	3.0 bc	2.5 bcd	3.5 b-e	4.5 ab	1.3	1.3	2.3 ab	2.8 ab	0.0	0.0	0.0	0.0	0.0	0.5
C7-1 app 0.5rate	3.8 abc	3.8 bc	4.5 abc	5.0 ab	1.3	1.5	3.3 ab	2.5 ab	0.0	0.0	0.0	0.0	0.0	0.5
C7-1 app 1 rate	3.5 abc	5.0 ab	5.0 ab	5.8 a	1.3	1.0	3.8 a	4.5 a	0.0	0.5	0.3	0.3	0.3	0.3
C7-2 app	2.8 bc	1.3 cd	2.3 cde	4.5 ab	1.0	1.8	1.5 ab	2.3 ab	0.0	0.5	0.3	0.3	0.3	0.3
C7-48 hr	1.8 c	3.5 bcd	3.8 bcd	4.8 ab	1.5	2.0	2.5 ab	2.8 ab	0.0	0.0	0.0	0.0	0.0	0.0
C7-spot	4.5 abc	3.5 bcd	3.3 b-e	4.8 ab	1.0	1.3	2.8 ab	3.3 ab	0.0	0.0	0.0	0.0	0.0	0.0
C9	5.3 ab	2.8 bcd	3.5 b-e	5.0 ab	1.0	1.8	2.8 ab	3.3 ab	0.0	0.0	0.0	0.0	0.0	0.3
C10-1 app 0.5rate	3.8 abc	3.3 bcd	3.3 b-e	5.3 ab	1.3	1.8	2.3 ab	3.0 ab	0.3	0.5	0.0	0.0	0.0	0.0
C10-1 app 1 rate	4.3 abc	4.8 ab	5.3 ab	4.8 ab	1.5	2.5	3.5 a	2.5 ab	0.3	0.0	0.0	0.0	0.0	0.0
C10-2 app	3.0 bc	1.3 cd	2.0 de	4.3 ab	1.0	2.3	1.5 ab	2.3 ab	0.0	0.3	0.0	0.0	0.0	0.3
C10-48 hr	2.3 c	3.5 bcd	4.5 abc	5.3 ab	2.0	2.0	2.3 ab	3.3 ab	0.0	0.0	0.0	0.0	0.0	0.0
C10-spot	3.3 abc	2.8 bcd	2.3 cde	4.3 ab	1.0	1.5	2.3 ab	2.5 ab	0.0	0.0	0.0	0.0	0.0	0.3
Control	6.0 a	7.3 ab	6.3 a	5.8 a	2.0	1.3	4.0 a	3.5 a	0.0	0.8	0.3	0.3	0.3	0.3
WBG-1	3.3 abc	5.0 ab	5.0 ab	5.3 ab	1.3	1.5	3.5 a	3.5 a	0.3	0.5	0.0	0.0	0.0	0.0
WBG-2	2.3 c	1.0 d	1.3 e	3.3 b	1.3	2.0	0.8 b	0.8 b	0.0	0.3	0.3	0.3	0.3	0.3
msd $p=0.05$	2.8	2.5	2.4	2.2	NS	NS	2.6	2.6	NS	NS	NS	NS	NS	NS

¹ Visual ratings 0-10, 10 = most weed. Means of 4 replicates. Means within columns followed by the same letter are not significantly different (Tukey's HSD test, $p=0.05$).

