Efficacy of experimental herbicide products – 2015 fall 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 17 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 on September 3, 2015, and reapplied September 17 (all 2 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.

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

Table 2. Spot treatment details.

Treatment	Application	Target weed count	Application rate (ml/weed)
417-spot	Sep 03	74.5±18.0	5.2±0.2
	Sep 17	43.3±18.3	4.6±0.4

Table 1. Treatments

Treatment		Treatment code	Rate ml m^{-2}
1	VNT2015-H417, 2 apps 2 wks apart	417-100	93.5
2	VNT2015-H417, 2 apps 2 wks apart	417-150	140.3
3	VNT2015-H417, 2 apps 2 wks apart	417-200	187.0
4	VNT2015-H417, 2 apps 2 wks apart	417-300	280.6
5	VNT2015-H417, 2 apps 2 wks apart	417-400	374.2
6	VNT2015-H417, 1 app	417-1x	187.0
7	VNT2015-H10, 2 apps 2 wks apart	H10	187.0
8	VNT2015-H318, 2 apps 2 wks apart	318	187.0
9	VNT2015-H412, 2 apps 2 wks apart	412	93.5
10	VNT2015-H413, 2 apps 2 wks apart	413	187.0
11	VNT2015-H414, 2 apps 2 wks apart	414	187.0
12	VNT2015-H416, 1 app on 2nd application date	416	187.0
13	VNT2015-C10, 2 apps 2 wks apart	C10	93.5
14	VNT2015-H417, 2 apps 2 wks apart	417-spot	See Table 2
15	Scotts weed-b-gone (FeHEDTA), 1app	Fiesta 1x	187.0
16	Scotts weed-b-gone (FeHEDTA), 2apps 2 wks apart	Fiesta	187.0
17	untreated control	Control	—

Figure 1. Plot area, September 17, 2015 (immediately after second application).

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.

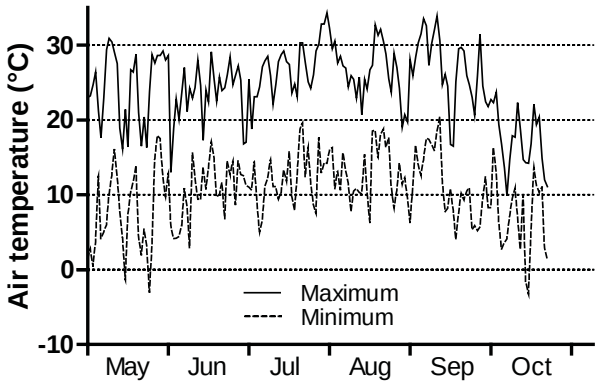

Figure 2. Daily air temperatures at GTI, summer 2015.

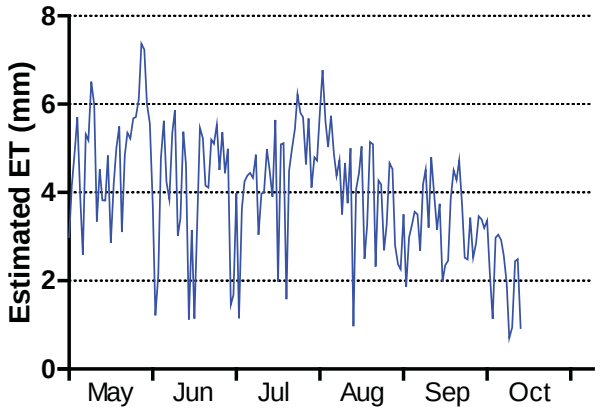

Figure 3. Daily estimated ET at GTI, summer 2015.

RESULTS

Environmental data

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

Visual ratings of phytotoxicity.

There was evidence on broadleaf weeds of oil-soaked leaves and necrosis after treatment (Table 3), but no significant differences among treatments, and interestingly, the control plots rated for some

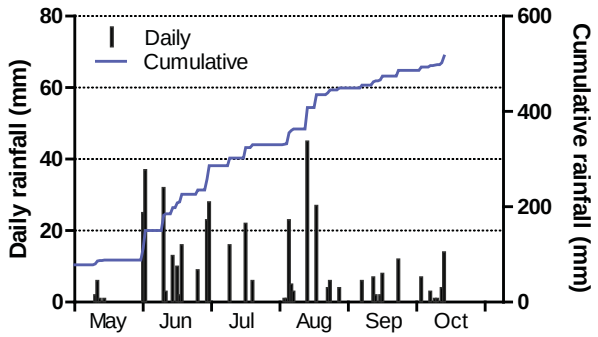

Figure 4. Daily and cumulative rainfall at GTI, summer 2015.

weed phytotoxicity as well. There was no evidence of phytotoxicity on grasses after the first application, but phytoxicity (slight browning of leaves) developed after the second application. Patterns of phytotoxic effects on weeds were statistically significant among herbicide treatments, but the differences were not large, though there was a rate effect noted among the 417 treatments. 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, any recovery in canopy reflectance would be 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 phytoxicity data (see Figure 5).

Broadleaf weed control.

Broadleaf weed infestation in the plot area before treatment (Aug 27) was about 26.4% of the area, as estimated by point-quadrat counts (Table 5). This is roughly equivalent to a visual rating of 4 (Figure 6 , Table 6). Most of the weed present was dandelion and clover. Other sporadic weeds which were included in the total weed counts were mouse-eared chickweed, broadleaf plantain, black medick, narrowleaf plantain and hawkweed. There was significant reduction in total broadleaf weed by 20 days after the first application in many treatments. By 5 weeks after the reapplication only the highest rate of 417 had significantly less weed than the control by visual rating.

Post-treatment point-quadrat weed counts taken 6 weeks after the first application (2 weeks after reapplication) showed a decrease of about 22 percentage points, from 26.4% to 4.2% weed cover on average. All of the treatments showed a decline in

Table 3. Visual ratings of phytotoxicity in treated plots.

Treatment	Weed		Grass		
	09/16	09/23	09/16	09/23	10/19
318	2.5[1]	2.8 abc	0.0	0.3 ab	0.8 bcd
412	2.5	3.8 a	0.0	1.3 ab	1.8 ab
413	2.5	3.0 abc	0.0	0.8 ab	1.0 a-d
414	3.5	4.0 a	0.0	1.0 ab	1.0 a-d
416	2.5	2.3 abc	0.0	1.5 a	1.3 abc
417-1x	1.5	1.0 abc	0.0	0.0 b	0.0 d
417-100	2.3	1.3 abc	0.0	0.0 b	0.3 cd
417-150	3.5	2.5 abc	0.0	0.0 b	0.3 cd
417-200	2.8	3.5 ab	0.0	0.3 ab	0.8 bcd
417-300	1.8	4.0 a	0.0	0.5 ab	1.3 abc
417-400	1.5	2.8 abc	0.0	0.5 ab	2.0 a
417-spot	2.3	3.0 abc	0.0	0.0 b	1.3 abc
C10	4.5	2.0 abc	0.0	0.0 b	0.5 cd
H10	2.3	2.5 abc	0.0	0.0 b	0.8 bcd
Control	3.3	0.0 c	0.0	0.0 b	0.0 d
Fiesta	2.5	3.8 a	0.0	0.0 b	0.8 bcd
Fiesta 1x	1.5	0.3 bc	0.0	0.0 b	0.0 d
msd p=0.05	NS	3.3	NS	1.3	1.2

[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. Change in canopy reflectance (ΔNDVI) in treated plots.

Treatment	09/15	09/17	09/23	10/26
318	-0.098[1] c-f	-0.124 efg	-0.232 g-j	-0.043 a-e
412	-0.076 b-e	-0.079 b-e	-0.242 hij	-0.104 de
413	-0.091 b-f	-0.076 b-e	-0.227 g-j	-0.065 b-e
414	-0.011 a	-0.053 a-d	-0.264 ij	-0.116 e
416	-0.142 fg	-0.157 fg	-0.288 j	-0.107 de
417-1x	-0.057 a-d	-0.083 cde	-0.139 c-f	-0.025 abc
417-100	-0.076 b-e	-0.100 def	-0.185 e-h	0.008 ab
417-150	-0.124 efg	-0.097 c-f	-0.074 bc	0.014 a
417-200	-0.091 b-f	-0.110 def	-0.228 g-j	-0.033 a-d
417-300	-0.124 efg	-0.146 fg	-0.251 hij	-0.058 a-e
417-400	-0.167 g	-0.172 g	-0.284 j	-0.078 cde
417-spot	-0.033 ab	-0.037 abc	-0.104 bcd	0.007 ab
C10	-0.035 abc	-0.020 ab	-0.113 cde	0.011 ab
H10	-0.101 def	-0.120 efg	-0.202 f-i	-0.031 a-d
Control	-0.001 a	0.000 a	0.000 a	0.000 ab
Fiesta	-0.041 a-d	-0.010 a	-0.159 d-g	-0.051 a-e
Fiesta 1x	-0.064 a-e	-0.050 a-d	-0.036 ab	0.011 ab
msd p=0.05	0.064	0.062	0.073	0.077

[1]Change in normalized-difference vegetation index (ΔNDVI) relative to control: mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

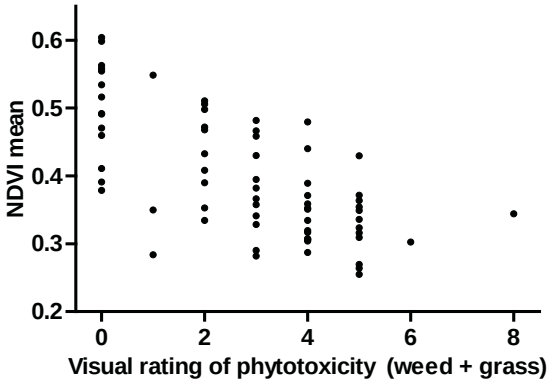

Figure 5. Association between canopy reflectance (NDVI) and visual phytotoxicity ratings (sum of weed + grass phytotoxicity), September 23, 2015 (20/3 DAT). Pearson r = 0.67.

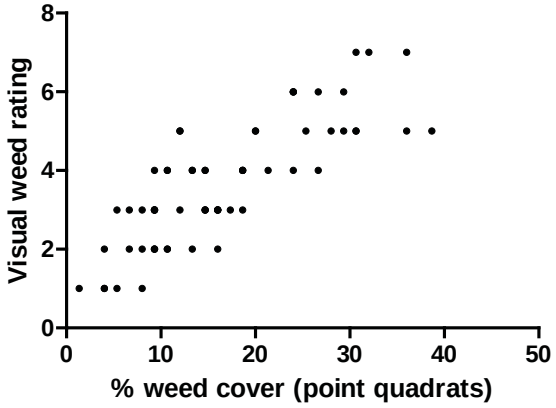

Figure 6. Association between point-quadrat weed cover estimates and visual weed ratings pre-treatment. Pearson r = 0.81.

weed cover when assessed as the difference between pretreatment cover and post-treatment (Table 5). The weed cover in the control plots declined by 1.3 percentage points; unlike the visual ratings, several treatments 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 with the Fiesta 2x and the higher rates of 417, and later in the trial treatments 318, 413, and 416 also continued to show good control. The rate effect that appeared in the 417 treatments in visual weed rating was not as clear in the point-quadrat data, as some of the moderate rates (150 and 200 gpa) showed as good control as the higher (300 and 400 gpa) rates.

Table 5. Total plot area (percent) covered by weed species pre-treatment (August 27, 2015) and post-treatment (October 7, 2015).

Treatment	Total weed			Dandelion		Clover		Chickweed		Broadleaf plantain		Black medick		Narrowleaf plantain		Hawkweed		Bare soil	
	08/27	10/07	Change	08/27	10/07	08/27	10/07	08/27	10/07	08/27	10/07	08/27	10/07	08/27	10/07	08/27	10/07	08/27	10/07
318	27.0[1]	0.7 b	-26.4 b	4.0	0.3 b	22.7	0.3 b	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
412	24.0	2.0 b	-22.0 ab	8.4	1.0 b	15.3	1.0 b	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
413	27.3	0.0 b	-27.3 b	3.7	0.0 b	23.7	0.0 b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
414	23.3	2.0 b	-21.4 ab	9.3	1.3 b	14.0	0.7 b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
416	27.7	3.0 b	-24.7 b	11.4	0.7 b	15.0	1.7 b	1.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.7	0.0	2.3
417-1x	24.0	7.7 b	-16.3 ab	8.0	3.3 ab	13.7	4.0 b	2.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
417-100	16.4	2.0 b	-14.3 ab	5.7	1.0 b	9.7	1.0 b	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
417-150	32.0	6.7 b	-25.3 b	6.7	0.0 b	25.3	5.3 ab	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.7
417-200	28.0	1.0 b	-27.0 b	6.4	0.3 b	21.7	0.7 b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
417-300	27.0	0.7 b	-26.3 b	10.7	0.7 b	15.4	0.0 b	0.3	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
417-400	26.4	0.0 b	-26.4 b	3.0	0.0 b	21.7	0.0 b	1.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
417-spot	21.7	3.0 b	-18.7 ab	5.4	0.3 b	15.7	2.3 b	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
C10	36.3	9.0 b	-27.3 b	4.0	0.7 b	32.0	7.4 ab	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.3
H10	27.3	1.3 b	-26.0 b	7.0	0.3 b	20.0	1.0 b	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control	21.7	20.3 a	-1.3 a	7.0	6.7 a	14.3	11.7 a	0.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fiesta	33.4	2.0 b	-31.3 b	9.0	0.0 b	24.3	1.0 b	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.7
Fiesta 1x	24.7	10.7 ab	-14.0 ab	10.7	4.7 ab	13.3	4.0 b	0.3	1.7	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
msd p=0.05	NS	11.1	22.1	NS	5.0	NS	7.6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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

Table 6. Visual ratings of weed presence.

Treatment	Total weed			Clover	Dandelion	Chickweed	Black medick	Broadleaf plantain
	09/02	09/23	10/19	09/02	09/02	09/02	09/02	09/02
318	4.5[1]	1.5 bc	1.0 ab	3.0	1.5	0.0	0.0	0.0
412	3.8	1.3 bc	1.0 ab	2.0	1.8	0.3	0.0	0.0
413	4.5	1.5 bc	1.0 ab	2.5	2.0	0.0	0.0	0.0
414	4.0	1.8 bc	1.3 ab	2.0	1.8	0.0	0.3	0.0
416	4.0	1.5 bc	1.5 ab	2.0	2.0	0.3	0.0	0.0
417-1x	3.5	2.3 abc	2.0 ab	1.3	2.0	0.8	0.3	0.0
417-100	3.3	1.8 bc	1.0 ab	1.3	2.0	0.8	0.0	0.0
417-150	4.5	2.3 abc	1.8 ab	3.5	1.8	0.0	0.0	0.0
417-200	4.5	1.8 bc	0.8 ab	2.8	1.8	0.0	0.0	0.0
417-300	4.0	1.0 c	1.0 ab	1.5	2.0	0.8	0.0	0.0
417-400	4.3	1.0 c	0.5 b	2.8	1.3	0.3	0.0	0.0
417-spot	4.0	2.0 c	0.8 ab	2.5	1.5	0.3	0.0	0.0
C10	5.3	3.3 abc	1.3 ab	4.0	1.3	0.0	0.0	0.0
H10	4.3	1.3 bc	0.8 ab	2.8	1.5	0.3	0.0	0.0
Control	3.3	4.0 a	2.5 a	2.0	1.5	0.3	0.0	0.0
Fiesta	4.8	0.8 c	1.3 ab	2.8	2.0	0.3	0.0	0.0
Fiesta 1x	3.5	2.8 abc	2.5 a	1.3	1.8	0.5	0.0	0.3
msd p=0.05	NS	2.1	1.9	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).