

Herbicidal activity of NEU1173H applied to turfgrass infested with dandelion, broadleaved plantain, and white clover – Spring 2010 trial

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MATERIALS/METHODS

Plots were located in the turf research area at the Guelph Turfgrass Institute, Guelph, ON. The site is an area of established turf (predominantly Kentucky bluegrass; some perennial ryegrass and fine fescue) (Figure 1). 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 6 treatments (see Table 1). Each treatment was replicated four times in 2 x 2 m plots arranged in a randomized complete block design. Treatments were applied beginning June 1, 2010, and reapplied June 23, 2010, and July 14, 2010. Treatments were applied with a compressed air sprayer (20 psi, Teejet 8001VS flat fan nozzles, 20 ml sec⁻¹). Turf was mowed 2-3 days prior to treatment. Turf was well watered prior to application, and irrigation/rainfall withheld for 24 hours after application.

An anecdotal photographic record of the experiment was kept.

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

Data Collection: Plots were rated pre- and post-treatment for turf color and quality, using visual assessments and canopy reflectance (normalized-difference vegetation index). Weed presence was assessed pre- and post-treatment with point-quadrat counts and visual ratings.

Phytotoxicity of treatments to plots (turfgrass and weeds) was assessed by visual ratings and NDVI.

RESULTS

Phytotoxicity – visual ratings. There was some phytotoxicity on the turfgrass as assessed by visual ratings in treated plots two DAT (Table 2), but it was slight and had disappeared by 2 weeks after the treatment. Subsequent applications had no effect on turfgrasses. Phytotoxicity to the broadleaf weeds in the plots was more pronounced.

Table 1. Treatments

Treatment	Dilution Rate	Application rate (ml m ⁻²)
1 Control	—	—
5 NEU1173H (0.25 g a.i. m ⁻²)	NEU 1173H:water 24:1	100
2 NEU1173H (0.5 g a.i. m ⁻²)	NEU 1173H:water 24:1	200
3 NEU1173H (1 g a.i. m ⁻²)	NEU 1173H:water 24:1	400
6 NEU1173+S (0.25 g a.i. m ⁻²)	NEU 1173H:water 24:1 (+adjuvant S - 0.1%)	100
4 Killex (0.55 ml m ⁻²)		100



Figure 1. Plot area June 2, 2010 (1 DAT).

Table 2. Visual ratings of phytotoxicity of treatments

Treatment	Grass		Broadleaf weeds
	06/03 2 DAT	06/29 28 DAT	06/03 2 DAT
Control	0.0 b ¹	0.0	0.0 c
Killex	0.0 b	0.0	2.3 b
NEU1173+S	0.8 ab	0.0	5.5 a
NEU1173H-100	1.3 a	0.0	5.3 a
NEU1173H-200	1.0 a	0.0	5.8 a
NEU1173H-400	1.3 a	0.0	6.0 a
msd p=0.05	0.8	NS	1.9

¹ Visual ratings 0-10, 0 = no toxicity. Effects on grass were slight necrosis of foliage; no adverse effects on color, uniformity, or density were noted. Means of four replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD, p=0.05).

Phytotoxicity – canopy reflectance. Canopy reflectance, which can be correlated with photosynthetic activity and plant health, was reduced very slightly by all treatments relative to the control (Table 3). There was a rate effect apparent in the experimental treatments, with higher rates producing a larger decline. Since the canopy reflectance readings integrate reflectance from both grass and weed foliage in the plots, it is possible that some of the decline in NDVI values was due to phytotoxicity of the treatments to the weeds present. Generally the decline in canopy reflectance disappeared by

several weeks after the last treatment application (Figure 2).

Weed infestation and control – visual ratings. There was fairly heavy and uniform broadleaf weed infestation in the plots pre-treatment (Table 4). The average visual rating was about 5.5, which correlates to about 35% cover as estimated by point-quadrat measurements. The weed pressure was fairly evenly distributed among the three major species, dandelion, white clover, and broadleaved plantain.

Table 3. Canopy reflectance of treated plots.

Treatment	05/17 -14	05/27 -4	06/01 Pre-	06/01 Post-	06/02 1 DAT	06/03 2	06/04 3	06/05 4	06/08 7
Control	0.626 cd ¹	0.641 abc	0.647 d	0.647 d	0.695 b	0.664 a	0.674 a	0.647 a	0.639 a
Killex	0.651 a	0.658 a	0.674 a	0.675 a	0.706 a	0.664 a	0.681 a	0.633 b	0.631 a
NEU1173+S	0.628 cd	0.640 bc	0.654 bc	0.666 b	0.617 c	0.603 b	0.619 b	0.556 c	0.577 b
NEU1173H-100	0.616 d	0.616 d	0.650 cd	0.659 c	0.613 c	0.595 bc	0.603 c	0.564 c	0.583 b
NEU1173H-200	0.643 ab	0.651 ab	0.673 a	0.679 a	0.585 d	0.596 bc	0.586 d	0.555 c	0.575 b
NEU1173H-400	0.632 bc	0.629 cd	0.657 b	0.665 b	0.576 d	0.590 c	0.596 c	0.543 d	0.546 c
msd p=0.05	0.013	0.016	0.007	0.0066	0.01	0.008	0.009	0.01	0.011
Treatment	06/14 13	06/16 15	06/23 22	06/24 1 DAT	06/28 5	07/02 9	07/06 13	07/12 19	07/15 1 DAT
Control	0.609 a	0.651 a	0.646 bc	0.665 b	0.671 a	0.689 a	0.642 b	0.706 a	0.669 b
Killex	0.618 a	0.638 b	0.644 bc	0.675 a	0.651 b	0.678 b	0.665 a	0.713 a	0.693 a
NEU1173+S	0.586 b	0.619 c	0.640 c	0.640 c	0.585 c	0.634 c	0.628 c	0.685 c	0.647 c
NEU1173H-100	0.592 b	0.626 c	0.652 ab	0.641 c	0.588 c	0.634 c	0.615 d	0.687 bc	0.631 d
NEU1173H-200	0.569 c	0.623 c	0.657 a	0.627 d	0.586 c	0.625 d	0.621 cd	0.694 b	0.643 c
NEU1173H-400	0.550 d	0.599 d	0.626 d	0.613 e	0.552 d	0.578 e	0.570 e	0.654 d	0.605 e
msd p=0.05	0.013	0.01	0.009	0.009	0.008	0.008	0.011	0.009	0.011
Treatment	07/19 4	07/23 8	07/27 12	08/03 19	08/09 25	08/19 35	09/14 61	09/27 74	Season mean
Control	0.674 a	0.661 b	0.669 a	0.639 a	0.615 a	0.574 a	0.578 a	0.658 a	0.653 a
Killex	0.660 b	0.685 a	0.666 a	0.638 a	0.591 b	0.550 bc	0.555 bc	0.631 b	0.654 a
NEU1173+S	0.582 d	0.608 d	0.639 b	0.567 c	0.550 d	0.525 d	0.530 d	0.603 d	0.608 c
NEU1173H-100	0.615 c	0.619 c	0.645 b	0.594 b	0.571 c	0.570 ab	0.557 b	0.623 bc	0.614 b
NEU1173H-200	0.579 d	0.601 d	0.626 c	0.558 c	0.546 d	0.537 cd	0.527 d	0.600 d	0.606 c
NEU1173H-400	0.570 e	0.571 e	0.612 d	0.484 d	0.493 e	0.534 cd	0.539 cd	0.610 cd	0.587 d
msd p=0.05	0.007	0.01	0.009	0.015	0.017	0.025	0.018	0.012	0.0029

¹ Normalized-difference vegetation index; means of 40-50 readings x 4 replicates. Means within columns followed by the same letter are not significantly different (Tukey's HSD, p=0.05).

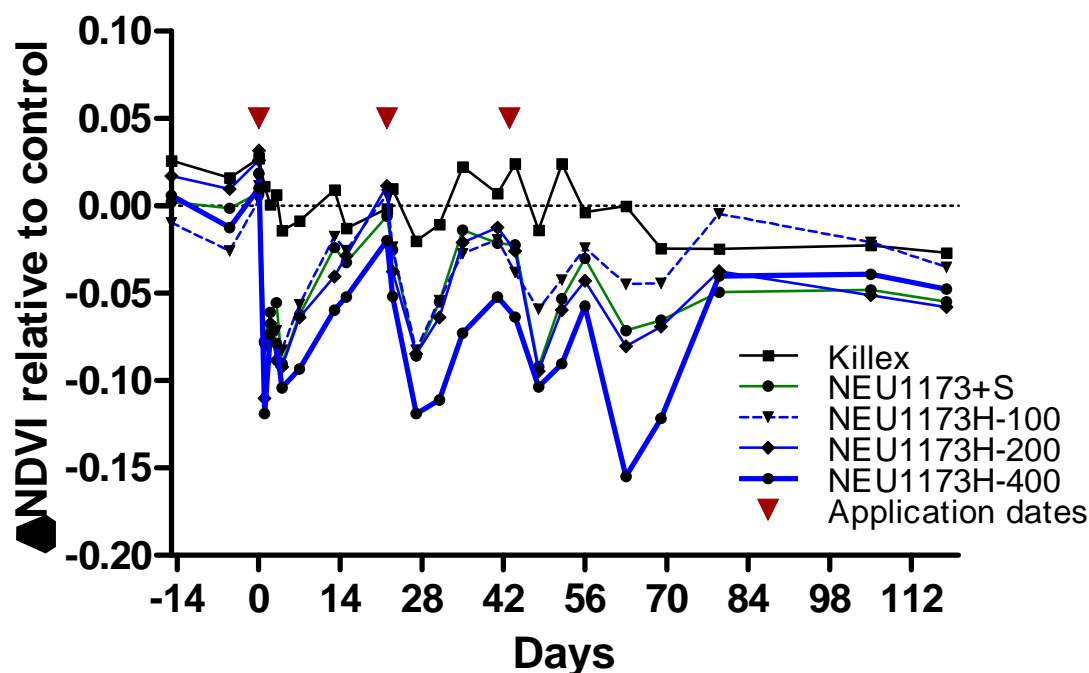


Figure 2. Changes in canopy reflectance relative to control plots. Declines generally coincided with treatment applications.

Table 4. Visual ratings of weed presence.

Treatment	Plantain						Clover						
	05/17	06/15	06/29	07/19	07/29	01/01	05/17	06/15	06/29	07/19	07/29	01/01	
Control	2.0	2.3	3.0 a	2.8 a	2.5 a	0.3	2.5	3.8	3.8 a	4.8 a	4.0 a	4.3 a	
Killex	1.5	1.0	0.5 b	0.5 b	0.3 b	0.0	4.3	1.0	1.3 b	1.5 b	1.3 b	1.1 b	
NEU1173+S	2.5	1.8	1.3 b	1.0 b	1.5 ab	0.1	3.0	1.5	1.0 b	0.5 b	1.0 b	0.6 bc	
NEU1173H-100	1.5	1.0	1.0 b	1.0 b	1.3 ab	0.1	3.0	2.3	1.8 b	0.8 b	1.0 b	1.0 bc	
NEU1173H-200	1.8	1.5	1.0 b	0.8 b	1.0 b	0.1	5.8	2.8	1.5 b	0.3 b	1.0 b	0.7 bc	
NEU1173H-400	2.3	1.3	1.0 b	0.5 b	0.8 b	0.0	3.0	1.0	0.3 b	0.0 b	0.0 b	0.1 c	
msd p=0.05	NS	NS	1.7	1.6	1.3	NS	NS	NS	2.0	2.3	1.6	0.9	
Treatment	Dandelion						Total weed						
	05/17	06/15	06/29	07/19	07/29	01/01	05/17	06/03	06/15	06/29	07/19	07/29	01/01
Control	2.5	1.0 a	1.0 a	1.5	1.3	2.1 a	4.8	5.5 a	5.0 a	5.3 a	6.5 a	5.3 a	5.4 a
Killex	1.8	0.0 b	0.3 b	0.8	1.0	1.2 b	5.8	5.3 a	1.3 c	1.5 b	1.8 b	1.5 b	1.6 b
NEU1173+S	2.8	1.0 a	0.0 b	0.8	0.8	1.3 b	5.3	3.0 ab	3.0 abc	1.8 b	1.3 b	2.0 b	1.5 b
NEU1173H-100	2.0	0.3 ab	0.3 b	0.8	0.5	1.0 b	5.0	3.0 ab	3.5 ab	2.8 ab	2.3 b	2.3 b	1.4 b
NEU1173H-200	1.5	0.3 ab	0.0 b	0.5	0.5	1.3 b	7.0	3.5 ab	3.5 ab	2.0 b	1.0 b	1.5 b	1.4 b
NEU1173H-400	2.5	0.5 ab	0.0 b	0.5	0.8	1.0 b	5.0	2.3 b	1.8 bc	1.0 b	1.0 b	1.0 b	1.0 b
msd p=0.05	NS	0.8	0.6	NS	NS	0.5	NS	2.8	2.2	2.6	2.1	2.2	1.1

¹ Visual rating 0-10, 0 = no weed, 10 = complete weed cover. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD, p=0.05).

There was significant control of all three common weeds by all treatments, with reduction in total weed as assessed visually to about 25% of the levels in the untreated plots. Control was clearer in the white clover and broadleaved plantain, largely because there was not the same seasonal decline in the untreated plots that appeared with dandelion. There was a trend for a rate effect on control of total weeds in the experimental treatments, though this was not statistically significant. There was not complete control of the weeds with any treatment, even the standard (Killex). It was not clear whether the weeds still present 8 weeks after treatments were ones which had survived the treatments or

regrowth, but there was not a noticeable rebound or increase in weed in any of the treatments during the trial period. Regrowth will be assessed again in the spring of 2011.

Weed infestation and control – point-quadrat measurements. The data from the point-quadrat evaluations of weed were very similar to the visual rating data. Nine different weed species were found in the point-quadrats, including the three most common species, dandelion, white clover, and broadleaved plantain. The other species were birdsfoot trefoil, black medic, chickweed, narrowleaf plantain, chicory, and bull thistle.. None of the less common species were frequent

Table 5. Percent area covered by total weeds, and the three most common weed species, estimated by point-quadrat counts.

Treatment	Dandelion				Clover			
	05/07	06/09	07/07	08/03	05/07	06/09	07/07	08/03
Control	11.63 a ¹	6.25 a	4.75 a	5.00 a	9.50 c	16.00 a	20.75 a	17.50 a
Killex	6.63 b	3.00 ab	0.50 b	0.50 b	44.38 a	6.75 b	1.25 b	3.25 b
NEU1173H-100+S	8.38 ab	1.75 b	1.75 ab	1.50 b	24.38 abc	4.00 b	5.25 b	1.00 b
NEU1173H-100	5.88 b	1.50 b	1.50 ab	1.25 b	20.75 bc	5.75 b	7.50 b	2.25 b
NEU1173H-200	6.38 b	0.50 b	1.25 b	0.25 b	37.38 ab	8.00 b	9.25 ab	2.00 b
NEU1173H-400	9.13 ab	0.50 b	2.00 ab	0.75 b	13.00 c	1.75 b	1.00 b	2.00 b
msd p=0.05	4.54	3.53	3.45	2.99	20.39	7.28	11.56	8.61
Treatment	Broadleaved plantain				Total weed			
	05/07	06/09	07/07	08/03	05/07	06/09	07/07	08/03
Control	3.00	5.25 a	6.25 a	5.25 a	24.50 c	28.25 a	32.50 a	27.75 a
Killex	3.63	2.50 ab	0.75 b	1.25 b	54.75 a	12.75 b	2.50 b	5.00 b
NEU1173H-100+S	3.13	2.25 ab	3.25 ab	2.50 ab	36.13 abc	8.00 b	10.25 b	5.25 b
NEU1173H-100	2.00	2.00 b	2.25 b	1.00 b	28.75 bc	9.50 b	11.25 b	4.50 b
NEU1173H-200	1.63	0.50 b	1.25 b	1.25 b	45.50 abc	9.25 b	11.75 b	3.50 b
NEU1173H-400	2.75	2.25 ab	0.75 b	1.00 b	25.50 c	5.25 b	3.75 b	3.75 b
msd p=0.05	NS	3.21	3.80	3.79	19.92	9.51	14.00	11.82

¹Point-quadrat count of 75 points x 4 replicates. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD, p=0.05).



enough to provide information on species-specific control, but their counts were included in the total weed data, and all had disappeared from the final post-treatment counts. Table 5 shows the results for the 3 most common weeds and the total weed presence. The overall weed presence was about 35% cover pre-treatment, and stayed at about the same level in the untreated control plots throughout the trial. All treatments controlled all three weeds compared to the untreated plots, with a reduction to about 16% overall. The reduction was highest in the clover (to 12% of untreated), then in dandelion (17% of untreated), with the lowest reduction in the broadleaved plantain (26% of untreated).

Analysis of visual weed ratings and point-quadrat cover estimates from dates when both were observed showed a strong correlation between the two estimates (Figure 3), though it is not a linear association (at intermediate weed presence levels, the visual estimates tend to over-estimate relative to the more accurate point-quadrat counts).

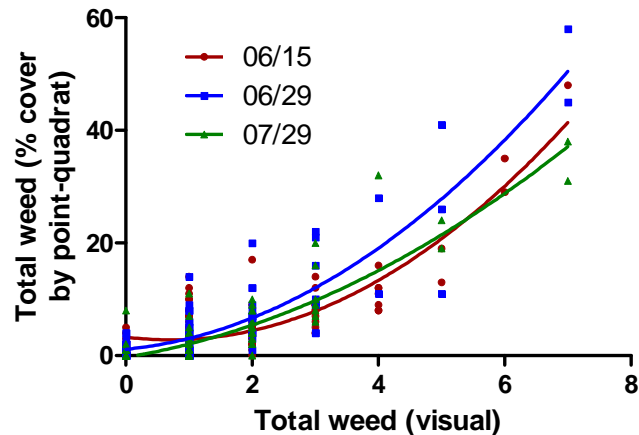


Figure 3. Association between point-quadrat weed cover estimates and visual weed ratings. Lines represent best fit quadratic curves. Datasets by date are means of all each plot (all treatments).

DISCUSSION AND CONCLUSIONS

All of the herbicide treatments gave effective control of dandelion, broadleaved plantain, and white clover (and some control of other broadleaf weeds). The experimental herbicide treatments gave levels of control as good as or better than the standard treatment (Killex). Levels of control ranged from reductions in weed to 26% of untreated levels (broadleaved plantain) to 17% of untreated (dandelion) and 12% of untreated (white clover). Overall, there was a reduction in total weed to about 16% of the untreated control. There was some suggestion of a rate effect in the experimental treatments, with the higher rates giving better control, but this effect was not statistically significant. For the experimental treatments, there was an initial immediate phytotoxic effect within one or two days, whereas the Killex took a week to 10 days to begin to reduce weed presence. Because the experimental treatments were applied in 3 applications, the pattern of control over the season was different, with the maximum control coming later in the trial for the repeated treatments than for the Killex standard.

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