

2017 Automated Thinner and Weeder Evaluations

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Background: Three experiments were conducted to address issues that affect automated thinners and weeders that use a spray kill mechanism. A critical concept for automated thinners and weeders is detection of the crop and distinguishing it from weeds. To date, automated thinners and weeders using traditional methods to distinguish crop plants from weeds such as evaluating differences in the size of the crop and weeds, as well as difference in spectral reflectance. New developments in distinguishing weeds from the crop include the use of deep learning; this technology ‘trains’ the machine to recognize weeds by evaluating numerous images. Crop signaling is another concept in which the crop plant is treated with a material that allows for detection of the crop by the machine. This can be accomplished by applying paint or dyes to the crop so that it can be recognized by the machine. In experiment 1 lettuce plants were treated with a fluorescent paint at thinning. Given that paint may reduce photosynthesis and slow the growth rate, we measured the impact of applying paint to lettuce on yield.

The camera and computer detection/processing system in automated weeders using a spray kill mechanism breaks the treatment area into a series of square grids (e.g. 0.5 cm²). Each grid is evaluated for the presence of weed and/or crop tissue. A “dot matrix” type sprayer is then used to treat squares that contain weed tissue. With this system, the potential exists that some treatment material can end up on the crop plant if the grid includes both weed and crop leaf tissue. Spray materials used by weeders are typically non-selective post-emergent herbicides. The amount of collateral damage caused by the spray hitting or wafting onto the crop plant has not been well studied. Ideally the spray material used by the kill mechanism would be selective (safe) to the crop to maximize safety. Raptor (BASF Corp) is a potential option for lettuce because it is registered for post emergent use on chicory (a closely related crop) and may provide more safety to lettuce. In experiment 2 Raptor was applied in three ways to simulate incidental contact of the herbicide onto the lettuce plant from the grid method described above: 1) one droplet on a leaf/plant, 2) half of one leaf/plant, 3) and one whole leaf/plant treated with the herbicide.

Experiment 3 was a screening trial of various herbicides for use in automated lettuce thinners and weeders. New materials were evaluated for their level of efficacy for killing lettuce (of importance in lettuce thinners) and controlling weeds.

Methods: *Experiment 1:* Two trials were conducted in a commercial lettuce field. The head lettuce variety ‘Tombstone’ was direct seeded in trial 1 on August 3 and in trial 2 on August 7; paint treatments were applied in trials 1 & 2 post thinning on August 18 and 22, respectively, and yield evaluations were conducted for both trials on October 13. Paint treatments were applied with a commercial paint sprayer applying the water based acrylic paint “Wildfire” at two rates, full coverage (Photo 1) and half coverage (Photo 2) immediately after thinning. ***Experiment 2:*** Three trials were conducted in commercial lettuce fields. The head lettuce variety ‘Tombstone’ was direct seeded in trial 1 on August 3, in trial 2 on August 7, and in trial 3 on August 11; herbicide treatments were applied in trials 1, 2 and 3 post thinning on August 18, 22 and September 1, respectively. Yield evaluations were conducted for trials 1 & 2 on October 13 and for trial 3 on October 19. Raptor was applied at the concentration of a 4 ounce/A rate applied in

30 gallons of water/A (0.104% v/v) and Shark was applied at the concentration of 0.25 ounce/A in 20 gallons of water (0.0097% v/v). Materials were applied to the plants with a small paint brush in the following methods: 1) one droplet applied to one leaf/plant; 2) half of a leaf/plant; and 3) an entire leaf/plant. **Experiment 3:** This trial was conducted at the Hartnell East Campus Research Facility. The Romaine lettuce variety 'Sun Valley' was seeded onto shaped beds on September 5 and the first irrigation water was applied on the same day. There was a high population of the following weeds at this site: malva, sow thistle, hairy nightshade, common purslane, burning nettle, shepherd's purse and nettleleaf goosefoot. The weeds and lettuce plants were treated 17 days after the first germination water (thinning stage) by applying the material over the top of the beds on September 22 with one pass of a one-nozzle wand with an 8008EVS nozzle applying the equivalent of 37 gallons of water per acre. Weed evaluations were made on September 26 and 29, 4 and 7 days after treatment, respectively. Weeds counts were made in two 1-ft² quadrats in each plot.

Results: Experiment 1: There were no significant differences in yield between painted and unpainted treatments in either trial (Table 1). Plants in the full-coverage paint treatment grew normally and had new leaves emerging within a week (Photo 3). **Experiment 2:** Trials 1 and 2 compared Raptor applied as described above. The droplet and half-leaf applications did not have significant phytotoxicity (Photos 4 & 5) (Table 2). However, Raptor full-leaf applications had unacceptable phytotoxicity (Photo 6). Trial 3 compared droplet and half-leaf applications of Raptor and Shark. Shark is a non-selective post emergence herbicide and it had significantly greater phytotoxicity than Raptor (Photo 7). There was statistically significant difference in the yield of the treatments, but a trend indicates lower yield in the Shark half-leaf treatment.

Experiment 3: There was a good population of weeds at this site (Photo 8). All materials were reasonably effective in killing lettuce plants, but Sharpen and Shark gave complete control of lettuce plants on the first evaluation date, September 26 (Table 3) (Photos 9 & 10). Both rates of Sharpen and Shark at 9.7 mls/A provided complete control of weeds, and were followed in efficacy by Shark at 15.7 mls/A and Suppress with Oroboost and natural oil (Photo 11). Raptor was weak on the weed spectrum present at this site (Photo 12). On the second evaluation date on September 29, there was some increase in the number of weeds in some of the treatments due to recovery of treated plants (Table 4). However, there was a decline in the number of weeds in the Rely treatments, which is a slower acting material and continued killing the weeds (Photo 13).

Table 1. Experiment 1. Yield of lettuce paint treatments

Paint Treatments	Trial 1		Trial 2	
	Yield T/A	Mean head lbs	Yield T/A	Mean head lbs
Full Coverage	31.35	2.43	21.41	1.66
Half coverage	29.48	2.28	21.69	1.68
Untreated	30.50	2.36	21.07	1.63
Pr>treat	0.4916	---	0.8393	---
LSD _{0.05}	ns	---	ns	---

Table 2. Experiment 2. Phytotoxicity and yield of herbicide treatments

Treatments	Trial 1			Trial 2			Trial 3		
	Phyto Sept 18	Yield T/A	Mean head lbs	Phyto Sept 18	Yield T/A	Mean head lbs	Phyto Sept 5	Yield T/A	Mean head lbs
Raptor Droplet	0.0	30.27	2.34	0.0	23.85	1.84	0.1	22.99	1.78
Raptor Half leaf	1.3	29.87	2.31	1.8	22.94	1.77	0.6	23.90	1.85
Raptor Full leaf	2.8	31.12	2.41	4.3	20.95	1.62	---	---	---
Shark Droplet	---	---	---	---	---	---	0.5	22.65	1.75
Shark Half leaf	---	---	---	---	---	---	0.9	21.06	1.63
Untreated	0.0	29.70	2.30	0.0	25.10	1.94	0.0	22.77	1.76
Pr>treat	0.0075	0.7498	---	0.0001	0.4846	---	0.0001	0.6220	---
LSD _{0.05}	1.5	ns	---	1.7	ns	---	0.3	ns	---

Table 3. Experiment 3. Weed counts (no/2 ft²) on Sept. 26 (4 days after application)

Material	Rate	Phyto on lettuce	Malva	Shepherd's purse	Purslane	Nettleleaf goosefoot	Night shade	Nettle	Sow thistle	Total weeds
Raptor MSO	3.0 oz 1% v/v	2.0	1.5	2.5	13.5	2.3	1.3	3.8	1.5	26.3
Raptor MSO	4.0 oz 1% v/v	2.8	1.3	1.3	15.5	3.0	0.8	1.3	0.5	23.5
Sharpen MSO	1.0 oz/A 1% v/v	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sharpen MSO	2.0 oz/A 1% v/v	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Suppress	6% v/v	9.3	0.5	0.0	0.0	0.0	0.0	1.0	0.0	1.5
Suppress Oroboost	6% v/v 0.4% v/v	9.6	0.3	0.0	0.0	0.0	0.0	0.5	0.0	0.8
Suppress Oroboost Oil	6% v/v 0.4% v/v 1% v/v	9.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Shark NIS	9.7 mls/A 0.25% v/v	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shark NIS	15.7 mls/A 0.25% v/v	9.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3
Rely	29 oz/A	9.3	2.8	0.3	0.0	0.0	0.0	0.0	0.0	3.0
Rely	43 oz/A	9.9	2.3	0.0	0.0	0.0	0.3	0.0	0.0	2.5
Untreated	---	0.0	1.8	3.3	11.8	4.8	2.8	2.0	2.5	28.8
	Pr>F treat	0.0001	0.0001	0.0376	0.0001	0.0001	0.0001	0.0001	0.0016	0.0001
	LSD _{0.05}	0.6	1.4	2.2	6.5	1.9	0.8	1.5	1.2	6.4

Table 4. Experiment 3. Weed counts (no/2 ft²) on Sept. 29 (7 days after application)

Material	Rate	Phyto on lettuce	Malva	Shepherd's purse	Purslane	Nettleleaf goosefoot	Night shade	Nettle	Sow thistle	Total weeds
Raptor	3.0 oz	2.8	0.3	2.0	15.8	2.0	0.5	0.8	1.3	22.5
MSO	1% v/v									
Raptor	4.0 oz	4.5	1.5	7.3	12.5	1.8	0.0	0.0	0.3	23.3
MSO	1% v/v									
Sharpen	1.0 oz/A	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSO	1% v/v									
Sharpen	2.0 oz/A	7.5	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.5
MSO	1% v/v									
Suppress	6% v/v	9.1	0.8	0.3	0.3	0.0	0.3	0.3	0.0	1.8
Suppress	6% v/v	9.3	0.5	0.5	1.0	0.0	0.0	0.3	0.0	2.3
Oroboost	0.4% v/v									
Suppress	6% v/v	9.7	0.5	0.0	0.0	0.0	0.0	0.3	0.0	0.8
Oroboost	0.4% v/v									
Oil	1% v/v									
Shark	9.7 mls/A	9.9	0.3	0.0	1.5	0.0	0.0	0.0	0.0	1.8
NIS	0.25% v/v									
Shark	15.7 mls/A	10.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	2.3
NIS	0.25% v/v									
Rely	29 oz/A	10.0	1.3	0.5	0.0	0.0	0.0	0.0	0.0	1.8
Rely	43 oz/A	10.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Untreated	---	0.0	2.8	5.0	10.8	4.8	1.3	2.0	1.8	28.3
	Pr>F treat	0.0001	0.0761	0.3142	0.0001	0.1388	0.1869	0.0212	0.0001	0.0001
	LSD _{0.05}	3.0	ns	ns	6.9	ns	ns	0.7	0.6	9.9



Photo 1. Exp. 1. Full rate of paint (Aug 18)



Photo 2. Exp. 1. Half rate of paint (Aug 18)



Photo 3. Exp. 1. Full rate of paint (Aug 24)



Photo 4. Exp. 2. Raptor, droplet application



Photo 5. Exp. 2. Raptor, half leaf application



Photo 6. Exp. 2. Raptor, full leaf application (note chlorosis)



Photo 7. Exp. 2. Shark droplet application



Photo 8. Exp. 3. Untreated control



Photo 9. Exp. 3. Sharpen at 1.0 oz/A



Photo 10. Exp. 3. Shark at 9.7 mls/A



Photo 11. Exp. 3. Suppress (+Oroboost & oil)



Photo 12. Exp 3. Raptor at 4.0 oz/A



Photo 13. Exp. 3. Rely 29 oz/A (first evaluation)