DETERMINING DISLODGEABLE FOLIAR RESIDUE LEVELS FOLLOWING THE APPLICATION OF TWO PESTICIDES USED TO MANAGE SPORTS TURF, 2016

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INTRODUCTION

The safety of pesticides usage on athletic fields is a complicated issue. Pesticide fate post application largely determines the potential for human exposure (Clark, 2007). This means playing on treated turf could be a risk of exposure if those compounds remain on the surface. Connecticut has banned all pesticides on school grounds from Kindergarten through 8th grade due to that concern that children are exposed to pesticide residues (State of Connecticut, 2009). By law, the labels for these products have re-entry periods or some designated amount of time before it is safe to re-enter the turfgrass area that received the application. Once this time has expired, the labels deem the turfgrass can return to normal function. Little research has been conducted regarding human exposure of pesticide residues on sports fields the days following an application. Quantification of residues post application may help lawmakers make science-based decisions concerning future legislation of minimizing pesticide exposure.

The objective of this project is to quantify foliar residues on playing surfaces following the application of two herbicides in two formulations sampled at post application time intervals of 0, 1, 3, 5, 7, 9 & 14 days after treatment.

MATERIALS AND METHODS

The research area was a three-year-old monostand of 'Granite', Kentucky bluegrass (*Poa pratensis*). No pesticides were applied on this stand of turfgrass within three months of conducting the study. The experiment utilized a split block design arranged in a 2 x 2 x 8 factorial with three replications (Figure 1). The first factor, product, included Trimec and Dimension. The second factor, formulation, included granular and liquid. The third factor was days after treatment (DAT), 0, 1, 3, 5, 7, 9 and 14. The granular form of Trimec was Fertilome Weed-Out Broadleaf killer. The granular form of Dimension was Lesco Dimension 0.10%; plus fertilizer (0-0-7). The liquid formulations were Trimec Classic and Dimension 2EW. The laboratory testing for Trimec products included all three active ingredients; MCPP, Dicamba and 2,4-Dichlorophenoxyacetic acid (2,4-D). Dimension was tested for the only active ingredient; Dithiopyr (DIT). Each product was applied according to their respective labels. The only modification to the application rates was matching the active ingredient levels across formulations. This avoided the liquid formulation of 2,4-D being applied at a higher rate of active ingredient than the granular formulation.

Figure 1. Wetting surface before Granular 2,4-D application with flow meter.

Per label instructions, granular Trimec was applied after watering the surface (0.25") so the granules would adhere to the leaf surface. Both the granular and liquid formulations of Dimension were watered in after application (0.50"). The amount of water was measured with a flow meter. (Figure 1.)

Initial sampling took place a week before any chemicals were applied to the turf. The initial testing represented our untreated control. Once the pesticides were applied, the stand was no longer mowed, irrigated, or traveled through on foot. Day 0 sampling took place from 2pm to 5pm. Samples were collected immediately once a single product was applied to all three replications. Strenuous efforts were taken on Day 0 to prevent chemicals from drying before sampling. The remainder of samples for the subsequent days after treatment were taken at 5am to ensure morning dew was present on the foliage. This timing was chosen based on previous research that showed a spike at 5am in liquid applied 2,4-D residues that gradually declined throughout the day and days after treatment (Gannon and Jeffries, 2014). The climate conditions during sampling are shown in table 1.

Figure 2. Cloth sample after being rolled. Dew moisture visible on cloth.

A modified California roller was used for sampling. The roller weighed 32 lbs and was foam wrapped to help conform to small undulations on the surface of the ground (Williams et al., 2008). This device was rolled on top of a percale cotton cloth covered with a plastic sheet to prevent contamination between samples. These were held down by a frame that clamped the edges of the sheets (Figure 2) (Williams et al., 2008).

Each sample that was taken was rolled twenty times; down and back counted as two separate passes. After being rolled, the sample was carefully removed from the harness and placed in an amber colored jar, then placed directly into a cooler. Samples were frozen immediately following collection to ensure no active ingredients were compromised. Extreme precaution was taken to prevent any cross contamination between samples.

An analysis of variance was completed to test for significant differences (p <0.05) among treatments using SAS statistical software 9.4 (SAS Institute. Cary, NC. 2004). The Mixed procedure and Fisher's least significant difference (LSD) test were utilized to separate the means when the appropriate F-test values were below the p-value of 0.05.

RESULTS AND DISCUSSION

The average dislodgeable pesticide residues extracted from each treatment are summarized in Table 2. Significant main effects were observed across all three factors; active ingredient, formulation, and days after treatment (DAT). Significant interactions were also observed across all combinations of the three factors. The results of the mean separation test are shown in Figures 3 and 4. Liquid 2,4-D residues for Day 0 and Day 1 were statistically different as were the remaining days after treatment. Table 2 shows that Trimec, in liquid form, had the most detectible residues in total, and the most residue detected days after treatment. The sharp decline on Day 3 (Table 2) residues may have been due to a significant rain event between the sampling Days 1 & 3. Interestingly, despite these rain events, the liquid formulation of Trimec had a slight increase in foliar residue on day 9 & 14. This suggests a potential relationship between the residues getting absorbed into, then re-suspending into the solution on the leaf blades.

The granular form of Trimec, however, had significantly less residues detected for total amounts and days after treatment and no statistical differences among days after treatment. Dithiopyr in granular and liquid formulations had low residues initially and were both non-detects one day after treatment. The only statistically different sample of Dithiopyr was the liquid formulation directly after sampling (Day 0) shown in Figure 3. Four consecutive non-detectible samples were considered no longer necessary to continue analyzing residue levels in the lab.

Dithiopyr had a minimum detectable residue level of 1.95 µg/sample. Any residue present that fell below this threshold was non-detectible. 2,4-D had a minimum detectable residue level of 0.39 µg/sample. It should be noted this experiment examined the worst-case scenario of pesticide exposure by sampling during the morning with optimum dew formation.

Additional research is needed to determine how the solubility of 2,4-D and Dicamba can lead to residues dislodging into solution multiple days and weeks after treatment. According to these data, Day 0 & 1 showed all four active ingredients tested in granular formulations had significantly reduced detectable residues compared to liquid formulations. This suggests that granular forms of Trimec and Dimension would be preferred over liquid formulations to minimize field closure times following the use of pesticides; however, this suggestion does not consider the efficacy of the products tested, which is an important component to sports turf management. These results can help improve recommendations for minimizing potential exposure risks and help lawmakers make science-based decisions concerning future legislation.

LITERATURE CITED

Clark, J.M., R. Putnam, and J. Doherty. 2007. Determining golf exposure and hazard to pesticides. Green Section Record. Mar.-Apr.: 21-24.

State of Connecitcut. 2009. An act concerning pesticide applications at child day care centers and schools. https://www.cga.ct.gov/2009/act/Pa/pdf/2009PA-00056-R00SB-01020-PA.PDF (accessed 1 March. 2017).

Gannon, T. W., and M. D. Jeffries. 2014. Dislodgaeable 2,4-D from Athletic Field Turfgrass. *European Journal of Horticultural Science* 79: 116-22.

Williams, Ryan L., Craig E. Bernard, Melinda Bigelow Dyk, John H. Ross, and Robert I. Krieger. 2008. Measurement of Transferable Chemical Residue from Nylon Carpet Using the California Roller and a New Mega-California Roller. *Journal of Environmental Science and Health, Part B* 43.8: 675-7

Table 1. Climate Conditions during experimental days after treatment†

DAT‡	Time	Precipitation (mm)§	RH (%)	Air Temp (°C)	Dew Point (°C)	AT-DP (°C)
Initial	14:00	0	72	25.5	17.8	7.7
0¶	14:00	0	82	20.0	15.0	5.0
1	5:00	0	85	18.9	18.3	0.6
3	5:00	12	80	19.4	21.7	1.3
5	5:00	0	80	20.5	20.0	0.5
7	5:00	10	67	21.1	18.3	2.8
9	5:00	0	66	14.4	13.3	1.1
14	5:00	16	70	20.6	19.4	1.2

† Climate conditions pulled from nearest weather station, Gurleyville Green (Gurleyville, Mansfield, CT)

‡ Abbreviations: DAT, days after treatment; RH, relative humidity.

§ Precipitation is the total amount accumulated since the previous sampling day.

¶ DAT of '0' is directly after application

Table 2. Average dislodgeable residues days after treatment in granular and liquid forms.

formulation	a.i	Days After Treatment†							
		Initial	0	1	3	5	7	9	14
		---------- µg/sample ----------							
L	2,4-D‡	ND	703.6	1251.9	18.5	4.3	2.1	8.1	7.3
G	2,4-D	ND	6.7	5.5	2.1	ND	ND	ND	0.5
L	MCPP§	ND	210.1	176.1	3.9	1.2	0.5	1.1	1.8
G	MCPP	ND	6.0	ND	1.5	ND	ND	ND	ND
L	Dicamba¶	ND	689.5	1279.2	14.2	ND	ND	5.6	6.7
G	Dicamba	ND	5.4	5.5	ND	ND	ND	ND	ND
L	Dithiopyr#	ND	26.4	ND	ND	ND	ND	-††	-
G	Dithiopyr	ND	3.9	ND	ND	ND	ND	-	-

†Abbreviations: DAT, Days after treatment; G/L, Granular/Liquid; a.i, active ingredient; ND, Non-detect

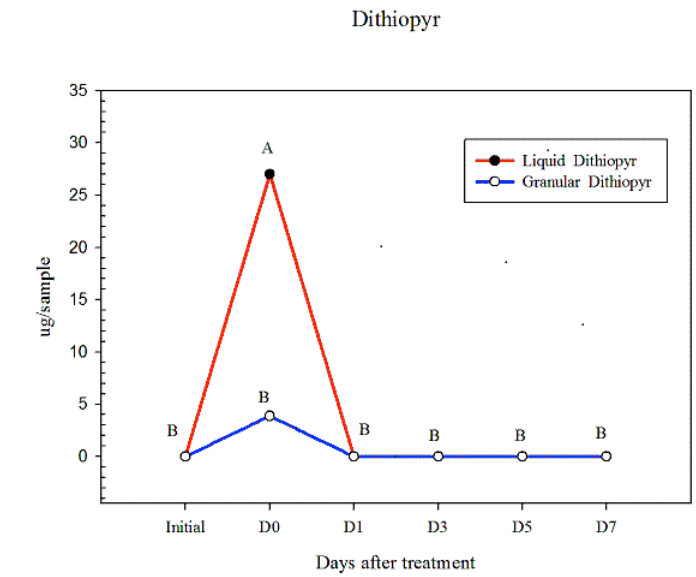
‡2,4-D had a detection limit of 0.39 µg/sample.

§ MCPP had a detection limit of 0.39 µg/sample.

¶ Dicamba had a detection limit of 3.9 µg/sample.

#Dithiopyr samples had a detection limit of 1.95 µg/sample.

†† '-' indicate no laboratory sampling took place because of four consecutive non-detects



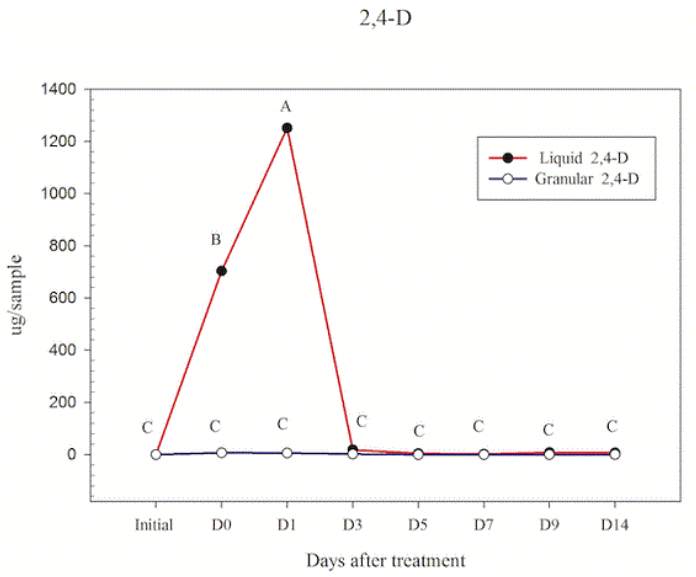


Figure 3 & 4. The effect of formulation and time on dislodgeable foliar residue levels of 2,4-D and Dithiopyr. Data points with the same letter are not statistically different according to Fisher's protected LSD ($p<0.05$).