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Final Report: Runoff from Concrete Wall
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I. Persistence and runoff of of Polyzone (deltamethrin) and Demand (lambda-cyhalothrin) Sprays

These two pyrethroid sprays are in direct competition in the pest control industry for use against ants. The Polyzone dries as a thin polymer matrix with the insecticide particles embedded in it. According to the company (Bayer) this matrix protects the insecticide from UV and water exposure, thereby extending its residual effect against ants. The Demand (Syngenta) is a capsule suspension with no protective matrix. We wanted to compare the runoff properties of these two products.

Methods

On the UCR campus we had Agricultural Operations construct a concrete wall with two adjacent concrete slabs. The wall measured 36 ft wide and was divided into 3 ft wide segments for 12 different treatments on each side. We were trying to simulate a wall or garage door of a house and the adjacent driveway. The wall is 3 ft high and received 2 coats of a latex paint. The concrete pad on each side of the wall extends 8 ft away from the wall at a 2 degree slope so that water runs off to 1 Liter amber collecting bottles (Figs. 1 and 2). The rain-simulating irrigation system was calibrated before spraying by using catch cups and a computer program that translates the amount of water collected to inches of rainfall (Fig. 3). Uniformity of irrigation was about 80%. On September 17, 2012 the east side of the painted wall and concrete pad was sprayed with 0.03% solutions of Polyzone (4.75% deltamethrin) and Demand (9.7% lambda-cyhalothrin), with 4 replicates of each (the fourth replicate was kept as a backup if needed). We calibrated plastic squirt bottles and determined how many times the trigger had to be pulled to deliver the rate of application specified by each product label. Each treated segment was 3 ft wide, 2 ft up, and 3 ft out from the base of the wall. There were also 3 untreated sections. Treatments were randomly assigned to sections of the wall. The label rates resulted in each treated segment receiving 18 mg of AI. The Polyzone rate was 0.75 fluid oz of concentrate per 1,000 square feet of surface. For Demand the rate was 0.4 oz of concentrate per 1,000 square feet of surface. Plywood barriers were placed between segments and sheets of paper were taped to the concrete and wall to limit lateral spread of the insecticides (Fig.4). The first 1 L of runoff was collected in the bottles for analysis and the sprinklers were left on until the last bottle was filled. Filling all the sample bottles took the equivalent of 0.17 in of rain and approx. 8.6 mins of sprinkler time. The samples were immediately returned to the laboratory where they were placed in a cold room until analysis could be done.

Water samples were collected at 1, 15, 24, 29, 58, and 114 days post-treatment. All except the Day 24 samples were collected from the irrigation system. The Day 24 samples were collected during a natural rainfall. A CIMIS weather station on the same university property provided data on temperature, rainfall, humidity, solar radiation, and precipitation. Concentrations of the tested products in the runoff were determined by GC at a precision of 0.01 parts per trillion. From these concentrations and the amount of simulated or natural rainfall we estimated the mass of AI in the runoff for each date. The day of application the maximum temperature was 88° F. During the next two weeks until the Day 15 samples, maximum temperatures varied between 85 and 103° F. During this same period solar radiation varied from 420 to 562 Langleys per day. There were approximately 15 hrs of sunlight between application and the first water sampling the next day. Trials were conducted on the east-facing side of the wall and it received direct morning sunlight.

Results

Fig. 5 shows the results as concentrations of the AIs in the runoff over time. Starting with near identical concentrations on Day 1, by Day 15 the Demand begins a sharp decline while the Polyzone has a small increase followed by a much slower decrease over time. Fig. 6 shows the results as the cumulative percent of total AI over time. The Day 1 results were 6.61% of AI for the Polyzone and 5.05% of the Demand. These runoff estimates are similar to values shown for pyrethroids in the Pyrethroid Working Group (PWG) Pathway report for driveway runoff. Our Day 1 runoff for Polyzone and Demand were not significantly different by two sample t-test. At day 15 the Polyzone runoff actually increased when compared to Day 1, while the Demand took a sharp drop. For Day 15 and all subsequent sample periods the mass of Polyzone collected from that sample was significantly greater than that for the Demand runoff. Cumulative AI after 114 days was 5.3% for the Demand and 19.3% for the Polyzone.

In the latter part of the study there were natural rainfall events where we did not collect samples for analysis (see Fig. 6). Fig. 7 shows what the cumulative runoff curve looks like if we estimate the concentrations of runoff during the rain events by using an average of the before and after concentrations for which we did have measurements. This average concentration and the amount of rainfall provides us an estimate of the mass runoff resulting from the rain dates. The cumulative runoff becomes 5.4% for the Demand and 22.4% for the Polyzone.

The untreated wall segments showed trace amounts of both AIs with slope curves similar to that of the treated segments. These tiny quantities could have been transferred between adjacent segments by blowing dust or other debris.

Discussion

The results show that compared to the Demand, the Polyzone matrix protects the AI from solar and temperature degradation over long periods of time. Furthermore, the product does not run off with the first rain, but continues to release AI slowly over the entire period of the study. These properties suggest that the product should also be active against ants over a longer time period than the Demand.

The unanswered question at this time is, What happened to the Demand? After initially having a runoff similar to the Polyzone, it then drops very quickly at 15 days. One working hypothesis is that without the protective shielding of the Polyzone, most of the Demand has been degraded by sunlight and high temperatures on the wall and concrete pad by day 15. It is also possible that the product has penetrated the concrete surface and is not available. These results suggest that the Demand would not be active against ants after 2 weeks. We do not currently have a way to look for pyrethroid degradates in the wall or pad to test this hypothesis. However, we plan to do surface wipes of the test area with various solvents to see what remains on the painted surface and concrete.

With the new labels for pyrethroids that limit applications near or on impervious surfaces such as concrete, the small amount of AI runoff from the Polyzone should not be an issue since the product would not be applied on hard surfaces and therefore would not be susceptible to runoff from the premises. These results again are in agreement with the PWG conclusions that by avoiding the driveway most of the pyrethroid runoff is eliminated.

II. Feasibility of using wipes to measure insecticide residues

We are interested in comparing water runoff from treated surfaces with wipes of these surfaces to see how closely the amounts of insecticides are correlated. Although water runoff gives good information about the runoff, the collection of a water sample is more time consuming than a simple wipe of the surface would be. Our first trial with wipes took advantage of the previously treated wall and pad to see whether residues were still there. These first trials were made to determine the best solvents and wipes to use for sampling the residues.

Methods

The water runoff from the wall trials was described above. The wall had been treated with Polyzone and Demand on September 17, 2012, with the final water sample collected on January 9, 2013. On February 21, 2013, we used two of the Polyzone-treated wall and pad segments for wipes of their surfaces. A 9-in square frame was held against the painted wall and the section of the wall within the frame was wiped with a cloth moistened with water (Fig. 8). On the same spot a follow-up wipe was done with a cloth treated with isopropanol. Then the same procedure was repeated on the horizontal unpainted pad (Fig.9). Each of the used cloths was put into a small bottle to be analyzed separately in the laboratory. On a second Polyzone-treated segment different kinds of wipes were compared. First the wipe was done with the same cloth as above, using isopropanol both on the wall and another on the pad. Then in a separate location on the same treated segment a wipe of both the wall and the pad was done with commercially available wipes that were pre-moistened with isopropanol. The 4 wipes from this treated section were each placed in a separate bottle for future analysis.

Results

Table 1 shows the analysis of the wipes used for this experiment. These results are preliminary to help in the design of future experiments. There are several interesting findings. First, the isopropanol wipes were more efficient than the plain water for extracting residues. Second, the painted wall surface gave much higher residues than the concrete pad. For example, the wipe concentration from the pad using water was 67 ppb, while for the painted wall it was 5,125 ppb. As the painted wall was designed to simulate the painted stucco of a house, this finding could have some bearing on where products should be sprayed to avoid runoff. And third, the pre-moistened isopropanol wipes were not as efficient as the dry cloths that were manually moistened.

Discussion

One of our goals is to correlate insecticide in water runoff to residue levels seen on surface wipes. If they are correlated then a wipe on the driveway could give an easy indication of potential runoff, and would be easier to do than flushing a driveway with water and collecting a water sample. We are trying a variety of solvents to use with the cloth and will continue to compare the painted surface with the concrete pad. We are also going to compare runoff profiles of a variety of products to see what happens to them over time.

III. Runoff of fipronil and a variety of pyrethroids

Our next goal is to get runoff profiles of fipronil (and its derivatives) and several pyrethroids from both water samples and surface wipes. We will then compare the water and surface wipes to see how well they correlate.

Methods

For this trial we used the previously untreated west side of the wall and pad. We treated 4 segments of the wall and pad, leaving an untreated segment between each treatment as follows: Treatment 1,Blank, Treatment 2, Blank, Treatment 1, Blank, and Treatment 2. Applications to the wall and pad were done with plastic spray bottles as described above, using the high application rate specified by the label instructions for each product.

The wall was treated on May 29, 2013. Treatment one consisted of a combination of products, each applied sequentially: fipronil, deltamethrin (SC), and bifenthrin. They are all soluble concentrates (SCs). One product was allowed to dry on the wall and pad before another product was applied. Treatment two consisted of only deltamethrin (Polyzone), which was tested separately because of its unusual matrix formulation.

On May 30, 2013, we collected Day 1 samples from these treatments. First, as described above, a single wipe with isopropanol was done on both the painted wall and on the concrete pad. To make it easier to interpret the results, the wall area was covered with plastic so that only runoff from the pad was collected for analysis. This result can then be compared over time directly with the wipe of the pad. The wipe of the painted wall can be compared with the wipe of the pad. Runoff into 1L amber bottles from the pad was collected as described above. On June 18 another sample using both wipes and water will be done. Analysis of the Day 1 wipes and water samples are expected within the next week. This trial will be followed for at least 3 months. Additional trials will be set up on other parts of the wall and pad.

IV. Water collection and wipes around treated homes

We have started monitoring homes that are under treatment by a collaborating pest control company. These treatments will run through the summer and fall. This company is following a treatment protocol of visiting each home every 6 weeks. The homes were supplied by the university from a list of local homeowners. The goal of these trials was to see whether runoff of either pyrethroids or fipronil down the driveway could be eliminated while maintaining control of ants.

Method

On April 10, 2013, we collected pretreatment water samples and sample wipes from the driveways of each of 5 houses that would be treated by the company. These 5 houses were treated on April 17. The company strategy is to avoid any fipronil or pyrethroids near the driveway or front of the house. In backyards they treat bushes, plants, and eaves with bifenthrin or Essentria IC[3] (a mixture of natural plant oils) if they have pest insects that are being tended by ants. The assumption is that depriving ants of these food sources will help to prevent the property from being invaded by more ants. In the front of the house, bushes and plants were treated with natural pyrethrins, a product called ExciteR. This product was also used on eaves and as a broadcast around the front of the house. The house foundation and eaves along the sides and back of the houses were treated with bifenthrin. In backyard areas visible Argentine ant mounds were injected with bifenthrin. Aphid sprays on the bushes are used earlier in the season using imidacloprid (Merit).

The day after the treatments isopropanol wipes of the driveway near the garage door were collected, followed by a water sample collection from the driveway. The analysis of the samples will search for fipronil and bifenthrin. Future samples will be taken at these houses after additional treatments by the company. We will get a long-term picture of runoff and how effectively it can be minimized.

Results

Environmental Sciences is currently analyzing these samples, and we should have results within a couple of weeks.

Table 1. Results of surface wipes of wall and pad segments treated with Polyzone (deltamethrin).

Deltamethrin (DMT)	Concentration (ppb)	Peak Area	µg DMT/m^2 surface
Concrete wiped with water	66.8	7911.77	1.7
Concrete wiped with isopropanol (same surface)	156.1	18535.4	3.9
Wall wiped with water	5125.0	610074	128.1
Wall wiped with isopropanol (same surface)	12600.4	1.50E+06	315.0
Concrete wiped with isopropanol	251.4	29886.2	6.3
Wall wiped with isopropanol	16464.4	1.96E+06	411.6
Concrete + prewetted (isopropanol) wipe	195.6	23248.5	4.9
Wall + prewetted (isopropanol) wipe	5353.6	637295	133.8

Figure 1. Finished wall with placards showing different treatments. Metal gutters direct water runoff from each segment to bottle that is placed at base of pad.

Figure 2. Sample bottle collecting runoff from wall and pad.

Figure 3. Preliminary calibration of sprinklers using catch cups on concrete pad to measure uniformity of spray pattern.

Figure 4. Preparation for spraying one of wall segments. Treatment will go 2 ft up and 3 ft out from base of wall. Plywood separates adjacent segments for spraying.

Figure 5. Concentration of runoff from wall in parts per trillion.

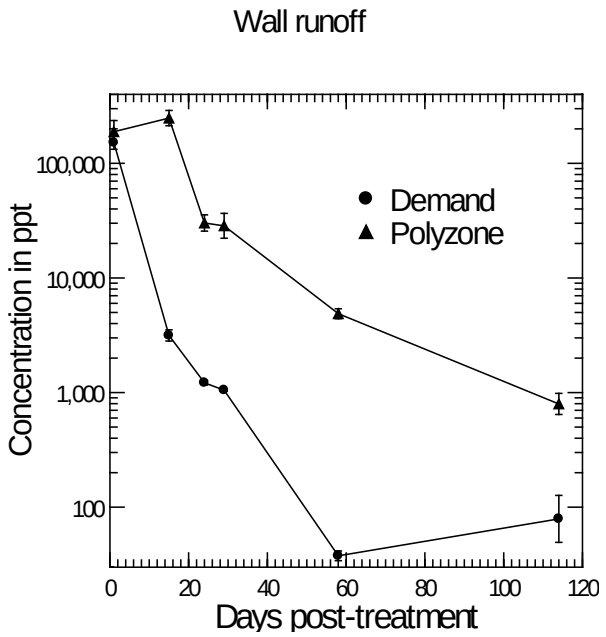

Figure 6. Cumulative mass runoff of AIs. Inches of natural precipitation are shown on the upper curve, but applies to both curves.

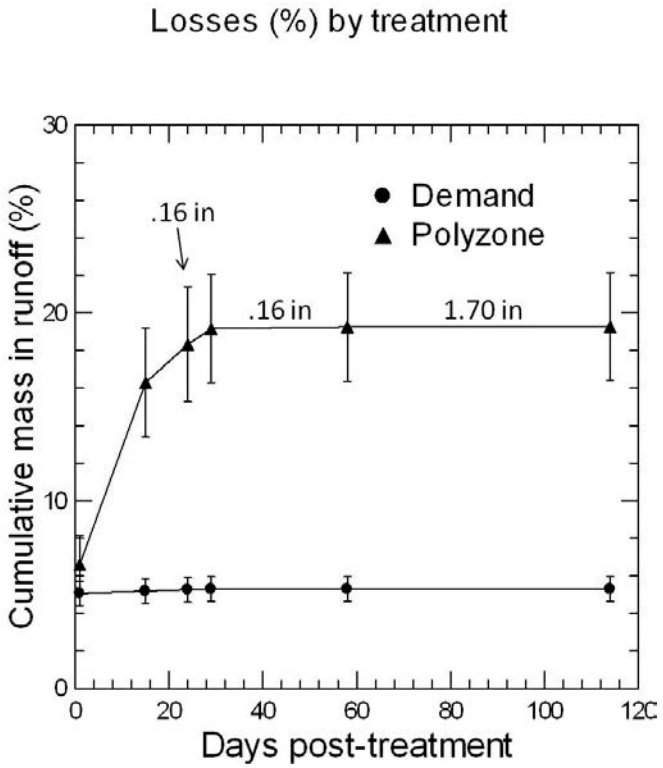

Figure 7. Cumulative mass runoff of AIs, including estimated runoff from natural rain events shown in Fig. 6.

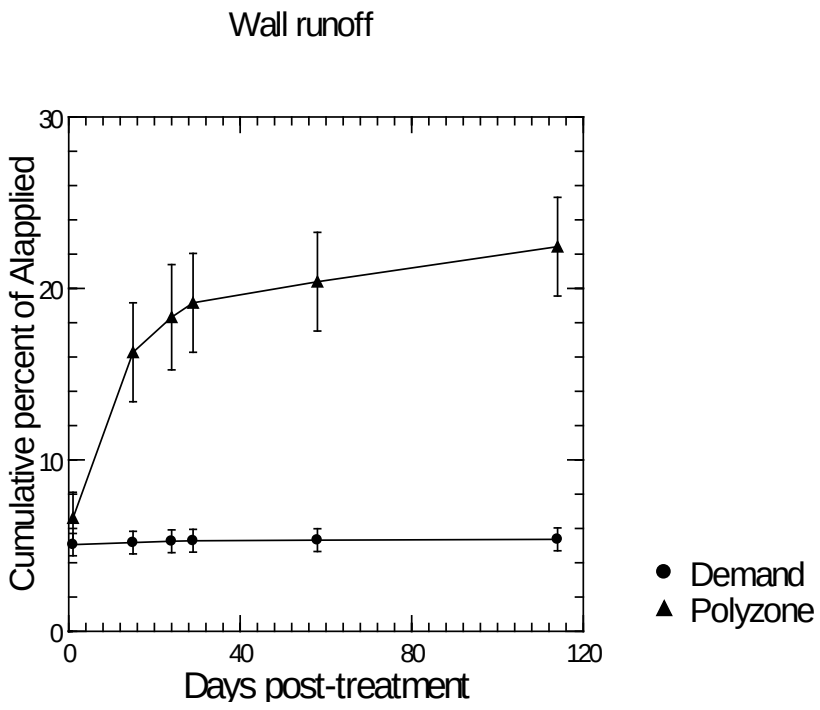

Figure 8. Wipe of latex-painted wall with a moistened cloth.

Figure 9. Wipe of concrete pad with a moistened cloth.