THE IMPORTANCE OF INSECTICIDE DISPENSERS IN BOLL WEEVIL TRAPS USED IN ACTIVE AND POST ERADICATION PROGRAMS

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Abstract

In October 1999, 0% to 100% mortalities of boll weevils, *Anthonomus grandis* Boheman, were determined 2, 4 and 8 hours after placing laboratory reared boll weevils in S&S and Precision Plastic (PP) traps containing yellow colored Plato Industries Insecticide Chips (PIICs) or Hercon Strips (HS) which contained 60 mg of dichlorvos (DDVP). Boll weevils escaped from both traps on "0" day. In August 2000, 100% mortality of marked, lab reared boll weevils was determined after 24 hours using the two dispensers described above, a blue colored PIIC and 60 and 90 mg PII Square dispensers of DDVP in S&S Traps. In both tests the dispensers were individually placed in traps on day "0" and remained there for 28 days. There was no significant difference in the 8% to 14% "escapes" from S&S traps with five different dispensers. The 90 mg dispenser had the lowest percentage "escapes". After 24 hours, 90 to 100 "wild" boll weevils per S&S trap were captured on all sample dates. Residues of DDVP from all dispensers determined on 0, 7, 14, 21 and 28 days showed equal rates of loss. Range of loss for the five dispensers was 43 to 61%, 51 to 58%, 64 to 78% and 64 to 83% after 7, 14, 21 and 28 days, respectively. It was determined that residues lost in each 24 hours were about 100 µg of DDVP per day.

Introduction

Traps baited with the aggregation pheromone (Grandlure) are used by eradication programs, producers and academia to capture boll weevils. The weevil capture data are generally used to make spray application decisions. Traps use dispensers containing an insecticide, as well as pheromone; these are placed in the capture "chambers" to attract and kill boll weevils. The insecticide should kill the boll weevils as soon as possible by vapors or by contact.

In the early 1970s, Cross and McKibben (unpublished) observed that about 10% of the boll weevils escaped from the traps being used at that time. If the orifice in the cone is large enough for a boll weevil to enter, it is large enough for the weevil to exit. There was a need to prevent this escape so that the capture count in each trap would be more accurate. In the early 1990s, DDVP was formulated in a polyvinyl chloride (PVC) strip by Hercon Environmental, Inc. and placed in the capture chamber to kill boll weevils. No published information has been found on the mortality of weevils in traps by DDVP or the "escape" of weevils from either the S&S or PP traps.

Residual toxicity of 5 different dispensers containing DDVP to the boll weevil was determined in S&S and PP traps in October 1999 and August 2000. In addition to the residual toxicity, the magnitude of "escape" from the traps was determined at 2, 4, 8 and 24 hours for 0, 7, 14, 21 and 28 days. Residues of DDVP were determined for the different types of dispensers on the same days so that quantities lost from one sample date to the next could be related to toxicity.

Material and Methods

The first test (October, 1999) was established with commercial dispensers that contained 60 mg of DDVP in a yellow PVC PIICs (18.6% a.i.) and 60 mg of DDVP in the HS (10% a.i.) (supplied by Plato Industries, Inc., Houston, TX.). The PIIC is a 0.6 cm cube and HS is 1.3 x 2.5 x 0.1 cm laminated "flat strip". The insecticide dispensers were left in the traps for 28 days.

S&S and PP traps were installed 1 meter apart in a row with 2 meters between rows in a grass field. The yellow PIIC dispenser and HS were used in S&S and PP traps for DDVP toxicity comparisons between the dispensers and the trap models. In each trap, the pheromone and insecticide dispensers and 10 boll weevils were placed inside the capture chamber, attached to the cone and mounted on the trap base cup and a stake. Observations for number of boll weevils were made on 0, 7, 14, 21 and 28 days. Dead and live weevils in each trap were counted at 2, 4 and 8 hours. On day "0" there was movement of weevils in and out of the capture chamber of all traps; therefore, on days 7, 14, 21 and 28, tissue paper plugs were placed in the entrance/exit of chambers of all traps to prevent the escape of weevils. Analysis of variance was determined for percentage mortalities of four treatments (S&S and PP traps with PIICs or Strips) with five replicates (1 trap/replicate). When analysis of variance on each day and hour showed significant differences, percentage mortalities were separated LSD at $P < 0.05$.

A second test (August 2000) was established with the same two types of commercial dispensers of DDVP used in the first test. Also in the test, evaluations were made using commercial, blue PVC PIICs of the same size and concentration as the yellow PIIC and 60 (5% a.i.) and 90 mg (7.5% a.i.) DDVP in 2.5 x 2.5 x 0.2 cm flat squares (the same sized squares are used for Grandlure formulation by Plato Industries, Inc., Houston, TX).

On 0, 7, 14, 21 and 28 days, five weevils were marked with one color (i.e. yellow, blue, red, green and white), designated for each dispenser and placed in a chamber. A toothpick was used to apply the paint to both elytra of each boll weevil. Five treatments were replicated 10 times, with each trap containing 5 weevils as a replicate. The painted weevils were placed in the capture chamber with the pheromone and insecticide dispensers. With attached capture chambers, the cones were taken to the field (southeast of Brownsville, TX) and placed on the bases of traps on 1.3 meters bamboo stakes. Traps were arranged in a randomized complete block design. They were spaced 17 meters apart in a row along a tree/brush line beside fields that had cotton, grain sorghum and sunflowers. Traps were examined after 24 hours for mortality of painted weevils, number of painted weevils that escaped, escaped painted weevils found in other traps and number of wild weevils. If live marked weevils were found after 24 hours, the trap would have been re-examined at intervals of 24 hours until all marked weevils were dead.

Analysis of variance was applied to percentage escape from all traps for all sample dates. For both tests boll weevils were obtained from the USDA-APHIS Laboratory, Mission, TX. In both tests 10 mg pheromone dispensers were replaced in the traps on 14 and 28 days after the "0 "day placements.

Residues of DDVP were quantified by internal standard technique from each of the five dispensers by ChemPro, Inc., (Baytown, TX). Dispensers were collected at 0, 7, 14, 21 and 28 days and held at 0°C until analysis. At the time of analysis, each dispenser was weighed within 0.1 mg and then cut into approximately 10 sections 1 to 2 mm wide. Sections were held in internal standard/chloroform extraction solution for 12 to 24 hours and solution weighed. Internal standard was alpha-terpinol. Percentage of DDVP in and on each dispenser was based on its weight. Weights of dispensers on 0, 7, 14, 21 and 28 days were 330, 308, 288, 303, and 287 mg for yellow PIIC, 358, 259, 323, 340 and 282 mg for blue PIIC, 552, 553, 554, 564 and 538 mg for HS, 1,204, 1,150, 1,145, 1,140, and 1,144 mg for 60 mg square, and 1,162, 1,128, 1,150, 1,116 and 1,112 mg for 90 mg square, respectively. Analysis was made by gas liquid chromatography

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(glc) with integrator. The flame ionization detector was maintained at 250°C at 1 x 10^{-9}; the flow rate of helium was 2.5cc/min through Restek Rtx column 530 mm long x 0.53 mm wide x 3.0 µm inside diameter. Column temperatures were programmed at 100°C for 4 minutes and then increased by 10 °C per minute to 230°C for 10 minutes, which was the same temperature of the injector.

The calibration standard was made with the mean of three concentrations of DDVP + internal standard and the DDVP + internal standard of each dispenser extract. The calibration standard was (DDVP peak area) (standard weight)/(standard peak area) (DDVP weight). With the average and weight and area for the standard and DDVP for each dispenser, the percentage DDVP on and in each dispenser was determined using the weight of dispenser. With the difference in micrograms DDVP lost from days 0 to 7, 7 to 14, 14 to 21 and 21 to 28, concentrations of DDVP vapors for each day were determined. These vapor concentrations were then related to percentage kill of boll weevil.

Results

On day"0" of the 1999 test, there was great activity and movement of boll weevils in and out of the traps after 2, 4 and 8 hours (Table 1). Boll weevils can exit any orifice that they can enter; therefore, insecticides may be the only way to prevent exiting of boll weevils from the trap capture chamber after they enter.

DDVP in S&S traps killed more boll weevils after 2 and 4 hours than in the PP traps on all days. There was greater percentage kill in S&S traps after 4 or 8 hours on 0, 7,14, 21 and 28 days than in PP traps. On day "0" there were significant differences in mortality in S&S and PP traps after 2 hours; on all other days, differences in mortalities were not significant after 2 hours.

In the year 2000 test, mortalities of marked weevils from all dispensers were 100% in 24 hours on 1, 8, 15, 22 and 29 days (data not shown in table). The percentage of weevils that escaped from the traps within 24 hours with each dispenser, varied from 0 to 30% during the five weeks (Table 2). There was no significant difference by analysis of variance in percentage "escape" on each of the five sample dates (F>0.22 df 4, 19). Four and 6 % were the mode; they comprised 32% of the weevils that escaped.

The boll weevils that escaped on day "0" were not captured in another trap (Table 2). On day "0", 91% to 100% boll weevils were killed in 8 hours (Table 1). On day "7" two escaped weevils were recaptured (Table 2). Mortalities were <10% after 2 hours, <15% after 4 hours and <49% after 8 hours (Table 1). On 14, 21 and 28 days five, four and five weevils were recaptured, respectively, (Table 2). On the same day mortalities were <13% after 2 and 4 hours; after 8 hours mortalities were <36%, <65% and <14%, respectively (Table 1). These mortalities were less than after 7 days. The data suggests that most of the weevils probably escaped within 4 hours of placement of trap in the field. During the four weeks none of the dispensers were superior to any of the other dispensers in recapturing the boll weevils.

Number of wild weevils captured in traps ranged from 0 to 486/trap. The mean for wild weevils, found after 24 hours, ranged from 83 to 100/trap on all five-sample days. One hundred forty-three (11%) marked weevils escaped on the five sample days (data not shown in table). Seventeen (11%) of the boll weevils, which escaped, were re-captured in other traps [Table 2). On examination at day 22, rain (0.5" in two hours) fell on half of the traps. No rain fell on the other half. Traps were on parallel sides of a grain sorghum/sunflower field. On the side of the field where the rain fell, the weevils, pheromone and kill dispensers in the 25 traps were completely soaked. Traps on the other half were completely dry. The escapes averaged 21% in the wet half and 12% in the dry half. Differences were not significant (P>0.134, df 1,24), but they illustrate how the effects of an environmental condition can affect weevil escape from a trap.

Micrograms of DDVP in and on the five dispensers are shown on 0, 7,14, 21, and 28 days (Table 3). After day 7, percentage loss from all the dispensers ranged from 43 to 61%. After day 14, percentage loss ranged from 51% to 58%; while after days 21 and 28, the percentage loss ranged from 64% to 78% and 73% to 83%, respectively. DDVP kills the boll weevil by contact with the surface of the dispenser and by vapors that accumulate inside the chamber. Vapors can exit the chamber of both traps via the gaps in the top of the "capture chambers" and the plastic or wire cone sections. The amount of weevils killed by contact or by vapors is not known, but both are important. Regardless, the test results show that it takes about 24 hours for complete kill of weevils in a chamber (Table 2).

The loss of DDVP at 7-day intervals was calculated from the concentrations as daily vapor loss. More than 100 µg were determined for each 24-hour period on all five-sample days and this data suggests that 100 µg of DDVP can kill 100% of the weevils during 24 hours of exposure.

Conclusion

DDVP from the dispensers killed all weevils in traps in 24 hours. Boll weevils escaped from both the S&S and PP trap; this is a study that will continue in 2001 and be reported at the next Beltwide meeting. Traps, pheromones and insecticide dispensers are needed in active programs to insure that if weevils are present in a field, spray applications are properly timed. They are needed in post-eradication programs to insure that the few boll weevils re-entering an area are detected and killed.

Acknowledgments

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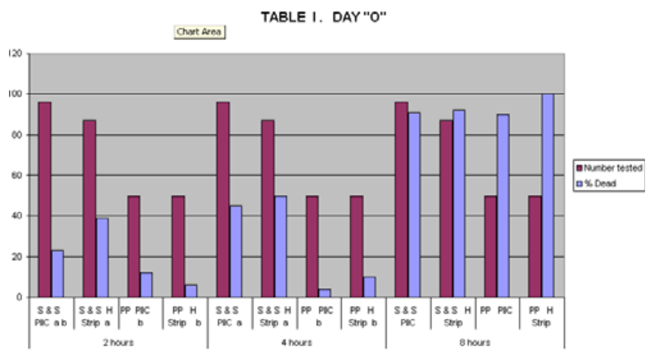


Table 1. Residual toxicity of boll weevil by DDVP in Plato chip or HS in S&S and Precision Plastic (PP) traps. Brownsville, TX. October, 1999[1]

[1] Means followed by the same letter for each day and hour are not significantly different from each other by LSD at P<0.05.

TABLE 3 Escaped (%)

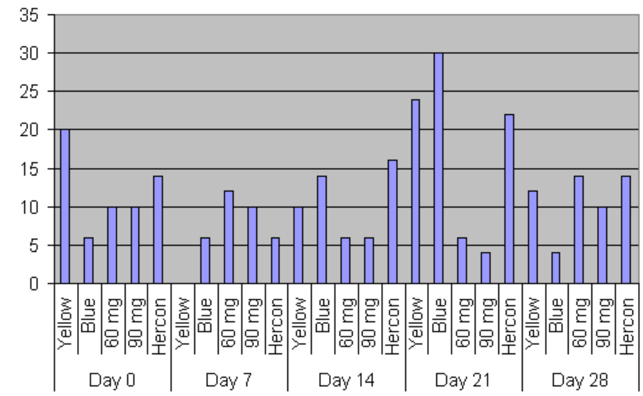
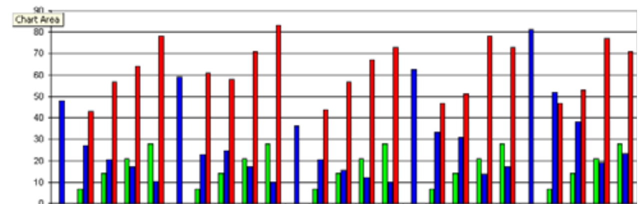


Table 2. Percentage escape of 50 weevils after 24 hours. Brownsville, TX. August, 2000.

TABLE 3. RESIDUES OF DDVP



	Yellow PBC				
DAY	0	7	14	21	28
µg	47.91	27.24	20.7	17.14	10.49
Loss (%)	0	43	57	64	78

	Blue PBC				
DAY	0	7	14	21	28
µg	59.07	23.01	24.9	17.01	9.856
Loss (%)	0	61	58	71	83

	Her. Strip				
DAY	0	7	14	21	28
µg	36.39	20.47	15.77	12.12	9.96
Loss (%)	0	44	57	67	73

	60 mg sq.				
DAY	0	7	14	21	28
µg	62.59	33.21	30.92	13.68	17.16
Loss (%)	0	47	51	78	73

	90 mg sq.				
DAY	0	7	14	21	28
µg	81.33	51.87	37.96	18.96	23.35
Loss (%)	0	47	53	77	71

Table 3. Residues of DDVP in and on dispensers held in S&S traps. Brownsville, TX. August 2000.