(4.14.04) Plastic Runoff

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF PREVENTION, PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM: Data Evaluation Record for Abamectin.

TO: Tom Harris
Registration Division (7508C)

FROM: Jim Carleton 4/14/04
Chemist, Environmental Risk Branch II
Environmental Fate and Effects Division (7507C)

THRU: Tom Bailey, Branch Chief
Environmental Risk Branch II
Environmental Fate and Effects Division (7507C)

General Conclusions

Attached to this memorandum is a data evaluation record (DER) for a plasticulture runoff study on abamectin (MRID 45906202). The non-guideline small plot, edge-of-field, raised-bed plasticulture runoff study is scientifically sound and provides limited information on surface runoff of abamectin-containing products applied to plastic-mulched strawberry fields on sandy soils. Because the study was conducted outside the major commercial strawberry growing region of Florida, study results must be interpreted cautiously with respect to drawing any conclusions or inferences from the study about the surface water contamination potential of strawberry production in Florida.

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DER

SHAUGHNESSY No.
COMMON NAME: avermectin
CHEMICAL NAME: 1,3-Dichloro-1-propene (E-Z)
FORMULATION: Agri-Mek® 0.15 EC (0.15 lb a.i./gallon formulation; EPA Reg. No. 65195-56-4)
DATA REQUIREMENT: Runoff of abamectin from Small Plots Under the Influence of Artificial Rainfall (Non-Guideline Study)

MRID#45906202
Wiepke, T., N.J. Snyder, B.R. Jacobsen, and W.M. Williams, 2003. A Small Scale Runoff (SSRO) Study Using Simulated Rainfall to Determine Abamectin Runoff Potential in Plastic Mulch Strawberry Production in Florida. Laboratory Study ID: 990034. Unpublished study performed and submitted by Syngenta, Greensboro, NC.

REVIEWED BY:	Jim Carleton, Chemist EFED/ERB II	Signature: Jim Carleton Date: 4/9/04
PEER REVIEWED BY:	Nelson Thurman, Senior Scientist EFED/ERB IV	Signature: Nelson Thurman Date: 4/8/04

CONCLUSIONS

The non-guideline small plot, edge-of-field, raised-bed plasticulture runoff study is scientifically sound and provides limited information on surface runoff of abamectin-containing products applied to plastic-mulched strawberry fields on sandy soils. Because the study was conducted outside the major commercial strawberry growing region of Florida, study results must be interpreted cautiously with respect to drawing any conclusions or inferences from the study about the surface water contamination potential of strawberry production in Florida.

BACKGROUND

In September, 2001 a meeting was held between Syngenta and EPA, in which options were discussed for field studies to help the Agency determine whether abamectin's use on plastic-mulched strawberries may result in runoff-driven aquatic concentrations of the chemical that exceed levels of concern. One option that was discussed is an edge-of-field runoff study conducted under controlled conditions with artificial rainfall. The purpose of such a study would be to help the Agency determine "the mass of avermectin transported to the edge of a treated field following a rain event after application and prior to entering a natural surface water feature" (Abel, 2001). The information gained from such a study was envisioned as being potentially usable to help calibrate a specific PRZM scenario.

METHODS AND MATERIALS

Site Description

The site selected for the study is in Seminole county, Florida, which according to the report has climatic conditions "representative of strawberry production in Florida". According to USDA crop profile information, 95% of the commercial strawberry acreage in Florida is located in Hillsborough and Manatee counties. Soils in Hillsborough county are described in the report as "almost exclusively fine sands", with 0 to 2 percent slope. Soils at the Seminole County test site are also fine sands (EauGallie and St. Johns series), on plots with an average slope of 0.73. Although, being sand, the soil at the site has high permeability (field-saturated hydraulic conductivity of the soil at the six inch depth, as measured in the troughs between raised beds, had an average value of 7.01 ± 1.69 inches/hr), the soil is classified in hydrologic soil group B/D because the water table is extremely high, being located at a depth of only approximately 18 inches below the land surface. Based upon tests conducted previously in a saturated test plot at the site, the authors calculated a saturated infiltration rate of 0.51 inches/hr at the site. In order to ensure the generation of runoff, high intensity (> 0.8 inches/hr), short duration rainfall events were therefore selected to simulate 1-in-10 year and 1-in-2 year return frequency storms.

The study area consisted of three treated plots and one control plot. Each plot was 20 feet wide by 300 feet long, and contained four raised plastic-mulched beds, with two rows of strawberries per bed, on 12-inch spacings. Raised beds within a plot were five feet from each other along the centerline, and separated from each other by exposed soil troughs. The beds ranged in height from 5.5 to 8 inches, and had an average plastic-covered width of 31.2 inches. Troughs ranged from 24 to 38 inches in width. Based upon field measurements, the average calculated exposed soil area was 46.6% of the total plot area.

Each plot contained diversion walls for directing runoff to a central collection point, where a flume with an autosampler was located. Each plot also included a rainfall simulator. During simulated and natural rainfall events, water samples were collected at the flume at accumulated flow intervals. Grab samples were also collected during simulated rainfall events as a backup, and to provide additional information on the rising and receding portions of the runoff hydrograph.

Site Preparation and Pesticide Application

The pesticide applied was Arig-Mek 0.15 EC, an emulsifiable concentrate containing 0.15 pounds of active ingredient (abamectin) per gallon of formulation. This material was applied to the raised, plastic-covered beds at a target rate of 0.01875 lb ai/Acre. Two applications at this rate took place to all three plots, with a seven day interval in between. The first application took place on April 24, 2002 and the second took place on May 1, 2002. On both occasions, a tractor-mounted boom sprayer was used to apply the pesticide to the top and sides of the raised beds. Sprayer output volume was calibrated at each application using water collected from each nozzle for 10 seconds.

Simulated Rainfall Application

Plots were subject to two simulated rainfall events of 0.8 to 0.9 inches/hr intensity. The first was of two hours duration (approximating a one-in-ten year event). The second was of 1.3 hours duration (approximating a one-year return frequency event) applied one, two, or three days after the first application for plots A, B, and C, respectively. The resulting runoff was sampled at the flume. Runoff resulting from a natural rainfall event, which occurred two days after the first application, was also collected. Runoff from another event that occurred six days after the first application was not collected, due to technical difficulties.

Site Instrumentation

Diversion walls constructed from two by eight foot plywood sheets were installed on each of the four plots to direct overland flow from the troughs to collection points (one per plot) for measurement and sampling. At each collection point a 0.75 foot H-flume constructed of fiberglass was installed. At each flume an ISCO 6712 or ISCO 6700 autosampler controller and data logger with a 730 bubbler module, was used to monitor flow and control sampling. Stage, rain, and flow data were collected on two-minute intervals. During runoff events, the autosamplers collected water samples at specified intervals. An on-site automated weather station was used to record meteorological data including rainfall, air temperature, wind speed and humidity. Rain gauges placed within each test plot were used to measure artificial rainfall.

Sampling

The autosampler controllers and data loggers provided continuous records (at two minute intervals) of water depth in the H-flumes. Autosamplers were programmed to collect 600 mL samples at set time intervals, so as to monitor rising and recession limbs of runoff hydrographs. Grab samples of runoff were also collected "as a backup" during the artificial rainfall events. All samples were collected in 1 L ISCO polypropylene autosampler bottles, then capped and placed in iced coolers for shipment to the laboratory, where they were stored frozen until analysis. Field spike samples were prepared in the field on May 4, and handled in the same way as the samples.

RESULTS

For the first runoff event, which occurred in response to simulated rainfall applied 24 hours after pesticide application, 38.3%, 37.2% and 34.0% of applied rainfall (1.77 to 1.83 inches, or 663.75 to 686.25 ft^3) left plots A, B, and C respectively as runoff through the H-flumes. For the second simulated rainfall event, which took place at 24, 50, and 72 hours after the second pesticide application for plots A, B, and C respectively, 34.4%, 28.9%, and 23.6% of applied rainfall (1.10 to 1.22 inches, or 412.5 to 457.5 ft^3) left the plots as runoff, respectively.

Concentrations of abamectin B1a ranged from 0.05 to 6.9 ppb during the first runoff event. During runoff from the monitored natural rainfall event, abamectin B1a concentrations ranged from 0.34 to 1.7 ppb. The study report authors estimated event mean concentrations of 0.69 to 1.74 ppb for the first runoff event, 0.56 to 0.58 for the natural runoff event, and 1.2 to 2.5 ppb for the second artificial runoff event, respectively. These correspond to estimated pesticide mass losses via surface runoff of 0.5 to 1.48% of applied for the first event, 0.07 to 0.1% for the natural runoff event, and 1.2 to 2.5% for the second artificial event.

COMMENTS

1. The study was not conducted in a major strawberry growing region of Florida (Seminole County is on the east coast of Florida, while Hillsborough County is on the west coast). The study does not provide sufficient information to allow a detailed comparison of the properties of the soils at the test site with the properties of soils in the strawberry growing region of the state. Therefore the applicability of the results to represent strawberry culture in Florida is questionable at this time.

2. SCS curve numbers estimated by the reviewer from the artificial and natural rainfall and runoff data ranged from 84 to 92, with a mean of 88. This value is the same as that listed in the National Engineering Handbook (NRCS, 2003) for contoured row crops on a hydrologic group "D" soil in "poor" condition.

3. Plastic mulch has been documented in the peer reviewed literature to significantly increase runoff volumes and loads of sediments and various pesticides in runoff (*e.g.* Rice *et al.*, 2001).

4. The first artificial rainfall event was initiated at 8:31 AM on April 25, 2002. Measurable runoff was not observed to commence at the flumes until approximately 9:00 AM. The intensity of the artificial rainfall was held constant at approximately 0.9 inches/hr, which means that about 0.45 inches of water had been applied to the plots before any runoff was observed. Infiltration of all of the water applied during the first 30 minutes would account for about a 25% water loss. The average observed water loss (rainfall minus runoff) for the three plots was 63.5%, which indicates that despite the high curve numbers, infiltration continued to occur at a substantial rate even after runoff began.

5. The study authors conducted dislodgeable residue studies on strawberry foliage and plastic mulch, but did not report the results. Application "deposition pattern monitoring"

samples were also collected but the results not reported, therefore the actual application rate is not known. Analyses were described as "still on-going", and the report indicated that results from these studies would be provided to the Agency at a later date in the form of amendments or addenda. Lack of verification of the application rate is a source of uncertainty in the study results.

6. In the absence of these results, or any mass balance analysis on the pesticide, and given that results from other studies indicate that abamectin is not an extremely immobile chemical (*i.e.* Koc of 2500 L/mg), the most likely explanation for the low recovery of abamectin in surface runoff is that the bulk of the pesticide passed into the subsurface (and probably into the water table aquifer) with the infiltrating water.

7. The study report includes estimates of hypothetical concentrations of abamectin in the Index Reservoir, based upon a spatial scaling up of the study results to the Index Reservoir watershed's size. Values ranged from 0.011 ppb to 0.827 ppb, depending on the assumptions employed, *i.e.* PCA, number of applications, aquatic half-life, percent drift. These calculations are not described in sufficient detail to allow independent confirmation of the estimates, and are therefore of limited value.

8. The results of this study highlight the need to consider other transport pathways to surface water besides direct surface runoff in areas with highly permeable soil. In areas with sandy soils and very high water tables such as the study area, surface and ground waters are not separate entities. Because the study authors' estimates only consider the direct surface runoff pathway, and not interflow or groundwater exchange, they may therefore underestimate potential concentrations in impacted water bodies.

9. Screening models currently employed by EFED do not explicitly take into account processes like interflow or groundwater exchange. Instead, surface runoff is modeled with a mixing cell process to entrain pesticide residues from the land surface. With hydrology reasonably well simulated by the SCS curve number method, the mixing cell model provides a reasonable surrogate for all potential advective or dispersive processes that may move pesticides from fields and into surface waters in different environments.

10. Based upon the results of this study, the reviewer suggests that the following procedure be employed to model surface water concentrations of abamectin resulting from the chemical's application to strawberries in Florida. The draft Florida strawberry scenario may be modified such that the current curve numbers of 94-97 are replaced with a value of 88, as derived from data in this study. PRZM and EXAMS may then be used to estimate concentrations in the standard fashion.

REFERENCES

Rice, P.J., McConnell, L.L., Heighton, L.P., Sadeghi, A.M., Isensee, A.R., Teasdale, J.R., Abdul-Baki, A.A., Harman-Fetcho, J.A., and C.J. Hapeman. 2001. Runoff loss of pesticide and soil: a comparison between vegetative mulch and plastic mulch in vegetable production systems. *Journal of Environmental Quality* 30:1808-1821.

NRCS, 2003. *National Engineering Handbook. Section 4: Hydrology*. National Soil Conservation Service (formerly Soil Conservation Service), USDA, Washington DC.