8-29-95

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

Chemical No.: 129006
DP Barcode: D213601
Case: 027375
Submission: S482680
Date Out of EFGWB:

To: Dennis Edwards
Project Manager #19
Registration Division

From: Henry Nelson, Ph.D., Head H Nelson
Surface Water Section
Environmental Fate and Groundwater Branch/EFED (7507C)

Thru: Henry Jacoby, Chief Henry Jacoby 8/29/95
Environmental Fate and Groundwater Branch
Environmental Fate and Effect Division (7507C)

Attached please find the EFGWB review of:

ID # (s): 129006

Common Name (s): Chlorethoxyfos (Chlorethoxyphos)

Type of Product (s): Insecticide

Product Name: Fortress 5G

Company Name: Du Pont

Purpose: Review of a runoff studies from corn seedbeds in Central and Western Iowa under simulated rainfall.

Action Code: 001

Total Review Time: 13 days

This review is of the data reported on field scale measurement of DPX-43898 (Fortress) insecticide runoff from corn seedbeds in Central and Western Iowa under simulated rainfall (MIRD # 435503-02 and 435503-03, respectively). The data was submitted by the Du Pont Company in compliance with FIFRA.

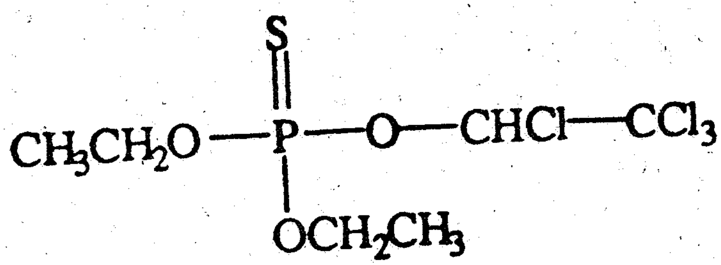
1. CHEMICAL:

Common Name: Chlorethoxyfos

Chemical Name: 0,0-diethyl 0-1,2,2,2-tetrachloroethylphosporothioate.

Type of Product: Insecticide

Chemical Structure:



Physical/Chemical Properties:

Physical State:	Granules
Molecular formula:	$C_6H_{11}O_3PSCl_4$
Molecular Weight:	336
Solubility (20 °C):	2.1 ppm in water
Vapor Pressure (20 °C):	1.7×10^{-7} mm Hg at 25 $_{o}$C
Soil Adsorption Coefficients:	
(K_d):	40-200
(K_{oc}):	6100

2. TEST MATERIAL:

Fortress 5G, Granular with 5% A.I. w/w

3. STUDY/ACTION TYPE:

Runoff measurements with simulated rainfall.

4. STUDY IDENTIFICATION:

Study #1. Coody, P. N. 1992. Field measurement of DPX-43898 (Fortress Insecticide) runoff from a corn seedbed in Central Iowa under simulated rainfall. MIRD # 435503-02.

Study #2. Coody, P. N. 1993. Field measurement of DPX-43898 (Fortress Insecticide) runoff from a corn seedbed in Western Iowa under simulated rainfall. MIRD # 435503-02.

5. REVIEWED BY:

Siroos Mostaghimi, Ph.D., Environmental Engineer
Surface Water Section
Environmental Fate and Groundwater Branch/EFED

6. APPROVED BY:

Henry Nelson, Ph.D., Head
Surface Water Section
Environmental Fate and Groundwater Branch/EFED

7. BACKGROUND:

Fortress is a corn root worm insecticide under development by Du Pont Company. Two duplicate field studies were conducted to quantitate the amount of Fortress runoff from treated corn seedbeds under simulated rainfall. The product was applied to the fields using three common application methods: 1) band incorporation; 2) T-band, and 3) in-furrow. Small plots were used to quantitate Fortress runoff. Rainfall was simulated using a system capable of delivering a uniform intensity over an entire test-plot.

8. CONCLUSIONS:

A. Studies in General:

The field runoff studies were conducted properly and the results are scientifically acceptable. However, the following major problem was observed in both studies:

1. The soils used in these studies are class B soils which have a moderately low potential for runoff. These soils may be representative of the soils in the areas where the study conducted; however, they do not represent worse case scenarios for the runoff studies.

Also the following minor problems were observed during the data review:

Study #1:

1. In several cases during the runoff water analysis, the volume of runoff water recovered after the initial filtration step was improperly determined whereby the collected volume was recorded after including the volume of water used to rinse the sample bottle. To correct this problem, a list of properly and improperly measured samples and corresponding volumes were compiled. The average volume of 254 ml from correctly measured samples were used in calculating total sediment and Fortress insecticide transport. The author believes that this problem did not have any effect on the overall study or study results. The alternative procedure used to correct this problem is acceptable.

2. The need to analyze runoff water and eroded sediment separately demanded that the entire runoff sample be filtered and used for the analysis. Since it was not possible to reanalyze any of these samples, it was necessary in some cases to utilize data where the analytical recovery was outside of the 70% < nominal < 120%. However; the analytical recoveries were generally acceptable and an experiment-wide average recovery of 86% for sediment samples was obtained.

3. During simulated rainfall on plot 2, a four-inch water supply pipe burst uphill from the plot approximately 15 minutes into the simulation event. An unmeasured amount of water was released, much of which flowed directly onto the test plot from an area treated with Fortress insecticide. The runoff data from this plot is not included in this report.

4. One setback in this study is that the statistical design had only two replications. This problem is especially evident for the results from plot 5 in which the data for only one lane was acceptable because of the problems encountered during the rainfall simulation for this plot. It would have been desirable to have three replications for each application method.

Study #2:

1. The statistical design had only two replications which limits data interpretation. This is particularly evident for the data obtained from plot 3. The results from the two lanes in this plot are significantly different. The author blames the difference on the sample contaminations in the laboratory. This may be true; however, the QA/QC procedures in the laboratory should have detected this problem before analyzing the

samples.

B. Study Period:

Study #1:

The study began with the initial tillage of the field on September 30, 1990 and was completed on October 9, 1990.

Study #2:

The study began with the initial tillage of the field on October 11, 1990 and was completed on October 24, 1990.

C. Soil characterization:

Study #1:

The physical and chemical characteristics of the Clarion loam soil (Hydrologic group B) collected from the runoff plots treated with chlorethoxyfos are presented in Table 1 (Table II of the report). A summary of the soils data for Clarion loam is presented in Table 2 (Table I of the report). Table 3 (Table III of the report) shows the bulk density and antecedent soil moisture obtained from samples collected immediately prior to each runoff event. The moisture content at 0.33 bar pressure averaged 0.28 g/g for soil collected from the upper 10 cm. The antecedent moisture before runoff ranged from 0.17 to 0.23 g/g in the upper 10 cm.

The average bulk density in the top soil layer ranged from 1.24 to 1.45 g/cm^3 within the four treated plots.

The upper 10 cm of the soil had an average 1.85 percent organic carbon. Since Fortress has a high affinity for organic matter (K_{oc}=6100), it is likely that a significant percent of the applied insecticide was bound to the soil.

Study #2:

The physical and chemical characteristics of the Galva silty clay loam soil (Hydrologic group B) collected from the runoff plots treated with chlorethoxyfos are presented in Table 1 (Table II of the report). A summary of the soils data for Clarion loam is presented in Table 2 (Table I of the report). Table 3 (Table III of the report) shows the bulk density and antecedent soil moisture obtained from samples collected immediately prior to each runoff event. The moisture content at 0.33 bar pressure averaged

0.33 g/g for soil collected from the upper 10 cm. The antecedent moisture before runoff ranged from 0.230 to 0.275 g/g in the upper 10 cm.

The average bulk density in the top soil layer ranged from 1.13 to 1.21 g/cm^3 within the four treated plots.

The upper 10 cm of the soil had an average 1.85 percent organic carbon. Since Fortress has a high affinity for organic matter (K_{oc}=6100), it is likely that a significant percent of the applied insecticide was bound to the soil.

D. Quantitation of Fortress insecticide applications:

Studies #1 and #2:

A summary of the insecticide applications to test plots are reported in Table 4 (Table V of the report). Overall, the insecticide delivery was 98.5% of the targeted application rate of 170 g formulated product (8.5 g A.I.) per 1000 row feet. This is the maximum application rate recommended on the label. These data represent the input amount to the lanes, which were used in determining the percent applied A.I. recovered in the runoff.

E. Fortress insecticide residues in soil prior to runoff:

Study #1:

The distribution of fortress insecticide within the application bands for each application method is presented in Figure 6 (Figure 7 of the report) and Table 5 (Table VI of the report). The T-band application placed most of the insecticide in the upper 2 cm of the soil, with more in the 1-2 cm layer than in the 0-1 cm layer. The band-incorporated application resulted in surface layer having significantly more insecticide than any other. The in-furrow application resulted in relatively low insecticide residues in the upper 2 cm, with much of the insecticide placed at a depth of 2-4 cm.

Study #2:

The distribution of fortress insecticide within the application bands for each application method is presented in Figure 6 (Figure 7 of the report) and Table 5 (Table VI of the report). The band-incorporated application placed most of the insecticide in the upper cm of the soil. The concentration profiles in the T-band and band-incorporated plots were similar, with concentration of active ingredient decreasing with depth. The in-furrow application resulted in relatively low insecticide residues in the upper cm of the soil with much of the insecticide placed at a depth of 2-4 cm.

F. Fortress insecticide residues in runoff water and sediment:

Study #1:

In this study, a simulated rainfall equivalent to approximately 2.4 inches in two hours (approximately 1.2 inches/hour for 90 minutes) was used to approximate a rainstorm with a 5-year return frequency. The runoff volume from each lane was quantitated in two minutes intervals (one-minute intervals for plot 5 because of the prediction of poor weather which resulted in plot 5 being tested without the benefit of a flow meter). A typical hydrograph showing cumulative and integrated flow from a runoff lane subjected to simulated rainfall is shown in Figure 7 (Figure 8 of the report). The cumulative flow provides the total gallons of runoff exiting the lane, while the integrated flow is that observed at each reported time interval. The hydrology of the runoff lanes is summarized in Table 6 (Table VIII of the report). Water yield, the amount of irrigation water recovered as runoff, ranged from 9 to 57 percent, with an average of 26 percent (on volume basis). The sediment eroded from the lanes ranged from 4.6 to 50.1 Kg. The total suspended solids (TTS) ranged from 0.54 to 1.55% (w/w).

The cumulative transport values for aqueous and sediment bound Fortress insecticide are summarized in Table 7 (Table X of the report). The percent of applied Fortress in runoff (bound + dissolved) ranged from 0.01 to 1.21 for the three treatments with an average of 0.29%. The portion of the insecticide residues in runoff bound to the sediments ranged from 70.3 to 100% with an average of 86.6% for all treatment methods. The dissolved portion of Fortress in runoff water ranged from 0 to 29.7 percent (not shown in this Table) with an average of 13.4 percent for all treatments. The in-furrow lanes yielded the lowest amount of total (dissolved plus bound) pesticide in runoff (average of 2443 ug). The T-band application produced slightly more Fortress insecticide in runoff (average of 8196 ug) than the in-furrow treatment, while the band-incorporated treatment had the highest yield of the three application methods tested (100087 ug).

Study #2:

In this study, a simulated rainfall equivalent to approximately 2.4 inches in two hours (approximately 1.2 inches/hour for 90 minutes) was used to approximate a rainstorm with a 5-year return frequency. The runoff volume from each lane was quantitated in two minutes intervals. A typical hydrograph showing cumulative and integrated flow from a runoff lane subjected to simulated rainfall is shown in Figure 7 (Figure 8 of the report). The cumulative flow provides the total gallons of runoff exiting the lane, while the integrated flow is that observed at each reported time interval.

The hydrology of the runoff lanes is summarized in Table 6 (Table VIII of the report). Water yield, the amount of irrigation water recovered as runoff, ranged from 13 to 56 percent, with an average of 29 percent (on volume basis). The sediment eroded from the lanes ranged from 5.7 to 55.6 Kg. The total suspended solids (TTS) ranged from 0.34 to 0.97% (w/w).

The cumulative transport values for aqueous and sediment bound Fortress insecticide are summarized in Table 7 (Table X of the report). The percent Fortress in runoff (bound + dissolved) ranged from 0.07% (this percentage is calculated by dividing the total amount of chlorethoxyfos in runoff to the amount of AI applied to runoff area) to 0.21% for the three treatment with an average of 0.12%. The portion of the insecticide residues in runoff bound to the sediments ranged from 70.4 to 91.6% with an average of 79.2 % for all treatment methods. The dissolved portion of Fortress in runoff water ranged from 8.4 to 26.1 (not shown in this Table) percent with an average of 20.8 percent for all treatments. The report blames the high chlorethoxyfos yield for the lane A in plot 3 on sample contamination in the laboratory. The results obtained from this plot have a significant effect on the ranking of the treatment methods in this study. These results indicate that in-furrow treatment produced the highest pesticide yield in the runoff (average 11488.5 ug). The band-incorporation treatment produced the second largest pesticide yield in the runoff (average 10262.5 ug). The T-band treatment produced the least amount of pesticide in the runoff (average 6607 ug). These results do not agree with the reported results for the same treatment in study #1. Also total losses in terms of % of applied are much less for this study than study #1. The author did not provide any explanation for these discrepancies. The in-furrow treatment producing the highest runoff is surprising since that treatment resulted in the lowest pesticide residue in the top 2 cm.

9. RECOMMENDATIONS:

Inform the registrant that the reported results in these studies are not acceptable for aquatic risk assessment. Please forward this review and the attached DER to EEB.

10. DISCUSSION:

Fortress insecticide (chlorethoxyfos) has K_d=40-200 and K_{oc}=6100 which indicate that this chemical has a strong affinity for soil organic matter. It is slightly soluble in water (2.1 ppm at 25 °C). The results indicate that an average of 0.29 and 0.12 percent of the total active ingredient applied to the soil were transported in runoff (dissolved + bound), in study #1 and #2, respectively. The percentage of pesticide transported bound to sediments were 79.2% and 86.6% for study #1 and #2, respectively. These results indicate that chlorethoxyfos (Fortress) is tightly bound to the soil during the runoff process.

The results in these studies indicate that mitigation practices that effect soil erosion can be effective in reducing Fortress transport to aquatic environments.

In study #1, the three treatment methods can be ranked with respect to pesticide residues in the top cm as follows: T-band ~band-incorporated > in-furrow. These data suggest that the runoff potential for Fortress insecticide is less with in-furrow application than the other two methods.

In study #2, the three treatment methods can be ranked with respect to pesticide residues in the top cm as follows: band-incorporated > T-band >> in-furrow. These data suggest that the runoff potential for Fortress insecticide is less with in-furrow application than the other two methods.

As it is evident, there is a discrepancy between the results in regards to which treatment method produced the least amount of total pesticide in runoff. In study #1, the in-furrow treatment produced the least amount of the pesticide in runoff while in study #2, the T-band treatment produced the least amount of pesticide in runoff. The band-incorporated and in-furrow treatments produced the highest amount of pesticide in the runoff in study #1 and #2, respectively. Based upon the lower amounts of residues in the top cm for the in-furrow treatment, the results of study #1 were expected whereas the results of study #2 were not. More conclusive data are needed to determine which treatment method will produce the least amount of pesticide in runoff from the field.

11. COMPLETION OF ONE-LINER:

None

12. CBI INDEX:

Not applicable

DATA EVALUATION RECORD (DER)

Fortress (Chlorethoxyfos)

ID # (s): 000352

Common Name (s): Fortress

Chemical Name (s): 0,0-diethyl 0-1,2,2,2-tetrachloroethylphosporothioate.

Data Requirement: Field runoff study for DPX-43898 (Fortress insecticide)

MRID No.: 435503-02

REVIEWED BY: Siroos Mostaghimi, Ph.D., Environmental Engineer Siroos Mostaghimi

ORGANIZATION: EFGWB/EFED/OPP

TELEPHONE: (703) 305-5208

APPROVED BY: Henry Nelson, Ph. D. H Nelson **Date:** 8/29/95

TITLE: Surface Water Section Head

ORGANIZATION: EFGWB/EFED/OPP

TELEPHONE: (703) 305-7356

SIGNATURE:

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8. CONCLUSIONS:

A. Studies in General:

The field runoff studies were conducted properly and the results are scientifically acceptable. However, the following major problem was observed in both studies:

1. The soils used in these studies are class B soils which have a moderately low potential for runoff. These soils may be representative of the soils in the areas where the study conducted; however, they do not represent

worse case scenarios for the runoff studies.

Also the following minor problems were observed during the data review:

Study #1:

1. In several cases during the runoff water analysis, the volume of runoff water recovered after the initial filtration step was improperly determined whereby the collected volume was recorded after including the volume of water used to rinse the sample bottle. To correct this problem, a list of properly and improperly measured samples and corresponding volumes were compiled. The average volume of 254 ml from correctly measured samples were used in calculating total sediment and Fortress insecticide transport. The author believes that this problem did not have any effect on the overall study or study results. The alternative procedure used to correct this problem is acceptable.

2. The need to analyze runoff water and eroded sediment separately demanded that the entire runoff sample be filtered and used for the analysis. Since it was not possible to reanalyze any of these samples, it was necessary in some cases to utilize data where the analytical recovery was outside of the 70% < nominal < 120%. However; the analytical recoveries were generally acceptable and an experiment-wide average recovery of 86% for sediment samples was obtained.

3. During simulated rainfall on plot 2, a four-inch water supply pipe burst uphill from the plot approximately 15 minutes into the simulation event. An unmeasured amount of water was released, much of which flowed directly onto the test plot from an area treated with Fortress insecticide. The runoff data from this plot is not included in this report.

4. One setback in this study is that the statistical design had only two replications. This problem is especially evident for the results from plot 5 in which the data for only one lane was acceptable because of the problems encountered during the rainfall simulation for this plot. It would have been desirable to have three replications for each application method.

Study #2:

1. The statistical design had only two replications which limits data interpretation. This is particularly evident for the data obtained from plot 3. The results from the two lanes in this plot are significantly different. The author blames the difference on the sample contaminations in the

laboratory. This may be true; however, the QA/QC procedures in the laboratory should have detected this problem before analyzing the samples.

B. Study Period:

Study #1:

The study began with the initial tillage of the field on September 30, 1990 and was completed on October 9, 1990.

Study #2:

The study began with the initial tillage of the field on October 11, 1990 and was completed on October 24, 1990.

MATERIALS AND METHODS:

1. Site description and preparation:

Study #1:

The study was conducted on a commercial farm in Grimes (Polk County), Iowa (Figure 1). The soil map is shown in Figure 2 which indicates that the soil series was a Clarion loam soil (Hydrologic group B). The study site was located on an area of nearly uniform with 5.0 ± 0.2 percent slope immediately uphill from a small farm pond (Figure 3). During the 1990 season, the test area was left uncropped as part of the Federal "Set Aside" program and the was not planted during the study period. The farm pond served as the water source for the rainfall simulators used in this study.

Prior to locating the individual test plots the entire test area was cultivated on the contour. Each plot received some secondary tillage immediately prior to treatment as is typical for corn production.

Study #2:

The study was conducted on a commercial farm in Hawarden (Sioux County), Iowa (Figure 1). The soil map is shown in Figure 2 which indicates that the soil series was a Galva silty clay loam soil (Hydrologic group B). The study site was located on an area of nearly uniform with 5.0 ± 0.5 percent slope within a large corn field. The 1990 corn crop was harvested shortly before this study was conducted. The corn stubble in the area under study was chopped and the soil was disked. Additional disking was performed using tillage equipment traveling across the slope, then up and down the slope to remove residual ridges and to finish with a final tillage operation oriented along the fall line of the field.

Water for rainfall simulation was obtained from an irrigation well located approximately 350 feet from the study area.

2. Experimental design:

Study #1:

A total of five test plots, each approximately 190 feet long by 43 feet wide (about 0.19 acre) were used in this study. The schematic of the study site is shown in Figure 3. Plot 1 was designated as untreated control and the treatments were applied to other plots as following:

Plot 2, T-band
Plot 3, T-band
Plot 4, in-furrow
Plot 5, band-incorporated

With the exception of plot 1, each plot was divided into two replicate runoff lanes, each the width of six planted corn row (15 feet) by approximately 170 feet and oriented with the long dimension extending down the fall line on a slope of 5.0 ± 0.2 percent (Figure 3). The two lanes within each treated plot received the Fortress insecticide using the application methods described previously. These lanes were identified as land A and B within plots 2 through 5 and land A in plot 1 as shown in Figure 4. The two runoff lanes within a given treated plot served as experimental replicates.

Immediately after the insecticide application, the runoff lanes were instrumented at the down-slope end to quantitate the surface runoff and a rainfall simulator was installed around the two runoff lanes. In order to maintain similar antecedent moisture conditions among the plots, each plot was evaluated before making a pesticide application to determine if it was necessary to pre-moisten the soil using simulated rainfall. The goal was to maintain the moisture content of the top 10 cm surface layer near a level which was just dry enough to permit cultivation and planting using typical agricultural practices.

The total flow, peak flow, sediment transport and Fortress insecticide transport (aqueous and sediment bound) were measured.

Study #2:

A total of four test plots, each approximately 170 feet long by 43 feet wide (0.19 acre) were used to quantitate chlorethoxyfos runoff after the product was applied using each of the three application methods typical to corn production. The schematic of the study is shown in Figure 3. Plot 1 was designated as untreated control. The treatments were assigned to treated plots as follows:

Plot 2, T-band
Plot 3, in-furrow
Plot 4, band-incorporated

With the exception of plot 1, each plot was divided into two replicate runoff lanes, each the width of six planted corn rows (15 feet) by approximately 170 feet and oriented down the fall line. The two lanes within each plot received the chlorethoxyfos using application methods described previously. The runoff lanes were identified as lane A (left) and lane B (right) within plots 2 through 4 and as lane A only, in plot 1 (See Figures 3 and 4).

Following the insecticide application, the run off lanes were instrumented to quantitate surface runoff and a rainfall simulator was installed around the two runoff lanes. A rainfall of fixed intensity/duration (1.8 inches in 90 minutes) was simulated to approximate a natural rainfall having a return frequency approximating one-in-five years. The rainfall duration for the control plot was increased to 189 minutes to ensure that sufficient control runoff water and sediment were obtained from the single runoff lane. The applications were made in separate days to allow each plot to be subjected to simulated rainfall as soon after treatment as possible.

To maintain similar antecedent soil moisture conditions among the plots, each plot was evaluated before making a pesticide application to determine if it was necessary to pre-moisten the soil using simulated rainfall. The goal was to maintain the moisture content of the top 10 cm layer near a level which was just dry enough to permit cultivation and planting using typical agricultural practices. Only plots 2 and 3 required supplemental simulated rainfall of 0.15 inch prior to treatment.

Because the forced runoff event closely followed each application, there was insufficient time for corn seeds that might be planted to germinate. Therefore, corn was not planted as part of this experiment.

Total flow, peak flow, sediment transport and pesticide transport (aqueous and bound) for each runoff lane were determined. The two runoff lanes within a given plot served as experimental replicates.

3. Soil characterization:

Studies #1 and #2:

Prior to insecticide applications, a soil core was extracted from each of the three randomly defined locations within each runoff lane. The soil samples were analyzed for: 1) Cation Exchange Capacity (CEC); 2) pH in 0.01 M $CaCl_2$; 3) organic carbon; 4) water holding capacity at 0.33 and 15 bar pressure and 5) texture. The results are shown in Table 1 (Table II of the respective reports).

4. Final tillage and insecticide applications:

Studies #1 and #2:

A chronology of the events including final tillage operations and insecticide applications is presented in Appendix 1.

The insecticide application was made to each runoff lane with the planter moving from the bottom of the plot upward to avoid uneven application which might result from the equipment moving over the sloped lanes in different directions. The application was made at the maximum labeled rate of 170 g Fortress per 1000 row feet (8.5 g A.I.).

5. Plot instrumentation:

Studies #1 and #2:

A. Runoff collection:

After the Fortress application, the lower end of the treated plot was excavated to allow a runoff quantitation apparatus to be installed. Runoff water, sediment and insecticide flowing from each lane were quantitated independently. For all plots other than the control plot, a preshaped, "V-shaped" collection platform was positioned below the retaining wall with the up-slope edge nailed to the retaining wall (Figure 5, Figure 6 of the report). The control plot was prepared to provide similar runoff quantitation system, but a preshaped collection platform was not used. In this case, the aluminum flashing was positioned on top of a plastic trap which was used to isolate the collection system from the excavated soil surface.

B. Flow measurement and sampling:

Flow through the two trapezoidal flumes was continuously monitored during the runoff event using calibrated Isco model 3230 bubbling flow meters attached to bubbling tubes positioned in each flume. The flow meter measures water depth as opposed to flow.

Runoff water was sampled from the flume using an Isco model 3700 pump sampler. For the treated plots, the pump was programmed to composite two consecutive samples to a single sample bottle. The pump was programmed to activate once every minute during the time when runoff was passing through the flume to provide a discrete sample of runoff water collected over two minutes of flow.

C. Rainfall simulation and runoff sampling:

In this study, a simulated rainfall equivalent to approximately 2.4 inches in two hours (approximately 1.2 inches/hour for 90 minutes) was used to approximate a rainstorm with a 5-year return frequency.

The simulated rainfall was initiated as soon as the plot was instrumented and all preliminary samples were collected. This was within approximately 24 hours of each Fortress insecticide application.

Runoff from the control plot was composited into three, 5.5 gallon, plastic carboys. Runoff samples from the treated plots were collected into glass bottles housed on wet ice in the base of the sampler unit.

D. Fortress insecticide residue analysis in soil:

Soil was analyzed by gas chromatography (GC) with Electron Capture Detection (ECD). The quantitation limit was 0.01 ppb.

E. Fortress insecticide residue analysis in runoff water:

1. Runoff/irrigation water:

The runoff water samples were filtered to remove entrained sediments for separate analysis. The filtered runoff water and irrigation water were analyzed by GC/ECD. The quantitation limit was 0.10 ug/L.

2. Eroded sediment:

The eroded sediment recovered from the initial filtering of the runoff water was extracted and analyzed using GC/ECD. The detection limit was 0.01 ug/g sediment.

RESULTS:

A. Soil characterization:

Study #1:

The physical and chemical characteristics of the Clarion loam soil (Hydrologic group B) collected from the runoff plots treated with chlorethoxyfos are presented in Table 1 (Table II of the report). A summary of the soils data for Clarion loam is presented in Table 2 (Table I of the report). Table 3 (Table III of the report) shows the bulk density and antecedent soil moisture obtained from samples collected immediately prior to each runoff event. The moisture content at 0.33 bar pressure averaged 0.28 g/g for soil collected from the upper 10 cm. The antecedent moisture before runoff ranged from 0.17 to 0.23 g/g in the upper 10 cm.

The average bulk density in the top soil layer ranged from 1.24 to 1.45 g/cm^3 within the four treated plots.

The upper 10 cm of the soil had an average 1.85 percent organic carbon. Since Fortress has a high affinity for organic matter (K_{oc}=6100), it is likely that a significant percent of the applied insecticide was bound to the soil.

Study #2:

The physical and chemical characteristics of the Galva silty clay loam soil (Hydrologic group B) collected from the runoff plots treated with chlorethoxyfos are presented in Table 1 (Table II of the report). A summary of the soils data for Galva silty clay loam is presented in Table 2 (Table I of the report). Table 3 (Table III of the report) shows the bulk density and antecedent soil moisture obtained from samples collected immediately prior to each runoff event. The moisture content at 0.33 bar pressure averaged 0.33 g/g for soil collected from the upper 10 cm. The antecedent moisture before runoff ranged from 0.230 to 0.275 g/g in the upper 10 cm.

The average bulk density in the top soil layer ranged from 1.13 to 1.21 g/cm^3 within the four treated plots.

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B. Quantitation of Fortress insecticide applications:

Studies #1 and #2:

A summary of the insecticide applications to test plots are reported in Table 4 (Table V of the report). Overall, the insecticide delivery was 98.5% of the targeted application rate of 170 g formulated product (8.5 g A.I.) per 1000 row feet. This is the maximum application rate recommended on the label. These data represent the input amount to the lanes, which were used in determining the percent applied A.I. recovered in the runoff.

C. Fortress insecticide residues in soil prior to runoff:

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The distribution of fortress insecticide within the application bands for each application method is presented in Figure 6 (Figure 7 of the report) and Table 5 (Table VI of the report). The T-band application placed most of the insecticide in the upper 2 cm of the soil, with more in the 1-2 cm layer than in the 0-1 cm layer. The band-incorporated application resulted in surface layer having significantly more insecticide than any other. The in-furrow application resulted in relatively low insecticide residues in the upper 2 cm, with much of the insecticide placed at a depth of 2-4 cm.

Study #2:

The distribution of fortress insecticide within the application bands for each application method is presented in Figure 6 (Figure 7 of the report) and Table 5 (Table VI of the report). The band-incorporated application placed most of the insecticide in the upper cm of the soil. The concentration profiles in the T-band and band-incorporated plots were similar, with concentration of active ingredient decreasing with depth. The in-furrow application resulted in relatively low insecticide residues in the upper cm of the soil with much of the insecticide placed at a depth of 2-4 cm.

D. Fortress insecticide residues in runoff water and sediment:

Study #1:

In this study, a simulated rainfall equivalent to approximately 2.4 inches in two hours (approximately 1.2 inches/hour for 90 minutes) was used to approximate a rainstorm with a 5-year return frequency. The runoff volume from each lane was quantitated in two minutes intervals (one-minute intervals for plot 5 because of the prediction of poor weather which resulted in plot 5 being tested without the benefit of a flow meter). A typical hydrograph showing cumulative and integrated flow from a runoff lane subjected to simulated rainfall is shown in Figure 7 (Figure 8 of the report). The cumulative flow provides the total gallons of runoff exiting the lane, while the integrated flow is that observed at each reported time interval. The hydrology of the runoff lanes is summarized in Table 6 (Table VIII of the report). Water yield, the amount of irrigation water recovered as runoff, ranged from 9 to 57 percent, with an average of 26 percent (on volume basis). The sediment eroded from the lanes ranged from 4.6 to 50.1 Kg. The total suspended solids (TTS) ranged from 0.54 to 1.55% (w/w).

The cumulative transport values for aqueous and sediment bound Fortress insecticide are summarized in Table 7 (Table X of the report). The percent of applied Fortress in runoff (bound + dissolved) ranged from 0.01 to 1.21 for the three treatments with an average of 0.29%. The portion of the insecticide residues in runoff bound to the sediments ranged from 70.3 to 100% with an average of 86.6% for all treatment methods. The dissolved portion of Fortress in runoff water ranged from 0 to 29.7 percent (not shown in this Table) with an average of 13.4 percent for all treatments. The in-furrow lanes yielded the lowest amount of total (dissolved plus bound) pesticide in runoff (average of 2443 ug). The T-band application produced slightly more Fortress insecticide (total) in runoff water (average of 8196 ug) than the in-furrow treatment, while the band-incorporated treatment had the highest yield of the three application methods tested (100087 ug).

Study #2:

In this study, a simulated rainfall equivalent to approximately 2.4 inches in two hours (approximately 1.2 inches/hour for 90 minutes) was used to approximate a rainstorm with a 5-year return frequency. The runoff volume from each lane was quantitated in two minutes intervals. A typical hydrograph showing cumulative and integrated flow from a runoff lane subjected to simulated rainfall is shown in Figure 7 (Figure 8 of the report). The cumulative flow provides the total gallons of runoff exiting the lane, while the integrated flow is that observed at each reported time interval. The hydrology of the runoff lanes is summarized in Table 6 (Table VIII of the report). Water yield, the amount of irrigation water recovered as runoff, ranged from 13 to 56 percent, with an average of 29 percent (on volume basis). The sediment eroded from the lanes ranged from 5.7 to 55.6 Kg. The total suspended solids (TTS) ranged from 0.34 to 0.97% (w/w).

The cumulative transport values for aqueous and sediment bound Fortress insecticide are summarized in Table 7 (Table X of the report). The percent Fortress in runoff (bound + dissolved) ranged from 0.07% (this percentage is calculated by dividing the total amount of chlorethoxyfos in runoff to the amount of AI applied to runoff area) to 0.21% for the three treatment with an average of 0.12%. The portion of the insecticide residues in runoff bound to the sediments ranged from 70.4 to 91.6% with an average of 79.2 % for all treatment methods. The dissolved portion of Fortress in runoff water ranged from 8.4 to 26.1 (not shown in this Table) percent with an average of 20.8 percent for all treatments. The report blames the high yield for the lane A in plot 3 on sample contamination in the laboratory. The results obtained from this plot have a significant effect on the ranking of the treatment methods in this study. These results indicate that in-furrow treatment produced the highest pesticide yield in the runoff (average 11488.5 ug). The band-incorporation treatment produced the second largest pesticide yield in the runoff (average 10262.5 ug). The T-band treatment produced the least amount of pesticide in the runoff (average 6607 ug). These results do not agree with the reported results for the same treatment in study #1. Also total losses in terms of % of applied are much less for this study than study #1. The author did not provide any explanation for these discrepancies. The in-furrow treatment producing the highest runoff is surprising since that treatment resulted in the lowest pesticide residue in the top 2 cm.

9. RECOMMENDATIONS:

Inform the registrant that the reported results in these studies are acceptable. Please forward this review and the attached DER to EEB.

10. DISCUSSION:

Fortress insecticide (chlorethoxyfos) has K_d=40-200 and K_{oc}=6100 which indicate that this chemical has a strong affinity for soil organic matter. It is slightly soluble in water (2.1 ppm at 25 °C). The results indicate that an average of 0.29 and 0.12 percent of the total active ingredient applied to the soil were transported in runoff (dissolved + bound), in study #1 and 2, respectively. The percentage of pesticide transported bound to sediments were 79.2% and 86.6% for study #1 and 2, respectively. These results indicate that chlorethoxyfos (Fortress) is tightly bound to the soil during the runoff process.

The results in these studies indicate that mitigation practices that effect soil erosion can be effective in reducing Fortress transport to aquatic environments.

In study #1, the three treatment methods can be ranked with respect to pesticide residues in the top cm as follows: T-band ~band-incorporated > in-furrow. These data suggest that the runoff potential for Fortress insecticide is less with in-furrow application than the other two methods.

In study #2, the three treatment methods can be ranked with respect to pesticide residues in the top cm as follows: band-incorporated > T-band > > in-furrow. These data suggest that the runoff potential for Fortress insecticide is less with in-furrow application than the other two methods.

As it is evident, there is a discrepancy between the results in regards to which treatment method produced the least amount of total pesticide in runoff. In study #1, the in-furrow treatment produced the least amount of the pesticide in runoff while in study #2, the T-band treatment produced the least amount of pesticide in runoff. The band-incorporated and in-furrow treatments produced the highest amount of pesticide in the runoff in study #1 and #2, respectively. Based upon the lower amounts of residues in the top cm for the in-furrow treatment, the results of study #1 were expected whereas the results of study #2 were not. More conclusive data are needed to determine which treatment method will produce the least amount of pesticide in runoff from the field.

Study #1

Field measurement of DPX-43898 (Fortress Insecticide) runoff from a corn seedbed in Central Iowa under simulated rainfall. MIRD # 435503-02.

Fortress

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Pages 23 through 54 are not included.

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