DP Barcode : 178192
PC Code No.: 121301
EFGWB Out : 1/11/93

TO: Phillip Hutton
Product Manager # 18
Reregistration Division (H7505C)

FROM: Elizabeth Behl, Head
Ground Water Technology Section
Environmental Fate & Ground/Water Branch/EFED (H7507C)

THRU: Henry Jacoby, Chief
Environmental Fate & Ground Water Branch/EFED (H7507C)

Attached, please find the EFGWB review of...

Reg./File # : 000100-00654

Common Name : Cyromazine

Product Name : Trigard® 75W, Larvadex®, Citation®

Company Name : Ciba-Geigy

Purpose : Prospective ground-water study final report and amended use.

Type Product : Insecticide

Action Code : 330 EFGWB #(s): 92-0891 Total Review Time = 22 days

EFGWB Guideline/MRID/Status Summary Table: The review in this package contains...

161-1			162-4			164-4			166-1	MRID422835; 424264	N
161-2			163-1			164-5			166-2		
161-3			163-2			165-1			166-3		
161-4			163-3			165-2			167-1		
162-1			164-1			165-3			167-2		
162-2			164-2			165-4			201-1		
162-3			164-3			165-5			202-1		

Y = Acceptable (Study satisfied the Guideline)/Concur P = Partial (Study partially satisfied the Guideline, but additional information is still needed)
S = Supplemental (Study provided useful information, but Guideline was not satisfied) N = Unacceptable (Study was rejected)/Non-Concur

2020998

DP BARCODE: D178192

CASE: 003141 — DATA PACKAGE RECORD — DATE: 01/11/93
SUBMISSION: S417488 — BEAN SHEET —

* * * CASE/SUBMISSION INFORMATION * * *

CASE TYPE: REGISTRATION ACTION: 330 TECH-NEW F/F USE AMND
CHEMICALS: 121301 Cyromazine 75.0000%

ID#: 000100-00654 TRIGARD 75W
COMPANY: 000100 CIBA-GEIGY CORP.
PRODUCT MANAGER: 18 PHILLIP HUTTON 703-305-7690 ROOM: CM2 213
PM TEAM REVIEWER: MICHAEL MENDELSOHN 703-305-5409 ROOM: CM2 203
RECEIVED DATE: 04/16/92 DUE OUT DATE: 10/23/92

* * * DATA PACKAGE INFORMATION * * *

DP BARCODE: 178192 EXPEDITE: N DATE SENT: 05/14/92 DATE RET.: / /
CHEMICAL: 121301 Cyromazine
DP TYPE: 001 Submission Related Data Package
ADMIN DUE DATE: 06/28/92 CSF: N LABEL: N

ASSIGNED TO	DATE IN	DATE OUT
DIV : EFED	05/19/92	/ /
BRAN: EFGB	05/20/92	01/11/93
SECT: GTS	05/21/92	01/06/93
REVR : JWOLF	11/01/92	01/06/93
CONTR:	/ /	/ /

* * * DATA REVIEW INSTRUCTIONS * * *

ATTENTION BETSY BEHL:

PLEASE REVIEW THE ATTACHED PROSPECTIVE GROUNDWATER STUDY AND GROUND WATER VULNERABILITY ASSESSMENT FOR CYROMAZINE AND DETERMINE THE ADEQUACY OF THE EFGWB DATABASE FOR TOMATO, PEPPER, LEAFY VEGETABLE, CUCURBIT, AND CARROT USES. THE ATTACHED STUDY IS SUPPOSED TO BE A WORST CASE ASSESSMENT THAT WILL BE APPLICABLE TO MANY USES. A CULTURAL PRACTICES SUBMISSION IS BEING SENT TO JANET ANDERSON'S BRANCH IN BEAD TO ASSIST IN VERIFYING THAT THIS IS INDEED A "WORST CASE" SITUATION. PLEASE COORDINATE WITH JANET REGARDING THIS PORTION OF THE REVIEW. THANKS FOR YOUR HELP. PLEASE CALL ME AT 305-5409 IF YOU HAVE QUESTIONS.

* * * ADDITIONAL DATA PACKAGES FOR THIS SUBMISSION * * *

DP BC	BRANCH/SECTION	DATE OUT	DUE BACK	INS	CSF	LABEL
178194	BAB	05/14/92	06/28/92	Y	N	N

REVIEW OF SMALL-SCALE PROSPECTIVE GROUND-WATER MONITORING STUDY FOR CYROMAZINE ON TOMATOES IN FLORIDA AND ITS APPLICATION TO OTHER CYROMAZINE USES.

1. CHEMICAL:
Chemical name: N-Cyclopropyl-1,3,5-Triazine-2,4,6-Triamine
Common name: Cyromazine
Trade name: Trigard® 75W, Larvadex®, Citation®
Structure: Not Applicable

Physical/Chemical Properties:

Chemical Formula	$C_6H_{10}N_6$
Molecular Weight	166.19
Water Solubility	1100 mg/L @20 °C (pH7.5)¶ 136000 mg/L§ 13600 mg/L¶
K_d	0.52 to 3.87
Vapor Pressure	3.36×10^{-9} torr
$\log K_{ow}$	--
Field dissipation half-lives	75 to 284 days¶§
Aerobic soil metabolism	150 days¶
Anaerobic soil metabolism	--

¶Wauchope et al., 1991
§One-Liner Database, USEPA, 1992a

2. TEST MATERIAL:
Not Applicable.

3. STUDY/ACTION TYPE:
330 TECH-NEW F/F USE AMND, Review of final report for small-scale prospective ground-water monitoring study.

4. STUDY IDENTIFICATION:

MRID #	TITLE
422835-01	Bussey, Carolyn B. "Summary of a Prospective Ground-Water Study with Cyromazine in Florida and Its Application to other Cyromazine Uses." Study Completed on 4/7/92. Received by EPA on 4/16/92.
422835-02	Bridges, Thomas. "Cultural Practices Used in the Production of Celery, Lettuce, Spinach, Tomatoes, Cucurbits, Peppers, Carrots, and Chrysanthemums." Study Completed on 4/7/92. Received by EPA on 4/16/92.
422835-03	Hatfield, M.W. and T.F. Masters. "Small-Scale Prospective Ground-Water Monitoring Study For Cyromazine (Trigard 75WP)." Two Volumes Study Completed on 3/4/92. Received by EPA on 4/16/92.

422835-04 Williams, W.M. and P.W. Holden. "An Assessment of Ground-Water Vulnerability Associated with Potential Market Areas for Trigard/Citation (Cyromazine) for Leafminer Control in Arizona, California, Florida, and Texas. Study Completed on 3/4/92. Received by EPA on 4/16/92.
(A total of six volumes including the submission document).

424264-01 Bridges, Thomas. " Supplemental Information on Rooting Depth, Soil Type, and Planting and Harvesting Dates for Tomatoes, Peppers, Cucurbits, Leafy Vegetables and Carrots in Areas where Trigard Insecticide is used to control leafminers." Completed 7/28/92.

Regulatory Classification

MRID	STUDY	DATA REQUIREMENT
422835-01(2 of 6)	N/A	Support Information
422835-02(3 of 6)	N/A	Support Information
422835-03(4 of 6)	Not Acceptable	166-1
(5 of 6)	166-1	
422835-04(6 of 6)		
424264-01	N/A	Support Information

Identifying No: ID# 000100-00654
Case: 003141
Submission: S417488
DP Barcode: 178192
Action Code: 330 TECH-NEW F/F USE AMND
Date Sent to EFED:
Date Received by EFED: 04/16/92
EFGWB #: 92-0891

5. Reviewed by:
James K. Wolf
Soil Scientist
OPP/EFED/EFGWB/GWTS

Signature: James K. Wolf
Date: 1/6/93

6. Approved by:
Elizabeth Behl
Section Head
OPP/EFED/EFGWB/GWTS

Signature: EBehl
Date: 1/6/93

7. CONCLUSIONS:

The registrant desires to use a small-scale prospective ground-water monitoring study conducted in Florida to address to two separate issues. The first issue was to review the Small-Scale Prospective Ground-Water Monitoring

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Study for Cyromazine to determine the impact of cyromazine use on tomatoes on ground-water quality in Florida. The second issue was to determine if this study could be used to support additional uses (tomatoes, peppers, leafy vegetables, cucurbit, and carrots) to control leafminers in Arizona, California, Florida, and Texas.

<u>Issue 1</u>

The prospective ground-water monitoring study with respect to the impact of cyromazine use on tomatoes on ground-water quality in Florida is incomplete, and therefore unacceptable at this time. The study can be made acceptable by addressing several (approximately 15) outstanding questions or issues (addressed in this review) and by analyzing (1) ground-water samples collected after sampling interval 29 for cyromazine and melamine residues, and (2) the 0 to 6 inch soil sampling increment for melamine residues.

Based upon the results of this study several general observations can be made concerning the utilization of cyromazine on tomatoes (and other similar crops) in Florida under typical environmental and management conditions (i.e., sandy soils with a shallow water table that are irrigated). First is that melamine, an important degradate of cyromazine will leach to ground-water. Secondly, melamine and cyromazine residues were quite persistent in the soil. The mobility of melamine within soil was also demonstrated. An additional observation is that melamine residues in soil may accumulate with repeated use.

The significance of the presence of melamine in ground water can not be determined, because no Health Advisories Levels (HAL) have been established for cyromazine and melamine and the limited number of detections.

Specific observations from the prospective study were as follows:

Cyromazine residues were not detected in any sample collected from any well. However, melamine residues (0.10 to 0.23 µg/L) were detected in four monitoring wells, three deep (8 to 13 feet) wells and 1 shallow (3 to 8 feet) well, 91 to 273 days after the last cyromazine application. The potential exists for further contamination of ground water by melamine, as cyromazine and melamine residues remain in the soil which can leach to ground water.

Melamine and to slightly lesser degree cyromazine are persistent in the soil. Melamine residues were present (23.2 to 33.2 ng/g) in the upper 0 to 6 inches 307 days after the last cyromazine application (365 after the first

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application). This would suggest the potential for melamine build-up with multiple uses of cyromazine. Cyromazine, with a theoretical concentration of 68.1 ng/g per application, was detectable up to 152 days (13.6 to 24.3 ng/g) after the last application, with sporadic detections at 176 days (13.3 ng/g) and 273 days (11.9 ng/g).

The study, although representing a "worst-case" condition, is only representative of agricultural activities for selected crops in Florida.

Issue II

The registrant desires to utilize the results of the prospective ground-water monitoring study and the accompanying hydrogeologic vulnerability assessment to support the registration of cyromazine on other crops (tomatoes, peppers, cucurbits, leafy vegetables, carrots, and chrysanthemums) that are economically impacted by leafminers in Arizona (AZ), California (CA), Florida (FL), and Texas (TX). The vulnerability assessment for AZ, CA, and TX indicated that depths to ground water and the need for irrigation to supplement rainfall vary throughout the proposed use areas. Therefore, the vulnerability of contamination from cyromazine use would depend upon the depth to ground-water, soil permeability and water retention relationships, soil organic carbon, the rain-irrigation frequency, intensity, and distribution, and when the pesticide is applied.

The agronomic practices and environmental conditions under which the prospective study was conducted in Florida on tomatoes, are similar to the conditions and practices used for the production of carrots, cucurbits, leafy vegetables, and peppers in Florida. Therefore, the study would be applicable (to access potential ground-water contamination) to these other uses (crops) only in Florida, and not for AZ, CA, and TX. The similarity of agronomic practices of the proposed other uses (crops) to tomatoes indicate that the potential for ground-water contamination from cyromazine use on these crops also exists in Florida. We conclude that cyromazine should not be used in areas exhibiting similar conditions to those found in Hillsborough County Florida. Conditions at the Hillsborough site include sandy to loamy sand soils with low organic matter contents and shallow water tables that are irrigated using a semi-closed system (sub/flood irrigation). Organic soils would also be vulnerable to ground-water contamination.

The assessment of ground-water vulnerability associated with potential market areas for cyromazine to leafminer control is acceptable for only AZ, CA, FL, and TX. Given the limits, restraints, and assumptions used by the registrant, the assessment of vulnerable areas is reasonable. The assessment states that Florida, with about 40 percent of the potential cyromazine use areas, has the highest vulnerability to ground-water contamination of the areas evaluated. Ground-water vulnerability to contamination in the other three states (AZ, CA, TX) evaluated, about 60 percent of the potential use areas, depends upon site specific characteristics, such as depth to ground water, soil properties, and rainfall plus irrigation. Therefore, a ground water label advisory should be developed for areas with permeable soils, low organic carbon (matter) contents, and shallow ground water, with a restriction from use under conditions such as those found at the Hillsborough site in Florida.

The semi-closed seepage irrigation system used in Florida may lead to surface water contamination from cyromazine use.

8. <u>RECOMMENDATIONS</u>:

(1) The registrant should provide the methods (state method used, provide a reference citation, and descriptions of any modifications used by the laboratory) of analysis used by the laboratory conducting any analysis, including soil characteristic analyses. The detection limit (limit of quantification) should be clearly stated for each analytical procedure used.

(2) Because this study indicated that cyromazine residues can leach in a worst-case environment, it is recommended that the registrant conduct one or more well-water monitoring surveys in a cyromazine use area, such as lettuce and celery rather than retrospective studies as previously stated in earlier reviews (memos C. Eiden, 7/26/89; Hutton, 1/4/90). The registrant could also consider conducting a prospective study in a use area in AZ, CA, or TX.

(3) According to Ciba-Geigy, during the July 15, 1992 meeting, ground-water samples were still being collected (after 9/10/91 to present). Because detectable levels of residue of melamine remained in (especially) the upper sampling increment and residues were detected in ground water as late as 8/07/91, the remaining samples <u>must</u> be analyzed. EFGWB suggests the following: first analyze the most recent two or three sets of samples. These data can be used to determine whether the study site can be decommissioned. For example, if no residues are detected, the study site can be decommissioned (with EFGWB concurrence). These data will help determine whether remaining melamine residues leached to ground water. EFGWB also requests that soil samples (0 to 6 inches, only) be

collected, following existing protocol, and be analyzed for melamine residues. EFGWB is not only interested in leaching potential, but also persistence of cyromazine residues. Ground-water samples remaining should then be analyzed sequentially, starting after sampling interval # 29.

(4) The study should not be terminated until the conditions in recommendation number 3 are satisfactorily met and EFGWB approval obtained. Ciba-Geigy requested permission to terminate the study in a August 21, 1992 letter to Mr. Phillip O. Hutton (PM 18) from Carolyn B. Bussey.

(5) A label advisory should be developed indicating that a potential exist for ground-water contamination. The label advisory should state:

> "Residues of cyromazine have been found in ground water as a result of agricultural use. Use of this product in areas where soils are permeable and water tables are shallow could result in contamination of ground water. The utilization of irrigation water in these areas will increase the likelihood of contamination".

Based upon the results of the additional analyses from the prospective ground-water monitoring study conducted in Florida, well monitoring studies in cyromazine use areas, and the results of the environmental and human risk assessment, use restrictions may be required under certain conditions.

(6) The potential for surface water contamination should be addressed by the registrant.

(7) Because no health advisory levels have been established and only a limited number of detections have occurred to date, a risk assessment can not be made. We recommend that the Toxicology Branch provide a risk assessment concerning both melamine and cyromazine residues.

The underlined/bold sentences in the Discussion Sections are comments that the registrant should address in response to this review or for future studies.

9. BACKGROUND:

Cyromazine is stable to hydrolysis and photolysis, and is also quite persistent since the aerobic soil metabolism half-life ($T_{½}$) is around 150 days. Field dissipation values are quite variable, ranging from 75 days to more than 250 days. Soil adsorption coefficients are generally quite low. Freundlich adsorption coefficients (K_{ads}) were less than 5

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for three mineral soils (sand, silty clay loam, and silt loam). The K_{ads} values are not equal to K_d, because the slope (1/n) in the adsorption isotherm was less than 1 (0.77 to 0.85). A primary degradate of cyromazine is melamine. At least two other degradates have also been identified. The registrant has indicated that certain plastics and fertilizers are potential sources of melamine in addition to cyromazine degradation. A comparison of environmental fate data of cyromazine is compared to environmental fate data of pesticides know to leach (Table 1).

Environmental fate data, submitted by the registrant, indicated that under certain conditions (sandy soils) cyromazine is both mobile and persistent, and will leach in soil.

Environmental fate data and monitoring data also indicate that the melamine degradate is both mobile and persistent, and will leach in soil. The persistence ($T_{½}$), adsorption (K_d), and dissipation rate of melamine has not been addressed. Aerobic metabolism studies indicated that melamine levels could be as much 33 percent of the parent. Melamine residues were detected at levels ranging from 0.10 to 0.21 µg/L in shallow ground water at the study site in Florida.

No detections of cyromazine residues were reported in the Pesticides in Ground Water Data Base (USEPA, 1992c). This maybe because very few ground-water samples have been analyzed for cyromazine (and melamine) residues in the United States and because it has limited use areas and crops. Cyromazine (and melamine) was not included in the suite of analyses conducted in the USEPA's National Survey of Pesticides in Drinking Water Wells (USEPA, 1990a).

Currently, the only registered uses of cyromazine (Trigard® 75WP) are on celery and head lettuce to control leafminers; on chrysanthemums (Citation® 75W) grown in greenhouses; and to control flies in chicken houses (Larvadex). Cyromazine is typically applied in multiple applications to foliage by aerial or ground equipment. Cyromazine is applied up to six times per year with application rates range between 0.125 and 0.25 lbs ai/acre (0.167 to 0.333 lb per acre) for a total of 0.75 lbs ai/acre (1 lb/acre). The registrant is proposing to register cyromazine for use on peppers, tomatoes, carrots, cucurbits, leaf lettuce, spinach, and mushrooms. EFGWB has previously recommended that Section 18 requests for cyromazine in Florida, New York, and Texas not be granted.

Health Advisory (HA) levels have not been established for cyromazine or cyromazine degradates.

Table 1. Physical and Chemical Characteristics[1] of CYROMAZINE Relative to EPA Leaching Criteria[2].

CHARACTERISTIC	LEACHING CRITERIA	CYROMAZINE PARAMETERS
Water Solubility	> 30 mg/L	1.35×10^5
Henry's Law Constant	$<10^{-2}$ atm-m³/mol	5.83×10^{-7} atm-m³/mol
Hydrolysis half-life	> 25 weeks	pH5 - stable pH7 - stable pH9 - stable
Photolysis half-life	> 1 week (water)	stable
Soil adsorption: K_d	< 5 (usually <1-2) [listed as K not K_d]	kads 1/n clay %OM 0.52 0.83 2.8 2.2 2.37 0.85 22.6 5.6 3.87 0.77 12.6 3.6 17.0 0.81 - 22.9
Soil adsorption: K_{oc}	<300-500	81, 208, 970, 1800
Aerobic soil metabolism half-life	> 2-3 weeks	150 days (21 wks)
Field dissipation half-life	> 2-3 weeks	83-284 days
Depth of leaching in field dissipation study	> 75-90 cm	46-91[3] cm

[1] USEPA One-liner Database.
[2] Cohen et al., 1984.

Indicates exceeds leaching criteria (environmental fate data are not complete).

[3] Depth of leaching may in some instances may have been deeper than sampling depth.

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10. <u>DISCUSSION</u>:

The registrant submitted a protocol for a small-scale prospective ground-water monitoring study which was reviewed and found to be deficient (USEPA, 1990b). The registrant also met with EFGWB several times and submitted responses to the EFGWB review (EFGWB #s 91-0222, 91-0569). The prospective study was initiated and completed prior to the registrant receiving EFGWB approval and acceptance of the protocol.

The purpose of this review is to review the Small-Scale Prospective Ground-Water Monitoring Study for Cyromazine use on tomatoes in Florida; and to determine the adequacy of the information in regard to potential ground-water contamination from cyromazine for additional uses (tomatoes, peppers, leafy vegetables, cucurbit, and carrots).

Alternatives methods of leafminer control were discussed; however, the leafminer is able to rapidly develop resistance to many of the pesticide alternatives.

Soil conditions most favorable to vegetable production are often sandy, sandy loam, loamy sand (light soils) that require frequent irrigation and organic (muck) soils. These edaphic conditions increase the likelihood of cyromazine residues leaching to ground water.

A: Discussion Ground-Water Monitoring Study, MRID # 422835-03

<u>In the future, please include page numbers with the Table of Contents (i.e., Vol. 5 of 6 page 129A, contains the appendices designation, but no page numbers), it makes locating information easier.</u>

The EFGWB requested a small-scale prospective ground-water monitoring study on September 7, 1988 to obtain information to support the registration of cyromazine (Trigard 75 WP) for use on tomatoes. The registrant submitted a protocol for conducting the study on 2-acres of a 10-acre tomato field site in Hillsborough County, Florida [approximately 15 miles southwest of Tampa] (USEPA, 1990); however, the protocol was never accepted by EFGWB. The tomato site in Florida was selected to represent the most sensitive environment for assessing the potential for cyromazine to reach ground.

The study objective was to determine the fate and movement of cyromazine and its degradate melamine by measuring cyromazine and melamine levels in soil, soil-pore water, and ground water over depth and time. A bromide (NaBr) tracer was also applied twice immediately following the first and last (6th) cyromazine applications for comparison of movement of the tracer in comparison to the pesticide residues.

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The registrant indicated that the study was generally conducted using GLP practices. Several exceptions were noted on pages 3 and 4. These exceptions should not adversely influence the findings of this study. The registrant also indicated that the study was conducted using appropriate QA/QC practices.

Test Site

The 2-acre study site was located at the southern end of a 10-acre tomato field. The study area was roughly triangular in shaped. Slope gradient was less than 1 percent to the west. A shallow ditch was located north and northeast of the 10-acre field. Approximately, 1.3-acres of the 2-acre study site were prepared as tomato beds. The plot was then divided into three approximately equal-sized subplots (A,B,C). A control area was also established east of the treatment area which did not receive any cyromazine or bromide tracer applications.

Soils: The soil series at the site was identified as the Myakka fine sand (Sandy, siliceous, hyperthermic Aeric Haplaquods), which consists of nearly level, sandy soil that was formed from marine sediments. The water table, under natural conditions, typically ranges from 10 inches to 40 inches below the soil surface, depending upon the amount of seasonal precipitation. The soils at the site were characterized from eight soil borings located within the 10-acre field. Soil samples were collected in 6-inch increments from the surface to the water table using a hand auger. These samples were analyzed for percent sand, silt, and clay, organic matter, pH, disturbed bulk density, field capacity, wilting point and available water content and are summarized in Table 2. The registrant presented these data in Table III (pages 45 and 46), and copies (poor quality) of the lab results are reported in Appendix B, pages 255 to 288. **The registrant should provide the methods (state method used, provide a reference citation, and descriptions of any modifications used by the laboratory) of analysis used by the laboratory conducting the soil analyses.**

The soils show considerable spatial variation within each sampling increment (depth) as can be noted in Table 2 (by the range of values). However, the soils at the study site generally exhibit the chemical and physical properties considered to be vulnerable by the EFGWB. The soil texture ranged from sand to

Table 2. Summary Florida Study Site Soil Characterization Data.

Depth (inches)	%Sand	%Silt	%Clay	%Organic Matter	pH	Bulk Density (g/cm^3)	Field Capacity[1]	Wilting Point[2]	Available Water[3]
0-6	84-92	4-12	4-6	1.8-3.7	6.1-6.7	1.25-1.42	5.45-10.51	4.38-7.74	0.24-3.12
6-12	88-94	2-8	4	0.7-3.0	5.7-7.1	1.33-1.53	3.01-7.02	2.52-6.07	0.06-1.45
12-18	90-92	4-8	4-6	0.3-1.1	5.6-7.4	1.37-1.55	1.85-5.88	1.19-4.42	0.07-2.22
18-24	90-92	4-6	2-6	0.1-0.9	5.3-7.1	1.42-1.56	1.63-4.11	1.01-1.64	0.12-2.47
24-30	88-92	4-6	4-6	0.3-0.7	5.1-7.1	1.29-1.51	1.53-5.11	0.32-2.75	0.63-3.39
30-36	84-92	4-8	4-10	0.1-0.8	5.0-6.4	1.29-1.51	1.39-6.40	0.55-4.19	0.84-3.58
36-42	80-90	4-12	4-12	0.1-0.9	5.0-6.3	1.19-1.48	1.88-9.40	0.81-5.21	0.52-5.00
42-48	78-90	4-10	4-12	0.1-1.0	5.1-6.3	1.23-1.44	2.30-7.84	1.17-4.31	1.13-3.63

1 Percent soil water at 1/3 bars.
2 Percent soil water at 15 bars.
3 Percent available water, where %available water = Field capacity - wilting point.

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loamy sand. Sand and clay size fractions ranged from 72 to 94 percent and 2 to 12 percent, respectively. Organic matter decreased with depth range from a high of 3.7 percent in the 0 to 6 inch increment to 0.1 to 1.0 at the 42 to 48 inch increment.

Agricultural Practices: The tomatoes were grown using methods typical to the region. The tomato plants were planted in 3-foot wide bedded-up rows covered with plastic. The raised beds were approximately 8-inches high and occur in pairs separated by a 1.5-foot row. Each pair of beds was separated by a 6-foot wide access road for harvesting and spraying activities. Soil surface was not covered by plastic between the paired beds and rows between beds.

The registrant provided a list identifying previously used pesticides. No information describing when or how much of each pesticide was reported. **The registrant should provide information describing at a minimum, how many years does the previously used chemical list cover. Also, information detailing the history of previously used chemicals should be reported on an annual basis.**

Irrigation, Precipation, and Evapotranspiration: Irrigation was conducted by using a semi-closed seepage system; a method appearing somewhere between sub-irrigation and furrow irrigation, as water is supplied to ditches (every other access row) which results in raising the ground water level. Water was discharged, at a rate of approximately 50 mm/day (Table IX, pages 62 to 70), from emitters (eastern side of plot) at the head of furrows. The water flowed within alternating open furrows in a westerly direction. The source of the water was a 900 foot well, located about 300 feet southeast of the study site. **The registrant should provide analytical information to describe the quality of the irrigation water. This should include pH, EC, cations and anions, total suspended solids, bromide, and cyromazine and melamine residues.** The irrigation efficiency reported by the Eastern Tampa Bay Water Use Caution Area ranged between 50 and 80 percent for the Myakka soil series (page 11, MRID # 4228835-02, Vol. 3 of 6). **Because of the irrigation method used was somewhat flood/sub-irrigation controlled, was the study plot uniformly irrigated?** The irrigation method combined with the high water table may limit or result in non-typical leaching patterns.

The irrigation system used consisted of a network of irrigation and drainage ditches which would suggest that cyromazine and melamine residues could be removed from the site through surface water pathways. **It is recommended that the Surface Water Section of EFGWB evaluate the impacts of cyromazine use on surface waters. Were any surface water samples collected down stream from the study site?**

Precipitation was measured on-site with a tipping bucket rain gauge and data logger. On-site measurements were not continuous, due to an instrument malfunction. Data were also obtained from a nearby weather station in Ruskin, Florida which was 2-3 miles from the test site (Table IX, pages 62 to 70). Due to the nearness of the study site, the Ruskin weather data would appear to be an acceptable source for precipitation data. The malfunction of the on-site rain gauges supports EFGWB's recommendation to have at least one back-up rain gauge at each study site. **The EFGWB recommends, for future studies, that at least one backup rain gauge be placed at study sites to ensure the collection of this data.**

The total amount of water from precipitation and irrigation (Table IX) was 156 inches (3961 mm). Cumulative precipitation plus irrigation was about 331 percent of the 10 year normal cumulative precipitation for the period (Table X, page 71). The registrants Figure 12 (page 121) indicated that the water table level did not change much during period of daily (during this period there were 5 days without irrigation, with three of the five days receiving rain) irrigation (09/11/90 to 11/05/90). **Page 33 indicates that when irrigation ceased in early November (1990) the depth to ground water declined in subsequent months. Is this statement correct? It would appear that the depth to ground water should increase. Please clarify.**

Annual evapotranspiration (ET) of the study area was assumed to be 54 inches; the sum of the mean monthly (1952-1976) potential ET (ETp) for Tampa, Florida. The registrant then subtracted the ETp value from the sum of precipitation plus irrigation (155.94 in - 54.08 in = 101.86 in) to estimate how much water moved through the site. Based upon this assumption, approximately 2.9 (156/54) times more water was added to the site then was estimated to be lost by ET. The registrant is probably safe in making this assumption, because the water application far exceeds ETp. It should be noted that although the net movement of water would appear to downward (leaching), as more water is applied than is lost by evapotranspiration, the high water table conditions may result in the upward movement of water under certain conditions. **Note: Tensiometers could be added to the site instrumentation, thus allowing for a determination of the direction of water movement.**

Daily ETp for the study period should be supplied for Tampa weather data and Ruskin (if measured).

Cyromazine and Tracer Application: Cyromazine (Trigard 75WP) was applied by pre-calibrated sprayer in six application (0.125 lb-ai/acre/application; 0.166 lb/acre/ application) over an eight week period beginning September 12, 1990 to the last application on November 7, 1990, for a total of 0.75 lb-ai/acre or 1.0 lb/acre of Trigard 75WP. Tank mix samples were taken before and after applications to confirm the concentration and to determine the uniformity of the tank mixes (Table VII, page 60). The measured concentrations averaged approximately 82%±3.6% of the theoretical value of cyromazine application.

A sodium bromide (NaBr) tracer was applied at approximately 40 lb/acre, ≈ 23 ug/g), following the first and last (6th) cyromazine applications. Analysis indicated that mixing of the tanks was uniform and that approximately 134% and 113% of the theoretical bromide concentrations were applied for the first and second applications, respectively.

The use of NaBr as a conservative tracer could have been an unfortunate selection for the registrant. There are at least two reasons for this. First and foremost was the detection of background levels of bromide. Bromide was detected in both the shallow (0.25 to 0.91 mg/L) and the deep (0.34 to 0.49 mg/L) monitoring wells prior to the first tracer application and in the "upgradient off-site wells". Bromide was also detected in the pre-application soil samples (1.13 to 6.14 μg/g). The second is the use of a sodium salt (NaBr). The application of sodium salts will also increase the exchangeable sodium levels. Soils with high levels of adsorbed Na^{1+} may develop a surface crust and swell or disperse, reducing soil infiltration and hydraulic conductivity.

The ground-water monitoring data indicated the presence of distinct bromide peaks (or breakthrough) at several of the wells following the two NaBr applications. Bromide peaks were also noted following the two applications (most notable after the second) in the three soil depth increments sampled. This would suggest that the bromide detected in some wells was from the tracer, as the levels were much greater than background levels. Bromide concentrations in the soil samples also seemed to demonstrate the downward movement of Br^{1-} through the soil profile.

In future studies, the registrant should analyze the ground water and irrigation water for the presence of pesticide residues of interest (i.e., cyromazine, melamine, and any known residues which may interfere with the measurement of cyromazine and melamine), and anions with the potential to be used as a tracer (i.e., Br^{1-}, Cl^{1-}). The negative effects of the sodium ion on soil structure and soil hydraulic properties should also be considered, but does not appear to have been a problem at this study site.

Sample Collection For Residue Analysis: Ground-water and soil samples were collected the day before application (-1 day), several hours after application (0 day), and during the weeks when no applications were made (+6 days) for the first five applications. Samples were also collected the day before the last application (-1 day), and following the final application

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(6) samples were collected on the day of (0), and 1, 3, 7, 14, and 30-days after the application, and then monthly.

Ground-water samples were collected using a teflon bailer. Wells were purged of at least three volumes or more of water, while the temperature, pH. and electrical conductivity were measured (and reported Table V, pages 51 to 55). Two one-liter samples were collected from each well, stored on ice, and then shipped for analysis.

Soil samples were collected during each sampling round from five random locations within each of the three subplots (designated A,B,C) in the treatment area. Samples were also collected from two random locations with the control area. Soil sample locations were pre-selected using a random number generation program (X,Y coordinates). The "X" coordinate for the subplots was established by numbering each side of the tomato beds, and the "Y" coordinate was the distance in feet from the border of the subplot. Sampling was also limited to the area nearest to the sides of the beds where the plastics sheets ended, as the registrant thought this area would be the most likely location for cyromazine residues to reach the ground surface. **It should be noted that soil sampling scheme was not random. The samples collected within each subplot were random, the subplots were not, because the subplots are setup parallel with the direction of flow of the irrigation water. The plot should have been divided into subplots running east-west rather than north-south.** It is doubtful that this adversely influenced the results of the study, but this should be avoided for future studies.

Soils samples were collected in 6-inch increments from the soil surface to the water table using stainless steel hand augers. The soil samples were collected near the tomato bed sides which were at a higher elevation than the tops of the well casings; thus, resulting in the depth to the water table observed in the soil borings appear deeper than what was measured in the ground-water monitoring wells. Due to fluctuations in the water table depth, soil sampling depths ranged from 12 to 30 inches. **Although it is stated (page 26) that the depth of sampling increased to 24 to 30 inches after cessation of irrigation, no analytical data were provided by the registrant for soil samples below 18 inches. The analytical results for these data should be provided by the registrant.**

Calculations: The registrant described the method of calibrating the sprayer and the application of the cyromazine test material (Trigard 75WP). The EFGWB will require for future studies that some sort of measurement verification procedure (i.e., spray cards or absorbent paper) be used which will allow the registrant to confirm the application rate and amount. This is necessary and evident in the data submitted by the registrant. Table XX (page 92) shows that immediately following and prior to cyromazine applications the registrant was often unable to detect cyromazine residues with a detection limit of 10 ng/g and theoretical application rate of about 68 ng/g.

Piezometers and Monitoring Wells: Site instrumentation included piezometers, and ground-water monitoring wells. Four of the eight soil characterization borings were completed as piezometers, and the relative elevations and water levels were determined. Water levels ranged between 3 and 4 feet below the land surface prior to the installation of the monitoring wells (Appendix 1D, Table 2.1, page 227). The direction of ground-water flow on August 18, 1990 (prior to any irrigation) was WNW (Figure 6, page 115). Ground-water levels rose to within 12 to 18 inches of the ground surface during irrigation. The registrants Figures 2, 4, 6, and 8 show the location of the four piezometers, and therefore four of the soil characteristic boring locations. **The location of the other four soil characterization borings should be shown on at least one of the figures.** Suction lysimeters were not used due to the shallow water table conditions at the study site.

Five ground-water monitoring well clusters, with two wells per cluster (shallow: screened 3 to 8 ft; deep: screen 8 to 13 ft below the land surface) were installed. It should be noted that although the shallow monitoring wells were installed according to applicable state requirements and EFGWB guidelines, the screen interval was not located where samples could be collected at (or near) the water table surface [Top of the screen had to be at least 3' below the land surface.]. Two well clusters were placed downgradient of the test plot, one cluster was placed roughly the center of the plot, and one cluster was placed upgradient of the study plot. The final cluster was placed upgradient and away from the study plot. Suction lysimeters could have been installed to obtain water samples above three feet.

The registrant measured the depth to water from the land surface in the shallow and deep monitoring wells (Table V, page 48 to 55). All monitoring wells were flush with the land surface; except for the monitoring wells located in the control plot (MW-1D and MW-1S) which extended above the land surface. The registrant indicates that there was a large amount of variation in the water levels. They attribute some of this variation to the air-tight seal created by the locking mechanism on the monitor wells when closed properly (page 30). As the water level in the well would try to recover to its static level a positive pressure would form and thus preventing recovery. **How long did it take these wells to recover after the air-tight seal was removed during sampling? How would this problem differ from the well purging activity prior to sample collection? Was this only a problem for measuring the water table fluctuations?** This apparently was a problem for monitoring wells MW-3D and MW-4D. During irrigation water level rose to less than 1-foot from the land surface. After irrigation the depth to water increased to about 2-feet from the land surface. Two piezometers were damaged (page 31) which required that the water levels be measured in the deep monitoring wells. **Please, identify which piezometers were damaged and when were they damaged (i.e., date).**

Ground-water contours and direction of flow for October 3, 1990 and March 7 1991 are shown by Figures 7 and 8 (pages 117 and 118), respectively. The ground-water contours on October 3 represent the water table level when approximately 50-mm of irrigation water was being applied daily to the study site. The ground-water contours on March 7 represent the water table contours when there was no irrigation water being applied, and the last rainfall event of 37 mm was on March 4. Overall the water levels reported on August 18, 1990 and March 7, 1991 are approximately 1-foot deeper than the water levels reported during irrigation (Oct. 3, 1990). **The ground-water contours shown on Figures 7 and 8 appear to indicate mounded ground water conditions, whereas Figure 6 does not. The registrant should better explain the apparent mounding indicated by the ground-water contours. Additionally, was the entire field irrigated at the same time as the study plot, or where they irrigated separately?** The registrant provided information on the direction of flow, hydraulic conductivity, and hydraulic gradient (slope of water table), and indicated that the velocity of the ground water flow was reported to be on the order of 0.2 to 1 meter per day (page 232 Volume 5; MRID# 422835-03).

Figures 1 to 8 are poor reproductions it is difficult to read the small print. Also many of the site figures included in the appendices (protocol and site characterization data) are not legible. Legible maps should be provided.

Although the several figures are of somewhat poor quality, and some additional (minor) information should be submitted by the registrant, the site instrumentation appear to be acceptable for the conditions present at the study site.

Analytical Results

GROUND WATER:

The average percent recovery for cyromazine and melamine in water were approximately 86% for both cyromazine and melamine, and are summarized in Table 3. Blind spiked samples were also conducted for 1.00 µg/L and 0.50 µg/L levels of cyromazine and melamine in water. Recoveries of cyromazine and melamine at 1.00 µg/L spikes were 87% and 64% respectively; and 0.50 µg/L level 90% and 48% respectively.

Storage stability of cyromazine and melamine was also evaluated by the registrant. Water spiked with 1.00 µg/L of cyromazine and melamine had recoveries of 95% and 75%; at 0.50

μg/L 107% and 83%, respectively after 216 days. Recoveries after 440 days of storage for cyromazine and melamine levels of 1.00 μg/L and 0.50 μg/L were 90% and 58%, 88% and 64%, respectively. All water samples were analyzed before 440 days of storage. Based upon the blind spikes and stability analyses, it appears that on average the recovery of cyromazine (93%) residues is better than for melamine (65%) which may influence the analytical results depending upon how long samples were permitted to sit around prior to analysis. Thus, if samples were not analyzed promptly, the measured values may actually under estimate the melamine residues in the ground water.

Table 3. Summary of percent procedural recoveries for cyromazine and melamine in water with three spiking levels.

Compound	Spiking Level		
	1.00 (μg/L)	0.50 (μg/L)	0.10 (μg/L)
	Percent Recovery (± Standard Deviation)		
Cyromazine	85 ± 11.8	86 ± 7.8	88 ± 14.6
# of samples	14	13	31
Melamine	79 ± 10.8	84 ± 19.6	95 ± 20.6
# of samples	14	13	30

Water samples were collected and analyzed from prior to the first application to 307 days (11 months) after the final application (365 days after first). During a meeting on July 15, 1992 between the registrant and EFGWB personnel, it was mentioned by Ciba-Geigy that monthly sampling has continued on the site. EFGWB indicated that these samples should be analyzed.

Residues in ground-water samples: The cyromazine monitoring results from the shallow and deep wells were reported (Table XV, pages 78-79) and melamine residues are presented in Table 4 (Table XVI,pages 80-81). Cyromazine residues were not detected in any to the shallow or deep monitoring wells with a detection limit of 0.10 μg/L. Melamine residues were detected in one shallow well (MW-5S - 0.10 μg/L), and in three deep monitoring wells (MW-2D, MW-4D, MD-5D - 0.10 to 0.21 μg/L). The detection occurred in the shallow well (MW-5S) at sampling interval 22 (91 days after the last application) and in the deep wells (MW-2D, MW-4D, MW-5D) at sampling intervals 22, 24, 25, 27, 28 (91 days to 273 days after the last application) as shown in Figure 1. Five of the six detections occurred in MW-4D and MW-5D which represent the downgradient monitoring wells. **Because the detections of melamine occurred at late sampling intervals (22 to**

28) and melamine residues were still detectable in soil, the remaining samples should be analyzed by registrant (collected since September 10, 1991).

Bromide in Water: Bromide recoveries in water were 97±18.9%, 95±13.7%, and 91±6.4% for 0.20 mg/L, 0.50 mg/L, and 1.0 mg/L spikes, respectively. Background levels of bromide were detected in ground water (<0.20 to 0.91 mg/L), prior to tracer application. The greatest concentrations (prior to and after) were detected in the downgradient wells (#4 and 5) and in the shallow monitoring wells. The registrant indicated that the Br^{1-} peaks in the shallow wells during sampling intervals 6 and 26 (following the bromide applications at application 2 and 14), indicated the arrival of the NaBr tracer (Figure 2). The bromide concentrations in the shallow wells ranged from <0.20 to 4.78 mg/L (sample interval 28, well #5). Bromide detections in the deep wells were much more erratic by well and time than the shallow wells (Figure 3). Concentrations were also much lower in the deep wells compared to the shallow wells, and ranged from <0.20 to 0.67 mg/L. Therefore, any breakthroughs of bromide in the deep ground-water monitoring wells were hidden by the background levels of bromide.

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SOILS:

Average procedural recoveries for 10 ng/g and 50 ng/g spikes of cyromazine and melamine by soil sampling increment were determined and are summarized in Table 5. Recovery was greater for cyromazine (75% to 92%) than for the melamine (67% to 79%), and generally decreased with depth, except for melamine with the 50 ppb (ng/g) spike. Soil samples increments 0 to 6 inches and 6 to 12 inches were also spiked with 100 ppb cyromazine and melamine. The percent recovery for cyromazine and melamine at this level were 72% and 61% for the 0 to 6 depth increment and 65% and 74% for the 6 to 12 inch depth increment, respectively.

Table 5. Summary of percent procedural recoveries for cyromazine and melamine in soil samples with two spiking levels.

Compound	Spiking Level	
	10.0 (ppb)	50.0 (ppb)
	Percent Recovery (± Standard Deviation)	
Depth (inches)	Cyromazine	
0 to 6	88 ± 17.5 (n[1]=28)	92 ± 13.9 (n=25)
6 to 12	81 ± 12.8 (n=29)	87 ± 13.7 (n=28)
12 to 18	75 ± 13.3 (n=14)	76 ± 10.0 (n=14)
	Melamine	
0 to 6	79 ± 16.6 (n=28)	67 ± 16.3 (n=26)
6 to 12	77 ± 14.2 (n=28)	71 ± 15.6 (n=28)
12 to 18	72 ± 8.6 (n=12)	70 ± 7.7 (n=14)

[1] n is the number of samples.

Soils samples prepared as blind spikes were treated with 500 ppb and 200 ppb of cyromazine and melamine to validate the laboratory procedure. The recovery of cyromazine and melamine for the 500 ppb (ng/g) spike were 81% and 86%, respectively; for the 200 ppb (ng/g) spike 85% and 102%, respectively.

Storage stability analyses were conducted to evaluate the stability of cyromazine and melamine residues with time. The average recovery of cyromazine in soil was 83 percent (200 ng/g spike) and 89 percent (500 ng/g spike) after 427 and 431 days, respectively. A third extraction of cyromazine for 200 and 500 ppb (ng/g) spikes, at 509 days, yielded an average recovery of 89 percent. The average recovery of extractable melamine 508 days after soil samples were spike with 200 and 500 ppb (ng/g) melamine was 72 percent. The registrant concluded that procedural recovery, storage stability and blind spike samples indicated the validity of the analytical data. It appears to EFGWB that the amount of residue recovered decreases with time, and indicates that samples should not be stored for long periods of time.

Residues in Soils: Cyromazine and melamine residues in soil for the three sampling increments (0 to 6, 6 to 12, and 12 to 18) over time are summarized in Table 6 (Table XX, pages 92 to 97). Deep soil samples (12 to 18 inch sampling increment) were not collected from sampling interval 6 (prior to third application - 10/02/90) to sampling interval 19 (14 days after last application - 11/21/90), due to high water table.

The theoretical concentration of cyromazine (0 to 6 inch interval) at the time of application is approximately 68.1 ng/g (0.125 lb ai/acre). The ability of the registrant to confirm the soil concentration after each cyromazine application was not very good. The average concentration of cyromazine residues in the upper 0 to 6 inch increment collected hours after application ranged from 0.0 ng/g (0 of 3; applications 2 and 3) to a maximum of 21.6 ng/g (3 of 3; application 4) compared to the 68.1 ng/g. The number of detections and concentration of the soil cyromazine residues measured hours after application decreased after application number 4. Data are not sufficient to determine whether the low (apparent) recovery is because of poor analytical methods, storage instability, or the application method (low application rates or inability to adequately address foliar/soil application).

Cyromazine residues were detected (detection limit = 10 ng/g) in 47 (54%) of 87 soil samples collected from the 0 to 6 inch sampling increment. Values ranged from <10.0 ng/g to 47.2 ng/g, and were detected in soil through sampling interval 28 (273 days after last application) (Figure 4). No cyromazine residues were detected in the 6 to 12 inch or 12 to 18 inch sampling increments.

Melamine residues were detected in 68 (78%) of 87 soil samples collected from the 0 to 6 inch sampling increment. Values ranged from <10.0 ng/g to 76.1 ng/g, and were present at detectable quantities at sampling increment 29 (307 days after last application) (Figure 5). Melamine residues were detected more frequently than cyromazine residues in the upper 0 to 6 inch sampling increment. The overall average melamine concentration (25.99 $\pm$ 11.31 ng/g) was greater than the overall average cyromazine concentration (18.09 $\pm$ 7.55 ng/g). Melamine residues ranging from <10.0 to 27.8 ng/g were detected in 15 percent (13

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of 87 samples) of the 6 to 12 inch. Melamine residues were detected up to 176 days after the last application of cyromazine for this sampling increment. No melamine residues were detected in the 12 to 18 inch sampling increment.

Cyromazine Half-Life in Soils: The registrant calculated cyromazine half-life ($T_{½}$) in soil (0 to 6 in) to be approximately 77 days. Concentrations which were below the detection limit were listed as zero (0) for both actual and natural (Napierian) logarithm transformed data. Results of the statistical analysis are shown in Figure 6 (Figure 16, page 125). The correlation coefficient was 0.60. It is apparent from Figure 6 that the regression line is highly influenced by the values less than detection limit (10 ng/g) which were set to zero (0). The figure suggests that by setting the values with "below detectable limits" to zero (0) the $T_{½}$ is under estimated. The most appropriate method to deal with the values "less than the detection limit of 10 ng/g" is to set these values to missing, which results in an estimated $T_{½}$ for cyromazine of around 1038 days, suggesting a longer half-life than 77 days. The influence of the setting these values to ln 10, ln 5, 0, and missing to represent the values reported as <10 ng/g is demonstrated in Table 7.

Table 7. Comparison of cyromazine and melamine half-life ($T_{½}$) and dissipation rate constant (-k) determined using soil residue values measured after last application of cyromazine.

Values used in regression calculation to represent values <10 ng/g (untransformed)	Cyromazine		Melamine	
	$T_{½}$	-k	$T_{½}$	-k
	days	days^{-1}	days	days^{-1}
10 ng/g	415	0.0017	1604	4.32E-04
5 ng/g	222	0.0031	1258	5.51E-04
0 ng/g	98	0.0071	808	8.57E-04
set to missing	1038	6.68E-04	2832	2.45E-04

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Bromide residues in soils: Bromide recoveries in soils were 82±15.5%, 87±11.5%, and 95±9.6% for 0.5 μg/g (ppm), 1.0 μg/g, and 5.0 μg/g, respectively. Background levels of bromide were detected in soils (1.22 to 6.14 μg/g), prior to tracer application, and generally decreased in concentration with depth for depth sampled (0 to 6, 6 to 12, and 12 to 18 inches) (Table XXV, pages 106 to 108). Bromide concentrations were spatially and temporally variable with time and depth, after both NaBr applications. **The units reported for bromide concentration is not clear. Table XXV reports that bromide concentration is ppm at top to the table and ppb at the bottom. This discrepancy should be corrected. It is assumed that ppm is correct.**

Interpretation of bromide, cyromazine, and melamine data: Bromide concentrations by depth and time provide an indication of water movement. The length of time, or days after treatment (DAT) required for the occurrence of bromide peaks (elevated concentrations in the soil profile) increased with depth. Peak bromide concentrations were apparent in the 0 to 6 inch soil samples, at sampling intervals 2, 3 and 4, which corresponded to 1, 7, and 8 days after the first bromide application, and sampling intervals 16, 17 and 18 corresponding to 1, 3, and 7 days after the second bromide application (Figure 7). Therefore, the increase in bromide concentration detected after each tracer application is probably due to the application of the bromide tracer, and not background. Peaks were also noted at sampling interval 20 (32.4 μg/g) and 22 (14.2 μg/g) which may indicate areas of lower mobility, or perhaps upward movement.

Bromide concentration peaks for the 6 to 12 inch soil increment occurred later (≈ 90 days after application) than did peaks for the 0 to 6 inch sampling increments (Figure 8). The bromide peak (a data gap existed between sampling interval 6 and 18) for the 12 to 18 inch soil sampling increment occurred two to three months after the second NaBr tracer application (Figure 9).

Average soil bromide concentrations ranged between 1.43 and 14.56 μg/g for the 0 to 6 inch increment, <0.50 to 6.59 μg/g for the 6 to 12 inch increment, and <0.50 to 4.74 μg/g for the 12 to 18 inch soil increment. Soil bromide concentrations in the 0 to 6 inch increment increased after the first bromide applications, and then decreased until the 6th cyromazine application (2nd Br^{1-} application of bromide; sampling interval 15), where levels increased and then decreased (Figure 7).

The decrease in soil bromide concentration following the first application is likely due to leaching. With the large quantity of water added daily (50 mm/day) for the first 59 days, considerable leaching of a soluble salt, such as NaBr, would be expected. The movement of cyromazine and melamine would be influenced by degradation rate and adsorption, and therefore would probably not move as readily as the tracer and would be detectable for longer periods of time. Another factor which should be considered, but is difficult to quantify is the upward flow/transport component because of the high water table conditions and losses due to surface water movement.

The detections of cyromazine, melamine, and the bromide ion in ground-water and soil samples over depth and time appear to be influenced by three quite different environmental conditions (or periods). The first runs from September 11, 1988 the day before the first cyromazine application through November 7, 1988 the day after the last application (Sampling interval 1 through 15). The second runs from November 8, 1988 to January 15. 1989 (Sampling interval 16 to 21). The final or third period can be look at in two portions, the first from January 16 to February 6, 1989 (Sample interval 22) and from February 7 to September 10, 1989 (Sampling intervals 23 to 29).

During the first period (58 days, 0 to 58 DAT), the site was irrigated at the rate of 50 mm/day for all but five consecutive days. Of these five days, the first three days received 15, 43, and 39 mm of rain. Only the last two days of this five day period received no rain or irrigation. The second period (69 days, 59 to 127 DAT) received no irrigation and ten rather limited rainfall (11, 4, 5, 1, 15, 6, 4, 1, 1, 5 mm) events. On January 16, 1991 (day 70, 128 DAT) 42 mm of rainfall were recorded, the first significant event since irrigation was discontinued. An additional 38 mm of rainfall occurred between January 16 and February 6, 1991 (sampling interval 22; 128 to 149 DAT), for a total of 80 mm. Between February 7 and September 10, 1991 (150 to 365 DAT) an additional 1024 mm of rainfall was recorded at the Ruskin weather station.

Leaching would be more effective after irrigation activities were discontinued, as the water table would be lower and rainfall would infiltrate into the soil and move in a downward direction. This is at least in part supported by the bromide concentrations in the 0 to 6 inch (Figure 7) and 6 to 12 inch (Figure 8) soil samples for sampling intervals 23 to 29. The bromide concentrations in the upper increment approach the pre-application background levels, whereas the concentrations in the second layer increase, becoming significantly greater than the detection limit of 0.50 mg/L.

The reason for the accumulation of bromide into the 6 to 12 inch soil increment at sampling interval 22 appears to be the 42 mm of rainfall which was recorded on January 16, rather than soil disking as was alluded to on page 38 and 39. After the January 16 rainfall event (42 mm) an additional 38 mm of rain was also recorded prior to the sampling interval 22 (2/6/91). This rainfall event would also leach the bromide to the 12 to 18 inch depth, which also showed an increase at sampling intervals 23 to 29 (Figure 9). Approximately 990 mm of precipation were recorded from 2/6/91 until the last sample reported (sampling interval 29 - 9/10/91) was collected.

Detectable levels of cyromazine remained in the soil profile through sampling interval 28 (Figure 4). Detectable levels of melamine residues were present in the soil profile at sampling increment 29 (Figure 5).

Several low level detections of melamine in ground water occurred at the late sampling increments. Four detections were measured in the deep wells, and one detection occurred in the shallow wells. Four of the five detections were also measured in the downgradient monitoring wells. The report submitted by the registrant states that the average velocity of ground water to be on the order of 1 meter per day. No information was provide concerning movement of residues in the surface water. But with the quantity of water being applied and the time between sampling intervals, it is possible that the tracer residues and cyromazine residues may have been transported out of the study area either in the ground water or surface water, or because of the low velocity of ground water flow residues may not have reached the monitoring wells when the samples were collected.

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B: Assessment of Ground-Water Vulnerability Associated with Market Areas for Trigard®/Citation® (Cyromazine) for Leafminer Control in AZ, CA, FL, and TX, MRID # 422835-04. Volume 6 of 6.

Discussion:

Cyromazine is currently registered for leafminer control on celery and head lettuce as Trigard®, and for greenhouse control of leafminers on ornamentals (chrysanthemums) as Citation®. The registrant, Ciba-Geigy, desires to also register cyromazine to control leafminers on tomatoes, peppers, carrots, cucurbits, leaf lettuce, and spinach. Vegetable crops are grown in 27 states, of these only four (AZ, CA, FL, TX) states have leafminers as a economic pest.

The objective of this review was to evaluate the ground-water vulnerability assessment, conducted by the registrant, for areas within the United States where chemicals containing cyromazine (Trigard®, Citation®) as the active ingredient may be used for leafminer control as proposed by the registrant. The assessment was conducted by focusing on three parameters which are thought to be related to ground-water contamination. These parameters are soil permeability, depth to ground water, and annual precipitation.

Methodology

Several databases were utilized to conduct this assessment. These included soil characteristics from USEPA Database and Parameter Estimator (DBAPE)(Imhoff et al., 1990), portions of DRASTIC (Aller et al., 1987), county soil surveys, and annual precipitation records from the National Weather Service. The registrant also presented information to identify states, counties, and number of acres with present or future potential for the use of cyromazine to control leafminers.

The registrant considered that the crop/soil/ground-water depth conditions at the Hillsborough County, Florida site would exhibit qualities that are representative of an extreme worst case environment. Other locations were therefore compared to the hydrological conditions at the Florida site.

The overall search strategy and summary is briefly outlined in Table 7.

The statement (page 11) concerning "soil-series resolution" is incorrect, as the resolution is at the "soil-mapping unit resolution".

The units of average annual rainfall is not given on Table 4, page 30. It is assumed that the rainfall is reported in inches. This should be corrected.

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Table 7. Summary of Steps to Identify Potential Hydrogeologically Vulnerable Areas to Cyromazine and Cyromazine Degradates in order to control leafminers.

DEFINE POTENTIAL PRODUCT USAGE AREAS FOR LEAFMINER CONTROL	
Crops	States/County[1]/Acres[2]
Cucurbits, tomatoes, peppers, carrots, lettuce, celery, spinach, chrysanthemums, and, gypsophia.	AZ,CA,FL,TX
CANDIDATE SOILS	
Soil Category: 3 of 8	Factors Considered
Prime agricultural soils - 1) irrigated & 2) nonirrigated, and 3) other prime soils.	Series name, SCS hydrologic group, crop.
From above group select "most likely to leach"	Infiltration capacity, slope <6%, %sand, % clay, organic matter %, bulk density, available water.
Supplemental Soil Surveys were also evaluated.	same as above.
PERMEABILITY OF CANDIDATE SOILS	
Relative permeability were evaluated using particle size distribution information.	Listed by decreasing relative permeability[3].
Select "most restrictive zone" for each soil.	Soil layer with lowest relative permeability.
AVERAGE ANNUAL RAINFALL	Review Climatological Data
DEPTH TO SHALLOW GROUND WATER	Percent of county with depth to ground water < 5 feet and < 30 feet.

[1] Identified by the registrant, but not listed here.

[2] Identified by the registrant, but not listed here.

[3] Sand, loamy sand, sandy loam, sandy clay loam, loam, sandy clay, clay loam, silty loam, silty clay loam, silt, silty clay, and clay.

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Summary and Conclusions

As stated above the registrant compared the hydrologic vulnerability of selected counties in four states to Hillsborough County, Florida, where a prospective ground-water monitoring study was conducted. From the four states and 42 counties considered, five counties [Broward (245), Collier (240), Dade (245), Seminole (231), Sumter (234)] in Florida had DRASTIC scores equal to or greater than Hillsborough County (231).

Twenty of the 42 vulnerable counties were identified in Florida. These counties all had DRASTIC scores between 199 and 245. From the twenty counties considered in Florida, 99 to 100 percent of each county had ground water levels less than 30 feet. Ten of these 20 counties had ground water levels at depths of less than five feet over approximately 99 percent of the county. Annual rainfall was between 50 and 60 inches for all twenty of the counties.

The Pesticides in Ground Water Database (USEPA, 1992c) reported pesticide residue detections in thirteen of twenty counties selected in Florida by the registrant. Detections ranged from 4 wells of 181 and 1 well of 55 in Broward and DeSoto Counties, respectively; to 712 wells of 5006 and 441 wells of 2020 in Polk and Highlands Counties, respectively. Thus, demonstrating the vulnerability of ground water to pesticide contamination in some of the selected counties.

The DRASTIC scores (97 to 172) for the remaining 22 counties in the other three states were generally (<140) much lower than those reported in Florida. Even with the lower DRASTIC scores determined for these locations, pesticides residues have been detected some ground water in these states. Several of the counties in California report wells having detectable levels of pesticide residues (Fresno - 789 wells out of 1529; Kern - 164 wells of 713; Stanislaus (133 wells out of 481). Other counties not selected by the registrant also have pesticide detections in ground water (San Bernardino - 68 wells of 617).

Several factors, as suggested by the registrant, appear to have influenced detections being recorded at locations with lower DRASTIC score. First, only rainfall was considered in the DRASTIC score assessment; irrigation water which can add to ground water recharge, and hence the potential for contamination was not considered. Second, a much smaller aerial percentage of the counties had ground-water depths < 5 feet and less than 30 feet. Thirdly, the SCS generally only reports ground-water depths when less than five or six feet below the surface. A forth, and key assumption made at the beginning of this assessment was that counties were only considered where there existed, or the potential existed for the use of cyromazine to control leafminers. Thus the evaluation was only conducted in

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four (AZ,CA,FL,TX) states. A fifth factor not specifically mentioned by the registrant is the spatial and temporal variability of soils and soil properties, rainfall and evapotranspiration, ground water aquifers, pesticide environmental interactions, crop variability, to name a few. Also agricultural practices, including irrigation and drainage methods and scheduling, differ between regions.

Generally, given the limits, restraints and assumptions used by the registrant, the assessment of vulnerable areas appears to be reasonable. The assessment states that Florida has the highest vulnerability to ground-water contamination of the areas evaluated. This is true as far as the assessment is concerned, but one can not compared shallow to ground water/irrigated agricultural activities in Florida to areas with variable depths to ground water (site specific information needed) and rainfall values in three states (Arizona, California, Texas), which clearly require irrigation to support comparable agricultural activities.

Given the uniqueness of environmental and hydrological conditions in Florida, and that about 40 percent of the potential cyromazine usage environments are located in Florida and display similar vulnerability to the Hillsborough County site, the potential for ground water contamination in Florida use areas would be high. The remaining 60 percent of the potential use areas addressed (AZ, CA, TX) also have the potential for the contamination of ground-water through the use of pesticides as pesticide residues have been detected in several of the counties investigated. These areas also generally receive irrigation water, which would increase the potential for leaching pesticide residues to ground. However, many of these areas have ground water levels at deeper depths, and therefore have a lower potential of ground water contamination compared to Florida. The vulnerability assessment only addresses ground vulnerability to ground-water contamination in the four states where leafminers were defined to be a problem.

C: Discussion of cyromazine and its application to other cyromazine uses. MRID # 422835-01.

The registrant desires to expand the list of crops registered for cyromazine use. The vegetable crops of interest (tomatoes, cucurbits, carrots, peppers, lettuce, spinach, celery) and chrysanthemums are grow commercially in 27 states. The leafminer is a significant economic pest in only four of these states (AZ, CA, FL, TX), and to a lower extent New Mexico. Periodic outbreaks of leafminers apparently may also occur infrequently in other states. The registrant indicates that although the 1,550,055 potential acreage of is substantial (lettuce/spinach - 267390 acres, celery/carrots - 141772 acres, cucurbits - 575323 acres, peppers - 61000 acres, tomatoes -

504570 acres, ornamental - 1045 acres), much less, approximately 925 acres, would be treated with cyromazine for leafminer control (FL - 600 acres, CA - 160 acres, Texas - 125 acres, NM - 40 acres, AZ not stated). This document only addresses vegetable and chrysanthemums production in four states listed above: AZ, CA, FL, and TX.

Florida Vegetables: Approximately 55,000 acres of tomatoes and 23,000 acres of peppers are produced annually in Florida using farming methods similar to the prospective ground-water monitoring study conducted in Hillsborough County, Florida. Others crops, such as leafy vegetables (spinach, lettuce) (12,000 ac), carrots (9,000 ac), and celery (8,000 ac) are grown in Florida on muck soils. Cucurbits are grown in all areas of Florida (86,000 ac) using methods including mulched beds. Vegetable crops require irrigation when rainfall is lacking. Sandy soil require 0.5 to 1.5 inches of irrigation water. Types of irrigation include seep (type used in prospective study), sprinkler, and drip irrigation methods. maintains the ground water level at 15 to 18 inches below the plant bed surface.

Texas Vegetables: Leafminers infest tomatoes (4000 acres), celery, pepper (11000 acres), carrots (12,000 acres), and leafy vegetables (1900 acres lettuce, 13000 spinach) in Texas. Cantaloupes (21000 acres), honey dew melons (6000 acres), and cucumbers (7000 acres) are also impacted. These crops are irrigated by furrow, sprinkler, and drip irrigation.

California Vegetables: Carrots, spinach, tomatoes, celery, lettuce, peppers, and cucurbits are grown in California. Soil textures range from sandy loams to clay, with most vegetable production occurring on soil with a loamy texture. Specific areas include the Imperial Valley, San Joaquin Valley and the North and South Coastal counties. Crops are irrigated by furrow, sprinkler and drip irrigation.

Arizona Vegetables: The majority of the vegetables (lettuce and tomatoes) are produced in Arizona are grown in four counties. The DRASTIC scores for three of the counties, Yuma, Manicopa, and Pinal counties were 97, 100, and 99, respectively. The forth county discussed was Lapaz (no DRASTIC score provided). Management and irrigation practices are similar to those of California.

Chrysanthemums and gypsophilia are also grown primarily in FL, CA,and TX. Acreages put into production are approximately 800 acres in FL, 1000 acres in CA, 200 acres in TX, whereas acres infested by leafminers is much less than planted; approximately 160 in CA, 125 in TX, and 40 acres in NM. The registrant briefly describes vegetable and chrysanthemum production (location, acreage and irrigation methods) in CA, FL, TX and to lesser extent AZ and NM.

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The vulnerability assessment indicated that the Florida sites were much more vulnerable than sites in Arizona, California, Texas. The major reasons for this is that depth to ground water is generally much less at the sites invested in Florida compared to those in AZ, CA, and TX. Also annual rainfall was much greater in Florida (50-60 inches) than the three states other (5-25 inches). The three states require irrigation for dependable vegetable and ornamental flower production which is not consider in the vulnerability assessment conducted by the registrant (Volume 6 of 6; MRID # 422835-04).

11. <u>COMPLETION OF ONE-LINER:</u>
    One-liner updated.

12. <u>CBI APPENDIX:</u>
    Not applicable.

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