ENVIRONMENTAL MONITORING RESULTS OF BASAMID® G (DAZOMET) APPLICATION IN WATSONVILLE, CALIFORNIA 2006

Study 212

By

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ABSTRACT

Dazomet, the active ingredient of Basamid® (99% dazomet), is one of the three soil fumigant pesticides that generate methyl isothyocianate (MITC). Though dazomet use is smaller relative to other soil fumigants, its use in the State of California is increasing. Department of Pesticide Regulation (DPR) initiated a pilot air monitoring study to gather information on MITC emissions following a dazomet field application. Such information was needed to adapt mitigation measures for human exposure and environmental contamination. Hence DPR scientists proposed at least two more studies in commercial field settings. This study was done in Watsonville, California in October 2006. A total mass of 205.0 kg (451.94 lbs) Basamid® G was broadcast applied to 0.4118 ha (1.0175 ac), a field of raised beds prepared for strawberry planting. Both beds and furrows were treated. This was equivalent to a rate of 493 kg/ha (440 lbs/ac) of dazomet or 22.2 g/m^2 of MITC. Sprinkler irrigation was used following application to activate the dazomet and to hold the soil near field capacity to minimize MITC losses as recommended by the label.

The highest individual concentration of MITC was 1058 $\mu g/m^3$ recorded 10 hours after start of application. The high concentration may have resulted in part from two inadvertent spills of Basamid® G upwind and off the treated field. MITC maximum concentrations nearby up to 70 hours after the start of Basamid® G application ranged between 1058 $\mu g/m^3$ and 192.7 $\mu g/m^3$. By 274 hours after the start of Basamid® G application (end of monitoring), the MITC concentration dropped to 3 $\mu g/m^3$.

The back-calculation method was used to estimate flux. Only 3 out of the 18 simulated periods showed significant r^2 values ($p < 0.05$). Measured and the modeled concentrations for the 15 non-significant intervals were sorted and reanalyzed. After 274 hours from the beginning of Basamid® G application, 32% of applied MITC was emitted from the plot. Ten per cent of applied MITC was released to air by the end of first 24-hr period. Twelve percent was released during the second 24-hr period. Peak emission was 8 % from 28 to 34 hours after the beginning of Basamid® G application. In general, emissions during night intervals were higher than the day intervals.

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Cindy Garretson and her staff at soil analytical laboratory in Fresno analyzed the soil samples, and we are thankful for their help. Carissa Ganapathy procured the sampling tubes and coordinated activities with two laboratories involved and with the field staff of this study. Dave Kim helped preparation of sampling equipment. Dr. Bruce Johnson reviewed this manuscript and made valuable comments. We thank all of them.

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INTRODUCTION

In June 2003, the California Department of Pesticide Regulation (DPR) declared methylisothiocyanate (MITC) and all pesticidal sources of MITC, to be toxic air contaminants that may cause or contribute to increases in illness or death (CDPR, 2003). Metam sodium, metam potassium, and dazomet are the three pesticidal sources of MITC. There is a reasonable body of knowledge on the environmental fate of metam sodium. Metam sodium has a linear molecule. Metam potassium has a similar chemical structure to that of metam sodium, and therefore, is expected to have a similar degradation rate. However, little is known about the degradation rates, off-site air concentrations following an application and flux estimates, and other characteristics of dazomet that may affect the public and the environment under field conditions. The chemical name of dazomet is Tetrahydro-3,5, -dimethyl-2H-1,3,5-thiadiazine-2-thione. Dazomet's chemical structure shows a heterocyclic ring containing carbon, nitrogen, sulfur, and hydrogen (Figure 1). Therefore, degradation products of dazomet could be different from those of the relatively better-understood metam sodium.

Dazomet use in agriculture has been minor relative to other soil fumigants, but is increasing (Table 1). This necessitates reliable estimates of MITC losses, off-site movement and flux estimates of dazomet under various field conditions (Wales, 2002; Fan et al., 2008). Fan et al. (2008) studied off-site MITC concentrations and estimated flux following a dazomet application to a field in June 2005, in Manteca, California. The Manteca study was a preliminary one with small field plots. Hence DPR scientists proposed at least two more studies in commercial field settings (Wofford and Johnson, 2006). The objective of this study, therefore, was to collect more information on off-site movement and flux estimates of MITC following an application of dazomet in a commercial field in Watsonville, California, in October 2006.

Table 1. Statewide dazomet use in lbs (Kg). Source: DPR's pesticide use database.

Site	2000	2001	2002	2003	2004	2005
Agriculture related	5,560 (2,522)	4,619 (2,095)	2,769 (1,556)	16,303 (7,394)	18,541 (8,409)	2,736 (1,241)
Landscape maintenance	1,103 (500)	2,384 (1,081)	1,851 (839)	2,963 (1,344)	4,773 (2,165)	25,120 (11,392)
Right of way	2,139 (970)	36,897 (16,733)	38,966 (17,672)	24,880 (11,283)	35,111 (15,923)	18,220 (8,263)
Soil- seedbeds	692 (314)	2 (0.9)	0 (0)	11 (5)	22 (10)	23 (10)
All other	992 (450)	397 (180)	1,434 (650)	1,158 (525)	45 (20)	1,827 (829)
Total	**10,486 (4,756)**	**44,299 (20,090)**	**45,020 (20,417)**	**45,315 (20,551)**	**58,492 (26,527)**	**47,926 (21,735)**

Dazomet is a broad-spectrum pesticide and has at least 18 registered products in California as of November 2006. It is a soil fumigant and used to control fungi, bacteria, nematodes, weeds, and soil insects. In moist soils, dazomet decomposes rapidly to methyl (methylaminomethyl) dithiocarbamic acid, which further degrades to MITC, formaldehyde, hydrogen sulfide, and methylamine. The commercial pesticide, Basamid® G used in this study (EPA Registration number 700051-101, manufactured by CERTIS, Columbia, MD) contained 99.0% dazomet as active ingredient. It is the soil fumigant, labeled "For Use in California only", and recommended for pre-planting control of most weeds in strawberries and tomatoes. According to the original manufacturer of Basamid® G, it is this combination of volatile gases that give the fumigant properties (BASF, 1989). The degradation of dazomet can occur rapidly, in 10-15 minutes from application (Thompson, 1989). The aerobic soil half-life (50% dissipation time) for dazomet was reported to be 18 hours at pH 5.8 in a loamy sand soil (DPR, 1999). Water is the primary factor in dazomet degradation. However, soil temperature, pH, and soil type can affect the rate of degradation (Wales, 2002; Munnecke and Martin, 1964; Sczerzenie, et al., 1987).

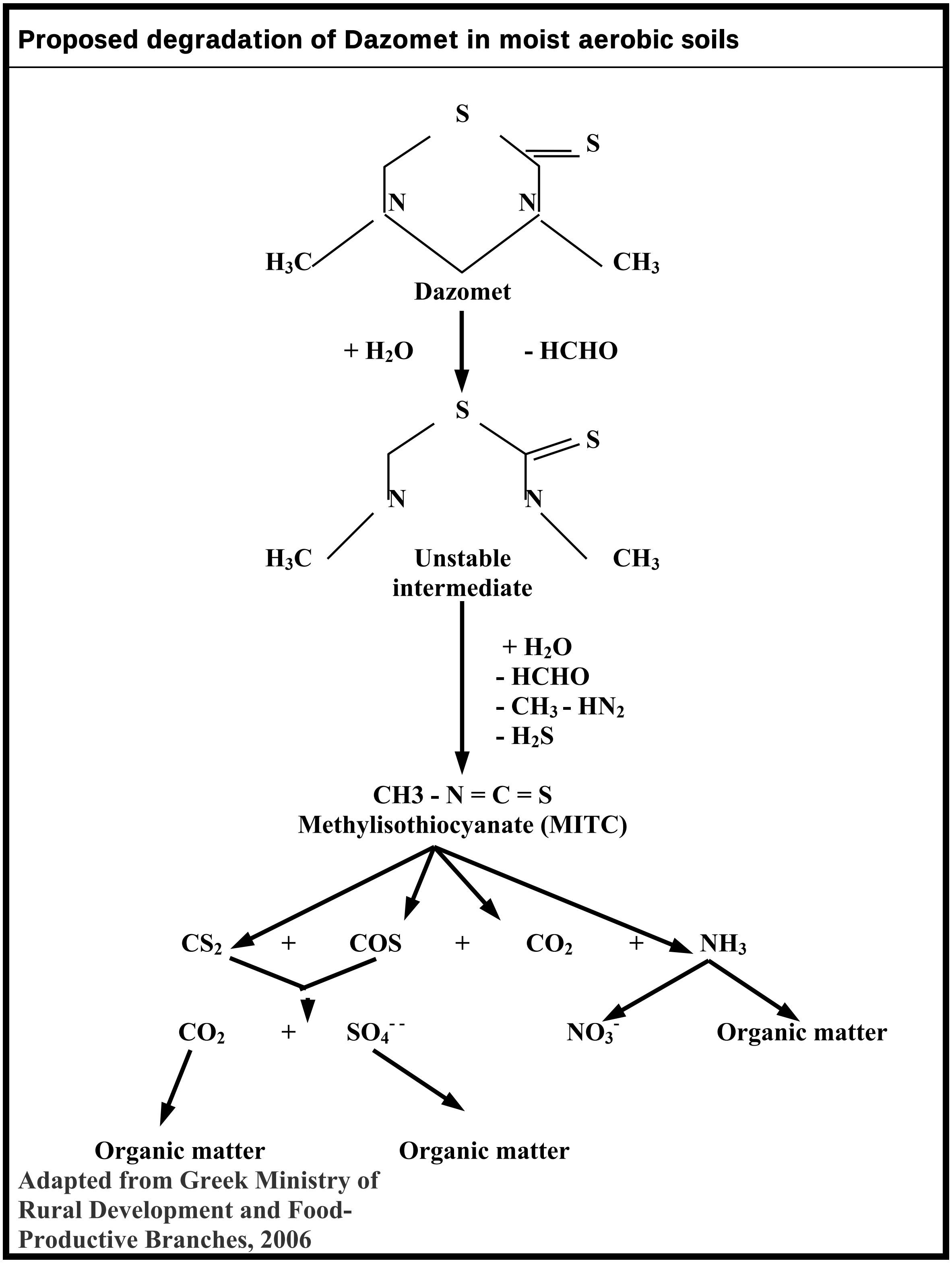
In most agricultural applications, Basamid® is used as a granular soil fumigant. The treatment could be a surface broadcast or sub-surface application and with or without tarp. Water applied on a schedule to keep the soil near field capacity generates the fumigant efficiently. The same wet soil at this condition is believed to keep the fumigant sealed in the soil, slowing down its release to air. Basamid® G is insoluble in water and non-volatile (Table 2). However, its major breakdown product, MITC, has a relatively high vapor pressure of 16.0 mm Hg at 20 ^{0}C (Wales, 2002; Greek Ministry of Rural Development and Food-Productive Branches, 2006). This results in a highly volatile fumigant (Wofford et al., 1994; Levine et al., 2005; Fan et al., 2008).

Table 2: Physicochemical properties of dazomet[a] and MITC.

	Dazomet	**MITC**
Molecular formula	$C_5H_{10}N_2S_2$	C_2H_3NS
Molecular weight (g)	162.3	73.12
Solubility in water (ppm)	3.63×10^{3} (20 ^{0}C)	8.61×10^3 (25 ^{0}C)
Vapor pressure (mmHg)	9.88×10^{-6} (25 ^{0}C)	16.0 (25 ^{0}C)
Boiling point[b] (760 mm Hg)	104 ^{0}C	Na
Henrys law constant (atm-m^3/mole)	2.57×10^{-10} (20 ^{0}C)	1.79×10^{-4} (25 ^{0}C)
Hydrolysis half-life (days)	0.146 (pH 7, 25 ^{0}C)	20.4 (pH 7, 25 ^{0}C)
Aerobic soil half-life (days)	0.75 (pH 5.8, loamy and sandy soil)	0.5-50 (25 ^{0}C)
Anaerobic soil half-life (days)	14.10	Na

[a]All data are from the DPR's Pesticide Chemical Database (DPR, 1999), unless otherwise indicated.
[b]MSDS, Basamid®, Certis U.S.A. LLC, 2005.
Na = Not available.

Figure 1: A proposed degradation of dazomet in moist soil under aerobic conditions.



Gamliel et al., (2001) estimated that 98% of the Basamid® applied to moist soil is broken down to MITC rapidly. Other breakdown products in low amounts included CS_2, HCHO,

H_2S and NH_3. According to Munnecke and Martin (1964), warmer soil temperatures increased the decomposition rate of dazomet, although they noted that the same amounts of MITC were eventually produced at all temperatures tested. Rate of decomposition increased with soil moisture, up to approximately 80% of soil saturation. Decomposition was fastest at pH 6.5, and declined at lower or higher pH levels. Soil type has an effect on dazomet degradation. Clays may act as catalysts in the initial breakdown of dazomet to MITC (Sczerzenie et al., 1987). The addition of peat moss to soil decreased breakdown of dazomet to MITC, presumably due to the sorption of dazomet to peat moss (Munnecke and Martin, 1964). Little is known about the fate of dazomet in water. Sczerzenie et al. (1964) summarized several studies on the fate of dazomet in water. This report suggests pH as the key factor affecting the decomposition of dazomet. In aqueous solution at pH levels of 5, 7, and 9, dazomet decomposed with half-lives of 8.6, 2.6, and 1.5 hours respectively. However, no temperatures were given. The half-life of dazomet in aqueous solution at pH 5 under irradiation was 4 hours compared to a dark control, where the half-life was 11 hours. Here too, the temperature was not reported. MITC and carbon disulfide were identified as degradation products (Wales, 2002).

Studying the MITC concentrations from another source, metam sodium, Wofford et al. (1994) found MITC levels that exceeded the Office of Environmental Health Hazard Assessment's 1-hour Reference Exposure Level (REL) for eye irritation of 1.2 $\mu g/m^3$. Conditions were considered extreme in that study due to high air temperature, low humidity, warm soil temperature, and the fumigant applied at the highest allowable rate of 935.0 l/ha (100 gals/acre). DPR has recognized the potential of MITC to drift into adjacent communities. For this reason, DPR is working to generate data to define buffer zones for mitigation. DPR has established an 8-hour reference concentration of 660 $\mu g/m^3$ (220 ppb) of MITC for metam sodium, which was identified in the DPR risk assessment as the no-observable effect level (NOEL), (CDPR, 2002).

MATERIALS AND METHODS

All the field measurements have been converted to metric units.

Application Site

A 0.4118 ha (1.0175 acre) plot at a nursery facility in Watsonville, California was the experimental site (Photograph 1). The periphery of the field was fenced on all sides except the west end where the main access was. On both north and south sides of the plot, and beyond the fence, there were raspberry screen houses, approximately 20 meters (65 feet) from the fence and about 7 meters (22 feet) tall. The farm roads ran along the three fences. A temporary fourth road at the west divided the field into experimental and non-experimental areas. The beds were standard raised bare beds usually prepared to plant strawberry. Beds in the experimental area as well as in the non-experimental area were prepared as contiguous beds. (Photograph 2). The soil was dry and there were few weeds on the beds. The beds ran in an east-west direction and were 1.22 meters (48 inches) wide from center of furrow to center of furrow (Figure 2). The top of the bed was 61 cm (24 inches) wide, and the bottom of the bed was 91.5 c.m. (36 inches) wide. The top of the furrow was 61 cm (24 inches). The bottom of the furrow was 30.5 cm (12 inches), and the beds were 30.5 cm (12 inches) tall (Figure 2 and Photograph 2).

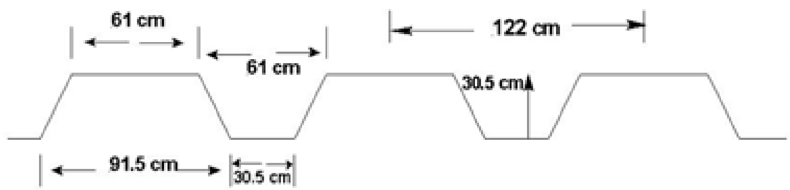


Figure 2. The bed layout

Air Sampling

SKC Universal sampler pumps, model 224-PCXR4 and model 224-PCXR8 were used in this study. Sampler pumps were set to a constant flow of 1000 ml/min. In both types of pumps, timer and the flow fault functions were active. At each location (station) two sampler pumps were mounted on a metal stake at about 0.7 meters aboveground (Figure 3 and Photograph 3). In Photograph 3, two pumps were under the black polyethylene rain guard and not visible, but the two tygon tubes connecting the pumps to samples are visible. The second pump was used to mount field spikes and collocated samples, and also was a back up. The air samples were collected using two-stage (200-400 mg) coconut charcoal tubes (SKC 226-09) that were mounted at about 1.5 meters aboveground, pointed towards the plot. The charcoal tubes were protected from sun and moisture by using aluminum foil wraps. Fully charged 12-volt car batteries powered the sampler pumps and were replaced every 48 hours. A flashing strobe light helped to locate the samplers in the night.

From one end to the other, the field was approximately 105 meters in length and 63 meters in width. Inside this field an area, 81.3 meters in length and 50.6 meters in width was treated with Basamid® G (Figure 4). This gave a treatment area of 0.4118 hectares (1.0175 acres) having 67 rows of beds. Sampler pumps ringed the field at 12 meter and 18 meter distances (Figure 4). The precise distances are given in Table 3.

Table 3. Distance of samplers from the edge of the field (meters).

Sampler location	1	2	3	4	5	6	7	8
Distance	18.3	12.2	18.1	11.6	18.1	12.2	18.5	12.3

Figure 3. Layout of a sampling unit (station)

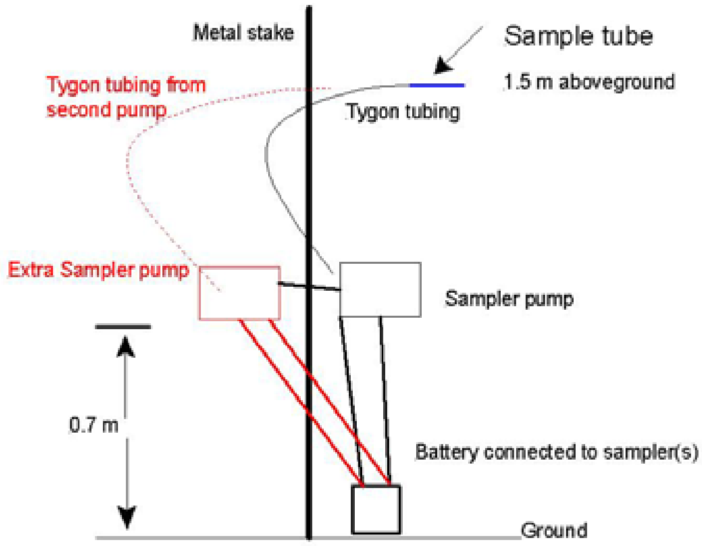
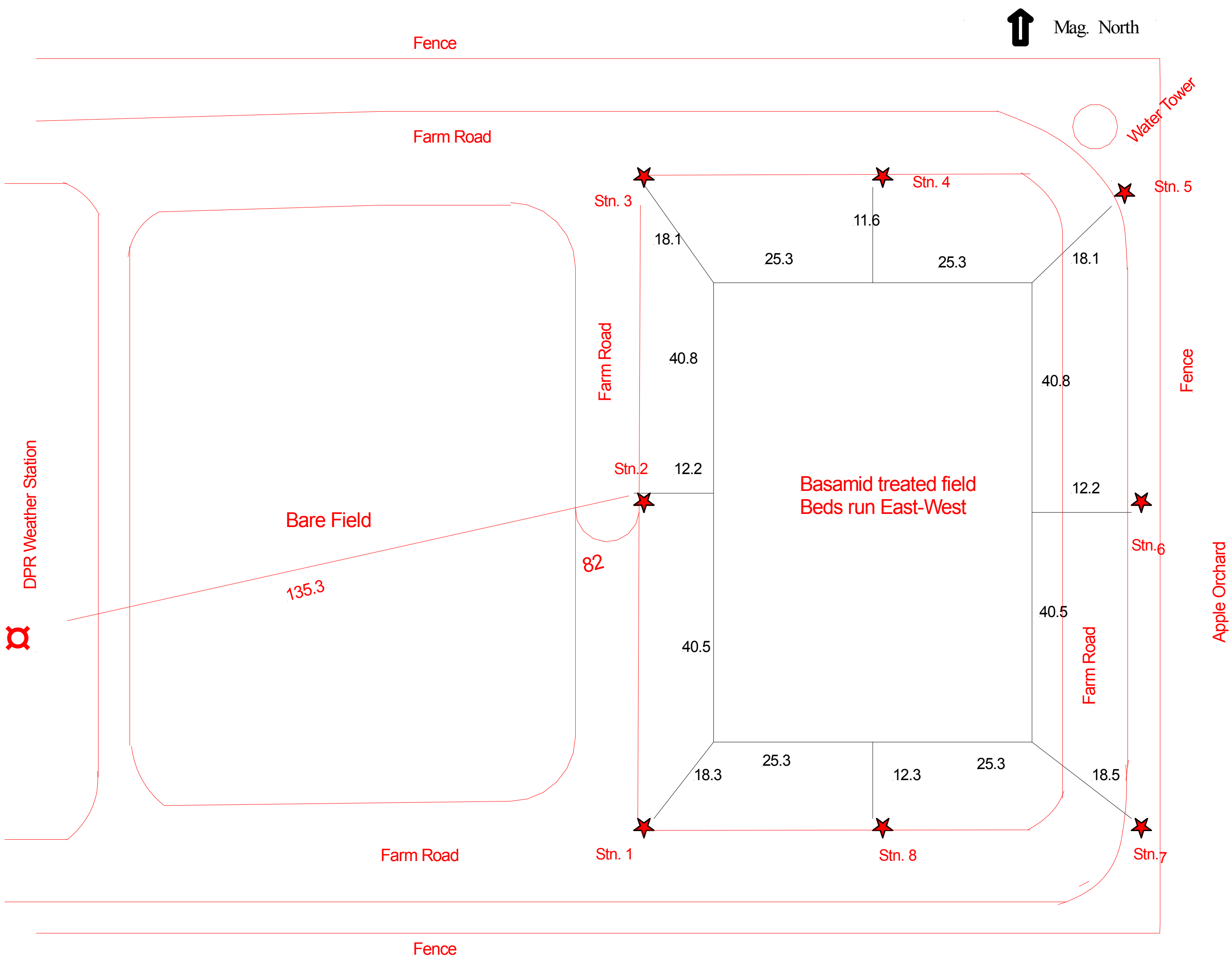


Figure 4: Sketch of the field.



All distances are in meters.

Weather data

A weather station was set up approximately 135 meters west of the application area (Figure 4). The trailer-mounted mast was approximately 10 meters (32.8 feet) high. Wind speed, wind direction, ambient air temperature, solar radiation, and relative humidity were collected for the duration of the study. The Met 1® meteorological sensors recorded data onto a Campbell Scientific, Inc. CR 21 X Datalogger. The data were recorded as one-minute averages of one-second readings, except for wind direction, which was collected as an instantaneous reading every minute. In addition to these readings, percent cloud cover was noted at each sample change.

Application of Test Substance

A total of 205.0 kg (451.94 lbs) of Basamid® G (EPA Reg.# 70051-101) was applied to the 0.4118 ha (1.0175 ac) plot giving an application rate of 497.81 kg/ha (444.17 lbs/ac) or 49.78 g/m^2. Since Basamid® G contains 99% dazomet, 497.81 x 0.99 = 493 kg/ha (440 lbs/ac) of dazomet was applied. The herbicide was packaged in 22.68 kg (50 lbs) double-layer plastic bags. The product was a fine white granule that flowed easily (Photograph 2).

Each pass treated a single row covering the bed and one half each furrow on either side. Thus the entire field surface was treated. Each pass took approximately 2 minutes to complete. The application was made with a Gandy Hopper, mounted on a John Deer Model 990 tractor, and the granular pesticide fell through a series of orifices perpendicular to the row. The pesticide dropped onto a slanted plate, 10.2- 12.7 c.m. (4-5 inches) above the ground, and was spread evenly upon the soil surface (Photograph 2).

Four background air-monitoring samples were started on October 17 at approximately 1800 hours and ended on October 18, approximately 0700 hours. The Basamid® G application commenced at 0845 hours and was completed at 1100 hours on October 18. Sampler pumps were started just prior to the start of the application. A little Basamid® G was dropped inadvertently, upwind, and to the north of the station 2 sampler, at about 1000 hours. On a subsequent pass of the tractor, a smaller amount of Basamid® G was spilled again, this time, upwind and south of the same sampler.

Irrigation

The sprinklers were started and were at full pressure at 1135 hours. However, irrigation to the beds between samplers 2 and 3 and to the west end was insufficient (Photograph 3). Irrigation was interrupted at 1140 hours, and a new pipe with a sprinkler outlet to cover this area was installed. After several adjustments, steady irrigation started at 1205 hours and continued until 1515 hours. Sprinkler lines were laid in the furrows of the treated beds. During the course of the trial, several irrigations were done (Table 4). The amount of water applied during each irrigation was measured by keeping a one inch (2.54 cm) diameter glass cylinder graduated to measure one tenth of an inch (0.25 cm) in the field. After the end of second irrigation and up to the 6^{th} irrigation, standing water was observed accumulating in the field at the east end.

Table 4. Irrigation schedule.

Irrigation Event	Date	Start Time	Approximate Duration	Approximate Amount of water, inches/(mm)
1	10/18/06	1200	3 hrs 15 minutes (min)	0.75 / 19.1
2	10/18/06	1918	1 hr	0.25 / 6.4
3	10/19/06	1020	15 min	0.10 / 2.5
4	10/19/06	1215	15 min	0.10 / 2.5
5	10/19/06	1415	35 min	0.20 / 5.0
6	10/19/06	1715	35 min	0.20 / 5.0
7	10/20/06	1140	20 min	0.10 / 2.5
8	10/20/06	1315	18 min	0.10 / 2.5
9	10/20/06	1500	40 min	0.20 / 5.0
10	10/20/06	1645	20 min	0.10 / 2.5
11	10/21/06	1108	35 min	0.20 / 5.0
12	10/21/06	1324	36 min	0.20 / 5.0
13	10/22/06	1005	30 min	0.20 / 5.0

Soil Samples

Soil samples were collected prior to treatment, at two locations for bulk density and soil moisture estimates. These samples were collected from a depth of 15.2 – 30.5 cm (6-12 inches) below the surface, and from two beds towards the middle of the field to represent the study area. A composite surface soil sample was collected from several places randomly, over the treatment area for soil texture analysis. These soil samples were analyzed at the Fresno field laboratory of DPR, following the SOP FSSO001.00 and SOP FSSO002.00 (Garretson 1999a and 1999b).

Air Sampling

Table 5: Approximate sampling times for 18 sampling intervals and sample specifics.

Interval	Date	Start	End	Time of day	Hours and minutes sampled	Sample details
BG[1]	17/18	1800	0700	night	13 h 0 min	At 1,2,3 and 6
1	18	0845	1520	day	6 h 35 min	All 8 locations
2	18	1520	1850	day	3 h 30 min	All 8[2] + CL[3] at 2,4,6, and 8
3	18/19	1850	0100	night	6 h 10 min	All 8
4	19	0100	0645	night	5 h 45 min	All 8 + CL[3] at 2,4,6, and 8
5	19	0645	1245	day	6 h 0 min	All 8
6	19	1245	1845	day	6 h 0 min	All 8
7	19/20	1845	0045	night	6 h 0 min	All 8
8	20	0045	0645	night	6 h 0 min	All 8
9	20	0645	1245	day	6 h 0 min	All 8
10	20	1245	1845	day	6 h 0 min	All 8
11	20/21	1845	0645	night	12 h 0 min	All 8
12	21	0645	1845	day	12 h 0 min	All 8
13	21/22	1845	0645	night	12 h 0 min	All 8 + FS[4] at 2, 4, and 6
14	22	0645	1845	day	12 h 0 min	All 8
15	22/23	1845	0645	night	12 h 0 min	All 8 + FS[4] at 4, 6, and 8
16	23	0645	1845	day	12 h 0 min	All 8
17[5]	28/29	1845	0645	night	12 h 0 min	All 8
18	29	0645	1845	day	12 h 0 min	All 8

[1] BG = Background samples before the commencement of treatment.
[2] Sampler at location 1 malfunctioned, no sample.
[3] CL = Collocated samples at locations; 2, 4, 6, and 8.
[4] FS = Field Spikes at locations 2, 4, and 6, during interval 13 and at 4, 6, and 8, during interval 15.
[5] 17 = Interval 17 started approximately 5 days after interval 16.

For every sample the start time, start flow rate, end time, and the end flow rate were recorded. At every start, the flow rate was kept within 1000 ml/minute ± 50, by adjusting the pump when necessary. During the second sampling interval, the sampler pump at location 1 malfunctioned, and no sample was collected.

Sample Handling
Prior to the commencement of the study, over 300, two-stage (200-400 mg) coconut charcoal tubes were purchased from the manufacturer. The study number (212) and sample identification number were attached to each individual tube. A Chain of Custody (COC) and Lab Result Report form was prepared to record sample information, and four samples were logged on each COC (Appendix 2). For convenience, two COCs and 8 sample tubes were placed in a 10-inch zip-lock bag, and 22 such sets were prepared giving 4 extra sets for the required 18 sampling intervals.

The collected samples were packaged and handled according to the procedures in DPR's SOP QAQC004.01 (Jones, 1999). Because of the distance involved, all samples were held on dry ice. The first set was delivered to the labs on October 24th and the second set on October 30th.

Calculation of Air Concentration

The sample MITC concentrations were calculated by moving a known volume of MITC laden air through charcoal trapping medium and recovering it through a chemical extraction process. The laboratory analytical results were reported in µg/sample. The air concentrations were converted from µg/sample to µg/m^3 using the following relationship.

$$\frac{\text{Sample mass (µg/sample)} * 1000 \text{ L/m}^3}{\text{Flow rate (L/min)} * \text{time (min)}} = \text{Air Concentration (µg/m}^3\text{)}$$

Concentrations can be converted from µg/m^3 to parts per billion (ppb):
At 25 ^{0}C (298 ^{0}K) and 1 atmosphere, 1 µg/m^3 = 24.45/ molecular weight (MW) in ppb
Therefore, 1 µg/m^3 MITC = 24.45 / 73.12 ppb MITC = 0.3344 ppb MITC

Chemical Analysis of Air Samples.

All air samples were analyzed for MITC. Air samples from 18 intervals (regular samples), four background samples, one set of field spikes (3 samples), one set of trip spikes (3 samples), and one trip blank were sent to Morse laboratory, a private laboratory. The MITC analytical procedures followed by the Morse laboratory are given in Appendix 3. The other sets of field spikes (3 samples), trip spikes (3 samples), one trip blank and eight collocated samples were analyzed by the California Department of Food and Agriculture (CDFA) Center for Analytical Chemistry, commencing on October 25, 2006. The details for analytical procedure of CDFA laboratory are given in Appendix 4.

Prior to the commencement of Watsonville study, CDFA conducted a method verification study for MITC using their procedure. The MITC was spiked at three levels, and desorbed from the charcoal in 5 ml of a 0.1% carbon disulfide in ethyl acetate solvent by occasionally agitating for 30 minutes. The extracts were analyzed on a gas chromatograph equipped with a Thermal Spray Detector. Method verification study results are reported in Table 6.

Table 6: Method verification data for MITC in air, CDFA laboratory.

Spike Level µg/sample	Recovery (% of spike) Rep #1	Rep #2	Rep # 3	Mean	SD	UCL	UWL	LWL	LCL
0.4	82.5	87.5	87.5	85.83	2.89				
3.0	97.3	107.0	103.0	102.43	4.87				
8.0	97.8	98.5	92.3	96.20	3.40				
				94.82	7.98	119.0	111.0	78.9	70.9

SD = Standard deviation UCL = Upper control limit UWL = Upper warning limit LWL = Lower warning limit LCL = Lower control limit

The Reporting Limit (RL) for CDFA laboratory when the Gas Chromatograph/Nitrogen Phosphorus Detector (GC/NPD) was used was 0.2 µg/sample. When Gas Chromatograph/Thermal Spray Detector (GC/TSD) was used, it improved to 0.05 µg/sample. The RL for the results reported in Table 6 was 0.2 µg/sample. From the recovery % values for three levels of spikes, near 95% recovery and small standard deviations (2.9 to 8.0) show the reliability of MITC recovery by the CDFA laboratory. The data were within the control limits defined. The efficacy of Morse laboratory analytical procedure is shown in Tables 7 and 8 of this report. The chemical analysis by Morse laboratory commenced on October 27, 2006.

QUALITY CONTROL

Field Spikes, Trip Spikes, and Trip Blanks

A spiked sample is a sample that is spiked with a known amount of MITC. For both field spikes and trip spikes, four sets of three different amounts of MITC were spiked on charcoal sampling tubes. Four charcoal tubes were spiked at a level of 0.2 µg/sample, four at 20.0 µg/sample and four at 200.0 µg/sample. All these samples were made on the morning of October 17 and were held on dry ice. In theory a spiked sample when exposed, should contain more MITC than the regular (unspiked) sample exposed at the same location and time. Since the spiked amount is known, the difference in MITC between spiked sample and regular sample provides an estimate of the reliability of field sampling procedures. One sample tube from each spike level was set on the additional pump along with the regular sample during interval 13 (Oct 21) and interval 15 (Oct 22) as field spikes. At the end of intervals 13 and 15, a matching set of trip spikes (the other half of the three level spiked set, but not exposed to field conditions) was added to the samples for that interval (i.e. 13 and 15). Trip spikes provide an estimate of the integrity of the sample storage and transport conditions. One trip blank (unused charcoal tube) per interval was also included for analysis. Trip blanks were handled the same way as other samples, and provided information of any contamination during handling. Therefore, at intervals 13 and 15, there were seven additional samples (3 field spikes, 3 trip spikes, and one trip blank). The extra samples from interval 13 were analyzed at Morse laboratory and the CDFA laboratory analyzed the interval 15 samples. Since all the regular samples were analyzed by Morse laboratory, the percent recovery results of seven extra samples analyzed by CDFA laboratory have an additional source of variability due to two different laboratory analytical procedures. These results are reported in Table 7.

Table 7: Results of field spikes, trip spikes and trip blanks.

Sample	Sample Type	Spiked amount µg/tube	Recovered amount from spiked sample µg/tube	Recovered amount from regular (unspiked) sample µg/tube	Difference (spiked – regular) µg/tube	% Recovery
Reporting Laboratory						
CDFA	Field Spike	0.20	16.60	17.64	-1.04	-520.00*
	Field Spike	20.00	28.10	14.70	13.40	67.00
	Field Spike	200.00	134.00	5.76	128.24	64.12
	Trip Spike	0.20	0.18	NA	NA	90.00
	Trip Spike	20.00	16.50	NA	NA	82.50
	Trip Spike	200.00	152.00	NA	NA	76.00
	Trip Blank	0.00	ND	NA	NA	NA
Morse Lab	Field Spike	0.20	11.50	10.58	0.92	460.00*
	Field Spike	20.00	89.40	72.32	17.08	85.40
	Field Spike	200.00	175.40	18.74	156.70	78.30
	Trip Spike	0.20	0.20	NA	NA	100.00
	Trip Spike	20.00	18.20	NA	NA	91.00
	Trip Spike	200.00	175.00	NA	NA	87.50
	Trip Blank	0.00	ND	NA	NA	NA

* These unusual recovery values may be associated with the experimental error relative to small spiked amounts. ND = not detected, NA=not applicable.

Except for the conflicting results for field spikes at 0.2 µg/tube concentration from two laboratories, the rest of the results show that the percent recovery values are reasonable. This gives confidence in the handling of samples in the field, in transit, and analysis methodologies of the two laboratories.

Continuing Quality Control

To assure that the Morse laboratory analyses were reliable, a set of fortified control samples was included when each batch of field samples were analyzed.

Table 8: Recovery of MITC from fortified samples at Morse laboratory.

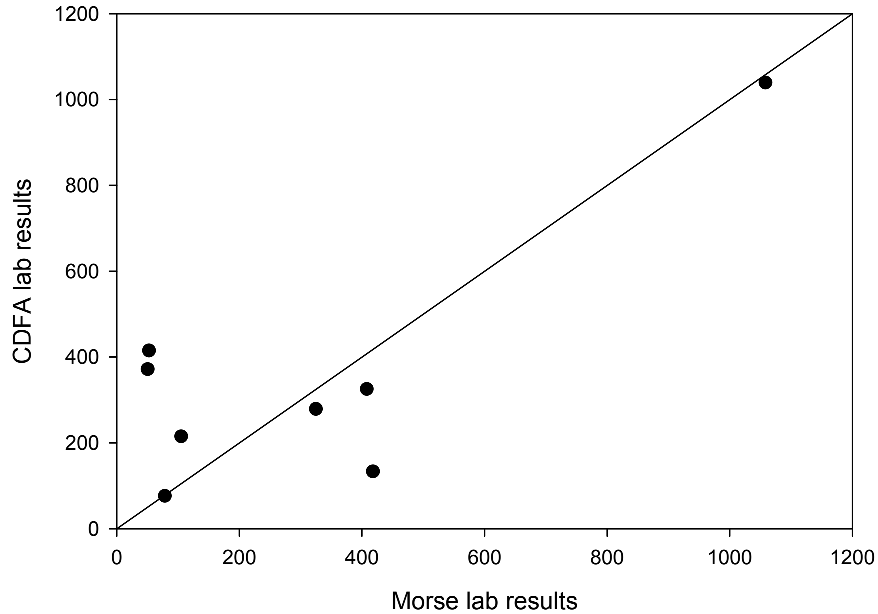
Date	Fortified Level µg/tube	Recovery Level µg/tube	% Recovery
10/30/06	0.1	0.108	108
10/30/06	10.0	8.77	88
10/31/06	0.5	0.478	96
10/31/06	10.0	10.3	103
10/31/06	0.5	0.460	92
11/01/06	0.5	0.483	97
11/01/06	50.0	50.1	100
11/01/06	0.5	0.448	90
11/01/06	50.0	45.4	91
11/02/06	0.5	0.464	93
11/02/06	100.0	89.5	90
11/02/06	0.5	0.417	83
11/02/06	100.0	80.9	81
11/06/06	0.5	0.506	101
11/06/06	100.0	96.5	97
11/07/06	0.5	0.496	99
11/07/06	200.0	171	86
11/07/06	0.5	0.482	96
11/07/06	500.0	456	91
Mean % Recovery			93.79

Table 8 shows the recovery of MITC from fortified samples during the analysis of field samples. In this analysis, the mean percent recovery was 93.79 and the standard deviation was 6.90. The standard error was 1.58, and the 95 % confidence level for percent recovery ranged from 90.46 to 97.12. Hence, the reliability of MITC recovery from the samples by the Morse laboratory analytical method was high.

Background and Collocated Samples

To assess whether any MITC was present in the ambient air prior to the experiment, four background air samples were collected from stations, 1, 2, 3 and 6 from October 17, 1800 hours to October 18, 0700 hours. The County Agricultural Commissioner's Office for Santa Cruz County was contacted to check whether any MITC generating pesticide(s) were used within a radius of one mile from the study location during the month of October 2006. They confirmed that no such use was reported. The four background samples analyzed at Morse laboratory did not detect any MITC.

Figure 5: The relationship of MITC concentration (ug/m^3) of collocated samples between Morse lab and CDFA lab



The collocated samples provide an estimate of field sampling variation. A collocated sample duplicates the regular field sample at the same location, and hence both can be compared, if no other variability was introduced during chemical analysis. It is desirable to do this assessment when the concentrations are near their peak. Therefore, at interval 2 (October 18, 1520-1850 hours), and at interval 4 (October 19, 0100-0645 hours), four extra samples per interval were collected at stations 2, 4, 6, and 8 respectively, giving 8 collocated and 8 regular samples. The regular samples were analyzed by Morse lab and the CDFA lab analyzed the collocated samples.

Table 9: The MITC concentrations (µg/m^3) of collocated samples by two laboratories.

Sample Period	Station	Morse lab results (µg/m^3)	CDFA lab results (µg/m^3)
2	2	1058.32	1039.43
2	4	78.61	76.19
2	6	52.78	415.11
2	8	105.34	215.28
4	2	324.79	278.96
4	4	417.94	133.34
4	6	50.42	371.63
4	8	407.81	325.26

There are at least two factors contributing to the variability; field variability, and laboratory analytical variability. The large variation shown by two laboratories for some of the collocated samples has no apparent explanation.

The plot of all 8 observations from two laboratories is given in Figure 5. The solid line represents a perfect correlation between the two laboratories. Regression analysis between the two labs gave a statistically significant correlation when all 8 points were used ($p<0.02$, $r^2 =0.61$, $n=8$). However, the relationship was dominated by a single high point. When the large valued data point was removed, the relationship vanished ($p>0.68$, $r^2=0.04$, $n=7$). Inadvertent spills may have lead to this high value point. Collocated samples were one of several Quality Control Quality Assurance (QAQC) samples included in this study.

Storage Stability

MITC samples kept on dry ice were stable for two weeks (Wofford et al., 2003; Leung, 1982). All samples from this study were analyzed within this period.

RESULTS AND DISCUSSION

Air Concentrations of MITC in Relation to Wind Speed and Direction

The sampler symbol and location number, MITC concentration, wind rose plot and their details for the 18 sampling intervals are given in Figure 6, as a series. Figure 6A gives the common notation and wind rose information. Figure 6B gives MITC values and wind data for the 18 sampling intervals. Other sampling interval details are given in Table 5. During interval 1 MITC production started. The station 2 during interval 2 (from 6.5 to 10.0 hours after beginning of Basamid® G application) recorded the largest MITC concentration of 1058.32 µg/m^3. This reading was corroborated by the collocated sample value of 1039.43 µg/m^3. Two small dazomet spills, west of this sampler and upwind may have affected the values recorded. Hence the measurements at this station were not used for the flux calculations.

Figure 6A: The notations and wind-rose information common to all 18 interval plots.

Δ1 = Sampler Symbol (Δ) and Station Number (1)
MITC concentration (µg/m^3) in ***Bold Italics***
Wind Direction: Blowing From
Na = Not Available

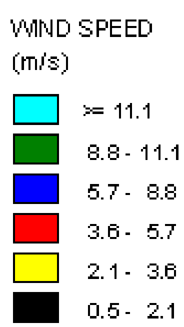


Figure 6B: MITC concentrations (µg/m³) and wind data.

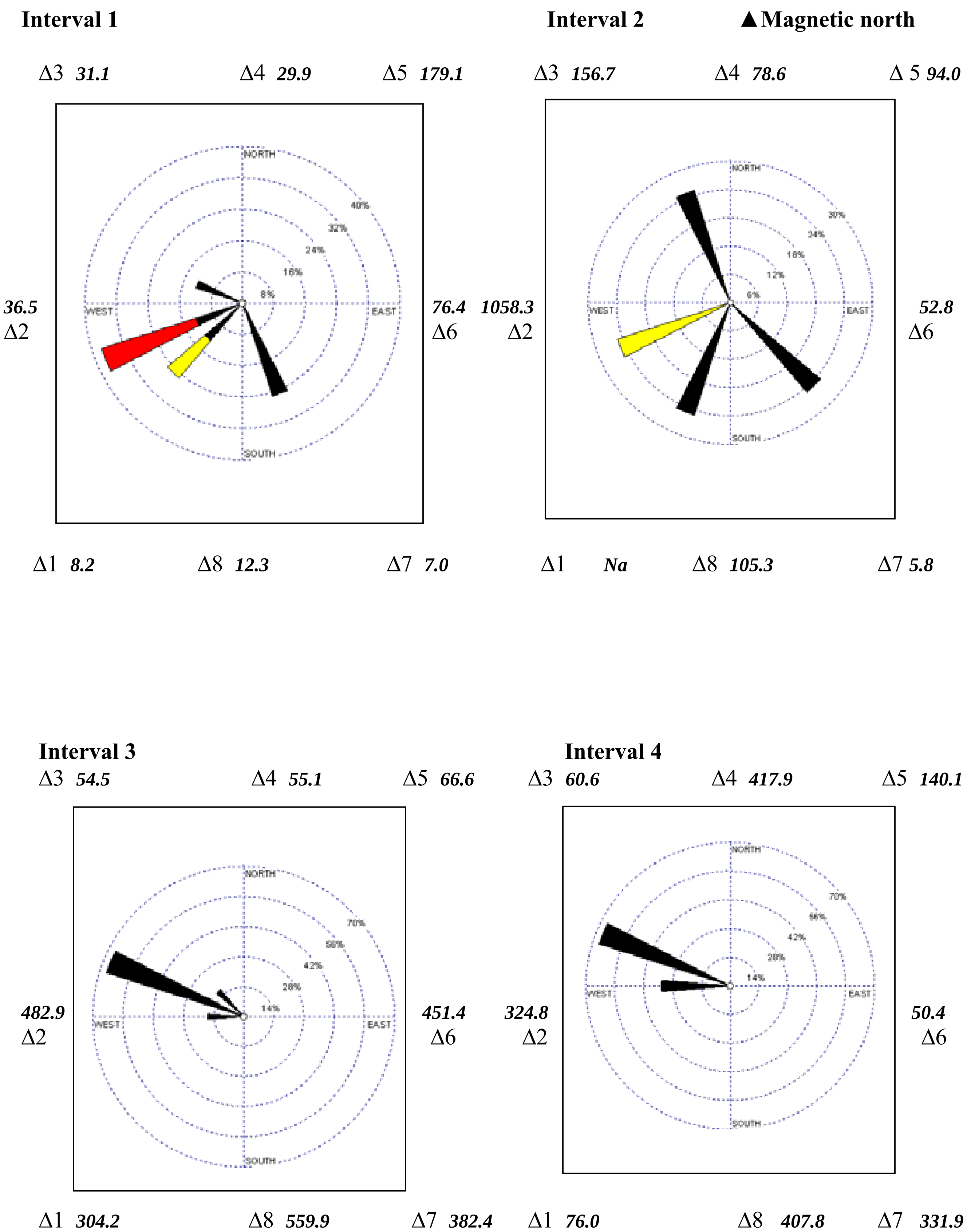
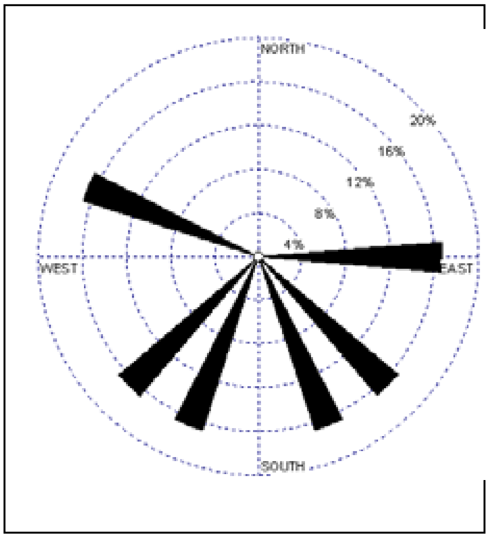


Figure 6B MITC concentrations (µg/m^3) and wind data continued.

Interval 5

Δ3 ***80.9*** Δ4 ***152.8*** Δ5 ***63.8***

198.9 Δ2



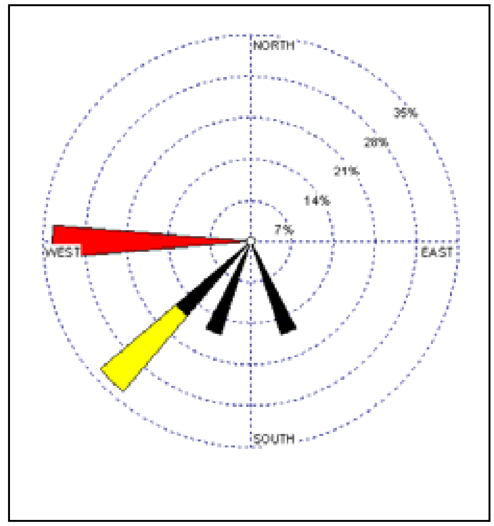
162.0 Δ6

Δ1 ***85.6*** Δ8 ***153.6*** Δ7 ***108.9***

Interval 6 **▲Magnetic north**

Δ3 ***44.7*** Δ4 ***45.7*** Δ5 ***98.8***

40.3 Δ2

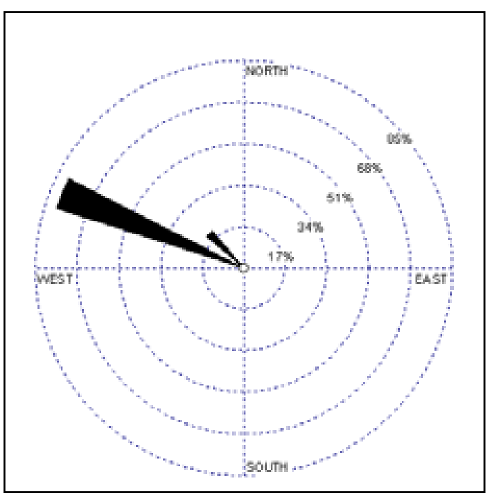


213.4 Δ6

Δ1 ***5.0*** Δ8 ***7.3*** Δ7 ***13.8***

Interval 7

Δ3 ***92.9*** Δ4 ***128.3*** Δ5 ***97.6***



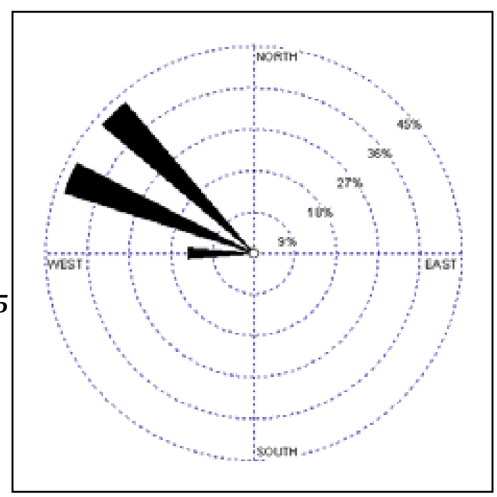
275.2 Δ2

199.4 Δ6

Δ1 ***155.2*** Δ8 ***224.9*** Δ7 ***151.1***

Interval 8

Δ3 ***62.6*** Δ4 ***86.1*** Δ5 ***71.2***



184.5 Δ2

166.4 Δ6

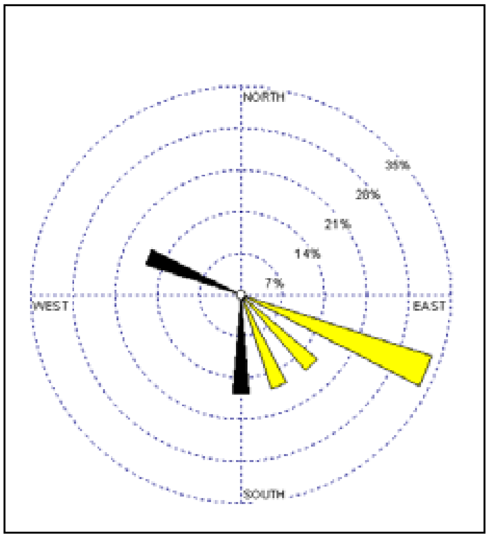
Δ1 ***80.0*** Δ8 ***209.2*** Δ7 ***184.8***

Figure 6B MITC concentrations (μg/m^3) and wind data continued.

Interval 9 | **Interval 10** | **▲Magnetic north**

Δ3 ***67.9*** Δ4 ***78.8*** Δ5 ***20.9***

136.1 Δ2

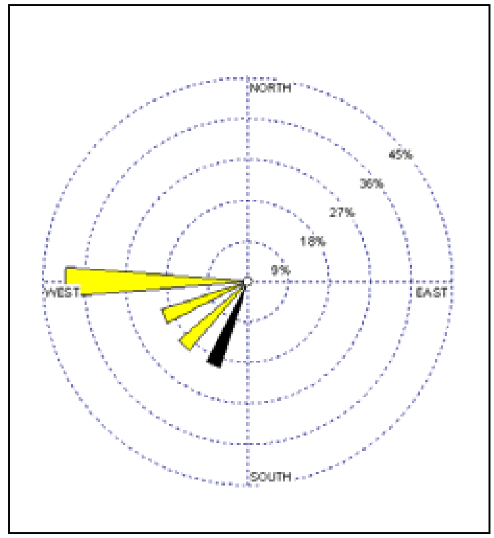


90.3 Δ6

Δ1 ***30.6*** Δ8 ***87.0*** Δ7 ***72.3***

Δ3 ***11.1*** Δ4 ***21.5*** Δ5 ***39.6***

22.3 Δ2



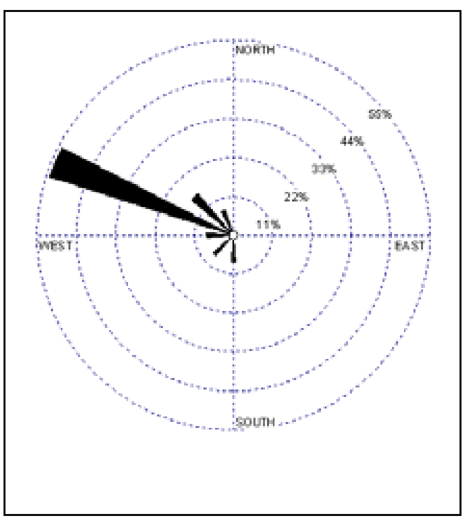
99.8 Δ6

Δ1 ***2.8*** Δ8 ***7.8*** Δ7 ***5.1***

Interval 11

Δ3 ***41.7*** Δ4 ***59.6*** Δ5 ***44.1***

137.9 Δ2



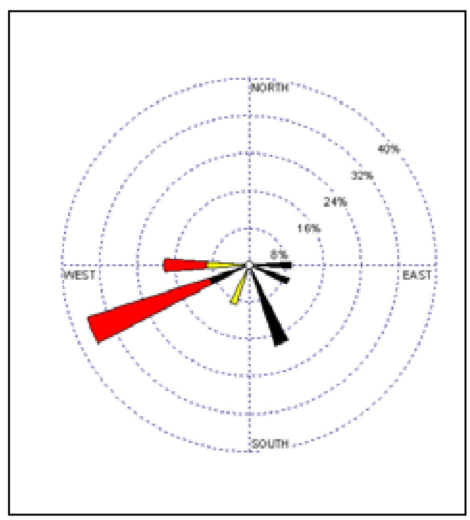
102. 3 Δ6

Δ1 ***92.4*** Δ8 ***192.7*** Δ7 ***97.4***

Interval 12

Δ3 ***9.7*** Δ4 ***18.7*** Δ5 ***27.1***

35.0 Δ2



56.2 Δ6

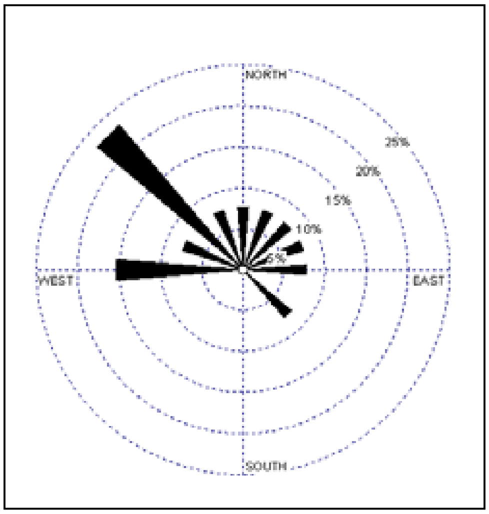
Δ1 ***11.2*** Δ8 ***21.3*** Δ7 ***10.0***

Figure 6B MITC concentrations (µg/m^3) and wind data continued.

Interval 13

Δ3 ***11.8*** Δ4 ***14.4*** Δ5 ***9.9***

95.8 Δ2



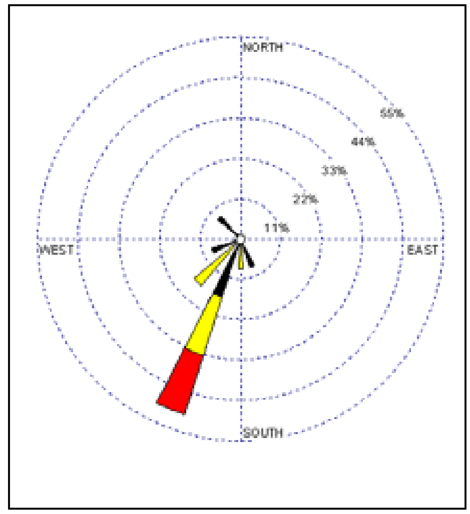
26.1 Δ6

Δ1 ***77.2*** Δ8 ***63.6*** Δ7 ***26.4***

Interval 14 ▲**Magnetic north**

Δ3 ***4.6*** Δ4 ***37.6*** Δ5 ***23.6***

7.5 Δ2



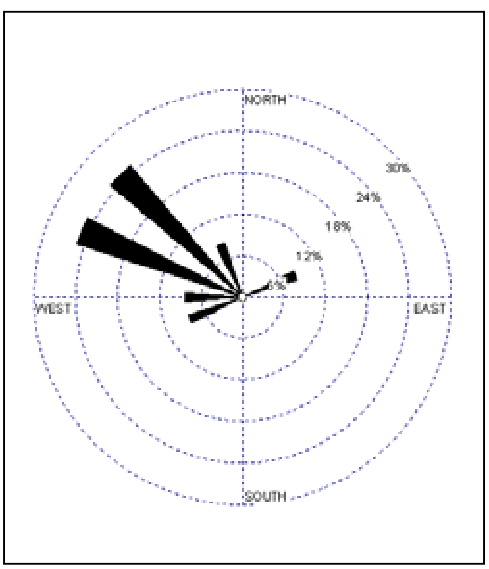
21.6 Δ6

Δ1 ***1.7*** Δ8 ***4.8*** Δ7 ***8.5***

Interval 15

Δ3 ***6.2*** Δ4 ***8.1*** Δ5 ***5.9***

26.9 Δ2



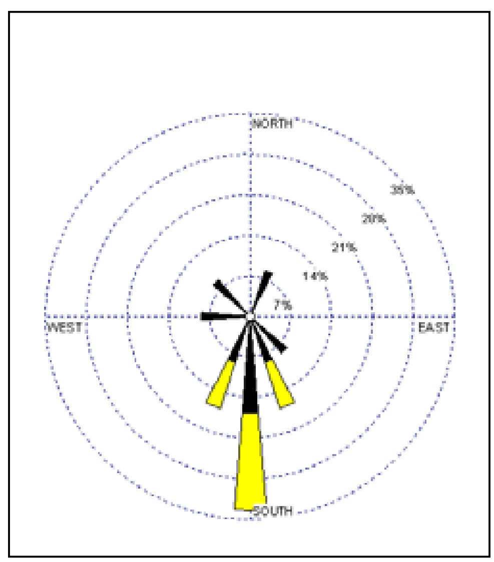
20.7 Δ6

Δ1 ***24.1*** Δ8 ***25.8*** Δ7 ***15.0***

Interval 16

Δ3 ***14.0*** Δ4 ***24.9*** Δ5 ***8.4***

14.2 Δ2



12.9 Δ6

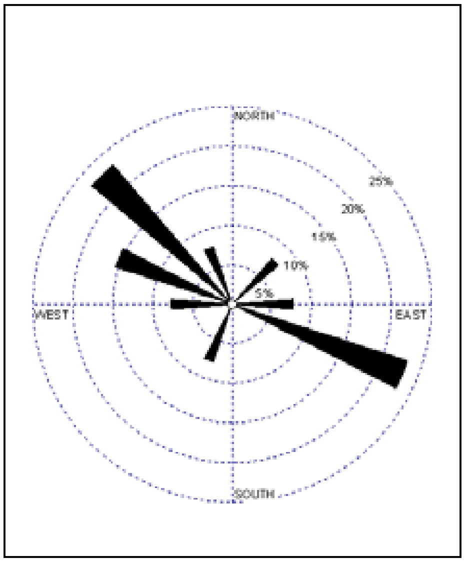
Δ1 ***1.8*** Δ8 ***3.6*** Δ7 ***3.0***

Figure 6B MITC concentrations (μg/m³) and wind data continued.

Interval 17

Δ3 ***3.1*** Δ4 ***4.3*** Δ5 ***3.1***

11.4 Δ2



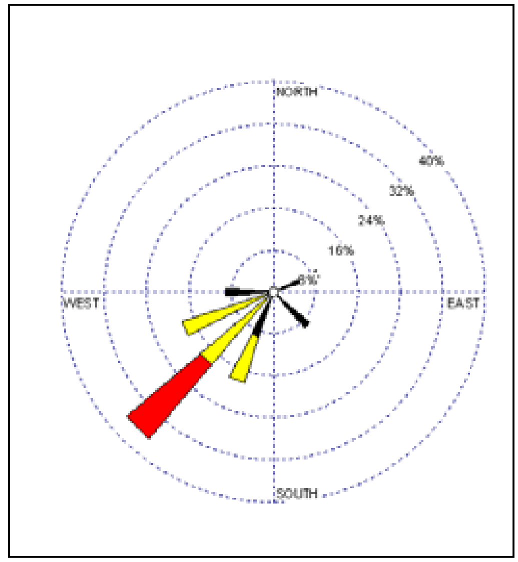
9.0 Δ6

Δ1 ***8.5*** Δ8 ***8.3*** Δ7 ***3.7***

Interval 18 **▲Magnetic north**

Δ3 ***0.8*** Δ4 ***1.9*** Δ5 ***2.6***

1.9 Δ2



3.0 Δ6

Δ1 ***0.3*** Δ8 ***0.7*** Δ7 ***0.3***

The predominant wind direction (over 40% of the time) during interval 1 (0 to 6.5 hours after the start of treatment) was from southwest to northeast. The downwind sampler, at station 5 recorded highest concentration, 179 μg/m³ of MITC for this period. Interval two was only 3 hours and 30 minutes long. If the high reading from station 2 is ignored, the MITC recorded by other stations are comparable to interval 1. The intervals 3 (10 - 16.2 hours after start of treatment) and 4 (16.2 - 22 hours after start of treatment) had higher concentrations of MITC (560 μg/m³ and 418 μg/m³ maximum values respectively) relative to intervals 1 and 2 (179 μg/m³ and 157 μg/m³ maximum values). The most frequent wind direction, over 65 % of the time for intervals 3 and 4 was from the west and north/west, and most of the high recording stations were down wind. Interval 5 (22 - 28 hours after start of treatment) showed a variation of MITC concentrations from 63.8 μg/m³ to 198.9 μg/m³, and the wind direction was variable too. During interval 6, 28 - 34 hours after start of treatment wind was mostly blowing from southwest and west to northeast and east over 70 % of the time, and down wind stations recorded more MITC than the upwind stations. This interval had wind speeds between 3.8 and 5.7 m/s, approximately 35% of the time. During the intervals 7-9 (34.0 - 52.0 hours after start of treatment), the MITC concentrations fluctuated between 20.9 and 275.2 μg/m³, but higher concentrations were frequently reported at down wind stations. From interval 10 to interval 16 (52 to 130 hours after start of treatment), the MITC concentrations gradually declined and ranged from 192.7 to 2.8 μg/m³. The wind speeds during interval 15 recorded the only calm conditions of the study (i.e. < 0.5 m/s), 16.7 percent of the time. With the completion of interval 16, collection of MITC samples was suspended. Past experience has suggested that by this duration the losses of MITC to air would be negligible (Fan et al., 2008). To test this concept, interval 17 commenced 250 hours after the start of application, which followed a 5-day suspension of sampling. This suspension is reflected as a “break” in X-axis of Figures 7 and 8. During interval 17 (250 – 262 hours after start of treatment) some MITC were detected (3.1 - 11.4 μg/m³). The last interval, i.e. interval 18 (262 – 274 hours after start of application) gave small, but detectable MITC, and in general an order of magnitude lower than that of interval 17. Table 10 gives the data used in Figures 7 and 8.

Table 10: Details of maximum wind speed (m/s), maximum concentrations (µg/m^3) of MITC, average wind speed (m/s) and average concentrations (µg/m^3) of MITC values for 18 sampling intervals.

Interval	Date	Time of day	Hours after start of application	Maximum wind speed m/s	Maximum concentration detected (µg/m^3)	Average wind speed m/s	Average concentration detected (µg/m^3)
BG*	17/18	night	NA	NA	ND	NA	ND
1	18	day	6.5	5.2	179.1	2.1	47.6
2	18	day	10	5.3	156.7**	2.5	82.2
3	18/19	night	16.2	2.5	559.9	0.9	294.6
4	19	night	22	2.3	417.9	1.7	226.2
5	19	day	28	2.5	198.9	1.0	125.8
6	19	day	34	5.1	213.4	2.8	58.6
7	19/20	night	40	2.8	275.2	1.0	165.6
8	20	night	46	2.2	209.2	1.2	130.6
9	20	day	52	4.4	136.1	1.7	73.0
10	20	day	58	3.9	99.8	2.4	26.2
11	20/21	night	70	3.0	192.7	1.2	96.0
12	21	day	82	6.2	56.2	2.7	23.7
13	21/22	night	94	2.1	95.8	1.0	40.6
14	22	day	106	5.1	37.6	2.3	13.7
15	22/23	night	118	2.1	26.9	0.6	16.6
16	23	day	130	4.7	24.9	1.8	10.3
17	28/29	night	262	2.8	11.4	1.1	6.4
18	29	day	274	4.9	3.0	2.3	1.4

NA=Not applicable ND= Not detected.
*BG = Background samples
**Note: The high concentration value of 1058.32 µg/m^3 MITC was not used in the Figures 7 and 8, and also omitted from flux and average concentration calculations.

Figures 7 and 8 and Table 10 show that high MITC concentrations coincided with low wind speeds. This is true for both maximum (Figure 7) and average (Figure 8) wind speeds and MITC concentration values.

Figure 7: Maximum MITC concentration and maximum wind speed over time

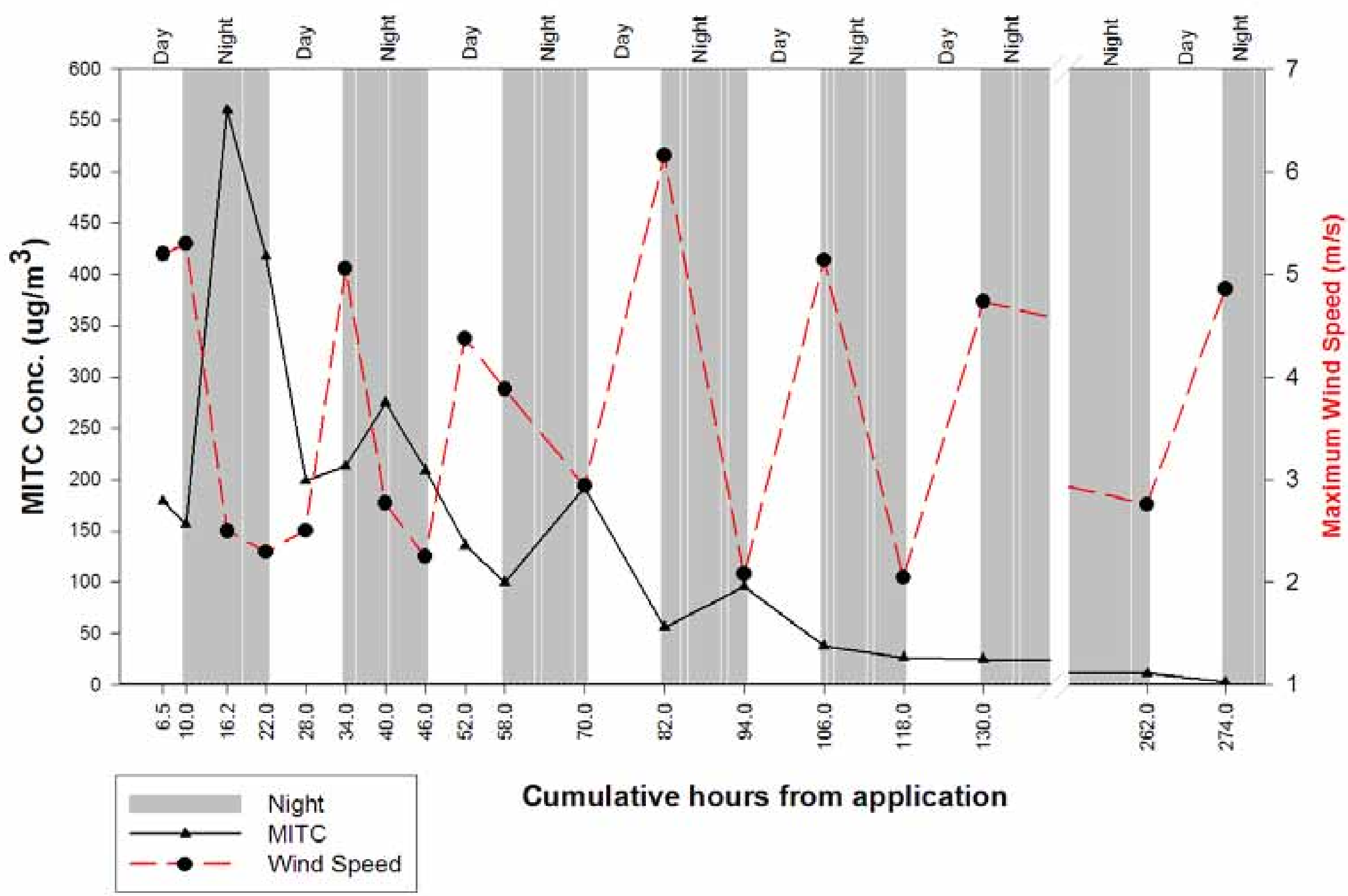
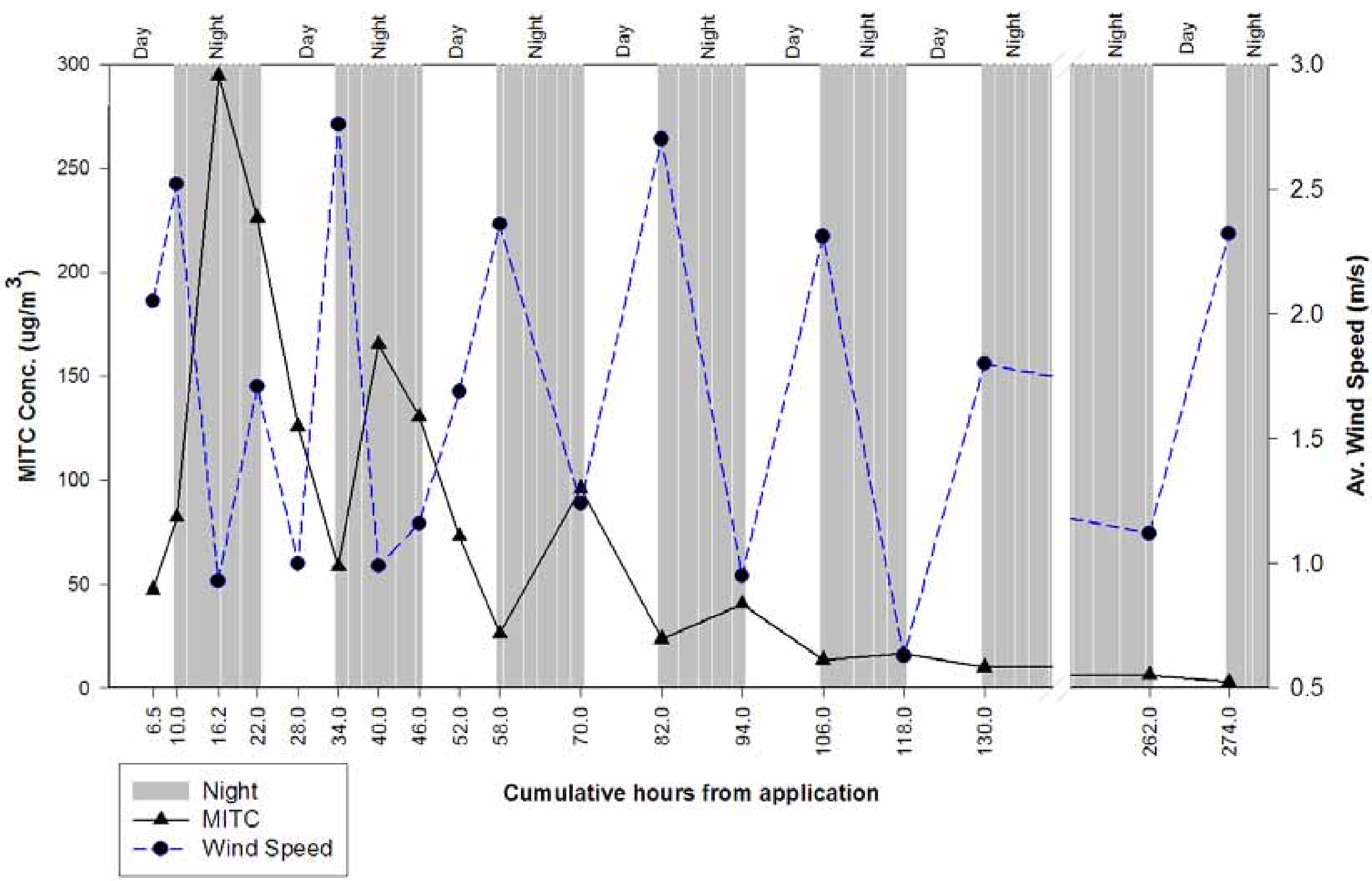


Figure 8: Average MITC concentration and average wind speed over time



Photograph 1: Google Earth hybrid map of the research field.

Photograph 2: Application of Basamid® G.

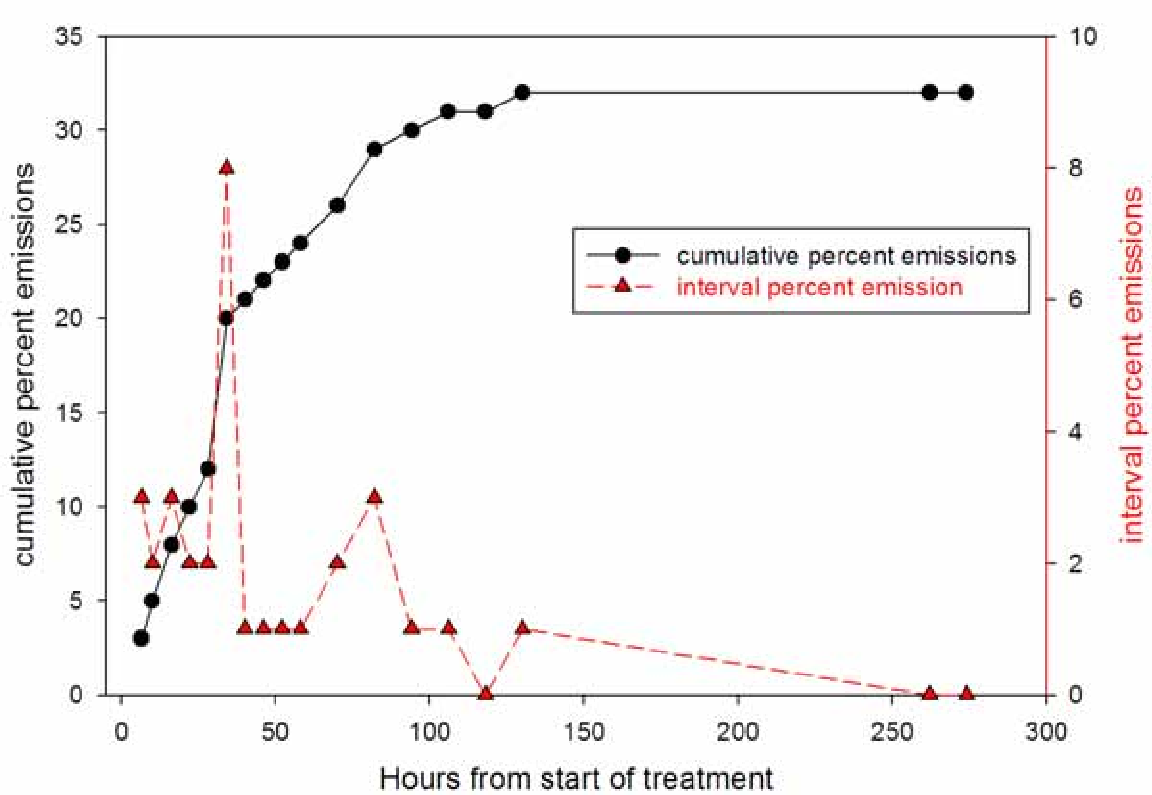
Photograph 3: View of the trial field from location (station) 1, looking to the north. The sampler assembly pumps are covered by black polyethylene to protect from water.

RESULTS OF MODELING

Flux Estimation and emission of MITC:

Appendix 5 presents modeling and back-calculation estimates of flux. By the end of the study (sampling interval 18, and 274 hours after the start of Basamid® G application), 32% of applied equivalent of MITC was emitted from the plot. Fan et al. 2008 estimated a loss of 43 % of the applied MITC in 5-days. In this study, 31 % of the applied MITC was emitted during a similar period (end of interval 14). In conducting regression analysis to estimate flux, only 3 out of the 18 simulated periods (intervals) showed significant r^2 values at $p = 0.05$. When the measured and modeled concentrations for each of the 15 non-significant intervals were sorted and reanalyzed, r^2 values improved. Figure 9 shows the cumulative percent and interval percent emissions of MITC. From the cumulative percent emission curve it is clear that the rapid losses took place from about 10 hours up to about 70 hours after the start of Basamid® G application. As for individual interval percent emission, the first five intervals reported losses between 2 and 3 % per interval, and the 6th interval (34 hours after the start of application) lost the highest amount of 8 % (Figure 9, right-handed axis). Ten percent of applied MITC equivalent (9,140g) was emitted to air by the end of first 24-hr period. Twelve percent or 10,969g of MITC equivalent was emitted during the second 24-hr period (Appendix 5). By the end of interval 6, the cumulative percent emission of MITC was 20 and by the end of interval 13, this value was 30. During interval 16, and 130 hours after start of application, 1% of the applied MITC was emitted from the plot, and became negligible during last two intervals.

Figure 9: MITC cumulative and interval emissions calculated from flux estimates as a percentage of applied MITC equivalent



(Adapted from Appendix 5: Flux memo).

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Appendix 1: Detailed information for all sampling locations and intervals.

Inter val	Location	Sample #	Flow On	Flow Off	Time On	Time Off	Cal.run time	µg/tube	Mean flow rate	Flow rate L/minute	Results Air Conc. µg/m^3	ppb
1	1	1066	1020	1150	834	1517	403	3.58	1085	1.085	8.19	2.74
1	2	1069	1004	1076	841	1521	400	15.2	1040	1.040	36.54	12.22
1	3	1068	991	1069	842	1525	403	12.9	1030	1.030	31.08	10.39
1	4	1063	1019	1027	842	1529	407	12.45	1023	1.023	29.90	10.00
1	5	1064	1013	1036	842	1517	395	72.48	1024.5	1.025	179.11	59.89
1	6	1065	1019	1100	843	1522	399	32.3	1059.5	1.060	76.41	25.55
1	7	1067	1014	1130	843	1531	408	3.08	1072	1.072	7.04	2.35
1	8	1070	1005	1054	844	1536	412	5.2	1029.5	1.030	12.26	4.10
*2	1	1062	1016	NA	1519	NA	NA	NA	NA	NA	NA	NA
**2	2	1345	1035	1013	1523	1858	215	233	1024	1.024	1058.32	353.90
2	3	1349	1017	1017	1526	1905	219	34.9	1017	1.017	156.70	52.40
2	4	1053	1023	1024	1530	1910	220	17.7	1023.5	1.024	78.61	26.29
2	5	1074	1025	1001	1519	1849	210	20	1013	1.013	94.02	31.44
2	6	1079	998	960	1525	1854	209	10.8	979	0.979	52.78	17.65
2	7	1080	1002	916	1532	1900	208	1.16	959	0.959	5.82	1.94
2	8	1073	1007	947	1537	1903	206	21.2	977	0.977	105.34	35.22
2	2	1342	1000	1018	1533	1858	205	215	1009	1.009	1039.43	347.58
2	4	1341	1042	1070	1530	1910	220	17.7	1056	1.056	76.19	25.48
2	6	1078	1002	997	1527	1855	208	86.3	999.5	1.000	415.11	138.81
2	8	1071	1017	1035	1538	1904	206	45.5	1026	1.026	215.28	71.99
3	1	1061	1007	1006	1849	103	374	114.5	1006.5	1.007	304.17	101.72
3	2	1336	1015	1000	1900	110	370	180	1007.5	1.008	482.86	161.47
3	3	1348	1015	994	1905	118	373	20.4	1004.5	1.005	54.45	18.21
3	4	1346	1027	1024	1911	122	371	20.96	1025.5	1.026	55.09	18.42
3	5	1076	995	1023	1851	104	373	25.08	1009	1.009	66.64	22.28
3	6	1072	1029	1045	1856	109	373	174.6	1037	1.037	451.39	150.95
3	7	1335	995	991	1901	115	374	142	993	0.993	382.36	127.86
3	8	1350	977	1016	1906	120	376	209.8	996.5	0.997	559.94	187.24
4	1	1121	995	986	103	649	346	26.05	990.5	0.991	76.01	25.42
4	2	1125	1011	977	111	656	345	111.38	994	0.994	324.79	108.61
4	3	1124	994	972	118	702	344	20.48	983	0.983	60.56	20.25
4	4	1223	1024	1015	124	709	345	147	1019.5	1.020	417.94	139.76
4	5	1216	1025	1029	106	650	344	49.5	1027	1.027	140.11	46.85
4	6	1123	952	980	110	658	348	16.95	966	0.966	50.42	16.86
4	7	1214	980	985	117	700	343	111.86	982.5	0.983	331.93	111.00
4	8	1219	995	960	122	706	344	137.13	977.5	0.978	407.81	136.37
4	2	1127	1010	1012	111	756	345	97.3	1011	1.011	278.96	93.28
4	4	1126	1014	1038	124	709	345	47.2	1026	1.026	133.34	44.59
4	6	1229	997	967	110	658	348	127	982	0.982	371.63	124.27
4	8	1233	985	1017	122	706	344	112	1001	1.001	325.26	108.77
5	1	1340	997	1053	649	1248	359	31.48	1025	1.025	85.55	28.61
5	2	1129	1010	1057	658	1253	355	72.96	1033.5	1.034	198.86	66.50
5	3	1056	1026	1100	702	1258	356	30.6	1063	1.063	80.86	27.04
5	4	1128	1009	1058	710	1304	354	55.9	1033.5	1.034	152.79	51.09
5	5	1320	1027	1040	651	1249	358	23.62	1033.5	1.034	63.84	21.35
5	6	1199	978	1057	658	1255	357	58.85	1017.5	1.018	162.01	54.18
5	7	1337	975	1091	701	1258	357	40.15	1033	1.033	108.87	36.41
5	8	1338	998	1076	708	1302	354	56.4	1037	1.037	153.64	51.38
6	1	1228	1033	986	1248	1848	360	1.83	1009.5	1.010	5.04	1.68
6	2	1221	1050	1046	1253	1852	359	15.16	1048	1.048	40.29	13.47
6	3	1225	1034	1022	1258	1856	358	16.44	1028	1.028	44.67	14.94
6	4	1222	1026	1007	1304	1900	356	16.54	1016.5	1.017	45.71	15.28
6	5	1334	1027	1013	1251	1849	258	26	1020	1.020	98.80	33.04
6	6	1343	968	925	1255	1852	357	72.1	946.5	0.947	213.38	71.35
6	7	1339	987	904	1259	1856	357	4.66	945.5	0.946	13.81	4.62

6	8	1204	976	920	1303	1900	357	2.48	948	0.948	7.33	2.45
7	1	1227	1024	967	1848	49	361	55.76	995.5	0.996	155.16	51.88
7	2	1224	1050	1016	1852	55	363	103.2	1033	1.033	275.22	92.03
7	3	1226	1027	998	1856	102	366	34.44	1012.5	1.013	92.94	31.08
7	4	1220	1011	999	1900	107	367	47.32	1005	1.005	128.30	42.90
7	5	1205	1020	1031	1850	49	359	35.92	1025.5	1.026	97.57	32.63
7	6	1203	969	980	1853	52	359	69.76	974.5	0.975	199.40	66.68
7	7	1202	976	988	1857	56	359	53.28	982	0.982	151.13	50.54
7	8	1208	966	921	1859	59	360	76.4	943.5	0.944	224.93	75.22
8	1	1315	998	967	49	648	359	28.2	982.5	0.983	79.95	26.74
8	2	1087	1020	1007	55	654	359	67.12	1013.5	1.014	184.47	61.69
8	3	1089	998	986	102	659	357	22.18	992	0.992	62.63	20.94
8	4	1075	1004	988	107	703	356	30.52	996	0.996	86.07	28.78
8	5	1200	1033	1040	50	649	359	26.48	1036.5	1.037	71.16	23.80
8	6	1207	995	984	53	654	361	59.44	989.5	0.990	166.40	55.64
8	7	1201	995	993	56	657	361	66.32	994	0.994	184.82	61.80
8	8	1206	975	918	100	700	360	71.28	946.5	0.947	209.19	69.95
9	1	1091	1022	1063	648	1249	361	11.51	1042.5	1.043	30.58	10.23
9	2	1101	1012	1068	654	1253	359	50.8	1040	1.040	136.06	45.50
9	3	1316	993	1062	659	1258	359	25.04	1027.5	1.028	67.88	22.70
9	4	1077	993	1063	703	1302	359	29.08	1028	1.028	78.80	26.35
9	5	1106	1030	1040	650	1250	360	7.79	1035	1.035	20.91	6.99
9	6	1103	990	1021	655	1253	358	32.5	1005.5	1.006	90.29	30.19
9	7	1109	998	1067	658	1256	358	26.72	1032.5	1.033	72.29	24.17
9	8	1104	1012	1040	701	1300	359	32.03	1026	1.026	86.96	29.08
10	1	1317	1027	987	1249	1750	361	0.998	1007	1.007	2.75	0.92
10	2	1352	1002	1012	1253	1753	360	8.07	1007	1.007	22.26	7.44
10	3	1333	1017	1029	1258	1757	359	4.06	1023	1.023	11.05	3.70
10	4	1318	1055	1014	1302	1801	359	8	1034.5	1.035	21.54	7.20
10	5	1108	1044	1047	1251	1749	298	12.33	1045.5	1.046	39.58	13.23
10	6	1110	1032	1033	1254	1752	298	30.7	1032.5	1.033	99.78	33.37
10	7	1099	960	952	1256	1756	300	1.463	956	0.956	5.10	1.71
10	8	1107	1009	957	1301	1759	298	2.29	983	0.983	7.82	2.61
11	1	1230	1012	946	1750	653	783	70.8	979	0.979	92.36	30.89
11	2	1236	1014	958	1753	658	785	106.75	986	0.986	137.92	46.12
11	3	1237	1031	952	1757	703	786	32.52	991.5	0.992	41.73	13.95
11	4	1234	1020	996	1801	706	785	47.15	1008	1.008	59.59	19.93
11	5	1145	1036	1035	1750	652	782	35.68	1035.5	1.036	44.06	14.73
11	6	1150	1035	984	1753	656	783	80.88	1009.5	1.010	102.32	34.22
11	7	1149	974	928	1757	659	782	72.4	951	0.951	97.35	32.55
11	8	1148	976	968	1800	703	783	146.63	972	0.972	192.66	64.43
12	1	1238	1021	1082	653	1837	707	8.31	1051.5	1.052	11.18	3.74
12	2	1231	1028	1056	658	1844	706	25.78	1042	1.042	35.04	11.72
12	3	1235	1041	1080	703	1850	707	7.29	1060.5	1.061	9.72	3.25
12	4	1232	995	1009	706	1856	710	13.32	1002	1.002	18.72	6.26
12	5	1134	1035	1025	653	1838	705	19.68	1030	1.030	27.10	9.06
12	6	1135	979	981	657	1841	704	38.8	980	0.980	56.24	18.81
12	7	1136	995	1020	700	1846	706	7.09	1007.5	1.008	9.97	3.33
12	8	1140	977	973	704	1850	706	14.64	975	0.975	21.27	7.11
13	1	1197	1027	903	1837	652	735	54.75	965	0.965	77.19	25.81
13	2	1196	1046	1009	1844	659	735	72.32	1027.5	1.028	95.76	32.02
13	3	1192	1025	963	1850	705	735	8.59	994	0.994	11.76	3.93
13	4	1190	1009	991	1856	710	734	10.58	1000	1.000	14.41	4.82
13	5	1137	1026	1034	1839	652	733	7.47	1030	1.030	9.89	3.31
13	6	1133	985	972	1842	656	734	18.74	978.5	0.979	26.09	8.73
13	7	1132	1023	985	1847	701	734	19.48	1004	1.004	26.43	8.84
13	8	1138	972	943	1851	704	733	44.65	957.5	0.958	63.62	21.27
13	2	1112	1005	995	1844	659	735	89.4	1000	1.000	121.63	40.67
13	4	1097	1045	1046	1856	710	734	11.5	1045.5	1.046	14.99	5.01
13	6	1090	1010	1080	1844	658	734	175.4	1045	1.045	228.67	76.47

14	1	1195	1003	1007	652	1853	721	1.2	1005	1.005	1.66	0.55
14	2	1194	1015	1024	659	1857	718	5.5	1019.5	1.020	7.51	2.51
14	3	1198	1000	1014	705	1900	715	3.31	1007	1.007	4.60	1.54
14	4	1193	994	999	710	1905	715	26.8	996.5	0.997	37.61	12.58
14	5	1144	1034	1034	653	1854	721	17.56	1034	1.034	23.55	7.88
14	6	1147	972	1000	657	1857	720	15.32	986	0.986	21.58	7.22
14	7	1143	996	1031	702	1903	721	6.24	1013.5	1.014	8.54	2.86
14	8	1142	970	943	705	1905	720	3.3	956.5	0.957	4.79	1.60
15	1	1213	1046	965	1853	648	715	17.3	1005.5	1.006	24.06	8.05
15	2	1210	1032	1008	1857	652	715	19.58	1020	1.020	26.85	8.98
15	3	1212	1021	981	1900	657	717	4.42	1001	1.001	6.16	2.06
15	4	1215	999	983	1905	703	718	5.76	991	0.991	8.10	2.71
15	5	1161	1036	1039	1855	648	713	4.37	1037.5	1.038	5.91	1.98
15	6	1167	1001	988	1858	652	714	14.7	994.5	0.995	20.70	6.92
15	7	1168	1022	1011	1904	657	713	10.9	1016.5	1.017	15.04	5.03
15	8	1165	981	932	1906	700	714	17.64	956.5	0.957	25.83	8.64
15	4	1182	1029	1040	1905	703	718	134	1034.5	1.035	180.41	60.33
15	6	1118	998	1018	1900	654	714	28.1	1008	1.008	39.04	13.06
15	8	1117	1020	1050	1907	704	717	16.6	1035	1.035	22.37	7.48
16	1	1217	1011	1018	648	1850	722	1.314	1014.5	1.015	1.79	0.60
16	2	1218	1013	1046	652	1854	722	10.58	1029.5	1.030	14.23	4.76
16	3	1211	1002	1054	657	1856	719	10.35	1028	1.028	14.00	4.68
16	4	1187	987	1018	703	1859	716	17.84	1002.5	1.003	24.85	8.31
16	5	1115	1008	988	649	1852	723	6.04	998	0.998	8.37	2.80
16	6	1111	989	1001	653	1854	721	9.24	995	0.995	12.88	4.31
16	7	1113	1015	1041	658	1856	718	2.218	1028	1.028	3.00	1.00
16	8	1120	970	992	701	1859	718	2.54	981	0.981	3.61	1.21
17	1	1083	1027	983	1842	645	723	6.2	1005	1.005	8.53	2.85
17	2	1162	994	1039	1845	650	725	8.41	1016.5	1.017	11.41	3.82
17	3	1163	989	1015	1849	654	725	2.23	1002	1.002	3.07	1.03
17	4	1164	1004	1033	1851	658	726	3.21	1018.5	1.019	4.34	1.45
17	5	1159	993	1005	1845	648	723	2.26	999	0.999	3.13	1.05
17	6	1157	1018	1047	1847	654	727	6.78	1032.5	1.033	9.03	3.02
17	7	1160	1008	1010	1850	659	729	2.7	1009	1.009	3.67	1.23
17	8	1158	1002	1025	1854	704	730	6.15	1013.5	1.014	8.31	2.78
18	1	1081	989	956	646	1846	720	0.24	972.5	0.973	0.34	0.11
18	2	1088	1009	994	651	1848	717	1.33	1001.5	1.002	1.85	0.62
18	3	1086	1023	1049	656	1851	715	0.56	1036	1.036	0.76	0.25
18	4	1084	990	1021	700	1853	713	1.39	1005.5	1.006	1.94	0.65
18	5	1152	1005	1040	650	1847	717	1.89	1022.5	1.023	2.58	0.86
18	6	1151	978	998	655	1850	715	2.09	988	0.988	2.96	0.99
18	7	1155	980	993	700	1854	714	0.19	986.5	0.987	0.27	0.09
18	8	1153	1035	1049	705	1857	712	0.48	1042	1.042	0.65	0.22

* = The sampler pump failed, no sample for this period NA = Not available ** Records from this sampler were disregarded in flux estimations.

Appendix 2: The template of Chain of Custody form.

California Department of
Pesticide Regulation
Environmental Monitoring
1001 I Street
Sacramento, CA 95812-4015

Chain of Custody Record
and Lab Result Report
(use dark blue or black ink only)

California Department of
Food and Agriculture
Center for Analytical Chemistry
Environmental Monitoring Section
3292 Meadowview Road
Sacramento, CA 95832

Air Monitoring Study

Study #	Date Start			Date End			Site: W A T S O N V I L L E
	Month	Day	Year	Month	Day	Year	
2 1 2							Crew:

Laboratory Results Section: Lab results relate only to the sample tested

First Sample

Sample Number	Location Code	Interval #	Machine #	Notes:		
Flow Rate On	Flow Rate Off	Time On	Time Off	Run time	PST	PDT

Lab Number	Analyte	Amount	RL
20______-	*MITC*		
_______			

Second Sample

Sample Number	Location Code	Interval #	Machine #	Notes:		
Flow Rate On	Flow Rate Off	Time On	Time Off	Run time	PST	PDT

Lab Number	Analyte	Amount	RL
20______-	*MITC*		
_______			

Third Sample

Sample Number	Location Code	Interval #	Machine #	Notes:		
Flow Rate On	Flow Rate Off	Time On	Time Off	Run time	PST	PDT

Lab Number	Analyte	Amount	RL
20______-	*MITC*		
_______			

Fourth Sample

Sample Number	Location Code	Interval #	Machine #	Notes:		
Flow Rate On	Flow Rate Off	Time On	Time Off	Run time	PST	PDT

Lab Number	Analyte	Amount	RL
20______-	*MITC*		
_______			

Field Notes:

Lab Notes:

Tube Type:

☐ SKC #__________

☐ Supelco #__________

☐ Hand packed By:__________ Type:__________

☐ Other __________

1. Sample started	Date/Time	Extracted by:	Date
2. Sample finished	Date/Time	Analyzed by:	Date
3. Sample transport	Date/Time	Approved by:	Date
4. QA staff receiving	Date/Time	Method #	Confirmation #
5. Relinquished to CDFA Lab	Date/Time	Received by at lab	Date/Time
6.	Date/Time	Logged in by lab	Date/Time

Appendix 3: Morse laboratory MITC analytical method <http://em/docs/pubs/chem/chem.htm>.

MEMO TO THE STUDY FILE

DATE: 12-8-06

RE: GC conditions for charcoal tubes.

Project Number: ML06-1325-CER
Protocol Number: Study #212 (non-glp)

FROM: Kevin Clark

The following conditions were used to analyze samples for MITC in charcoal tubes.

1. Column: Rtx-50 30m x 0.53mm id x 1.0µm film thickness.

2. Column temperature: 90°C isothermal

3. Column Flow : He @ 10mL/min

4. RT : ~3.0 min.

5. Inlet Temp: 240°C
   Detector Temp: 260°C

The standard concentrations used for analysis were 0.012, 0.025, 0.05, 0.10 and 0.20 µg/mL.

Kevin Clark

ML 261A 7/99

Appendix 4: CDFA laboratory MITC analytical method.

Dpr 282

California Department of Food and Agriculture
Center for Analytical Chemistry
Environmental Monitoring Section
3292 Meadowview Road
Sacramento, CA 95832

EMON-SM 41.9
Revision: 2nd
Revision Date: 5/25/2004
Original Date: 7/05/1998
Page 1 of 12

Title: Determination of MITC in Air By GC/NPD or GC/TSD

1. Scope

   This section method (SM) is for the analysis of MITC from air sample tubes using GC/NPD or GC/TSD and is to be followed by all authorized EMON section personnel. The reporting limit of MITC is 0.2 µg per sample by NPD and 0.05 µg per sample by TSD.

2. Principle:

   Residues of MITC (methyl isothiocyanate), $CH_3-N=C=S$, that has been absorbed from the air onto activated charcoal is desorbed from the charcoal with 0.1% CS_2 in ethyl acetate. It is analyzed by gas chromatography using a nitrogen phosphorus detector (GC/NPD or GC/TSD).

3. Safety:

   3.1 All general laboratory safety rules for sample preparation and analysis shall be followed.
   3.2 All solvents should be handled with care in a ventilated area.

4. Interferences:

   No known matrix interferences that cause quantitative problems above the established reporting level. However, nitrogen or phosphorus compounds with the same retention time may interfere with the quantification.

5. Apparatus and Equipment:

   5.1 Test tubes, 25 mL, with Teflon lined screw cap
   5.2 Assorted pipettes and micro syringes
   5.3 Volumetric flasks
   5.4 Files able to score the sample tubes or a Dremel (an electric rotary flex shaft tool) with ¾" diamond saw
   5.5 Thermolyne Vortex Maxi mixer
   5.6 Forceps
   5.7 Plug puller, Supelco #2-0596

Mary-Ann Warmerdam
Director

MEMORANDUM

Arnold Schwarzenegger
Governor

Appendix :5 Flux Memo

TO: Pam Wofford
Senior Environmental Scientist, Supervisor
Environmental Monitoring Branch
(916) 324-4297

FROM: Tamara Roush, Ph.D.
Environmental Research Scientist
Environmental Monitoring Branch
(916) 324-4279

DATE: May 2, 2007

SUBJECT: FLUX ESTIMATION AND EMISSION OF MITC RESULTING FROM A SMALL PLOT APPLICATION OF DAZOMET IN WATSONVILLE, CA

In October 2006, the Department of Pesticide Regulation conducted a small plot study in conjunction with Plant Sciences, Inc. to monitor MITC concentrations in air around the field from an application of dazomet. In total, 452 pounds (205 kg) BasamidG® were applied by granular spreader to a fallow, 1.0175 acre (0.4118 ha) plot at Plant Sciences, Inc., Nakano Complex, Watsonville, California. Application began October 18, 2006 at 0845. It took 2 hours 15 minutes to complete, and a sprinkler system was activated approximately 30 minutes after the application finished to incorporate the pesticide into the soil. This first irrigation session lasted 3 hours 15 minutes; intermittent watering continued over the next few days. Air monitoring with eight receptors (numbered 1 through 8) began 12 hours before application for a background sample and continued for six consecutive days and a total of 16 sampling periods. Data for the 17^{th} and 18^{th} sampling periods were collected five days after the 16^{th} period. Parakrama (Gura) Gurusinghe will report on this study and its results in greater detail.

Tammy Roush conducted modeling and back-calculation of the flux rates following methods established by Johnson et al. (1999). ISCST3 (U.S. EPA 1995) was used to model the application. Pam Wofford and Tammy used WEATH6 to convert data recorded by CDPR's weather station into the format required by ISCST3. The wind direction was calculated from magnetic north, which matched the orientation of the test plot. The receptor coordinates were input into the control file in the following order: 7, 8, 1, 2, 3, 4, 5, 6. Appendix A shows an example of the control file for sampling period 1 and its resulting output data.

Modeled and measured MITC concentrations were compared by regression analysis for each period. Concentration data for all periods are listed in Appendix B. Only periods six, twelve, and eighteen had significant r^2 values at alpha = 0.05. Additionally, period two showed an unusually high measured concentration of 1058 µg MITC/m^3 at receptor two. After consultation between Tammy, Pam, Gura, and Bruce Johnson, it was determined that this measurement corresponded to a small spill of BasamidG® at that receptor during application. The wind direction during this time period caused this receptor to be upwind, thus the high concentrations would not have come from the plot. We decided to remove measured and modeled data for receptor two from all analyses and re-run the regressions. Although this improved the fit of the data for all periods, six, twelve and eighteen were still the only three periods with significant r^2 values (Table 1). Consequently, measured and modeled concentrations for the 15 non-significant periods were sorted from lowest to highest and reanalyzed. After sorting, 14 of these 15 periods were significant at the 0.05 level; period four had a p-value equal to 0.07 (Table 1). Additionally, the intercepts for periods three, four, five, seven, eight, nine, ten, fifteen, and seventeen were significantly different from zero. We chose not to force them through the origin.

Table 1. Comparisons of regression analyses before and after sorting data within each sampling period. Data from receptor two were excluded from all analyses.

PERIOD	Before sorting				After sorting			
	R^2		intercept		R^2		intercept	
	Value	P	Value	P	Value	P	Value	P
1	0.18	0.336	21.99	0.552	0.75	0.012	-5.55	0.784
2	0.21	0.359	56.16	0.16	0.93	0.002	6.56	0.615
3	0.38	0.142	181.19	0.086	0.72	0.016	148.31	0.049
4	0.10	0.487	239.18	0.024	0.51	0.07	151.11	0.041
5	0.26	0.24	92.39	0.009	0.89	0.001	73.04	0.0004
6	0.80	0.007	30.53	0.108	**not sorted; no change**			
7	0.14	0.401	138.84	0.003	0.88	0.002	115.13	<0.0001
8	0.41	0.119	97.97	0.009	0.77	0.01	88.97	0.002
9	0.37	0.144	46.87	0.017	0.69	0.021	40.78	0.008
10	0.49	0.08	6.61	0.651	0.62	0.036	4.17	0.741
11	0.03	0.694	82.45	0.031	0.71	0.017	55.13	0.015
12	0.60	0.04	10.25	0.152	**not sorted; no change**			
13	0.38	0.139	13.41	0.383	0.77	0.009	5.29	0.564
14	0.35	0.162	1.96	0.835	0.50	0.06	-0.55	0.947
15	0.04	0.602	42.99	0.098	0.76	0.011	9.08	0.011
16	0.42	0.116	3.15	0.502	0.91	0.001	0.01	0.997
17	0.08	0.547	4.92	0.032	0.84	0.004	3.05	0.007
18	0.64	0.03	0.21	0.671	**not sorted; no change**			

Flux estimates from the regression analyses were used to calculate the percent emission of MITC for each period per the equation:

$$\% \text{ emission}_P = [((\text{flux}_P\ \mu g / m^2\ s^* \ 1\ g / 1 \times 10^6\ \mu g)\ \times\ (\text{total seconds}_P))/\ \text{total MITC applied } g/m^2] \times 100$$

where P = sampling period. Amount of MITC applied was calculated from the total amount of BasamidG® during the application as follows:

Application rate of BasamidG® = 452 lb (205 kg)/ 1.0175 ac (0.4118 ha)= 444 lb/ac (498 kg/ha) The active ingredient, dazomet, comprises 99% of BasamidG®, therefore application rate of dazomet = 447 lb (203 kg) / 1.0175 ac (0.4118 ha) = 440 lb/ac (493 kg/ha). Total dazomet applied = 447 lb x (453.6 g/lb) x (1 mol/162.3 g) (i.e. molecular weight of dazomet) = 1,250 mol.

Whereas Gamliel et al. (2001) estimated that 98% of the dazomet in BasamidG® breaks down into MITC after incorporation into the soil, CDPR assumes 100% degradation of dazomet into MITC. Thus, total amount of MITC applied = 1,250 mol x (73.1 g/mol) (i.e. molecular weight of MITC) = 91,405 g. The plot area measured 50.6m x 81.4m, or 4119 m^2, so the value used in the equation for percent emission for total MITC applied = 91,405g/4119m^2, or 22.2 g/m^2.

The 24-hour time-weighted average (TWA) flux rates were also calculated according to the equation: TWA = Σ (sampling hours * flux estimate) / total hours. Table 2 lists the flux estimates for each period, 24-hour TWA flux rates, percent emission, and cumulative emission. By the end of sampling period 18, 32% (29,250g) of the MITC applied was emitted from the plot. Ten percent of the MITC applied, or 9,140g, was released during the first 24-hr period. Twelve percent, 10,969 g, was released during the second 24-hr period; period six alone accounted for eight percent. Emission of MITC declined over the remainder of the monitoring. By the end of period 16, 127 hours after the application was completed, 1% MITC emitted from the plot. The 24-hr time-weighted average flux during periods 17 and 18, which began 10 d, 8h after the application ended, was 0.75 μg/m^2s. Essentially 0% MITC was emitted by this time.

Table 2. MITC emissions calculated from flux estimates for each sampling period.

Period	hours in period	Flux estimate (μg/m^2s)	% emission	TWA flux (μg/m^2s)	Cumulative % emission
1	7	29	3		3
2	4	35	2		5
3	6	26	3		8
4	6	21	2	27.0	10
5	6	17	2		12
6	6	79	8		20
7	6	8	1		21
8	6	8	1	28.0	22
9	6	11	1		23
10	6	15	1		24
11	12	9	2	6.5	26
12	12	14	3		29
13	12	7	1	10.5	30
14	12	7	1		31
15	12	1	0	4.0	31
16	12	3	1		32
17	12	0.7	0		32
18	12	0.8	0	0.75	32

References:

Gamliel et al. 2001. Application of dazomet (Basamid®) as soil fumigant: generation, movement, and dissipation of MITC and pest controls. www.agri.gov.il/AGEN/Reports/Gamli009.html.

Johnson et al. 1999. Workbook for Gaussian modeling analysis of air concentration measurements. Report EH-99-03. California Department of Pesticide Regulation.

U.S. EPA. 1995. User's Guide for the Industrial Source complex (ISC3) Dispersion Models, Volume 1. User Instructions. U.S. EPA Office of Air Quality Planning and Standards; Emissions, Monitoring, and Analysis Division, Research Triangle Park, North Carolina.

Appendix A: Control file and the first page of output data from ISCST3 for sampling interval 1.

```
CO STARTING
CO TITLEONE BASAMID TEST
CO TITLETWO PERIOD 1
CO MODELOPT CONC RURAL
CO AVERTIME PERIOD
CO POLLUTID OTHER
CO FLAGPOLE 1.20
CO RUNORNOT RUN
CO ERRORFIL D:\Gaussian\P1newERR.OUT
CO FINISHED

SO STARTING
SO LOCATION SRC0001 AREA 0.0 0.0 0.0
SO SRCPARAM SRC0001 1.e-4 0.00 50.0 81.4
SO EMISUNIT 0.100000E+07 (GRAMS/M**2/SEC) (MICROGRAMS/METER**3)
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE DISCCART 62.2 -13.91 1.20        **receptor 7
RE DISCCART 24.4 -12.3 1.20         **receptor 8
RE DISCCART -13.1 -12.78 1.20       **receptor 1
RE DISCCART -12.2 40.5 1.20         **receptor 2
RE DISCCART -13.1 93.89 1.20        **receptor 3
RE DISCCART 25.3 93.0 1.20          **receptor 4
RE DISCCART 62.2 94.87 1.20         **receptor 5
RE DISCCART 62.2 40.5 1.20          **receptor 6
RE FINISHED

ME STARTING
ME INPUTFIL D:\Gaussian\WP1.MET (4I2,2F9.4,F6.1,I2,2F7.1)
ME ANEMHGHT 10.0 METERS
ME SURFDATA 99999 2006
ME UAIRDATA 99999 2006
ME WINDCATS 2.00 3.09 5.14 8.23 10.80
ME FINISHED

OU STARTING
OU POSTFILE PERIOD ALL PLOT D:\Gaussian\P1.RAW
OU FINISHED
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* ISCST3 (02035): BASAMID TEST
* MODELING OPTIONS USED:
*  CONC                  RURAL FLAT  FLGPOL
*        POST/PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: ALL
*        FOR A TOTAL OF     8 RECEPTORS.
*        FORMAT: (3(1X,F13.5),1X,F8.2,2X,A6,2X,A8,2X,I8.8,2X,A8)
*       X           Y      AVERAGE CONC  ZELEV    AVE     GRP      NUM HRS   NET ID
* ____________ ____________ ____________ ______ ______ ________ ________ ________
     62.20000    -13.91000     25.05398    0.00  PERIOD  ALL      00000007    NA
     24.40000    -12.30000      0.02400    0.00  PERIOD  ALL      00000007    NA
    -13.10000    -12.78000      0.00000    0.00  PERIOD  ALL      00000007    NA
    -12.20000     40.50000    101.03069    0.00  PERIOD  ALL      00000007    NA
    -13.10000     93.89000    241.50749    0.00  PERIOD  ALL      00000007    NA
     25.30000     93.00000    360.79279    0.00  PERIOD  ALL      00000007    NA
     62.20000     94.87000    225.76189    0.00  PERIOD  ALL      00000007    NA
     62.20000     40.50000    453.03238    0.00  PERIOD  ALL      00000007    NA

***       02/22/07
                  *** PERIOD 1                                     ***       10:44:22
**MODELOPTs:                                                                 PAGE   6
CONC                RURAL FLAT  FLGPOL


          *** THE FIRST   7 HOURS OF METEOROLOGICAL DATA ***

   FILE:   D:\Gaussian\WP1.MET
   FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1)
   SURFACE STATION NO.:  99999              UPPER AIR STATION NO.:  99999
           NAME: UNKNOWN                             NAME: UNKNOWN
           YEAR:   2006                     YEAR:   2006

            FLOW    SPEED  TEMP  STAB  MIXING HEIGHT (M)  USTAR  M-O LENGTH   Z-0 IPCODE PRATE
YR MN DY HR VECTOR  (M/S)   (K)  CLASS   RURAL   URBAN    (M/S)     (M)       (M)      (mm/HR)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

06 10 18 08  102.9   1.19  281.7   4     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 09  328.5   1.16  285.2   3     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 10  339.6   1.15  289.3   2     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 11   57.5   1.17  293.5   2     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 12   41.7   1.42  295.6   1     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 13   41.8   2.96  295.8   2     300.0   300.0    0.0000       0.0  0.0000   0   0.00
06 10 18 14   64.9   3.76  295.6   3     300.0   300.0    0.0000       0.0  0.0000   0   0.00
```
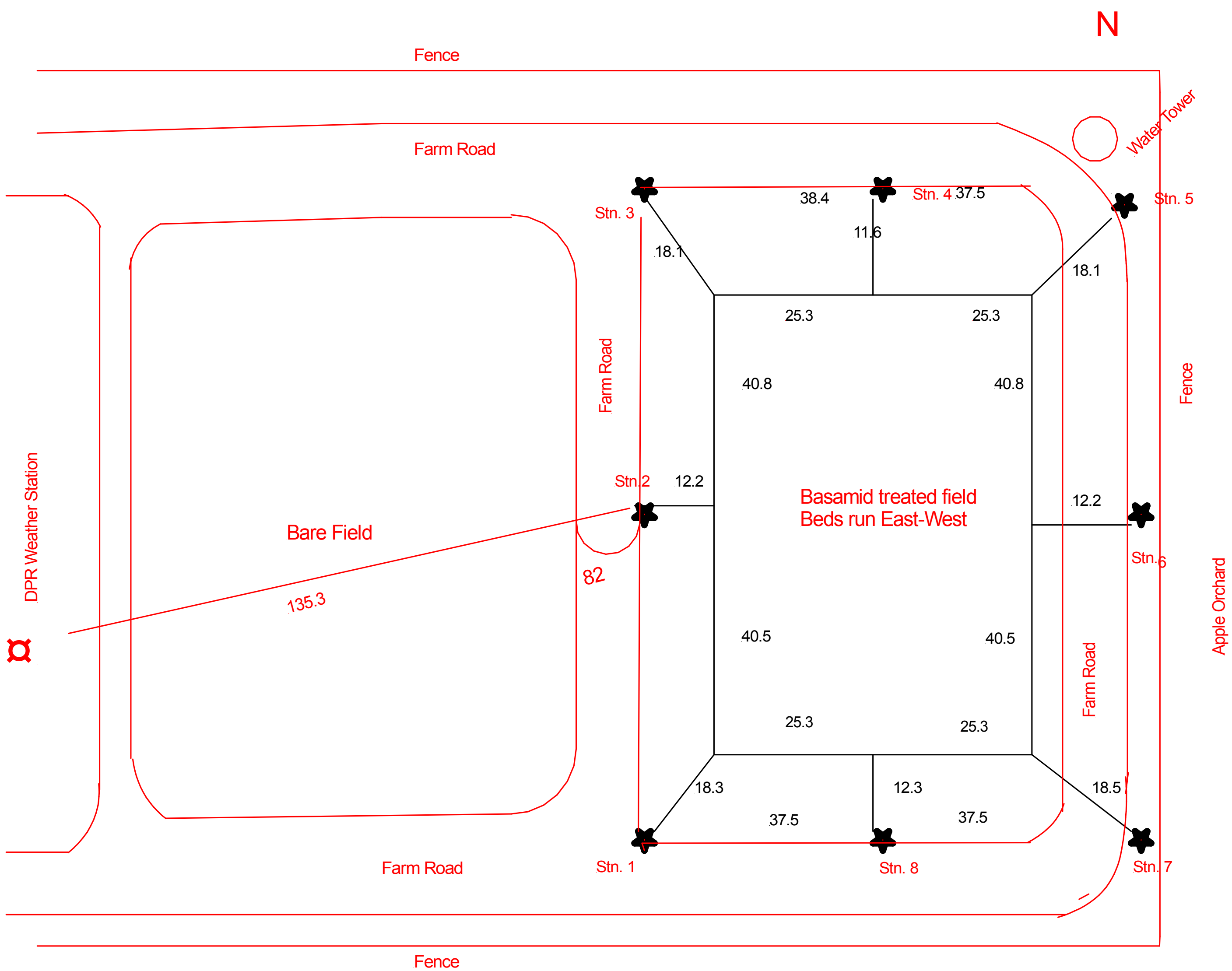

Appendix B. Measured and modeled MITC concentrations for all 18 periods.

Period	Receptor	measured	modeled	Period	Receptor	measured	modeled	Period	Receptor	measured	modeled
1	1	8.18744211	0	7	1	155.158045	0	13	1	77.19149836	415.64706
	2	.	101.03069		2	.	0		2	.	529.11945
	3	31.07759763	241.50749		3	92.9366525	0		3	11.75762055	149.76237
	4	29.90193606	360.79279		4	128.2958504	242.74641		4	14.41416894	21.55596
	5	179.1055841	225.76189		5	97.56773311	191.67982		5	9.894170784	2.10798
	6	76.40621138	453.03238		6	199.4023076	1471.31104		6	26.09232003	601.07111
	7	7.041995903	25.05398		7	151.1326439	1137.81787		7	26.43337744	620.86011
	8	12.25969813	0.024		8	224.9308132	109.18357		8	63.61780871	808.83838
2	1	5.815352531	0	8	1	79.95066874	0	14	1	1.656074689	0
	2	52.78308595	186.59724		2	.	0		2	.	8.34322
	3	78.6072745	338.37653		3	62.62989067	0		3	4.597190297	49.79597
	4	94.01588869	405.66583		4	86.07463562	0		4	37.61416707	295.5051
	5	105.335334	172.11195		5	71.16299632	0		5	23.55421897	307.35385
	6	156.6968836	208.33745		6	166.4009496	1436.2334		6	21.57989633	357.77359
	7	.	0.00004		7	184.8208364	1222.19275		7	8.539364898	286.7222
	8	.	0		8	209.1917591	157.12614		8	4.791775571	312.61777
3	1	304.1726107	0	9	1	30.58384317	0.0026	15	1	24.06345519	28.83606
	2	.	0		2	.	126.42984		2	.	141.80403
	3	54.44667895	0		3	67.88253394	136.38155		3	6.1584162	0
	4	55.09113298	0		4	78.79648396	438.55887		4	8.095140386	128.36073
	5	66.63885619	0		5	20.90713902	77.5302		5	5.907500972	284.53262
	6	451.3949033	1496.75183		6	90.28555237	545.60242		6	20.70209683	1399.64685
	7	382.3556338	1379.20374		7	72.28752688	268.21353		7	15.03932576	929.67804
	8	559.9385082	322.83984		8	86.95911863	36.09587		8	25.82946404	232.72194
4	1	76.01112301	0	10	1	2.745325657	0.13137	16	1	1.793932576	62.47061
	2	.	0		2	.	80.14397		2	.	47.17303
	3	60.56447988	0		3	11.05492884	21.07357		3	14.00291152	59.3914
	4	417.9371815	0		4	21.54095946	366.61902		4	24.85406595	488.30502
	5	140.1123163	0		5	39.57516875	312.70602		5	8.370821865	100.50159
	6	50.42121796	1489.74109		6	99.77736971	331.05228		6	12.87993365	414.27103
	7	331.9312458	471.06015		7	5.10111576	3.96029		7	3.004996586	267.71478
	8	407.8094332	29.91035		8	7.817460588	0.01519		8	3.606120751	137.74352
5	1	85.54929003	20.10756	11	1	92.36103773	0	17	1	8.532716776	203.73401
	2	.	348.00464		2	.	0		2	.	451.27933
	3	80.86082425	244.49057		3	41.72874009	0		3	3.069722624	100.83681
	4	152.7911026	348.21597		4	59.58699828	190.33392		4	4.34117585	84.85691
	5	63.8390456	77.34594		5	44.06238384	172.17326		5	3.128993447	112.69553
	6	162.0107502	641.72162		6	102.3229511	1191.92224		6	9.032442856	794.77002
	7	108.8722033	421.95157		7	97.3534387	1056.29114		7	3.670667694	935.10028
	8	153.6374483	38.71024		8	192.6614425	193.83476		8	8.3124396	394.27292
6	1	5.03549612	28.28474	12	1	11.17821177	0.0532	18	1	0.342759212	73.12766
	2	.	1.05923		2	.	251.28008		2	.	368.19019
	3	44.67099972	0		3	9.722936327	141.92223		3	0.756000756	230.60695
	4	45.70651663	0.14836		4	18.72311715	130.46834		4	1.938845466	219.54231
	5	98.79920961	14.27261		5	27.10183846	67.49207		5	2.577978742	215.2299
	6	213.3764229	227.71033		6	56.23840445	329.23486		6	2.958579882	279.42398
	7	13.80562802	1.01542		7	9.967734906	61.68396		7	0.269748041	0.48003
	8	7.327825645	0.00097		8	21.26825016	2.18349		8	0.646983976	12.26311


N
Fence
Farm Road
Water Tower
Stn. 3
38.4
Stn. 4
37.5
Stn. 5
11.6
18.1
18.1
25.3
25.3
Farm Road
40.8
40.8
Fence
DPR Weather Station
Stn.2
12.2
12.2
Basamid treated field
Beds run East-West
Bare Field
Stn.6
82
135.3
Apple Orchard
40.5
40.5
Farm Road
25.3
25.3
18.3
12.3
18.5
37.5
37.5
Farm Road
Stn. 1
Stn. 8
Stn. 7
Fence