Data Evaluation Report on the Acute Toxicity of Dimethyl Disulfide to Terrestrial Vascular Plants: Vegetative Vigor

PMRA Submission Number {.....} **EPA MRID Number 47381002**

Data Requirement: PMRA Data Code:
EPA DP Barcode: D351572
OECD Data Point:
EPA Guideline: 850.4150

Test material: Dimethyl disulfide **Purity:** 99.6%
Common name
Chemical name: IUPAC: Not reported
CAS name: Not reported
CAS No.: Not reported
Synonyms: DMDS

Primary Reviewer: Moncie Wright
Staff Scientist, Cambridge Environmental

Signature: Moncie V Wright
Date: 05/19/08

Secondary Reviewer: Teri S. Myers
Senior Scientist, Cambridge Environmental

Signature: Teri S Myers
Date: 07/24/08

Primary Reviewer: **Contractor Draft Copy**
{EPA/OECD/PMRA}

Secondary Reviewer(s): {.....} **Date:** {.....}
{EPA/OECD/PMRA}

Reference/Submission No.: {.....}

Company Code	{.....}	[For PMRA]
Active Code	{.....}	[For PMRA]
Use Site Category:	{.....}	[For PMRA]
EPA PC Code	029088	

Date Evaluation Completed: {dd-mm-yyyy}

CITATION: Porch, J.R. and H.O. Krueger. 2008. Dimethyl Disulfide: A Toxicity Test to Determine the Effects of the Test Substance on Vegetative Vigor of Ten Species of Plants. Unpublished study performed by Wildlife International, Ltd., Easton, Maryland. Laboratory Project Number: 524-103. Study sponsored by Arkema Inc., Philadelphia, Pennsylvania. Study completed March 17, 2008.

DISCLAIMER: This document provides guidance for EPA and PMRA reviewers on how to complete a data evaluation record after reviewing a scientific study concerning the acute toxicity of a pesticide to terrestrial vascular plants. It is not intended to prescribe conditions to any external party for conducting this study nor to establish absolute criteria regarding the assessment of whether the study is scientifically sound and whether the study satisfies any applicable data requirements. Reviewers are expected to review and to determine for each study, on a case-by-case basis, whether it is scientifically sound and provides sufficient information to satisfy applicable data requirements. Studies that fail to meet any of the conditions may be accepted, if appropriate; similarly, studies that

meet all of the conditions may be rejected, if appropriate. In sum, the reviewer is to take into account the totality of factors related to the test methodology and results in determining the acceptability of the study.

Data Evaluation Report on the Acute Toxicity of Dimethyl Disulfide to Terrestrial Vascular Plants: Vegetative Vigor

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EXECUTIVE SUMMARY:

The effect of dimethyl disulfide on the vegetative vigor of monocot (onion, *Allium cepa*; oat, *Avena sativa*; ryegrass, *Lolium perenne*; and corn, *Zea mays*) and dicot (sugarbeet, *Beta vulgaris*; cabbage, *Brassica oleracea*; cucumber, *Cucumis sativa*; soybean, *Glycine max*; lettuce, *Lactuca sativa*; and tomato, *Lycopersicon esculentum*) crops was studied at a nominal concentrations of 0 (negative control) and 600 lbs a.i./A. The application rates were not analytically verified. The growth medium used in the test was natural soil, classified as a sandy loam, with an approximate organic matter content of 1.3%. On day 21 the surviving plants were pot were recorded and cut at soil level for measuring the plant height and dry weight.

In the vegetative vigor test, the plant dry weight and plant height were affected by dimethyl disulfide treatment. Corn was the most sensitive monocot species, based on a 58% inhibition in dry weight relative to the negative control, with a NOAEC and EC_{25} value of <600 and <600 lbs a.i./A. Lettuce was the most sensitive dicot species, based on a 93% inhibition in survival relative to the negative control, with a NOAEC and EC_{25} value of <600 and <600 lbs a.i./A.

There were widespread cases of necrosis, leaf curl, and chlorosis across all species.

A Tier II test will need to be conducted to satisfy guideline requirements.

Maximum Labeled Rate: 600 lb a.i./A
Results Synopsis

Monocot
EC_{05}/IC_{05}: <600 lbs ai/A 95% C.I.: N/A
EC_{25}/IC_{25}: <600 lbs ai/A 95% C.I.: N/A
EC_{50}/IC_{50}: <600 lbs ai/A 95% C.I.: N/A
NOAEC: <600 lbs ai/A
Slope: N/A
Std err: N/A
Most sensitive monocot: Corn
Most sensitive parameter: Dry weight

Dicot
EC_{05}/IC_{05}: <600 lbs ai/A 95% C.I.: N/A
EC_{25}/IC_{25}: <600 lbs ai/A 95% C.I.: N/A
EC_{50}/IC_{50}: <600 lbs ai/A 95% C.I.: N/A
NOAEC: <600 lbs ai/A
Slope: N/A
Std err: N/A
Most sensitive dicot: Lettuce
Most sensitive parameter: Survival

This toxicity study is classified as [enter acceptability classification, e.g., acceptable/unacceptable/supplementary) and satisfies/does not satisfy the guideline requirement for a Tier I Terrestrial Plant Vegetative Vigor toxicity study.

Table 1 (Tier I studies). Summary of most sensitive parameters by species.

	Plant height (cm)			Dry weight (g)		
Species	**Control**	**Treatment**	**%difference**	**Control**	**Treatment**	**%difference**
Onion	23.7	19.0	20	0.11	0.06	43
Oat	78.4	44.7	43	3.28	1.44	56
Ryegrass	30.3	30.4	0	2.07	1.84	11
Corn	75.3	45.7	39	2.32	0.96	58
Sugarbeet	26.0	25.0	4	2.62	1.89	28
Cabbage	18.8	16.4	13	2.78	1.49	46
Cucumber	24.7	6.0	76	3.10	0.58	81
Soybean	36.6	14.3	61	2.99	0.39	87
Lettuce	15.8	10.5	33	3.81	0.87	77
Tomato	38.4	17.8	54	4.15	1.96	53

Table 1 (Tier I studies; cont). Summary of parameters by species.

	Survival		
Species	**Control**	**Treatment**	**%difference**
Onion	5.0	5.0	0
Oat	5.0	5.0	0
Ryegrass	5.0	5.0	0
Corn	5.0	5.0	0
Sugarbeet	5.0	4.2	17
Cabbage	5.0	2.3	53
Cucumber	5.0	0.5	90
Soybean	5.0	0.5	90
Lettuce	5.0	0.3	93
Tomato	5.0	5.0	0

I. MATERIALS AND METHODS

GUIDELINE FOLLOWED: This study was conducted following guidelines outlined in US EPA Series 850 – Ecological Effects Test Guidelines OPPTS Number 850.4150. The following deviations from OPPTS 850.4150 were noted:

1. The geographic location, depth of collection, CEC and moisture of the test soil were not reported.
2. All species were tested under identical environmental conditions rather than separating the warm-loving species from the cold-loving species.
3. The physico-chemical properties of the test material were not reported.
4. The results of the vegetative vigor test indicate an adverse effect of greater than 25 percent on nine of the ten plant species. A Tier II test will need to be conducted.

These deviations do/do not impact the acceptability of the study.

COMPLIANCE: Signed and dated No Data Confidentiality, GLP and Quality Assurance statements were provided. This study was conducted in compliance with the requirements of 40 CFR Part 160, OECD Principles of Good Laboratory Practice (ENV/MC/CHEM (98)-17), and Japan MAFF with the exception of

periodic analyses of well water and soil for contaminants.

A. MATERIALS:

1. Test Material Dimethyl disulfide

Description: Liquid

Lot No./Batch No. : 05.03.06 (Batch No.)

Purity: 99.6%

Stability of compound under test conditions: Samples were not analyzed for dimethyl disulfide due to its administration as neat material.
(OECD recommends chemical stability in water and light)

Storage conditions of test chemicals: Stored at ambient room temperature.

Table 2. Physical/chemical properties of Dimethyl disulfide.

Parameter	Values	Comments
Water solubility at 20EC	Not reported.	
Vapor pressure	Not reported.	
UV absorption	Not reported.	
pKa	Not reported.	
Kow	Not reported.	

2. Test organism:

Monocotyledonous species: Onion (*Allium cepa*, Family Liliaceae, WI 301), Oat (*Avena sativa*, Family Poaceae, Armor), Ryegrass (*Lolium perenne*, Family Poaceae, Manhattan 4 Perennial) and Corn (*Zea mays*; Family Poaceae, Mandan Bride); *EPA recommends four monocots in two families, including corn.*

Dicotyledonous species: Sugarbeet (*Beta vulgaris*, Family Chenopodiaceae, none given), Cabbage (*Brassica oleracea*, Family Brassicaceae, Late Flat Dutch), Cucumber (*Cucumis sativa*, Family Cucurbitaceae, Straight 8), Soybean (*Glycine max*, Family Fabaceae, Williams 82), Lettuce (*Lactuca sativa*, Family Asteraceae, Summertime), and Tomato (*Lycopersicon esculentum*, Family Solanaceae, Rutgers); *EPA recommends six dicots in four families, including soybean and a root crop.*

OECD recommends a minimum of three species selected for testing, at least one from each of the following categories: Category 1: ryegrass, rice, oat, wheat, and sorghum; Category 2: mustard, rape, radish, turnip, and Chinese cabbage; Category 3: vetch, mung bean, red clover, fenugreek, lettuce, and cress.

Seed source: Onion obtained from Wannamaker Seeds, St. Matthews, SC; oat obtained from Wilken Seed Grains, Inc., Pontiac, IL; ryegrass, cabbage, cucumber, and tomato obtained from The Meyer Seed Co.,

Baltimore, MD; corn obtained from Johnny's Selected Seeds, Winslow, ME; sugarbeet obtained from BetaSeed Inc., Shakopee, MN; soybean obtained from Missouri Foundation Seeds, Columbia, MO; and lettuce obtained from Territorial Seed Co., Cottage Grove, OR.

Prior seed treatment/sterilization: Seeds were not treated with fungicides, insecticides, or repellents prior to test initiation.
Historical % germination of seed: Onion, cabbage, cucumber, and tomato – 85%; oat – 84%; ryegrass and sugarbeet – 90%; corn and soybean – 94%; and lettuce – 98%
Seed storage, if any: Not reported.

B. STUDY DESIGN:

1. Experimental Conditions

a. Limit test: The definitive study was conducted as a limit test.

b. Range-finding study: A range-finding study was not conducted.

c. Definitive Study

Table 3: Experimental Parameters - Vegetative Vigor

Parameters	Vegetative Vigor	
	Details	**Remarks** ***Criteria***
Duration of the test	21 days	*Recommended test duration is 14-21 days.*
Number of seeds/plants replicate	All species were comprised of 6 replicated experimental units. Each replicate unit was comprised of 5 pots, with 1 plant per pot.	*Five plants per replicate are recommended.*
Number of plants retained after thinning	N/A	
Number of replicates Control: Adjuvant control: Treated:	6 N/A 6	*Four replicates per dose are recommended*

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Parameters	Vegetative Vigor	
	Details	**Remarks** ***Criteria***
Test concentrations (mg ai/kg soil and g ai/ha) Nominal: Measured:	0 (negative control) and 600 lbs a.i./A Measured application rates could not be determined because analytical verification was not performed.	*Five test concentrations should be used with a dose range of 2X or 3X progression*
Method and interval of analytical verification LOQ: LOD:	Not performed due to use of neat test substance. N/A N/A	
Adjuvant (type, percentage, if used)	N/A	
Test container (pot) Size/Volume Material: (glass/polystyrene)	All species: 11 cm (diameter) x 10 cm (tall) Plastic	*Non-porous containers should be used.* *OECD recommends that non-porous plastic or glazed pots be used.*
Growth facility	Greenhouse; after initial 48-hour exposure period, treatment groups were taken out of the greenhouse, removed from treatment bags, and placed in subirrigation trays on greenhouse benches.	
Method/depth of seeding	Ryegrass, onion, sugarbeet, cabbage, cucumber, soybean, lettuce, and tomato planted at *ca.* 6 mm depth; corn and oat were planted at 20 mm.	
Test material application Application time including the plant growth stage Number of application Application interval	Test material was applied on Day 0 to injection containers. Each species was treated once N/A; single application	

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Parameters	Vegetative Vigor	
	Details	**Remarks** ***Criteria***
Method of application	Test material was injected into dosing containers that were placed in bags along with the replicate pots containing the plants. The bags were sealed for 48 hours so that the test substance could volatilize.	
Details of soil used Geographic location Depth of soil collection Soil texture % sand % silt % clay pH: % organic carbon CEC Moisture at 1/3 atm (%)	Representative of a sandy loam soil Not Reported 75 11 14 Not reported. 1.3% organic matter. Not reported. Not reported.	*EPA prefers soil mixes containing sandy loam, loam, or clay loam soil with no greater than 2% organic matter. Glass beads, rock wool, and 100% acid washed sand are not preferred..* *OECD prefers the soil to be sieved (0.5 cm) to remove coarse fragments. Carbon content should not exceed 1.5% (3% organic matter). Fine particles (under 20um) makeup should be between 10 and 20%. The recommended pH is between 5.0 and 7.5.*
Details of nutrient medium, if used	N/A	
Watering regime and schedules Water source/type: Volume applied: Interval of application: Method of application:	Well water from the greenhouse facility. Not reported. Intermittent; every 1 to 7 days. Sub-irrigation trays filled to a pre-determined depth.	*EPA prefers that under foliage watering or bottom watering be utilized for vegetative vigor studies so that the chemical is not washed out of the soil during the test.*
Any pest control method/fertilization, if used	None.	
Test conditions Temperature:	5.49-29.64°C	

Parameters	Vegetative Vigor	
	Details	**Remarks**
		Criteria
Photoperiod: Light intensity and quality: Relative humidity:	16L:8D 1.3-16.9 moles photosynthetically active radiation. Natural light supplemented by artificial light. 13.83-85.20%	*EPA prefers that the cold vs warm loving plants be tested in two separate groups to optimize plant growth.* *OECD prefers that the temperature, humidity and light conditions be suitable for maintaining normal growth of each species for the test period.*
Reference chemical (if used) Name: Concentrations:	N/A	
Other parameters, if any	None	

2. Observations:

Table 4: Observation Parameters - Vegetative Vigor

Parameters	Vegetative Vigor	
	Details	**Remarks**
Parameters measured (i.e., plant height, dry weight or other endpoints)	Height, survival, dry weight, and plant condition.	
Measurement technique for each parameter	Plant condition and survival were assessed visually. Seedlings were clipped at soil level, and the shoots of all living seedlings dried in an oven, and then weighed to determine dry weight. Dry weight was estimated by measuring the total dry weights of the shoots within each replicate and dividing by the number weighed. Height was measured to the nearest whole centimeter from the soil surface to the tip of the tallest leaf or apical meristem.	

Observation intervals	Plant condition, survival and dry weight were evaluated on days 7 (day 8 for corn), 14, and 21 days. Plant height was evaluated after test termination.	
Other observations, if any	None.	
Were raw data included?	Yes.	
Phytotoxicity rating system, if used	0%- No injury/effect; 10-30%- slight plant effect (effects barely noticeable to not obviously detrimental; 40-60%- moderate effect involving the whole plant (recovery possible to doubtful); 70-90%- severe effect with recovery not possible (loss of some leaves to only a few surviving leaves); 100%- complete plant effect (death of plant)	

II. RESULTS and DISCUSSION:

A. INHIBITORY EFFECTS:

Vegetative Vigor:

Percent survival in the negative control was 5% while treatment group survival ranged from 0.3% to 5% relative to the negative control.

The study author's results indicated that the level of inhibition in plant height was high for seven of the 10 species (excluding sugarbeet, ryegrass, and cabbage). Cucumber exhibited the largest inhibition of plant height of up to 76%.

The level of inhibition in dry weight across all treatments was moderate to very high (up to 87%) with only the exception of ryegrass, indicating that there were adverse effects on dry weight.

The study authors' results indicate that based on survival, the most sensitive dicot was lettuce, with reported NOAEC and EC25 values of <600 and <600 lbs a.i./A, respectively. Based on dry weight, the most sensitive monocot was corn, with estimated NOAEC and EC25 values of <600 and <600 lbs a.i./A. The study authors did not report NOAEC and EC_{25} values, therefore all reported results are the reviewer's interpretation of the data provided.

The study authors used a standard phytotoxicity rating system. There were numerous cases of necrosis, leaf

curl, and chlorosis across all species.

B. REPORTED STATISTICS:

The study author analyzed phytotoxicity, survival, plant height and dry weight. Mean survival, dry weight, and height of the control and treatment groups were compared to determine a 25% or greater adverse effect using a personal computer with SAS software (Version 8).

Table 5: Reported effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for biomass (lb ai/A)									
	Weight (g)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	0.046-0.180	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Oat	0.82-3.56	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Ryegrass	0.99-2.67	<600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	0.73-2.79	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Sugarbeet	1.73-3.04	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Cabbage	0.43-3.20	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Cucumber	0.57-3.27	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Soybean	0.37-4.02	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	0.69-4.43	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Tomato	1.58-4.89	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

Table 5a: Reported effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for height (lb ai/A)									
	Height (cm)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	17.0-29.8	<600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Oat	40.4-85.2	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Ryegrass	27.8-32.6	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	41.8-80.4	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Sugarbeet	22.2-30.2	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cabbage	13.5-22.0	<600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cucumber	5.0-26.4	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

Species	Results summary for height (lb ai/A)									
	Height (cm)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Soybean	13.5-44.0	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	9.0-16.8	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Tomato	15.8-42.2	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

Table 5b: Reported effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for survival (lb ai/A)									
	%	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Oat	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Ryegrass	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Sugarbeet	60-100	<600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cabbage	40-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Cucumber	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Soybean	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Tomato	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A

Plant Injury Index										
Control	Onion	Oat	Ryegrass	Corn	Sugarbeet	Cabbage	Cucumber	Soybean	Lettuce	Tomato
0-40	0-10	30-50	0-20	30-70	0-100	30-100	30-100	80-100	40-100	30-50

0%- No injury/effect; 10-30%- slight plant effect (effects barely noticeable to not obviously detrimental; 40-60%- moderate effect involving the whole plant (recovery possible to doubtful); 70-90%- severe effect with recovery not possible (loss of some leaves to only a few surviving leaves); 100%- complete plant effect (death of plant)

C. VERIFICATION OF STATISTICAL RESULTS BY THE REVIEWER:

Any species exhibiting an inhibition of 5% in survival, dry weight or plant height at the 600 lbs ai/A treatment level relative to the negative control was statistically analyzed using a t-test for two samples assuming equal variance, with the exception of soybean height and dry weight, which were analyzed assuming unequal variance. If inhibitions were <5% at the treatment level relative to the negative control, the reviewer visually determined that no significant differences were present. All analyses were conducted using the nominal application rate of 600 lbs ai/A.

Table 6: Effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for biomass (lb ai/A)									
	Weight (g)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	0.046-0.180	600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Oat	0.82-3.56	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Ryegrass	0.99-2.67	600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	0.73-2.79	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Sugarbeet	1.73-3.04	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Cabbage	0.43-3.20	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Cucumber	0.57-3.27	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Soybean	0.37-4.02	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	0.69-4.43	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Tomato	1.58-4.89	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

Table 6a: Effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for height (lb ai/A)									
	Height (cm)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	17.0-29.8	<600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Oat	40.4-85.2	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Ryegrass	27.8-32.6	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	41.8-80.4	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Sugarbeet	22.2-30.2	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cabbage	13.5-22.0	600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cucumber	5.0-26.4	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

Species	Results summary for height (lb ai/A)									
	Height (cm)	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Soybean	13.5-44.0	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	9.0-16.8	<600	<600	N/A	<600	N/A	>600	N/A	N/A	N/A
Tomato	15.8-42.2	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A

* provide the range

Table 6b: Effect of Dimethyl disulfide on Vegetative Vigor

Species	Results summary for survival (lb ai/A)									
	%	NOAEC	EC_{05}	95%CI	EC_{25}	95%CI	EC_{50}	95%CI	slope	std err
Onion	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Oat	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Ryegrass	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Corn	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A
Sugarbeet	60-100	600	<600	N/A	>600	N/A	>600	N/A	N/A	N/A
Cabbage	40-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Cucumber	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Soybean	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Lettuce	0-100	<600	<600	N/A	<600	N/A	<600	N/A	N/A	N/A
Tomato	100	600	>600	N/A	>600	N/A	>600	N/A	N/A	N/A

Plant Injury Index										
Control	Onion	Oat	Ryegrass	Corn	Sugarbeet	Cabbage	Cucumber	Soybean	Lettuce	Tomato
0-40	0-10	30-50	0-20	30-70	0-100	30-100	30-100	80-100	40-100	30-50

0%- No injury/effect; 10-30%- slight plant effect (effects barely noticeable to not obviously detrimental; 40-60%- moderate effect involving the whole plant (recovery possible to doubtful); 70-90%- severe effect with recovery not possible (loss of some leaves to only a few surviving leaves); 100%- complete plant effect (death of plant)

Monocot

EC_{05}/IC_{05}: <600 lbs ai/A 95% C.I.: N/A
EC_{25}/IC_{25}: <600 lbs ai/A 95% C.I.: N/A
EC_{50}/IC_{50}: <600 lbs ai/A 95% C.I.: N/A
NOAEC: <600 lbs ai/A
Slope: N/A
Std err: N/A
Most sensitive monocot: Corn
Most sensitive parameter: Dry weight

Dicot

EC_{05}/IC_{05}: <600 lbs ai/A 95% C.I.: N/A
EC_{25}/IC_{25}: <600 lbs ai/A 95% C.I.: N/A
EC_{50}/IC_{50}: <600 lbs ai/A 95% C.I.: N/A
NOAEC: <600 lbs ai/A
Slope: N/A
Std err: N/A
Most sensitive dicot: Lettuce
Most sensitive parameter: Survival

D. STUDY DEFICIENCIES:

With the exception of ryegrass, all species were inhibited by the test material at the single application rate (600 lbs ai/A). A Tier 2 study is required

E. REVIEWER=S COMMENTS:

The study authors did not report their statistical results, and as such did not report NOAEC or EC_{25} values. As a result, the reviewer visually interpreted their data and reported the results in the Reported Effects tables.

The reviewer visually determined NOAEC and EC_{25} values when inhibitory effects of <5% were observed.

Cabbage survival was inhibited by greater than 5%, but the reviewer was unable to generate a p-value. The NOAEC was visually determined and reported.

F. CONCLUSIONS:

This study is acceptable/unacceptable/supplementary. Corn was the most sensitive monocot species, based on a 58% inhibition in dry weight relative to the negative control, with a NOAEC and EC_{25} value of <600 lbs a.i./A. Lettuce was the most sensitive dicot species, based on a 93% inhibition in survival relative to the negative control, with a NOAEC and EC_{25} value of <600 lbs a.i./A.

Most sensitive monocot and EC_{25}: Corn (Dry weight), <600 lbs ai/A
Most sensitive dicot and EC_{25}: Lettuce (Survival), <600 lbs ai/A

III. REFERENCES:

U.S. Environmental Protection Agency. 1996. Series 850- Ecological Effects Test Guidelines (*draft*), OPPTS Number 850.4150: Terrestrial Plant Toxicity, Tier I (Vegetative Vigor).

Frans, Robert E. and Ronald E. Talbert. 1977. Design of Field Experiments and the Measurement and Analysis of Plant Responses. Pages 15-23 in B. Truelove, ed. Research Methods in Weed Science. Southern Weed Science Society, Auburn University, Alabama.

SAS Institute, Inc. 1999. SAS Proprietary Software Version 8, Cary, NC, SAS Institute, Inc.

APPENDIX I. OUTPUT OF REVIEWER'S STATISTICAL VERIFICATION:

Onion Dry Weight	*Neg Ctrl*	*600 lbs ai/a*
Mean	0.106333	0.0603333
Variance	0.002873	0.0001303
Observations	6	6
Pooled Variance	0.001501	
Hypothesized Mean Difference	0	
df	10	
t Stat	2.056178	
P(T<=t) one-tail	0.033407	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**0.066814**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Oat Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	3.28	1.436666667
Variance	0.05512	0.234826667
Observations	6	6
Pooled Variance	0.144973	
Hypothesized Mean Difference	0	
df	10	
t Stat	8.385335	
P(T<=t) one-tail	3.89E-06	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**7.78E-06**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Ryegrass Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	2.068333	1.836666667
Variance	0.086977	0.349226667
Observations	6	6
Pooled Variance	0.218102	
Hypothesized Mean Difference	0	
df	10	
t Stat	0.859201	
P(T<=t) one-tail	0.205177	
t Critical one-tail	1.812461	

P(T<=t) two-tail	**0.410353**
t Critical two-tail	2.228139

t-Test: Two-Sample Assuming Equal Variances

Corn Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	2.315	0.961666667
Variance	0.12387	0.045936667
Observations	6	6
Pooled Variance	0.084903	
Hypothesized Mean Difference	0	
df	10	
t Stat	8.044574	
P(T<=t) one-tail	5.61E-06	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**1.12E-05**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Sugarbeet Dry Weight	*Neg Ctrl*	*600 lbs ai/a*
Mean	2.623333	1.888333333
Variance	0.128227	0.021896667
Observations	6	6
Pooled Variance	0.075062	
Hypothesized Mean Difference	0	
df	10	
t Stat	4.646638	
P(T<=t) one-tail	0.000456	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**0.000913**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Cabbage Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	2.776667	1.493333333
Variance	0.224427	0.701306667
Observations	6	6
Pooled Variance	0.462867	
Hypothesized Mean Difference	0	

df	10
t Stat	3.267173
P(T<=t) one-tail	0.004235
t Critical one-tail	1.812461
P(T<=t) two-tail	**0.008471**
t Critical two-tail	2.228139

t-Test: Two-Sample Assuming Equal Variances

Cucumber Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	3.096667	0.583333333
Variance	0.019627	0.000233333
Observations	6	3
Pooled Variance	0.014086	
Hypothesized Mean Difference	0	
df	7	
t Stat	29.94854	
P(T<=t) one-tail	5.97E-09	
t Critical one-tail	1.894579	
P(T<=t) two-tail	**1.19E-08**	
t Critical two-tail	2.364624	

t-Test: Two-Sample Assuming Unequal Variances

Soybean Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	2.993333	0.395
Variance	0.436107	0.00125
Observations	6	2
Hypothesized Mean Difference	0	
df	5	
t Stat	9.596545	
P(T<=t) one-tail	0.000104	
t Critical one-tail	2.015048	
P(T<=t) two-tail	**0.000208**	
t Critical two-tail	2.570582	

t-Test: Two-Sample Assuming Equal Variances

Lettuce Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	3.813333	0.87

Variance	0.184787	0.0648
Observations	6	2
Pooled Variance	0.164789	
Hypothesized Mean Difference	0	
df	6	
t Stat	8.880167	
P(T<=t) one-tail	5.68E-05	
t Critical one-tail	1.94318	
P(T<=t) two-tail	**0.000114**	
t Critical two-tail	2.446912	

t-Test: Two-Sample Assuming Equal Variances

Tomato Dry Weight	*Neg Ctrl*	*600 lbs ai/A*
Mean	4.146667	1.958333333
Variance	0.281507	0.121776667
Observations	6	6
Pooled Variance	0.201642	
Hypothesized Mean Difference	0	
df	10	
t Stat	8.440807	
P(T<=t) one-tail	3.67E-06	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**7.34E-06**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Onion Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	23.666667	19.03333333
Variance	20.730667	3.862666667
Observations	6	6
Pooled Variance	12.296667	
Hypothesized Mean Difference	0	
df	10	
t Stat	2.2885504	
P(T<=t) one-tail	0.0225624	
t Critical one-tail	1.8124611	
P(T<=t) two-tail	**0.0451248**	
t Critical two-tail	2.2281388	

t-Test: Two-Sample Assuming Equal Variances

Oat Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	78.36667	44.7
Variance	22.03867	10.124
Observations	6	6
Pooled Variance	16.08133	
Hypothesized Mean Difference	0	
df	10	
t Stat	14.54118	
P(T<=t) one-tail	2.36E-08	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**4.71E-08**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Corn Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	75.33333	45.66666667
Variance	16.53867	5.962666667
Observations	6	6
Pooled Variance	11.25067	
Hypothesized Mean Difference	0	
df	10	
t Stat	15.31935	
P(T<=t) one-tail	1.43E-08	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**2.86E-08**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Cabbage Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	18.8	16.38333333
Variance	3.808	4.181666667
Observations	6	6
Pooled Variance	3.994833	
Hypothesized Mean Difference	0	
df	10	
t Stat	2.094248	
P(T<=t) one-tail	0.03134	

t Critical one-tail	1.812461
P(T<=t) two-tail	**0.06268**
t Critical two-tail	2.228139

t-Test: Two-Sample Assuming Equal Variances

Cucumber Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	24.66667	6
Variance	2.842667	3
Observations	6	3
Pooled Variance	2.887619	
Hypothesized Mean Difference	0	
df	7	
t Stat	15.53502	
P(T<=t) one-tail	5.53E-07	
t Critical one-tail	1.894579	
P(T<=t) two-tail	**1.11E-06**	
t Critical two-tail	2.364624	

t-Test: Two-Sample Assuming Unequal Variances

Soybean Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	36.63333	14.25
Variance	14.87067	1.125
Observations	6	2
Hypothesized Mean Difference	0	
df	6	
t Stat	12.83573	
P(T<=t) one-tail	6.87E-06	
t Critical one-tail	1.94318	
P(T<=t) two-tail	**1.37E-05**	
t Critical two-tail	2.446912	

t-Test: Two-Sample Assuming Equal Variances

Lettuce Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	15.76667	10.5
Variance	0.470667	4.5
Observations	6	2
Pooled Variance	1.142222	

Hypothesized Mean Difference	0
df	6
t Stat	6.035401
P(T<=t) one-tail	0.000468
t Critical one-tail	1.94318
P(T<=t) two-tail	**0.000935**
t Critical two-tail	2.446912

t-Test: Two-Sample Assuming Equal Variances

Tomato Height	*Neg Ctrl*	*600 lbs ai/A*
Mean	38.36667	17.83333333
Variance	7.190667	5.462666667
Observations	6	6
Pooled Variance	6.326667	
Hypothesized Mean Difference	0	
df	10	
t Stat	14.13945	
P(T<=t) one-tail	3.08E-08	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**6.16E-08**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Sugarbeet Survival	*Neg Ctrl*	*600 lbs ai/A*
Mean	5	4.166666667
Variance	0	0.966666667
Observations	6	6
Pooled Variance	0.483333	
Hypothesized Mean Difference	0	
df	10	
t Stat	2.076137	
P(T<=t) one-tail	0.032308	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**0.064615**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Cucumber Survival	*Neg Ctrl*	*600 lbs ai/A*

Mean	5	0.5
Variance	0	0.3
Observations	6	6
Pooled Variance	0.15	
Hypothesized Mean Difference	0	
df	10	
t Stat	20.12461	
P(T<=t) one-tail	1.01E-09	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**2.02E-09**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Soybean Survival	*Neg Ctrl*	*600 lbs ai/A*
Mean	5	0.5
Variance	0	0.7
Observations	6	6
Pooled Variance	0.35	
Hypothesized Mean Difference	0	
df	10	
t Stat	13.17465	
P(T<=t) one-tail	6.04E-08	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**1.21E-07**	
t Critical two-tail	2.228139	

t-Test: Two-Sample Assuming Equal Variances

Lettuce Survival	*Neg Ctrl*	*600 lbs ai/A*
Mean	5	0.333333333
Variance	0	0.266666667
Observations	6	6
Pooled Variance	0.133333	
Hypothesized Mean Difference	0	
df	10	
t Stat	22.13594	
P(T<=t) one-tail	3.97E-10	
t Critical one-tail	1.812461	
P(T<=t) two-tail	**7.94E-10**	
t Critical two-tail	2.228139	