

Agricultural Development and Advisory Service

Report to: Nation-wide Ornamental
Marketing and Distribution (NOMAD)
Milton Road
West Adderbury
Banbury
Oxon OX17 3EY

Tel: 0295 811464

ADAS Contract Manager: Mr R F Clements
Efford Experimental Horticulture Station
Lymington
Hampshire SO41 0LZ

Tel: 0590 673341

Period of investigation: June to August, 1989

Date of issue of report: October, 1989

Number of pages in report: 21

Initial number of copies of report: 10 (5 held by NOMAD) (5 held by ADAS)

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CONTRACT REPORT

No C/89/0442

Phytotoxicity Testing of Dichlorvos
Fogs on Bedding Plants
Undertaken for NOMAD

PRINCIPAL WORKERS

Dr Michael Saynor PhD
(Co-ordinator and
joint author of report)

Regional Entomologist
MAFF, ADAS
Coley Park
Reading
Berkshire

Miss Victoria Norris BSc (Hons) Hort

HAO IV (to July 1989)

Miss Elaine J Sapsed BSc (Hons) Hort
(Joint author of report)

HAO III (Temp)
Efford EHS
Lymington
Hampshire

Mr Roger Goode O.N.D.

Assistant Scientific Officer

Mr Chris Vigor

Nursery Staff

Mr Graham Stancer

Nursery Staff

Authentication:-

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

M Saynor
Regional Entomologist
ADAS
Reading
9 October 1989

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Summary

Dichlorvos controls western flower thrips (WFT) (Franklinella occidentalis) effectively, but high volume sprays are often phytotoxic. It tends to be less damaging to many crops when applied as a fog or an aerosol, but little is known about its effects when applied this way to bedding plants. Two trials were therefore done at Efford EHS on a range of bedding plants to gain information on the crop safety of dichlorvos when applied as a fog through a thermal fogging machine.

In the larger, replicated trial none of the 20 species of bedding plants tested was affected by up to four applications of dichlorvos fog applied at 3-4 day intervals at 0.6 g a.i. per hectare (1.2 l product per hectare) in 10 l Nevolin as a carrier. However the leaves of young cucumbers, a crop known to be highly sensitive to dichlorvos became chlorotic. At 1.8 l product per hectare in 15 l Nevolin, nine species showed some signs of damage. Of these Begonia semperflorens, tuberous Begonias, Impatiens and Primula sp. were worst affected. At 2.4 l product per hectare in 20 l Nevolin all but three species (Ageratum, Alyssum, and Cyclamen) were damaged. Those species affected at 1.8 l per hectare were the ones most severely damaged when the rate was increased to 2.4 l per hectare. At both rates the more frequently plants were fogged the worse the damage.

The types of damage caused varied considerably. Symptoms included general chlorosis of the leaves, the commonest damage, marginal leaf chlorosis, leaf cupping and paling and/or speckling of flowers.

In a smaller, unreplicated trial two of the five species fogged at the small - seedling stage, at 1.2 l product per hectare, were damaged. Pansies, where chlorotic areas developed on the leaves, were the most badly affected and were apparently more susceptible at this stage than they were when larger. The growth of Geraniums was checked, but only temporarily.

Introduction

Western flower thrips (WFT)(Franklinella occidentalis) poses a serious threat to bedding plant producers. It damages plants directly and also transmits tomato spotted wilt virus (TSWV) making many plants totally unsaleable. Dichlorvos controls WFT effectively, but high volume sprays are often phytotoxic although, it tends to be less damaging when applied as fogs or aerosols. Fogging is also a convenient method of applying dichlorvos, but little is known about its phytotoxic effects on bedding plants.

Off-Label Approval for this method of application has recently been given, provided operators wear full protective clothing, including a respirator, when applying it. Such Approval does not signify however that the product is effective or that is safe to use on crops.

Objective

To assess the susceptibility/tolerance of a range of bedding plants to dichlorvos applied as an exhaust fog at varying rates and frequencies.

Materials and Methods

Site

The trials were carried out at Efford EHS, Lymington, Hampshire in a single span glasshouse subdivided into north and south compartments, 102 and 67 square metres in area respectively. The glasshouse was equipped with gas fired hot water heating.

Insecticide

Dichlorvos 50% e.c. (Darmycol Dichlorvos) was applied as a fog using a Puls Fog K10 thermal fogger.*

Initially in the replicated trial, and in the unreplicated one, it was applied at 0.6 g a.i. per hectare (1.2 l product per hectare) in 10.0 l of Nevolin as a carrier. Later in the main trial dichlorvos was applied at 0.9 or 1.2 g a.i. per hectare (1.8 or 2.4 l product per hectare) respectively in 15 or 20 l of Nevolin.

Details of the times when the fogs were applied and the weather conditions at the time are given in Appendix 1.

* Approvals exist for a number of pesticides, formulated primarily for use in pneumatic sprayers, to be applied in suitable carriers through fogging machines. Even though few critical comparisons have been made, the same amount of product per hectare is normally used whether it is sprayed conventionally or fogged.

Under glass dichlorvos is generally recommended at 1.0 l product per 1000 l water per hectare as a high-volume spray to run-off. The amount of spray used depends on the size and nature of the crop, but bedding plants are seldom likely to be sprayed at more than 1000 l per hectare. As phytotoxicity tests should arguably be done using rates slightly higher than those recommended, the initial (lowest) rate used in the replicated trial was increased by 20 per cent to 1.2 l product per hectare.

It should be noted that under the terms of the Off-Label Approval dichlorvos may be applied as a fog at up to 2.2 l product in 10.0 l Nevolin per hectare.

Treatments

Replicated trial

Plants were treated at varying intervals over a six-week period, from 9 June to 28 July, 1989 (Table 1). There were five treatments:-

1. Fogged every 3-4 days
2. Fogged every 7 days
3. Fogged every 10-11 days
4. Fogged every 14 days
5. Untreated control

Unreplicated trial

Three treatments were compared:-

1. Fogged twice 4 days apart (24 and 28 July)
2. Fogged once (24 July)
3. Untreated control

Procedure

Those plants to be fogged on a particular day were moved into one or other of the two compartments which was then treated. Details of when treatments were applied and the rates of dichlorvos used are shown in Table 1.

The fogs were applied late each day, (between 19.10 and 22.55 hours) and the glasshouse was vented the following morning. Before treatment the plants were checked to ensure that they did not need watering and that the leaves were dry. The times when the fogs were applied and the prevailing weather conditions are shown in Appendix 1.

Table 1: Dates when plants were treated with dichlorvos fogs and rates used.

Date	Rate of dichlorvos fog applied (l product per ha)	* Treatments fogged
<u>Replicated trial</u>		
9 June	1.2	1, 2, 3, 4
12 June	1.2	1
16 June	1.2	1, 2
19 June	1.2	1, 3
23 June	1.8	1, 2, 4
26 June	-	(Treatment not applied because equipment failed)
28 June	1.8	1 (Treatment deferred from 26 June)
30 June	1.8	1, 2, 3
3 July	1.8	1
7 July	2.4	1, 2, 4
10 July	2.4	1, 3
14 July	2.4	1, 2
17 July	2.4	1
21 July	1.2	1, 2, 3, 4
<u>Unreplicated trial</u>		
24 July	1.2	1, 2
28 July	1.2	1

* Treatment 1 = fogged every 3-4 days Treatment 3 = fogged every 10-11 days
 " 2 = " " 7 days " 4 = " " 14 days

Types of plants used*

Replicated trial

20 species, of bedding plants were used in the main trial (Tables 2 & 3 and where possible three replicates of each were tested. Although the size and numbers of the plants differed considerably, four distinct types or ages of plants were supplied:-

* The plants used in these trials were supplied by H. Evans & Roundstone Nurseries, both members of NOMAD and W.J. Findon.

- a. Mature "plug" plants
- b. New trays (mature "plug" plants pricked out into strip trays)
- c. Established trays (12 plants in separate cells - "double sixes")
- d. Pot "bedding" (Mature plants in individual pots or double sixes)

Unreplicated trial

Towards the end of the trial young seedlings of five species sown in small cellular trays ("plugs") were added to the trial. These were treated either once or twice four days apart with dichlorvos fog at 1.2 l product per hectare. Other plants were left untreated. This observation was unreplicated.

Cultural details

Site: Single span glasshouse divided into north and south compartments, 102 and 67 sq in size respectively.

Temperature settings: 12°C Day and night
16°C Vent

Liquid feed: 900 g potassium nitrate) in 20 litres of water
800 g ammonium nitrate)

Diluted 1:100 to give 200 ppm N and K₂O commenced 15 June.

Assessments

Plants were examined weekly and the nature and extent of the damage was recorded. Photographs were also taken of all the different types of damage as and when they appeared.

Results

In the replicated trial none of the 20 species of bedding plants was affected by up to four applications of dichlorvos applied at 3-4 days intervals at 1.2 l product per hectare in 10 l Nevolin as a carrier. However the leaves of young cucumbers plants, a crop known to be highly sensitive to dichlorvos and that were included in the trial as a "standard", became chlorotic. At 1.8 l product per hectare in 15 l Nevolin nine species showed some signs of damage (Table 2). Of these Begonia semperflorens, tuberous Begonias, Impatiens and Primula sp. were most badly affected. At 2.4 l product per hectare in 20 l Nevolin all but three species (Ageratum, Alyssum and Cyclamen) were damaged. Those species affected at 1.8 l per hectare were the ones most severely damaged when the rate was increased to 2.4 l per hectare. At both rates the more frequently plants were fogged the worse the damage (Table 2).

The types of damage caused varied considerably. Symptoms included general chlorosis of the leaves, the commonest damage, marginal leaf chlorosis, leaf cupping and paling and/or speckling of the flowers (Table 3, Appendix 2, Plates 2-9).

Two of the five species fogged at the small seedling stage at 1.2 l per hectare were damaged. Pansies, where chlorotic areas developed on the leaves, were the most badly affected and were apparently more susceptible at this stage than they were when larger (Tables 3, Appendix 2 Plates 3 and 9). The growth of Geraniums was checked, but only temporarily.

Table 2 Species and severity of damage to bedding plants caused by dichlorvos fogs - Replicated trial

Species	Size/type of plants tested (* indicates type tested)				Size/type of plant affected and severity of damage							
					Dichlorvos @ 1.8 l product per ha (1.5 x high volume spray rate)				Dichlorvos @ 2.4 l product per ha (2.0 x high volume spray rate)			
	a	b	c	d	Treatments +				Treatments +			
				1	2	3	4	1	2	3	4	
Ageratum	*	*	*	*								
Alyssum			*									
Begonia semp.	*	*	*	*	<u>bcd</u>		b		<u>abcd</u>	<u>abcd</u>	<u>abcd</u>	<u>abcd</u>
Campanula			*						c			
Chrysanthemum			*		c	c	c	c	<u>c</u>	<u>c</u>	c	c
Cyclamen			*									
Dianthus			*						<u>c</u>	<u>c</u>	c	
Fuchsia			*						c			
Geranium			*						<u>c</u>	c	c	c
Impatiens	*	*	*		<u>abc</u>	<u>abc</u>	abc		<u>abc</u>	<u>abc</u>	abc	abc
Lobelia			*	*	d				<u>cd</u>			
Marigold	*	*	*	*					a	a	a	a
Nicotiana			*						<u>c</u>	c	c	
Pansy			*		c	c	c		<u>c</u>	<u>c</u>	c	c
Petunia	*	*	*	*	a	a	a	a	ac	ac	ac	ac
Poppy			*						<u>c</u>	<u>c</u>	c	
<u>Primula</u>			*		<u>c</u>	c	c	c	<u>c</u>	c		c
Salvia	*	*	*	*	d				<u>acd</u>	acd	acd	ad
Tuberous Begonia			*		<u>c</u>	<u>c</u>	c		<u>c</u>	<u>c</u>	c	c
Verbena	*	*	*						<u>ac</u>	ac	ac	ac
Cucumber	Plants severely damaged (chlorosis) at 1.2 l product per hectare											

+ Treatment frequency: Fogs applied every 3-4, 7, 10-11 or every 14 days to Treatments 1-4 respectively.

NB. Letters underlined indicate symptoms more severe.

Table 3 Types of damage caused to bedding plants by dichlorvos fogs

Unaffected	Chlorosis	Necrosis	Leaf Deformation	Petal Spoilage
Ageratum	<u>Begonia</u> <u>semperflorens</u>	Tuberous Begonia	<u>Begonia</u> <u>semperflorens</u>	Geranium
Alyssum	Tuberous Begonia	Campanula	Fuchsia *	Lobelia
Cyclamen	Chrysanthemum	Marigold	Primula	Petunia
	Dianthus	Verbena		Salvia
	Impatiens			
	Nicotiana			
	Pansy			
	Petunia *			
	Poppy			
	Primula			
	Salvia			

* Indicates a transitory symptom

qualification applies particularly to the unreplicated trial on young seedlings, done in a small and opportunist way at the end of the main trial. If more phytotoxicity tests are done on bedding plants the tests should include some of those species that proved to be particularly sensitive to or tolerant of dichlorvos fogs in these trials, to provide continuity.

Appendix 1

Dates, times and weather conditions when dichlorvos fogs were applied

Date	Time	Temperature (°C)	Dull/bright	Comments
<u>Main trial</u>				
9 June	20.40	17	B	Calm
12 June	20.40	21	B	Slight SE wind
15 June	20.35	18	B	Calm
19 June	20.55	21	B	Calm
23 June	21.00	18	B	SW Force 2
26 June*	20.30	18	D	SW Force 4
28 June	19.10	16	D	SW Force 7
30 June	20.00	17	D	NW Force 5
3 July	20.00	21	B	Calm
7 July	20.00	18	D	Calm
10 July	19.30	20	D	Calm
14 July	20.00	22	B	Breeze
17 July	19.45	24	B	Slight breeze
21 July	10.00	21	D	Calm
<u>Subsidiary trial</u>				
24 July	20.00	21	B	Calm
28 July	20.00	18	D	Breeze

* Fogging equipment failure - application delayed until 28 June.

Appendix 2

Types of damage to bedding plants caused by dichlorvos fogs

Species	Symptoms
<u>Replicated trial</u>	
Ageratum	None
Alyssum	None
<u>Begonia semperflorens</u>	Chlorosis + leaf rolling
Campanula	Necrosis of leaf tips
Chrysanth	Chlorosis
Cyclamen	None
Dianthus	Chlorosis
Fuchsia	Slight puckering
Geranium	Flower speckling
Impatiens	Severe chlorosis
Lobelia	Paling of flowers
Marigold	Necrosis of leaf margins
Nicotiana	Chlorosis
Pansy	Chlorosis
Petunia	Flower speckling - overall chlorosis *
Poppy	Chlorosis
<u>Primula</u>	Leaf rolling + marginal chlorosis
Salvia	Paling of flowers, slight chlorosis
Tuberous Begonia	Marginal - interveinal chlorosis - necrosis
Verbena	Necrosis of leaf margins (slight)
<u>Unreplicated trial</u>	
Geranium	Growth check*
Impatiens	None
Marigold	None
Pansy	Chlorosis
Primula	None

* Indicates transitory symptoms

ACKNOWLEDGEMENTS

Thanks are due to the growers, H. Evans, Roundstone Nurseries and W. J. Findon who provided all the plants used in these trials.

STORAGE OF DATA

The raw data will be stored by Efford Experimental Horticultural Station, Lymington, Hants SO41 0LZ for a period of ten years.

Plate 1. Introduction of dichlorvos fog to the glasshouse compartment.



Plate 2. Tuberous begonias showing damage caused by dichlorvos fog at 3/4 day interval. Lesser damage at 10/11 day interval and undamaged control.



Plate 9. Chlorosis on Pansy seedlings

