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Effects of dichlorvos fogs on Pot and Bedding Plants and on the control of Western Flower Thrips

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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.

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POT AND BEDDING PLANTS: DICHLORVOS FOGS - PHYTOTOXICITY TESTS AND EFFECTIVENESS AGAINST WESTERN FLOWER THRIPS

Summary

Dichlorvos is the most effective insecticide for the control of western flower thrips (WFT) *Franklinella occidentalis*). Unfortunately it tends to damage many plants, although it is much safer to some crops when applied as a fog or as an aerosol, rather than as a spray, particularly if glasshouses are ventilated fairly soon after treatment. Fogs of dichlorvos were therefore applied at different rates, frequencies and exposure times to see how much damage they caused to 45 species or types of bedding and pot plants and to assess how well they controlled WFT.

All but eight of the 45 species, cultivars or types of plants tested were damaged to some extent by at least one of the rates of dichlorvos fog tested. However only six of the 23 true species were badly affected ("moderately" or "severely" damaged permanently) at 1.8 litres/hectare, with a further two at 2.4 litres/hectare the highest rate tested fully. Symptoms varied from chlorosis (32 species), necrosis (7 species), stunting (28 species) and damage to the flowers (20 species); some plants showed more than one symptom.

The damaging effects of dichlorvos fogs were cumulative, two applications at each of the four rates tested, applied at weekly intervals, were more damaging than a single application in alternate weeks. Ventilating glasshouses 4 instead of 8 hours after treatment did not generally reduce damage significantly.

Impatiens (large and small plants), small petunia and pansy seedlings and *Begonia semperflorens* were the most sensitive species tested. African marigold, antirrhinum, *Cineraria maritima*, coleus, hypoestes, dianthus, misembryanthemum, verbena and both ivy and zonal geraniums were among the most tolerant.

Small seedlings were generally more sensitive than larger plants, and in some cases, eg impatiens, petunias and *Begonia semperflorens*, cultivars even within the same series differed in their susceptibility.

Tests to assess how well dichlorvos fogs controlled WFT were done on different batches of impatiens, verbena and petunias, each fogged once in two separate experiments.

In the main experiment the level of control increased both as the dose rate increased (0.5, 1.0, 1.5 or 2.0 litres/hectare) and as the length of time before the glasshouses were ventilated increased (1, 4 or 11 hours). At 0.5 litres per hectare for one hour, the lowest rate tested, a mean of 51 per cent of the WFT were killed on the three species and this increased to 94 per cent control at 2.0 litres/hectare for 11 hours, the highest rate used.

In a second, smaller experiment, dichlorvos at 1.5 litres/hectare for 15, 30 or 60 minutes gave an average 19, 50 and 50 per cent control of WFT respectively on the three species.

Results from these trials suggest that growers could, by carefully selecting methods and rates of use, apply dichlorvos fogs safely to many pot and bedding plants and still achieve appreciable control of WFT. The relevance of the results to growers who use either chemical or biological methods to control pests is discussed.

Introduction

Western flower thrips (WFT) (*Franklinella occidentalis)* is now probably the most serious pest that affects UK glasshouse crops. The majority of nurseries are infested to some extent. The pest attacks a wide range of crops including many of the most important pot and bedding plants. It causes direct damage and transmits tomato spotted wilt virus (TSWV).

WFT is difficult to control with insecticides because most are not very effective. The best one, dichlorvos, often damages plants (i.e. is "phytotoxic"), particularly when it is applied as a high volume spray, although it is generally safer applied as a fog. Damage, at least on some crops (eg cucumbers) treated with dichlorvos aerosols rather than fogs, (different formulation), is further reduced if glasshouses are ventilated shortly (eg 2-4 hours) after treatment, instead of waiting until the next morning (11-12 hours later).

Useful but limited information was obtained about the crop safety of dichlorvos fogs on pot and bedding plants, from a commercially-funded trial* done by ADAS (Saynor & Sapsed) in 1989. The experiments described in this report are effectively a continuation of this work. They were designed not only to provide more information on crop safety, but to show how well dichlorvos fogs control WFT on pot and bedding plants.

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* Trial sponsored by Nation-wide Ornamental Marketing & Distribution (NOMAD). A copy of this report is available from the HDC.

Objectives

The experiment had two main objectives and to achieve these a number of individual objectives were identified.

1. To test the crop safety of dichlorvos fogs on a range of pot and bedding plants. Individual objectives included:-

   (a) To assess the tolerance/susceptibility of a wide range of species to different rates of dichlorvos fog.

   (b) To see whether damage was reduced if glasshouses were ventilated shortly (4 hours) after treatment, instead of the next morning (11-12 hours), and if so to quantify the effect.

   (c) To see whether small seedlings were more sensitive to dichlorvos fogs than larger plants.

   (d) To see whether different cultivars of the same species differed in their sensitivity to dichlorvos fogs.

   (e) To see whether damaged plants recovered when they were either grown-on in another glasshouse or planted outside.

2. To assess how well dichlorvos fogs controlled WFT at different rates after exposure for differing lengths of time.

   a) To compare the effectiveness of four rates of dichlorvos fog applied in glasshouses ventilated after 1, 4 or 11 hours.

   †b) To compare the effectiveness of dichlorvos fog applied at one rate (1.5 l/hectare) in glasshouses ventilated after 15, 30 or 60 minutes.

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† An additional experiment done because in the first experiment over 50 per cent of the WFT were killed by the lowest rate tested for the shortest time.

Materials and Methods

The experiments were done in the new Glasshouse Unit at ADAS, Reading.

All the fogging treatments were applied in three compartments, each measuring 13 x 3 m, but a number of other glasshouses and compartments were used to accommodate some of the plants for short periods and to infest others with WFT. A video is available from the HDC that shows how these experiments were done, the results obtained and their relevance both to growers who use chemical or biological methods to control WFT.

Plants used for the experiments

Forty five "species" of plants were used in the phytotoxicity trial and three species, petunias, impatiens and verbena were used to evaluate how well dichlorvos fogs controlled WFT. The species used in the phytotoxicity trial are shown in Appendices 1-4. Different "species" in this context included small seedlings or larger plants of the same species (eg pansy, impatiens, cyclamen, lobelia and petunia) and different cultivars of the same species [eg *Begonia semperflorens*, impatiens and petunias (seed-raised*) and ivy-leaved and zonal geraniums (vegetatively propagated*)].

The plants, all plug-raised, arrived at Reading at intervals, depending on their availability and the requirements of the trials. They were pricked out/potted-up into larger containers appropriate to the species, in a peat/bark compost containing 3.5 kg/m^3 Osmocote Plus (5-6 Month-Spring Potting). The small seedlings used in the phytotoxicity trial, that were used 19 days after sowing (approximately 7-10 days after they emerged), were all grown in half trays in Levington F1 compost in separate glasshouses at ADAS, Reading.

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* Apart from the small seedlings that were raised at Reading, all the seed-raised plants used in these experiments were donated by Colegrave Seeds Ltd. The geraniums were donated by Young Plants Ltd.

Each batch of seedlings was used to test the effects of one rate of dichlorvos (1 or 2 applications). They were then transferred to a different glasshouse to see if they recovered. In contrast, the same (larger) plants were used to evaluate the effects of either one or two applications of progressively higher rates of dichlorvos fogs. Any effects, apparently due to the last application would in fact be due to any cumulative effects that the earlier, lower doses might also have had.

Fogging and Ventilating the Glasshouses

A Kingfog Fog Generator KF40 Fogger was used to apply the dichlorvos, (Darmycel Dichlorvos 50% e.c.) with Nevolin as a carrier. The treatments were all applied at 12 litres of the mixture per hectare. In this way it was felt that (almost certainly) the same amount of fog/number of particles would be applied, even though the relative proportions of insecticide and carrier would differ (Table 1). The rates of dichlorvos mentioned in this report relate to the amount of product used. Rates used and dates and times of application are shown in Appendix 5.

Table 1. Rates of Darmycel Dichlorvos fog and Nevolin used in the phytotoxicity and efficacy trials compared with the maximum rate approved in the Specific Off-Label Approvals for dichlorvos fog

Rates of Dichlorvos and Nevolin (l product/hectare)

Phytotoxicity trial Dichlorvos (Nevolin)	SOLAs 0667/90 and 0668/90 (Max. rate approved)	Efficacy trial Dichlorvos (Nevolin)
0.6 (11.4)		0.5 (11.5)
1.2 (10.8)		1.0 (11.0)
1.8 (10.2)		1.5+ (10.5)
2.4 (9.6)	2.2	2.0 (10.0)
(3.6)* (8.4)		

* Single application only. results not inlcuded in the analysis

\+ Rate used in second efficacy trial

The output of the machine was calibrated (3.4 ml/sec), the size of the compartments was known (13 x 3 m = 39 m^2), and the volume of mixture to be applied (12 litres/hectare) was fixed. From these figures it was calculated that each compartment had to be fogged for:-

$$\frac{39 \times 12000}{10000 \times 3.4} = 13.8 \text{ sec} = 14 \text{ sec approx.}$$

The machine was powerful enough to carry the fog to the ends of the glasshouses from the doorway.

To ensure that the fog was applied for the correct time the machine was set to run pointing along the side of the glasshouse until it was fogging evenly. It was then turned through 90° so the barrel pointed through the doorway and after 14 seconds the machine was turned back again through 90° and then switched off. An assistant timed the operation.

The glasshouses were equipped with fans, controlled and linked with the ventilators by computer. When working these would bring about an air change in 4 minutes. The fans and ventilators were set to operate automatically at the required times after treatment.

All fogging operations were carried out between 16.15 - 19.00 hrs, depending on the weather (applied later on bright, clear days) (Appendix 5).

Treatments - Phytotoxicity Trial

Details of the treatments used (rates, frequency of application and exposure times) to assess how safe dichlorvos fogs were to the plants are shown in Table 2. Plants in two of the compartments were fogged at the same rate on each occasion, but they were ventilated either 4 or 11 hours after treatment. The third compartment was not fogged.

Table 2. Rates of dichlorvos, frequency of application and intervals between treatment and ventilating used in phytotoxicity tests on pot and bedding plants

Treatment	Untreated control		Fogged and ventilated after 11 hrs		Fogged and ventilated after 4 hrs	
	Rate of dichlorvos fog used (l/hectare)					
Frequency of application (days)	7	14	7	14	7	14
Week of Experiment						
1	Nil	Nil	0.6	0.6	0.6	0.6
2	"	"	0.6	Nil	0.6	Nil
3	"	"	1.2	1.2	1.2	1.2
4	"	"	1.2	Nil	1.2	Nil
5	"	"	1.8	1.8	1.8	1.8
6	"	"	1.8	Nil	1.8	Nil
7	"	"	2.4	2.4	2.4	2.4
8	"	"	2.4	Nil	2.4	Nil
9	"	"	3.6	3.6	3.6	3.6

From Table 2 it can be seen that half the (large) plants were treated twice at each rate of dichlorvos, and the others just once. The latter were kept on mobile frames on top of the benches and these were carried into an adjacent glasshouse for one night, when the second application of each rate of dichlorvos was applied to the remaining plants.

At the end of the experiment a number of the badly damaged species were planted-out in beds outdoors to see whether and how well the would recover.

Treatments - Efficacy Trials

Two trials (the main one and a supplementary one) were done to see how well dichlorvos fogs controlled WFT on impatiens, petunias and verbenas. These plants were grown in a separate glasshouse heavily infested with WFT. Batches of all three species were moved at intervals into the three compartments used for fogging. Here each batch was treated with dichlorvos fog once at a different rate for different lengths of time.

In both experiments the numbers of thrips on comparable plants remaining in the "infested" glasshouse were used as untreated controls.

In the main trial trial batches of plants were treated at four rates of dichlorvos (0.5, 1.0, 1.5 or 2.0 litre/hectare) in glasshouses ventilated after 1, 4 or 11 hours. (Table 1; Appendix 5). Because over half the thrips were killed by the lowest rate of dichlorvos used after exposure for the shortest period, a second, smaller trial was done. Here one rate of dichlorvos (1.5 litre/hectare) was used in glasshouses ventilated 15, 30 or 60 minutes after treatment.

It is sometimes difficult to apply the intended rates of pesticides accurately when fogging. Because of this, somewhat higher rates of dichlorvos were used in the phytotoxicity trial than were used in the efficacy trial. How these rates compare and how they relate to the maximum rate permitted in the Specific Off-Label Approvals for dichlorvos fogs (SOLAs 0667/90 and 0668/90) are shown in Table 1. This was done to provide a measure of leeway, should growers attempt to apply dichlorvos fogs at these rates themselves.

Assessments - Phytotoxicity Trial

All the plants were assessed for weekly damage 7 (or 14) days after each fogging treatment, by two people working together. Four types of damage were identified - "chlorosis", "necrosis" and "stunting" (to the vegetative parts of the plants) and "flower damage", recorded only in the later stages of the trial to older plants and inevitably therefore only at the higher rates of dichlorvos tested. Damage was also recorded as "permanent" or "transitory".

The degree of damage of each type was scored on a 0-3 basis, where 0 = no and 3 = severe damage. Some species showed more than one type of damage. Many photographs (35 mm slides) were taken of the damage that was caused and a number of these are reproduced in Plates 1-4. Details of the other photographs taken are listed in Appendix 6 and a set of these slides is held by the HDC.

Assessments - Efficacy Trial

The numbers of "live" and "dead" adult and immature WFT present 24 hrs after treatment were assessed on four trays (replicates) of each of the three species used in the experiment. This was done by cutting the plants off at soil level, and tapping them ten times over a white tray. Petunia flowers were picked-off, torn open and examined for thrips before the foliage was tapped. "Live" thrips moved! The numbers of WFT on comparable plants in the "infested" glasshouse were used as untreated controls.

Design of the Experiments - Phytotoxicity Trial

A multifactorial design was used, with five factors (species, rate of dichlorvos, ventilation, frequency of application and number of assessments). It was possible to assess the effects of each of these factors separately and to see whether there were significant 2, 3, 4 or even 5-way interactions. Each treatment was replicated twice.

The untreated plants (which never showed symptoms) were not used in the analysis, but were used as references when deciding whether or not symptoms on fogged plants were due to the treatments.

Design of the Experiments - Efficacy Trials

A multifactorial design was also used in the main efficacy trial, with three factors (rate of dichlorvos, ventilation and species of plant). There were four replicates of each species. The analysis was done on a Log (n + 1) transformation of the numbers of WFT per tray.

Three treatments (ventilating 15, 30 or 60 minutes after application of dichlorvos at 1.5 litre/hectare) with four replicates were used in the supplementary trial. An analysis of variance (also Log (n + 1) of the numbers of live WFT 24 hours after treatment) was used to analyse the data.

Results - Phytotoxicity Trial

All but eight of the 45 species, cultivars or types of plants tested were damaged to some extent by at least one of the rates of dichlorvos fog tested. However only six of the 23 true species were badly affected ("moderately" or "severely" damaged permanently) at 1.8 litres/hectare, with a further two at 2.4 litres/hectare the highest rate tested fully. (Table 3; Appendices 1-4). Symptoms varied from chlorosis (32 species), necrosis (7 species), stunting (28 species) and damage to the flowers (20 species); some plants showed more than one symptom.

More species were damaged the higher the rate of dichlorvos used and two applications at the same rate almost always caused more and in some cases much more damage, than a single application (Fig. 1). Ventilating the glasshouses 4 or 11 hours after fogging did not have a significant or consistent effect when the results from the four rates of dichlorvos used were averaged. However after the first application of dichlorvos at 1.8 litre/hectare appreciable less damage (statistically significant at the $p = 0.07$ probability level - ie. one chance in 14 of obtaining such a result by chance) was recorded on plants in the glasshouse ventilated after four than after 11 hours (Fig. 1).

Impatiens (large and small plants), small petunia and pansy seedlings and *Begonia semperflorens* were the most sensitive species tested. African marigold, antirrhinum, *Cineraria maritima*, coleus, dianthus, mesembryanthemum, verbena and both ivy and zonal geraniums were among the most tolerant. A set of 35 mm slides and a video showing the damage caused to many of the plants (and how the trials were done) are held by the HDC. Details of the slides are given in Appendix 6 and some are reproduced in Plates 1-4.

Small seedlings were generally more sensitive than larger plants. In some species, eg *Begonia semperflorens*, impatiens and petunias, cultivars even within the same series differed in their susceptibility (Table 3; Appendices 1-4; Figs. 2-4). There were significant interactions between species, rates of use and the frequency of application, with these factors affecting the various species differently (Appendix 7).

When a number of the more badly damaged species were planted out in flower beds after the last treatments had been applied, some (eg impatiens) seemed to establish and recover better than others (eg *Begonia semperflorens*). The plants were over-mature and "leggy" by then and any apparent results from this exercise should be treated with extreme caution.

Results - Efficacy Trials

Dichlorvos fogs controlled WFT very effectively in both trials. In the main trial the level of control increased the higher the rate of dichlorvos used and the longer the period between fogging and ventilation (Fig. 5; Appendix 8). The highest rate/time combination used (2.0 litre/hectare for 11 hours) reduced the numbers of live thrips 24 hours after treatment by 94 per cent. This fell to 51 per cent control in the glasshoused fogged at 0.5 litre/hectare and ventilated after one hour, the lowest rate tested.

In the second trial, where dichlorvos was applied at 1.5 litre/hectare in glasshouses ventilated after 15, 30 or 60 minutes, the treatments, averaged across the three species of plants, gave 19, 50 and 50 per cent control respectively (Table 4; Appendix 8).

Appreciably more WFT were present on impatiens and verbena than on petunias (Appendices 8 and 9). Statistically speaking WFT were controlled equally well by on all three species (although there was a suggestion that the level of control on petunias improved relatively more as the rate of dichlorvos increased).

Table 3. Types of damage caused to pot and bedding plants treated with dichlorvos fogs

Lowest rate of dichlorvos to cause each type of damage (l/ha)	Species showing damage: Chlorosis	Necrosis	Stunting	Flower Damage
0.6	Impatiens: Accent (L) " : " (S) " : " Apricot Pansy: Turbo (L) " : Turbo (S) Petunia: Express (S)			Impatiens: Accent (S) Pansy: Turbo (S)
1.2	Impatiens: Accent Pink " : " Red " : " Scarlet Lobelia: C.Palace (S) N.Guinea Imp: Tango Petunia: Express Pink " : " Red Dahlia: Jester	Lobelia: C.Palace (S) Petunia: Express Pink " : " Red	Impatiens: Accent (L) " : " Apricot " : " Pink " : " Red " : " Scarlet Lobelia: C.Palace (S) Pansy: Turbo (L) Petunia: Express Pink " : Express Red	Geranium-Ivy Leaved: Corot " -Ivy Leaved:S.Queen Petunia: Express (L)
1.8	Begonia Semp:Organdy (L) " " : (S) Begonia Semp:Devil Series Cyclamen:Mirabebelle (S) Geranium-Zonal: R.Satisf' Gloxinia: Express Nicotiana: Domino Salvia: Fury	Begonia Semp:Organdy (L) " " : " (S) Begonia Semp:Devil Series	Begonia Semp:Organdy (L) " " : (S) Begonia Semp:Devil Series Cyclamen: Mirabelle (S) Geranium-Zonal: R.Satisf' Gloxinia: Express N.Guinea Imp: Tango Nicotiana: Domino Salvia: Fury	Geranium-Zonal: Cherry Impatiens: Accent (L) " : Accent Red Pansy: Turbo (L) Petunia: Express: Pink
2.4	Alyssum: Snowdrift Cyclamen:Sierra Rose (L) Lobelia: Cambr. Blue (L) Tagetes: Starfire	Lobelia: Cambr. Blue (L)	Alyssum: Snowdrift Cyclamen:Sierra Rose (L) Lobelia: Cambr.Blue (L) Tagetes: Starfire	Geranium-Zonal: B.Franklin Impatiens: Accent Apricot " : " Pink " : " Scarlet Nicotiana: Domino Petunia: Express Salmon Petunia: Express Red
3.6	Geranium-Ivy.L: C.Pink " : Corot " Zonal: Cherry Hypoestes: Pink Splash Petunia: Express Salmon " : " White		Geranium-I.L:Cascade Pink " : Corot " Zonal: Cherry Hypoestes: Pink Splash Petunia: Express Salmon " : " White	Geranium-I.L:Cascade Pink N.Guinea Impatiens: Tango Salvia: Fury

Key (L) Large Plants
(S) Small Plants

Names of some species and cultivars are abbreviated: these are given in full in Appendices 1-4

Fig. 1: Effect on plants of venting 4 or 12 hours after fogging once or twice with dichlorvos

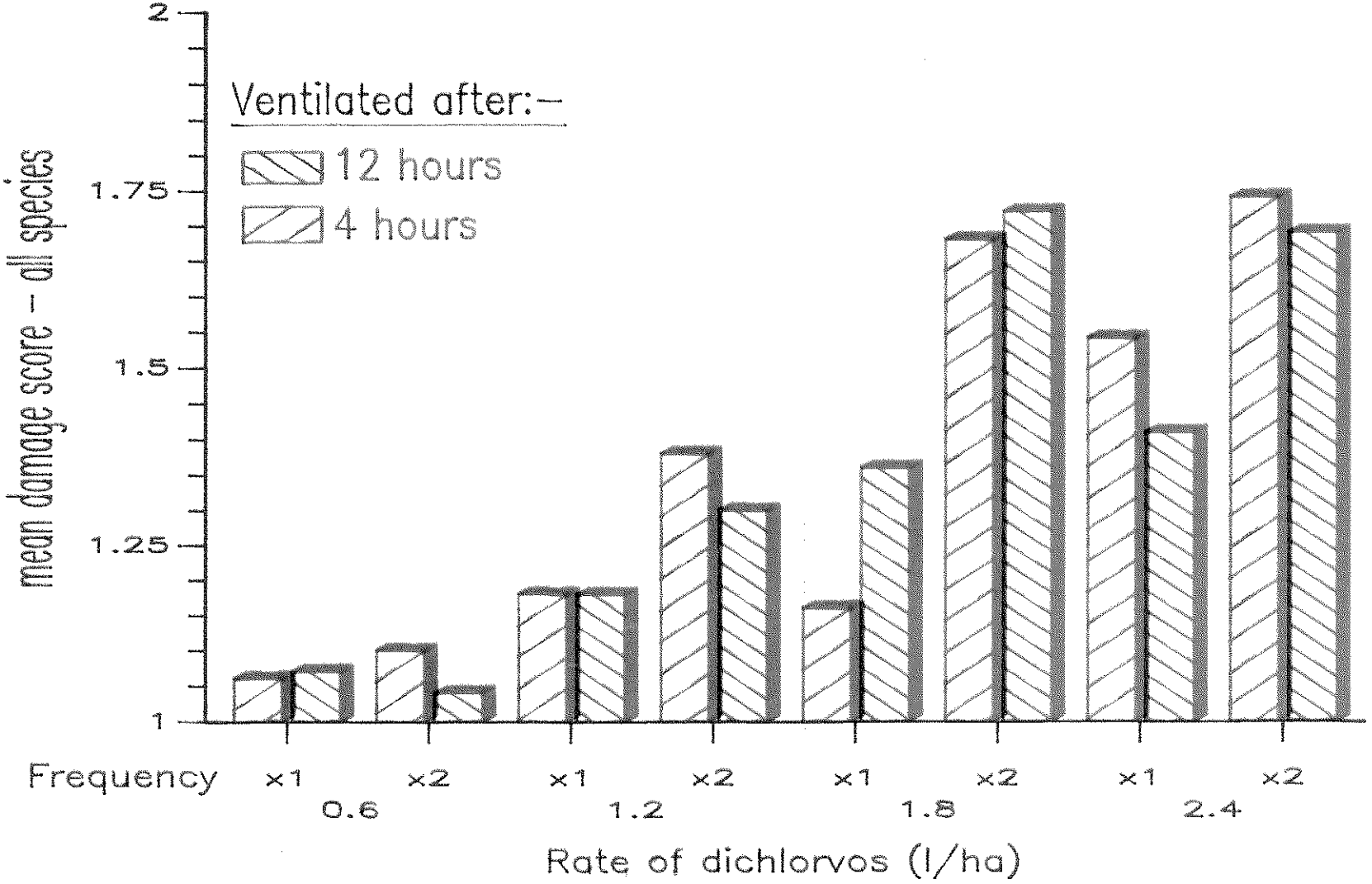


Fig. 2: Sensitivity of four Begonia semperflorens cultivars to dichlorvos fog

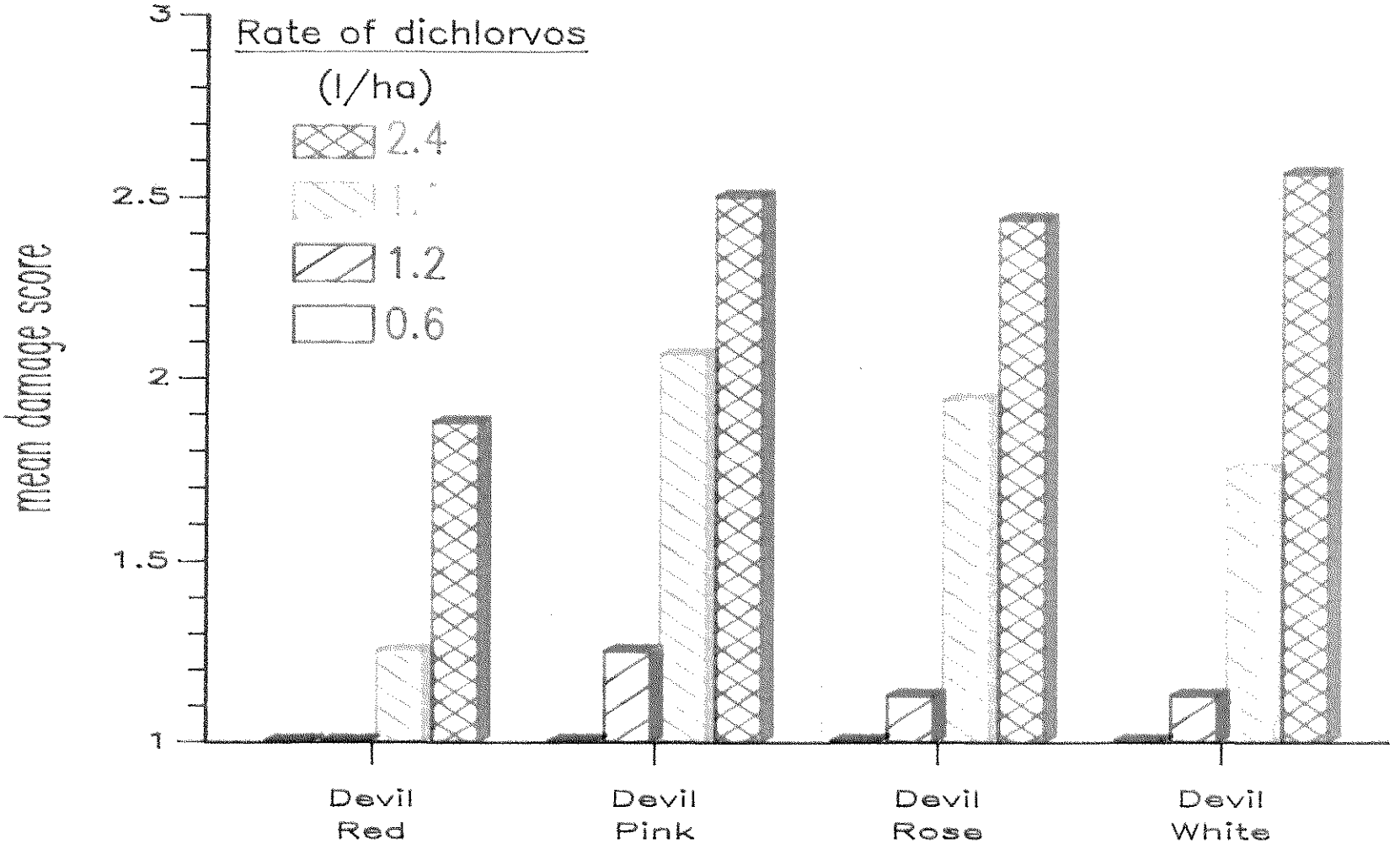


Fig. 3: Sensitivity of four Impatiens cultivars to dichlorvos fog

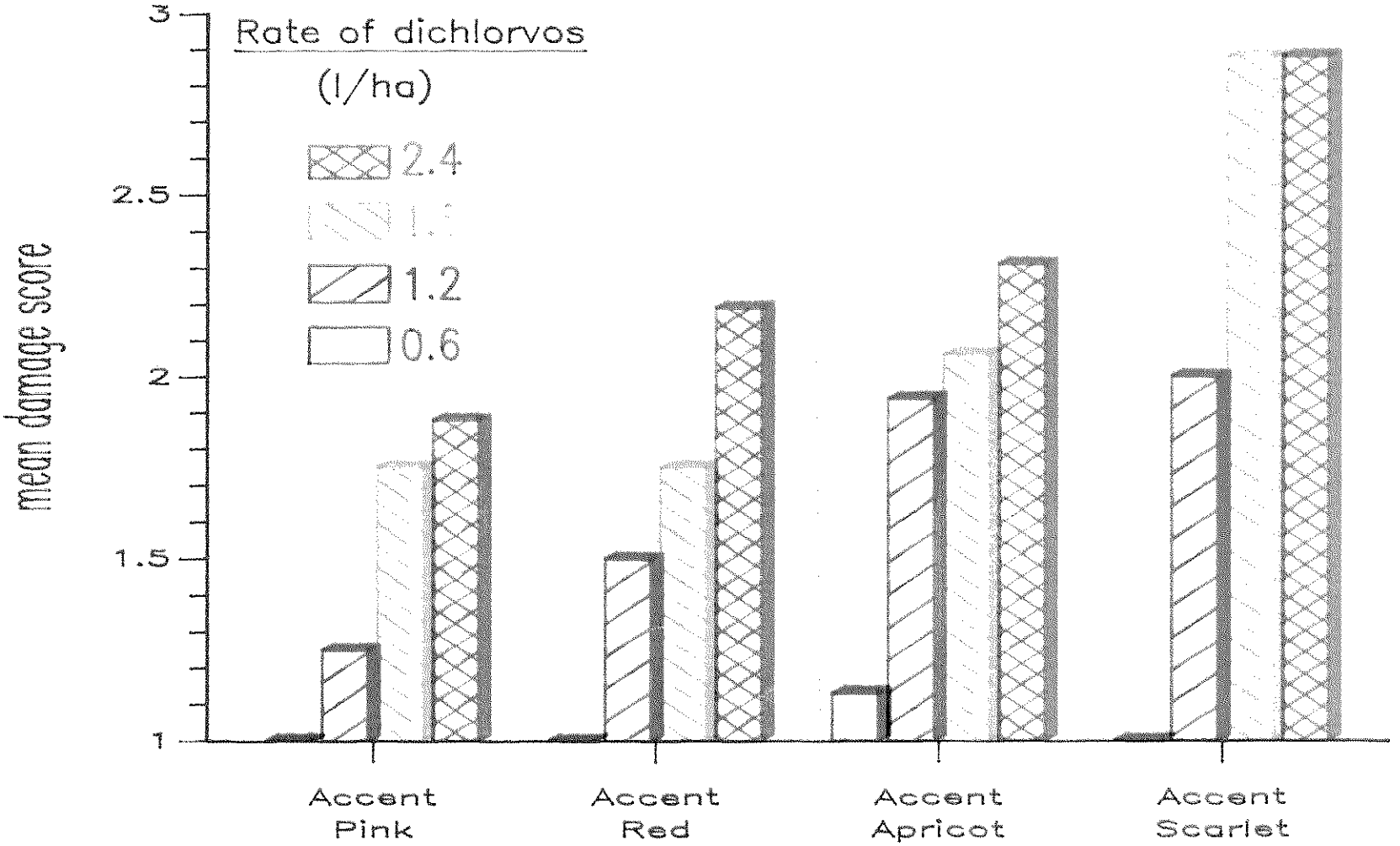


Fig. 4: Sensitivity of four Petunia cultivars to dichlorvos fog

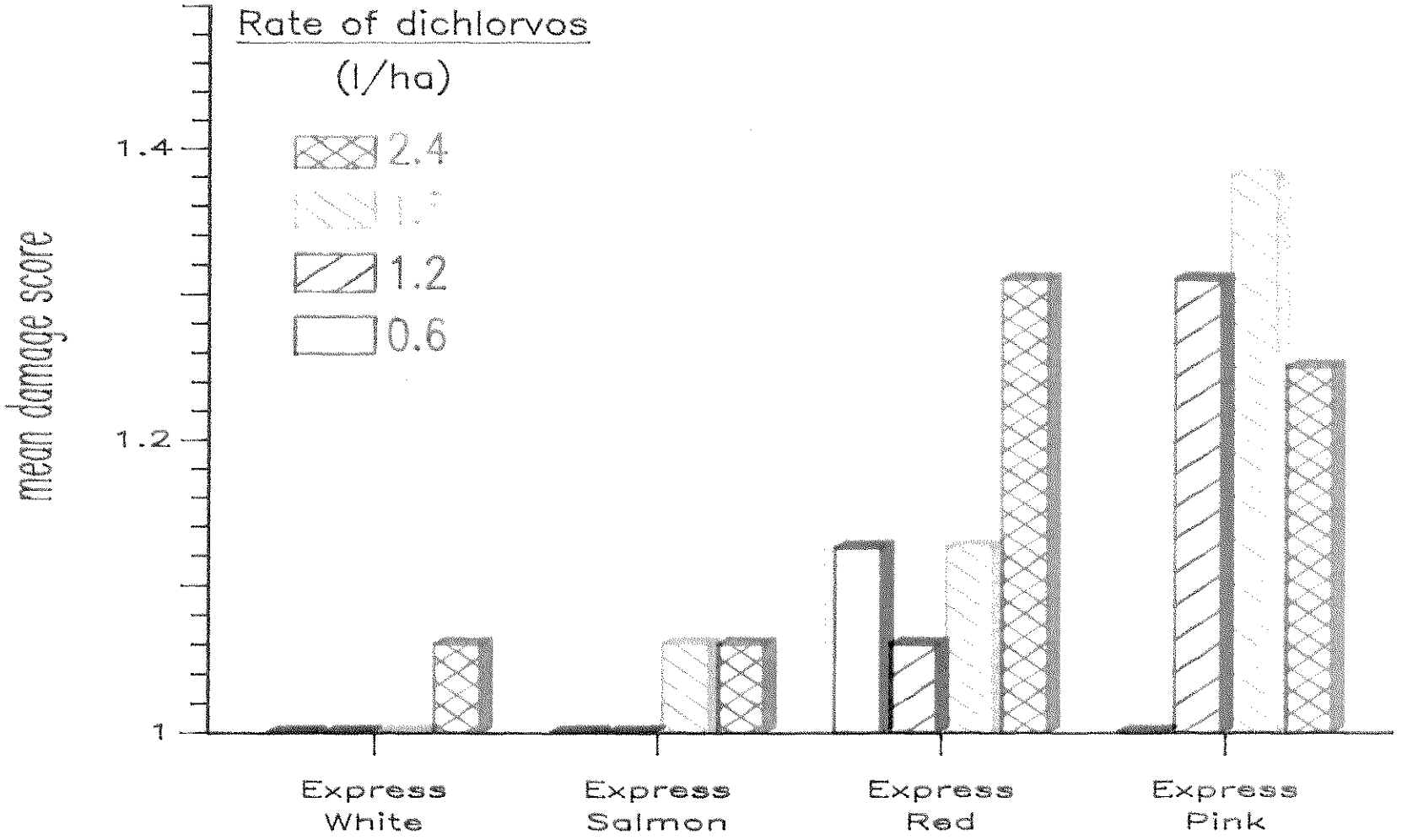


Fig. 5: Control of WFT with dichlorvos fogs

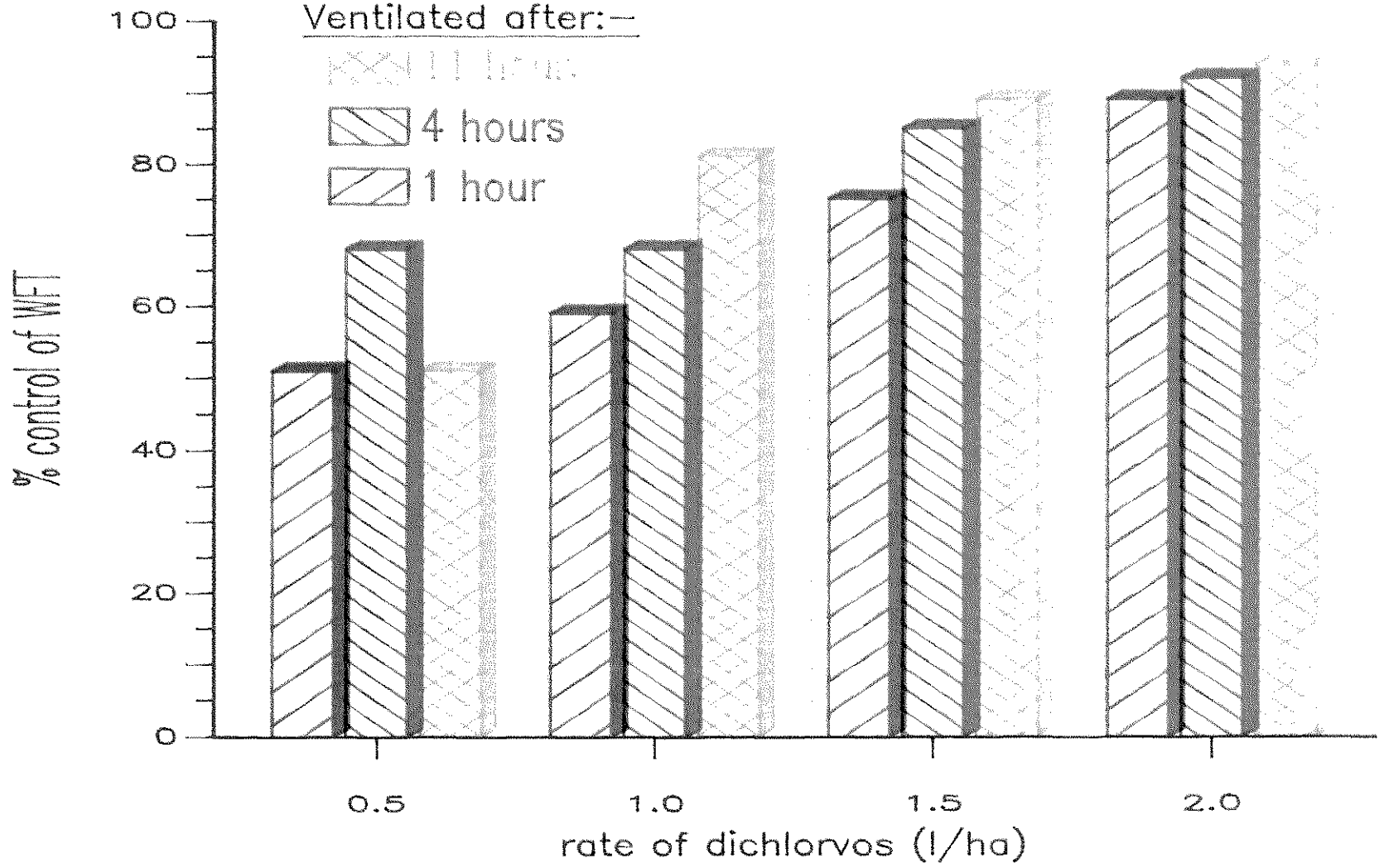


Table 4. Control of WFT on three species treated with dichlorvos fog at 1.5 l/hectare in glasshouses ventilated after 15, 30 or 60 minutes

	Per cent control*		
Ventilation time (minutes)	15	30	60
a) Numbers on individual species			
Petunia	-33	0	0
Impatiens	39	71	70
Verbena	19	44	59
b) Mean of the 3 species	19	50	50

* Calculated from detransformed (Log (n + 1)) data, so not valid to compare data from the two halves of the table.

Discussion

Results from these trials suggest that most of the species of pot and bedding plants tested can tolerate treatment with dichlorvos fogs at rates that control a high proportion of the WFT (adults and nymphs) on them. A number of the most tolerant (verbena) are good hosts of WFT, but unfortunately so too are some of the most susceptible (impatiens).

Crop damage increased rapidly as the dose rate increased, so it is important to be able to apply the intended dose accurately. Damage was also cumulative, with two, weekly applications at the same rate being more harmful than a single one in alternate weeks. Even though there was this cumulative effect from applying fogs repeated, the amount of damage apparently caused by the highest rate of dichlorvos tested (2.4 litres/hectare) may well have been an underestimate. The plants were large and fairly mature by that time (well beyond the stage when bedding plants are planted out). They were possibly therefore rather more tolerant than tender, young plants would have been.

Although dichlorvos fogs are toxic to parasites and predators present when they are applied, they are not generally believed to have a long, residual effect. They could therefore be useful in certain situations even on nurseries using integrated pest management (IPM) techniques to control pests. One or two applications could perhaps be made if large numbers of WFT built up, to reduce the numbers quickly before predators were reintroduced (or other physical or chemical methods of control were used).

There was little evidence that ventilating glasshouses four rather than eleven hours after fogging reduced the amount of crop damage much: possibly it did a little at intermediate rates (1.8 l/hectare). This aspect needs investgating further, to see if damage is reduced if glasshouses are ventilated sooner still after fogging (eg 0.5 or 1 hour), times quite adequate it would appear to kill many WFT. The effects on plants of exposure for short periods (15, 30 or 60 minutes) were not assessed although they had appreciable effects on the pest. Highly susceptible plants on which to do critical tests (impatiens, pansy and petunia seedlings) have now been identified.

Even though 45 "species" of plants were tested, little is known about the dichlorvos tolerance of a number of other important crops. A strong case can be made to test such plants as well, perhaps over a smaller range of dose rates. Types of crops worth testing include:-

(a) Important species of pot and bedding plants not yet tested.

(b) Edible crops prone to attack by WFT (eg. cucumbers, tomatoes, peppers).

(c) Crops prone to attack by pests subject to statutory control that are also likely to be killed by dichlorvos fogs (eg. lettuce, celery - *Lyriomyza* spp.; poinsettias - *Bemisia tabaci*).

These experiments were all done using a thermal fogging machine. The last season has seen a large increase in the use of low volume mist (LVM) cold fogging machines. It is claimed that certain pesticides are safer to plants when they are applied this way than through thermal foggers. Perhaps the relative safety of dichlorvos applied each way should also be assessed?

The efficacy of control was determined in these trials by assessing how well the insecticide controlled adults and larvae 24 hours after treatment. Eggs laid within plant tissue or pupae in the soil would not be affected. Growers with a serious WFT problem really need to know not just what rate can be used safely and effectively once or twice, but how many times and how frequently fogs need to be applied to control the population of thrips in their glasshouses without damaging crops.

As often happens with trials that produce positive results, they raise almost as many questions as the answer. However, the prospects of obtaining answers to most of these questions if this work is continued are good.

Conclusions

1. 45 species and types of pot and bedding plants can now be classified as susceptible to, or moderately or highly tolerant of fogs of dichlorvos: cultivars even within the same series may differ considerably.

2. The lowest rates of dichlorvos tested only damaged a few species, but still gave significant control of WFT.

3. The amount of damage caused increased rapidly as the rate used increased, so it is important to apply dichlorvos fogs accurately.

4. Dichlorvos fogs had a cumulative effect, two, applications at weekly intervals at each rate being appreciably more harmful than a single, fortnightly one. The insecticide could therefore be useful where it is necessary to control unexpected attacks of WFT, even if it is not used regularly eg. on nurseries using IPM.

5. Ventilating glasshouses 4 hours, instead of 11 hours after treatment, reduced very slightly the amount of damage caused by intermediate rates of dichlorvos. Significant control of WFT was given when glasshouses were ventilated after 30 or 60 min, but the effects on plants of such short periods of exposure to dichlorvos was not assessed.

6. The study highlighted a number of aspects worth investigating further. These include:-

   (a) More phytotoxicity tests on different species and groups of plants.
   (b) Tests to identify the optimum rate of dichlorvos/ventilation time (particularly short exposures).
   (c) Comparison of the crop safety of low volume mist (LVM) cold foggers and thermal foggers.
   (d) Determining how best to control populations of WFT in glasshouses.

Acnowledgements

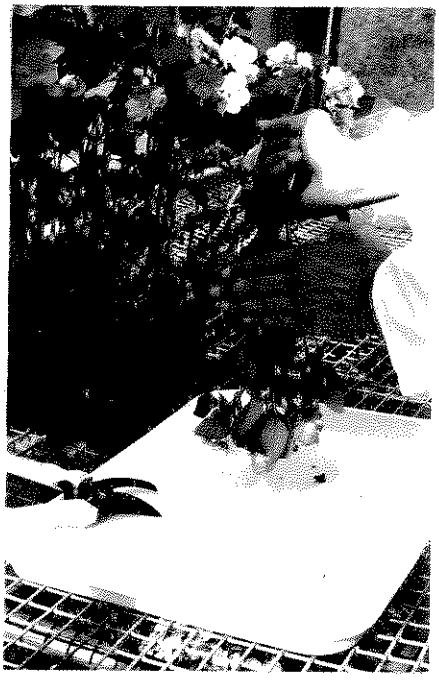
We thank Ivor Parry and Mark Rackley, Experimental Garderners at Reading, who maintained the plants throughout and Brian Crosby, the HDC Project Co-ordinator for all his helpful advice and comments.

We are most gateful to Young Plants Ltd who donated the geraniums and to Colegrave Seeds Ltd who donated all the other plants. We are particularly grateful to Alan Miles of Colegrave Seeds Ltd who organised the delivery of these plants and all the scheduling and planning that this involved.

Storage of the data

The raw data will be stored by the ADAS Regional Entomologist, ADAS, Block A, Coley park, Reading RG1 6DT for a period of 10 years. The HDC will be consulted before disposal.

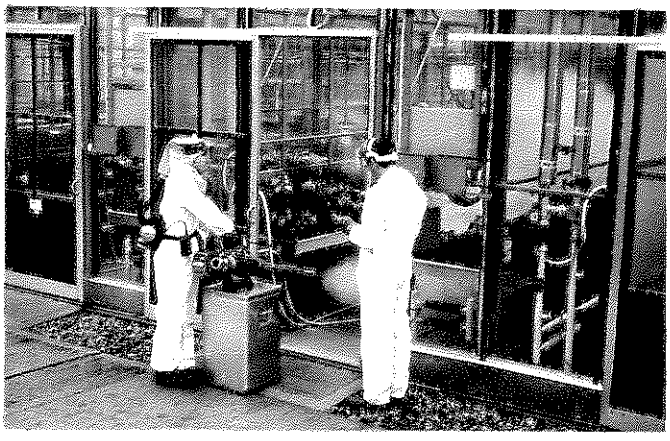
1a. Untreated plants in phytotoxicity trial



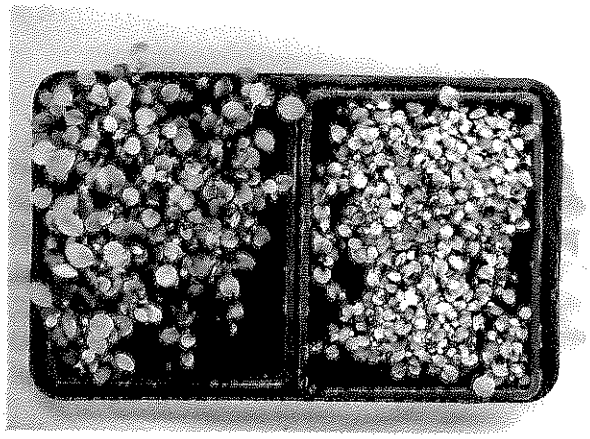
1b. Assessing the numbers of WFT

1c. Young plants in glasshouse infested with WFT

1d. Monitoring levels of WFT



1e. Fogging in progress



1f. Lobelia seedlings - chlorosis and stunting

2a. Pansy - chlorosis on 'large' plants

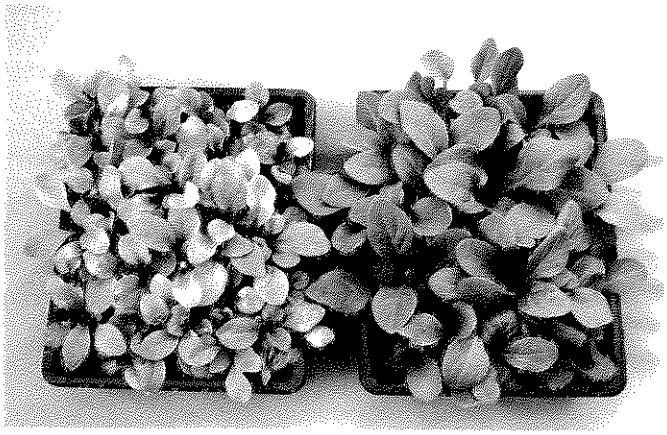
2b. Pansy seedlings - chlorosis

2c. Ivy-leaved geranium - chlorosis

2d. Cyclamen - chlorosis and slight stunting

2e. Begonia semperflorens - leaf necrosis

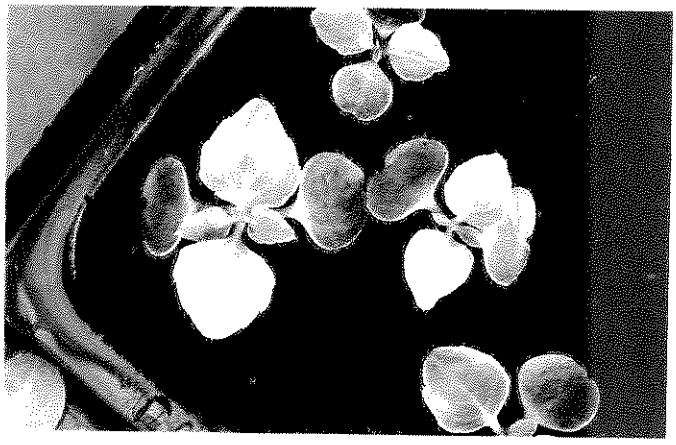
2f. Begonia semperflorens - stunting and leaf necrosis



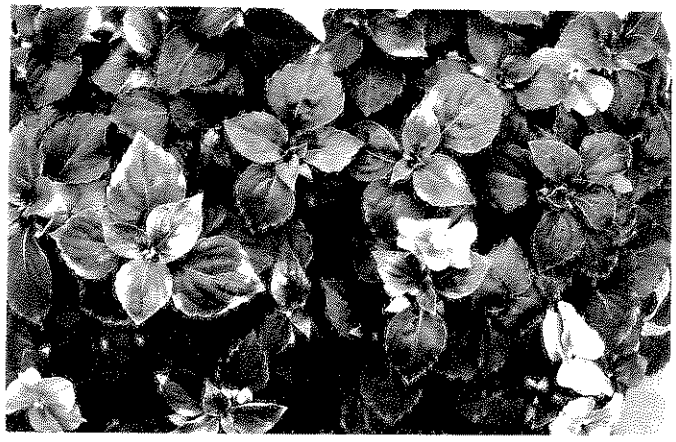
3a. Petunia seedlings - chlorosis and stunting

3b. Petunia seedlings - plants recovering from damage

3c. Impatiens seedlings - chlorosis and stunting



3d. Impatiens seedlings - chlorosis



3e. Impatiens: Accent Apricot - chlorosis

3f. Impatiens: Accent Scarlet - chlorosis and stunting

4a. Gloxinia - stunting

4b. Salvia - damage to the bracts

4c. Zonal Geranium: Red Satisfaction - Damage just on flowers open during fogging

4d. New Guinea impatiens - chlorosis and necrosis

4e. Petunia - flower damage

4f. Nicotiana - flower damage

Severity of damage caused to pot and bedding plants by different rates of dichlorvos fogs applied in different ways.
Dichlorvos treatment: 2 applications at each rate at weekly intervals, ventilated after 11 hours

Species	Rate of dichlorvos fog (l/hectare)	Severity of damage 0.6	1.2	1.8	2.4	3.6
Alyssum: Snowdrift				▪	▪	
Antirrhinum: Liberty						
Begonia semperflorens: Organdy	Large			▪▪▪	▪▪	▪▪▪
" " "	Small		o	oo	o	▪▪
Begonia semperflorens: Devil Pink			▪▪	▪▪	▪▪▪	▪▪
" " : " Red				▪	▪▪	▪▪
" " : " Rose				▪▪	▪▪	▪▪▪
" " : " White				▪▪	▪▪	▪▪
Cineraria maritima						
Coleus: Wizard						
Cyclamen: Sierra Rose	Large			▪		
" : Mirabelle	Small			▪▪	▪▪	▪▪
Dahlia: Jester			▪	▪	▪▪	
Dianthus: Princess						
Geranium - Ivy Leaved: Cascade Pink					+	▪+
" " " : Corot						
" " " : Salmon Queen					+	
Geranium Zonal: Ben Franklin						+
" " : Cherry					+	▪++
" " : Red Satisfaction			+		+	+
Gloxinia: Empress						
Hypoestes: Pink Splash						▪
Impatiens: Accent	Large		▪	▪▪	▪▪++	▪▪
" "	Small	oo	oo	oo	oo	o
Impatiens Accent: Scarlet			▪▪	▪▪▪	▪▪▪+	▪▪▪++
" " : Red			▪	▪▪	▪▪+	▪▪▪++
" " : Apricot		▪	▪	▪▪	▪▪	▪▪▪+
" " : Pink				▪	▪	▪▪+
New Guinea Impatiens: Tango			▪	▪▪▪	▪▪▪	▪▪▪
Lobelia: Cambridge Blue	Large					
" : Crystal Palace	Small		o	o	o	o
Marigold: Inca						
Mesembryanthemum: Magic Carpet						
Nicotiana: Domino				▪	▪▪+	▪▪+
Pansy: Turbo	Large		▪	▪	▪+	▪
" : "	Small		oo	oo	oo	oo
Petunia: Express	Large		+	▪	▪▪	
" : "	Small	o	o	o	oo	o
Petunia: Express Pink			▪++	▪	▪	▪++
" : " Red				▪	▪	▪
" : " Salmon						▪+
" : " White						
Salvia: Fury				▪	▪	▪
Tagetes: Starfire						
Verbena: Garden Party						

Total species damaged:						
	▪	1	7	11	6	8
	▪▪	0	2	7	11	8
	▪▪▪	0	0	3	3	6
	o	1	3	2	2	2
	oo	1	2	3	3	1
	ooo	0	0	0	0	0
	+	0	2	0	8	6
	++	0	1	0	1	4
	+++	0	0	0	0	0

Key: Type of damage

▪ Permanent damage to vegetative parts of plant
o Transitory damage. Plants (small seedlings) generally recovered within 21 days
+ Damage to the flowers

Severity of damage

▪ Slight
▪▪ Medium
▪▪▪ Severe

Severity of damage caused to pot and bedding plants by different rates of dichlorvos fogs applied in different ways.
Dichlorvos treatment: 2 applications at each rate at weekly intervals ventilated after 4 hours

Species	Rate of dichlorvos fog (l/hectare)	Severity of damage 0.6	1.2	1.8	2.4	3.6
Alyssum: Snowdrift						
Antirrhinum: Liberty						
Begonia semperflorens: Organdy	Large		▪	▪▪	▪▪	▪▪
" " : "	Small		o	o	oo	▪▪
Begonia semperflorens: Devil Pink			▪▪	▪▪▪	▪▪▪	▪▪▪
" " : " Red				▪	▪▪	▪▪▪
" " : " Rose			▪	▪▪	▪▪	▪▪▪
" " : " White			▪▪	▪▪▪	▪▪▪	▪▪▪
Cineraria maritima						
Coleus: Wizard						
Cyclamen: Sierra Rose	Large					
" : Mirabelle	Small			▪	▪▪	▪▪
Dahlia: Jester			▪▪	▪▪	▪	
Dianthus: Princess						
Geranium - Ivy Leaved: Cascade Pink			+		++	+
" " " : Corot						+
" " " : Salmon Queen			+		+	
Geranium - Zonal: Ben Franklin					+	+
" " : Cherry					++	▪+
" " : Red Satisfaction			+		+	▪++
Gloxinia: Empress				▪	▪▪	▪
Hypoestes: Pink Splash						▪
Impatiens: Accent	Large			▪	▪▪+	▪
" : "	Small	o	oo	ooo	oo	o
Impatiens: Accent Scarlet			▪▪	▪▪▪	▪▪▪+	▪▪▪++
" : " Red			▪	▪	▪▪	▪▪▪++
" : " Apricot		▪	▪▪	▪▪▪	▪▪▪+	▪▪▪+
" : " Pink			▪	▪▪▪	▪▪+	▪
New Guinea Impatiens: Tango			▪	▪▪	▪▪▪	▪▪▪
Lobelia: Cambridge Blue	Large			▪	▪	
" : Crystal Palace	Small		o	o	o	o
Marigold: Inca						
Mesembryanthemum: Magic Carpet						
Nicotiana: Domino					▪+	▪▪+
Pansy: Turbo	Large	▪▪	▪▪	▪▪▪	▪▪▪+	▪+
" : "	Small	o	oo	oo	oo	▪▪
Petunia: Express	Large		+	▪		
" : "	Small	o	o	oo	oo	o
Petunia: Express Pink			▪	▪+		▪+
" : " Red		▪	▪	▪	▪+++	
" : " Salmon						▪+
" : " White					▪	▪▪
Salvia: Fury				▪		▪
Tagetes: Starfire					▪	
Verbena: Garden Party						
Total species damaged:	▪	2	7	10	6	10
	▪▪	1	6	4	8	6
	▪▪▪	0	0	6	6	8
	o	3	3	2	1	3
	oo	0	2	2	4	0
	ooo	0	0	1	0	0
	+	0	4	1	9	10
	++	0	0	0	2	2
	+++	0	0	0	1	0

Key: Type of damage

▪ Permanent damage to vegetative parts of plant
o Transitory damage. Plants (small seedlings) generally recovered within 21 days
\+ Damage to the flowers

Severity of damage

▪ Slight
▪▪ Medium
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Severity of damage caused to pot and bedding plants by different rates of dichlorvos fogs applied in different ways.
Dichlorvos treatment: 1 application at each rate at weekly intervals ventilated after 11 hours

Species	Rate of dichlorvos (l/hectare)	Severity of damage 0.6	1.2	1.8	2.4	3.6
Alyssum: Snowdrift				▪	▪	
Antirrhinum: Liberty						
Begonia semperflorens: Organdy	Large		▪▪	▪▪▪	▪▪	▪▪
" " : "	Small		oo	o	oo	oo
Begonia semperflorens: Devil Pink				▪	▪	▪▪
" " : " Red					▪	▪
" " : " Rose			▪	▪	▪	▪▪
" " : " White					▪	▪▪
Cineraria maritima						
Coleus: Wizard						
Cyclamen: Sierra Rose	Large					
" : Mirabelle	Small			▪	▪	
Dahlia: Jester			▪	▪▪▪	▪	▪
Dianthus: Princess						
Geranium - Ivy Leaved: Cascade Pink				+	+	▪++
" " " : Corot						▪+
" " " : Salmon Queen					+	
Geranium - Zonal: Ben Franklin						+
" " : Cherry				+	+	▪+
" " : Red Satisfaction					+	+
Gloxinia: Empress					▪	▪
Hypoestes: Pink Splash						▪
Impatiens: Accent	Large	▪			▪+	▪+
" : "	Small	oo	oo	o	oo	o
Impatiens: Accent Scarlet			▪▪	▪▪	▪▪+	▪▪+
" : " Red			▪		▪	▪
" : " Apricot			▪	▪	▪+	▪▪+
" : " Pink			▪	▪	▪	▪
New Guinea Impatiens: Tango				▪	▪	▪+
Lobelia: Cambridge Blue	Large					
" : Crystal Palace	Small		o	o		o
Marigold: Inca						
Mesembryanthemum: Magic Carpet						
Nicotiana: Domino					▪	▪+
Pansy: Turbo	Large		▪▪	▪+	▪+	▪▪
" : "	Small		o	o	o	oo
Petunia: Express	Large					
" : "	Small	o	o	oo	o	o
Petunia: Express Pink			▪	▪	▪	▪++
" : " Red						+
" : " Salmon						▪+
" : " White						
Salvia: Fury				▪	▪	▪▪++
Tagetes: Starfire						
Verbena: Garden Party						

Total species damaged:						
	▪	1	6	10	17	14
	▪▪	0	3	1	2	8
	▪▪▪	0	0	2	0	0
	o	1	3	4	2	3
	oo	1	2	1	2	2
	ooo	0	0	0	0	0
	+	0	0	3	8	11
	++	0	0	0	0	3
	+++	0	0	0	0	0

Key: Type of damage

▪ Permanent damage to vegetative parts of plant
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\+ Damage to the flowers

Severity of damage

▪ Slight
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Severity of damage caused to pot and bedding plants by different rates of dichlorvos fogs applied in different ways.
Dichlorvos treatment: 1 application at each rate at weekly intervals ventilated after 4 hours

Species	Rate of dichlorvos fog (l/hectare)	Severity of damage 0.6	1.2	1.8	2.4	3.6
Alyssum: Snowdrift				■■	■	
Antirrhinum: Liberty						
Begonia semperflorens: Organdy	Large			■	■	■■
" " : "	Small		o	o	oo	o
Begonia semperflorens: Devil Pink					■	■■
" " : " Red				■	■	■■
" " : " Rose					■	■■
" " : " White					■■	■■
Cineraria maritima						
Coleus: Wizard						
Cyclamen: Sierra Rose	Large				■	
" : Mirabelle	Small				■	■
Dahlia: Jester				■	■	
Dianthus: Princess						
Geranium - Ivy Leaved: Cascade Pink			+		+	+
" " " : Corot					+	
" " " : Salmon Queen						
Geranium - Zonal: Ben Franklin					+	++
" " : Cherry					++	++
" " : Red Satisfaction					+	■++
Gloxinia: Empress				■	■	■
Hypoestes: Pink Splash						■
Impatiens: Accent	Large			+	■	■
" : "	Small	o	oo	o	oo	o
Impatiens: Accent Scarlet			■	■+	■+	■■++
" : " Red			■	■+	■+	■■++
" : " Apricot			■		■	■■++
" : " Pink			■	■	■	■+
New Guinea Impatiens: Tango					■	■
Lobelia: Cambridge Blue	Large					
" : Crystal Palace	Small		o	o	o	o
Marigold: Inca						
Mesembryanthemum: Magic Carpet						
Nicotiana: Domino					■+	■■+
Pansy: Turbo	Large		■	+	■+	■
" : "	Small	o	o	o	o	oo
Petunia: Express	Large		■		■	■
" : "	Small	o	o	oo	o	
Petunia: Express Pink				■	■	■+
" : " Red		■				
" : " Salmon				■	+	■++
" : " White						
Salvia: Fury				■	■	■■++
Tagetes: Starfire						
Verbena: Garden Party						

Total species damaged:						
	■	1	6	10	20	11
	■■	0	0	1	1	10
	■■■	0	0	0	0	0
	o	3	4	4	3	3
	oo	0	1	1	2	1
	ooo	0	0	0	0	0
	+	0	1	4	9	3
	++	0	0	0	1	8
	+++	0	0	0	0	0

Key: Type of damage

■ Permanent damage to vegetative parts of plant
o Transitory damage. Plants (small seedlings) generally recovered within 21 days
+ Damage to the flowers

Severity of damage

■ Slight
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Fogging Darmycel Dichlorvos: Rates used, dates and times applied and tempertures during treatment

Rate of Darmycel Dichlorvos used (l/hectare)	Date applied	Days from start of experiment	Time applied	Temp (°C)
Phytotoxicity Trial				
0.6	21 May	0	19.00	22.0
0.6	28 May	7	19.00	15.0
1.2	5 June	15	16.30	20.0
1.2	12 June	22	16.30	23.0
1.8	18 June	28	16.30	17.0
1.8	25 June	35	16.30	21.0
2.4	2 July	42	18.30	23.0
2.4	9 July	49	19.00	20.0
3.6	16 July	56	16.15	22.5
Efficacy Trials				
1.0	29 July	1	18.45	26.5
1.5	30 July	2	16.50	21.0
2.0	31 July	3	17.00	25.0
0.5	1 August	4	17.00	23.0
1.5	5 August	7	16.30	22.0

35 mm Slides of the trial held by the HDC

1. General view of plants used in the Phytotoxicity Trial.
2. Young plants in the glasshouse infested with WFT.
3. Plants in the glasshouse infested with WFT at the stage when they were used in the Efficacy Trial.
4. Fogging in progress.
5. Moving plants fogged on alternate weeks.
6. Assessing numbers of WFT.
7. Lobelia seedlings showing chlorosis and stunting.
8. Lobelia seedlings - differential bronzing.
9. Pansy seedlings showing chlorosis and stunting.
10. Older pansy plants showing chlorosis.
11. Impatiens seedlings showing chlorosis and stunting.
12. Impatiens seedlings - close up of damage.
13. Impatiens c.v. Accent Apricot showing chlorosis.
14. Impatiens c.v. Accent Scarlet showing chlorosis and stunting.
15. Impatiens c.v. Accent Salmon showing chlorosis and stunting.
16. Impatiens c.v. Accent Scarlet - flower damage.
17. Impatiens c.v. Accent Apricot 2 days after fogging: damage only on flowers open during fogging.
18. New Guinea impatiens c.v. Tango showing stunting and necrosis.
19. New Guinea impatiens c.v. Tango - close up showing necrosis and chlorosis.
20. Small petunia seedlings showing chlorosis.
21. Older petunia seedlings stunted and chlorotic, but growing.
22. Petunia seedlings - close up of damage.
23. Petunia - large seedlings "growing-out" of damage.

24. Petunia c.v. Express Red in flower: damage confined to flowers open during fogging.
25. Begonia semperflorens - 'Large' and 'small' plants used in the trial.

26. Begonia semperflorens c.v. Devil White showing stunting and necrosis.

27. Begonia semperflorens c.v. Devil Pink - close up of necrosis on leaves.

28. Ivy leaved geranium - marginal leaf chlorosis.

29. Geranium c.v. Red Satisfaction - damage confined to flowers open during fogging.

30. Salvia c.v. Fury - stunting and damage to the bracts.

31. Gloxinia - stunting, but little other signs of damage.

32. Hypoestes c.v. Pink Splash - stunting.

33. Cyclamen - chlorosis and slight stunting.

34. Dahlia c.v. Jester - chlorosis.

35. Nicotiniana - flower damage.

Analysis of the phytotoxicity trial - part of the computer printout

***** Analysis of variance *****

Variate: score

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Factor4.Factor5.Factor1.Factor2.Block stratum					
Factor4	3	117.0847	39.0282	72.33	<.001
Factor5	1	0.0347	0.0347	0.06	0.801
Factor1	1	0.0889	0.0889	0.16	0.688
Factor2	1	30.8347	30.8347	57.15	<.001
Factor4.Factor5	3	4.3069	1.4356	2.66	0.065
Factor4.Factor1	3	4.2139	1.4046	2.60	0.069
Factor5.Factor1	1	0.2000	0.2000	0.37	0.547
Factor4.Factor2	3	20.1681	6.7227	12.46	<.001
Factor5.Factor2	1	1.5125	1.5125	2.80	0.104
Factor1.Factor2	1	0.0889	0.0889	0.16	0.688
Factor4.Factor5.Factor1	3	0.9361	0.3120	0.58	0.634
Factor4.Factor5.Factor2	3	0.6903	0.2301	0.43	0.735
Factor4.Factor1.Factor2	3	0.5194	0.1731	0.32	0.810
Factor5.Factor1.Factor2	1	0.2722	0.2722	0.50	0.483
Factor4.Factor5.Factor1.Factor2	3	0.0694	0.0231	0.04	0.988
Residual	32	17.2667	0.5396		
Factor4.Factor5.Factor1.Factor2.Block.Factor3 stratum					
Factor3	44	332.2625	7.5514	49.51	<.001
Factor4.Factor3	132	171.4153	1.2986	8.51	<.001
Factor5.Factor3	44	5.4653	0.1242	0.81	0.802
Factor1.Factor3	44	18.8486	0.4284	2.81	<.001
Factor2.Factor3	44	58.2903	1.3248	8.69	<.001
Factor4.Factor5.Factor3	132	29.3181	0.2221	1.46	<.001
Factor4.Factor1.Factor3	132	22.9736	0.1740	1.14	0.140
Factor5.Factor1.Factor3	44	4.6125	0.1048	0.69	0.941
Factor4.Factor2.Factor3	132	51.3319	0.3889	2.55	<.001
Factor5.Factor2.Factor3	44	8.8625	0.2014	1.32	0.079
Factor1.Factor2.Factor3	44	12.9736	0.2949	1.93	<.001
Factor4.Factor5.Factor1.Factor3	132	12.6264	0.0957	0.63	1.000
Factor4.Factor5.Factor2.Factor3	132	13.3097	0.1008	0.66	0.999
Factor4.Factor1.Factor2.Factor3	132	13.2931	0.1007	0.66	0.999
Factor5.Factor1.Factor2.Factor3	44	3.2903	0.0748	0.49	0.998
Factor4.Factor5.Factor1.Factor2.Factor3	132	13.9930	0.1060	0.70	0.996
Residual	1408	214.7332	0.1525		
Total	2879	1185.8875			

Control of WFT on three host plants treated with dichlorvos fogs at different rate in glasshouses ventilated at varying intervals after treatment

Interval between treatment and ventilation (hrs)	No. of WFT/tray -Log (n + 1) (Detransformed data) Nil	1	4	11
a) Mean effect of exposure time*	1.374 (23)	0.866 (6)	0.747 (6)	0.679 (5)
S.E.D. (48 D of F)		±0.0597		
b) Effect of rate of dichlorvos (l/hectare) and exposure time*				
0.5	1.323 (20)	1.034 (10)	0.875 (7)	1.037 (10)
1.0	1.520 (32)	1.149 (13)	1.058 (10)	0.846 (6)
1.5	1.355 (22)	0.805 (5)	0.638 (3)	0.515 (2)
2.0	1.299 (19)	0.478 (2)	0.417 (2)	0.320 (1)
S.E.D. (12 D of F)		±0.1194		
c) Effect of host plant and exposure time				
Petunias	0.686 (4)	0.465 (2)	0.401 (2)	0.222 (1)
Impatiens	1.798 (62)	1.069 (11)	0.994 (9)	0.957 (8)
Verbena	1.639 (43)	1.066 (11)	0.846 (6)	0.859 (6)
S.E.D. (16 D of F) - Horizontal and diagonal comparisons				±0.0896
- Vertical comparisons				±0.0818

*N.B. Comparisons between the three sections of the table not valid.

Control of WFT on three test plants treated with dichlorvos fog at 1.5 l/hectare in glasshouses ventilated after 15, 30 or 60 minutes.

Interval between treatment and ventilation (minutes)	Numbers of WFT per tray											
	Nil			15			30			60		
	Log (n+1)	Det	(% control)	Log (n+1)	Det	(%)	Log (n+1)	Det	(%)	Log (n+1)	Det	(%)
a) Mean effect of exposure time*	1.217	16	(-)	1.159	13	(19)	0.962	8	(47)	0.935	8	(51)
S.E.D. (27 D of F)			±0.0975									
b) Effect of host plant and exposure of time*												
Petunia	0.540	3	(-)	0.663	4	(+33)	0.551	3	(0)	0.571	3	(0)
Impatiens	1.671	46	(-)	1.456	28	(39)	1.143	13	(71)	1.175	14	(70)
Verbena	1.441	27	(-)	1.358	22	(19)	1.191	15	(44)	1.059	11	(59)
S.E.D. (27 D of F)			±0.1584 - Horizontal and diagonal comparisons ±0.1689 - Vertical comparisons									
c) Mean effect of host plant*		Petunia			Impatiens			Verbena				
	0.581	3		1.361	22		1.262	17				
S.E.D.			±0.0607									

Nos = Numbers of WFT per tray, derived by detransforming (i.e. antilogs) the mean log (n+1) of the numbers/tray.

* Because the numbers of WFT and the per cent control are derived by detransforming data, it is not valid to compare data from the 3 parts of the table.

Off-Label Approval for Dichlorvos Fog

CONTROL OF PESTICIDES REGULATIONS 1986
(S.I. 1986 NO. 1510) :
APPROVAL FOR OFF-LABEL USE OF AN APPROVED PESTICIDE PRODUCT

This approval provides for the use of the product named below in respect of crops and situations, other than those included on the product label. Such "off-label use" as it is known is done at all times at the user's choosing, and the commercial risk is entirely his or hers.

The conditions below are statutory. They must be complied with when the off-label use occurs. Failure to abide by the conditions of approval may constitute a breach of that approval, and a contravention of the Control of Pesticides Regulations 1986. The conditions shown below supercede any on the label which would otherwise apply.

Level — Pursuant to Regulation 5 of the Control of Pesticides Regulations 1986, made under Section 16 of the Food and Environment Protection Act 1985, the Minister of Agriculture, Fisheries and Food and the Secretary of State, acting jointly, have granted provisional approval for

Product name Darmycel Dichlorvos

Active Ingredient: 500 g/l dichlorvos

Marketed by: Darlington Mushroom Laboratories under MAFF No. 02420
Subject to the conditions relating to off-label use set out below:

Date of issue: 1 November 1990

Date of expiry: (subject to the continuing approval of MAFF 02420)

Field of use: ONLY AS A HORTICULTURAL INSECTICIDE

Crops/situations: NON EDIBLE ORNAMENTALS AND THE FOLLOWING EDIBLE CROPS ALL GROWN UNDER PROTECTION

Celery, fennel, lettuce, endives, radicchio, chicory, spinach beet, spinach, asparagus, aubergine, tomato, peppers, broad, navy, runner, soya, dwarf and French beans, edible podded peas, kale, kohlrabi, Chinese cabbage, courgette, cucumber, garlic, onion, leek, shallot, gherkin, marrow, melon, pumpkin, squash, leafy herbs (ie basil, bay, borage, camomile, caraway, chives, chervil, coriander, dill, feverfew, fenugreek, fennel, lovage, marjoram, mint, parsley, rosemary, sage, sorrel, summer savory, tarragon and thyme).

Seedlings of the following brassica crops:

Broccoli, Brussels sprouts, cabbage, calabrese, and cauliflower.

Maximum individual dose: 2200 ml product/hectare

Latest time of application:

Broccoli	- 7 weeks	before harvest	
Brussels sprouts	- 14 weeks	"	"
Cabbage	- 14 weeks	"	"
Calabrese	- 7 weeks	"	"
Cauliflower	- 9 weeks	"	"
Kohlrabi	- 1 week	"	"

All other edible crops - 24 hours before harvest

Operator protection:

1) Dichlorvos is an anticholinesterase organophosphorus compound and must not be used by those under medical advice not to work with such compounds
2) Engineering control of operator exposure must be used where reasonably practicable in addition to the following personal protective equipment:

   (a) Operators must wear suitable protective clothing (a coverall) face protection (faceshield) and suitable protective gloves (butyl rubber gloves or neoprene gloves of minimum 0.6 mm thickness) when handling the concentrate, opening container, diluting, mixing or transferring from one container to another, adjusting apparatus after filling and washing out containers.

(b) Operators must wear butyl rubber or neoprene (minimum thickness 0.6 mm) gloves and rubber boots, coverall, hood and full face piece respirator to a standard or of a type approved by HSE when applying Darmycel Dichlorvos via the fogging machine.

3) However, engineering controls may replace personal protective equipment if a COSHH assessment shows they provide an equal or higher standard of protection.

Environmental protection: Since this product is harmful to bees, crops must not be treated during flowering and flowering weeds must be kept down

Other specific restrictions:

1) This product must only be applied if the terms of this approval, the product label and/or leaflet and any additional guidance on off-label approvals have first been read and understood.

2) This product must not be used as a fog with a carrier other than Nevolin.

3) Unprotected persons must not enter treated areas within 12 hours of treatment.

4) Treated areas must remain locked overnight and must carry clear warning of treatment and must be ventilated before entry the following morning.

5) Fenugreek must not be treated when grown as a seed crop.

Signed V.W.Williams

(Authorised signatory)

Date 1 November 1990

APPLICATION REFERENCE NUMBER : COP 9000266

THIS NOTICE OF APPROVAL IS NUMBER 9448 of 1990

ADVISORY INFORMATION

This approval relates to the use of Darmycel Dichlorvos as a fog for control of:

1. Western flower thrips

2. Non-indigenous leafminers.

Fogging (using a thermal fogging machine such as 'Pulse fog', 'Swing fog' or 'Dyna fog') should be done, with all doors and windows closed and with correct jet sizes set by directing the fog over the crop. This operation should be carried out in the late afternoon or evening. The dilution rate is 2200 ml product in 10 litres of Nevolin per hectare (900 ml product in 4 litres Nevolin per acre). Nevolin, containing 65% dichloromethane, is a liquid fogging agent marketed by Applied Horticulture, Toddington Lane, Littlehampton, West Sussex. Due to the possibility of thermal stress on the operator in the glasshouse environment, air fed respiratory protective equipment may be more appropriate.

Use of Darmycel Dichlorvos on certain crops and cultivars of crops generally tolerant may result in scorch so, if in doubt, test a few plants before treating the whole crop. The product should not be used on chrysanthemums in flower, or on roses where plants may be damaged. When using Darmycel Dichlorvos on cucumbers and other cucurbits phytotoxicity may occur.