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***Effect of rate and duration of exposure to
Eco₂fume on onion thrips***

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1 Executive summary

Eco₂fume[®] is a novel formulation of phosphine that may be an appropriate replacement for methyl bromide for disinfesting onions. We carried out a series of trials to identify the most effective rate and duration of Eco₂fume[®] exposure for the control of eggs, nymphs and adult onion thrips (*Thrips tabaci*) in export onions.

The results clearly show that low rates of Eco₂fume[®] are effective for controlling adult thrips. All adult and nymph thrips were killed following exposure to 0.29 g/m³ (200 ppm) phosphine for 24 hours. Higher rates (1.43 g/m³ or 1000 ppm) and longer exposure times (48-72 hours) are required to kill thrips eggs. Treatments designed to control thrips egg hatch should be repeated when the thrips population is more active to confirm our findings.

We found no evidence to suggest Eco₂fume[®] affected onion firmness, skin quality and the incidence of rots.

Practical issues not covered in this work, such as optimising fumigant distribution within a load of onions and measuring phosphine residues, need to be investigated before developing recommendations for commercial practice.

2 Introduction

Eco₂fume[®] is a formulation of 2% phosphine gas in liquid carbon dioxide. It is applied as a gas under high pressure. Phosphine has a number of advantages as a horticultural fumigant over alternatives such as methyl bromide. Methyl bromide is potentially very damaging to many crops, such as *Allium* species (including onions and garlic). Phosphine is slower to act than methyl bromide (Karunaratne & Moore 1994; Karunaratne 1996), but has a similarly broad biocidal activity on fresh produce without affecting produce quality as severely. Phosphine is very toxic to mammals as well as to insects. It appears to act similarly to hydrogen cyanide in inhibiting respiration.

Internationally Eco₂fume[®] is widely used as a grain and food fumigant in countries as diverse as Australia, Malta, China and the USA. It is registered for use as a grain and timber fumigant in New Zealand. Registration documents for its use as a cut flower fumigant have been lodged with the Agricultural Compounds and Veterinary Medicines Group in New Zealand.

Preliminary testing of Eco₂fume[®] for onion fumigation was initiated in the 2000 export season (Carpenter 2000). The work continued at a field scale in 2001 (Carpenter et al. 2002). Parallel research has been funded through the New Zealand Onion Exporters Association to refine the practical use of

Eco₂fume® based on good agricultural practice (GAP). That work is subject to separate reports to the New Zealand Onion Exporters Association (Brash et al. 2002). This research report summarises three CTP trials (concentration x time product) on export onions aimed at defining the most appropriate rates and durations of exposure to Eco₂fume® that will kill thrips adults and eggs while not compromising onion quality.

3 Method

3.1 Trial 1 - rates and duration of Eco₂fume® on adult thrips, December 2001

In December 2001, Pukekohe Long Keeper (PLK) onions infested with thrips (*Thrips tabaci*) were treated with four rates of Eco₂fume® for two exposure times. Thrips mortality on treated bulbs was compared with that on bulbs in untreated controls. The rates of phosphine (for Eco₂fume® rate multiply by 50) were 0.43, 1, 1.43 and 1.86 g/m³ (or 300, 700, 1000 and 1300 ppm) applied once followed by exposure times of 24 and 48 hours. There were 2 replicates of each treatment and 2 untreated control plots, giving a total of 18 plots. Each plot contained a 20 kg netted bag of onions. Fumigation was carried out in sealable plastic barrels of various sizes using a timed banana gun (flow rate of 5.56 g Eco₂fume® per second) to supply the desired dose from an Eco₂fume® cylinder. Controls used 200 l barrels, treatments with rates of 0.43 and 1 g/m³ were applied in 1000 l barrels and treatments with rates of 1.43 and 1.86 g/m³ were applied in 500 l barrels. The barrels used for fumigation were all Skellerup polyethylene Rototanks (manufactured by Skellerup Rotomould, Christchurch, New Zealand).

A 10 onion sample was selected after treatment from each plot for the assessment of thrips numbers. Counts were made two days after the end of treatment. Dead thrips counts were based on assessments of recently dead thrips which looked fresh after treatment and not squashed from earlier grading or handling.

3.2 Trial 2 - rates and duration of Eco₂fume® on adult thrips, March-April 2002

The first trial had low thrips numbers and used old PLK onions (with a mature thrips population). To increase confidence in the results we carried out a second trial using new season PLK onions with a higher and more active thrips population. In late March and early April 2002, onions infested with thrips (*Thrips tabaci*) were treated with four rates of Eco₂fume® for two exposure times. Thrips mortality on treated bulbs was compared with that on bulbs from untreated controls. The phosphine treatments were 0, 0.29, 0.57, 1 and 1.43 g/m³ (or 0, 200, 400, 700 and 1000 ppm) and the exposure times were 24 and 48 hours. There were 3 replicates of each treatment, giving a total of 30 plots. Each plot contained 20 onions. Fumigation was carried out in sealable plastic barrels of various sizes using a timed banana gun to supply the desired dose from an Eco₂fume® cylinder. Controls used 200 l

barrels, 0.29 and 0.57 g/m³ used 1000 l barrels and 1 and 1.43 g/m³ used 500 l barrels.

Thrips counts were made on all 20 onions per plot 2 days after treatments were applied. The experiment took place in three runs in successive weeks. We checked phosphine levels in the barrels once during fumigation using a Silocheck phosphine sensor. Air temperature in the control barrels was measured using Sapac temperature loggers.

3.3 *Trial 3 - rates and duration of Eco₂fume® on thrips eggs and onion quality, May-June 2002*

The second trial showed that adults were killed quickly at low rates of Eco₂fume®. We set up this third trial to investigate the ability of Eco₂fume® to control thrips eggs. We also examined the effect of Eco₂fume® on onion quality.

In two runs (one in late May 2002 and the other starting four weeks later) onions infested with thrips (*Thrips tabaci*) were treated with two rates of Eco₂fume® for two exposure times. Thrips mortality on treated bulbs was compared with that on bulbs from untreated controls. The Eco₂fume® treatments were 0.57 and 1.43 g/m³ and exposure times were 48 and 72 hours. There were 2 replicates of each treatment in each run and 2 runs, giving a total of 20 plots. Each plot contained 30 thrips-infested onions and 20 thrips-free onions for quality assessment. Fumigation was carried out in sealable plastic barrels of various sizes using a timed banana gun to supply the desired dose from an Eco₂fume® cylinder. Controls used 200 l barrels while treatment at a rate of 0.57 g/m³ was applied in 1000 l barrels and 1.43 g/m³ in 500 l barrels.

Air temperature in the control barrels was measured using Sapac temperature loggers. We checked phosphine levels in the barrels at the end of fumigation using a Drager phosphine sensor.

Counts of live thrips were made 4 weeks after the end of treatment on 20 onions per plot. It was not possible to count thrips killed from the treatments after 4 weeks. Quality assessments were made on 10 onions per plot. They involved hand assessment of firmness and visual assessment for skin quality and rots. Three onions per plot were cut open and assessed for flesh colour.

4 *Results*

4.1 *Trial 1*

Eco₂fume® appears to be effective for thrips control, although thrips numbers were low. A short exposure (24 hours) was sufficient to control adult thrips.

Table 1: Effect of rate and duration of exposure to Eco₂fume® on onion thrips mortality (Trial 1) (means of 2 reps, counts on 10 onions per plot).

Eco ₂ fume®		No. of live thrips		No. of dead thrips	
Rate (g/m ³)	Rep	24 hrs	48 hrs	24 hrs	48 hrs
0	1	12	6	10	6
0.43	1	1	0	4	15
	2	0	0	5	14
1	1	0	0	5	6
	2	0	0	13	12
1.43	1	0	0	8	11
	2	0	0	8	13
1.86	1	0	0	9	5
	2	0	0	2	6

4.2 Trial 2

All Silocheck phosphine readings were within 5% of the intended levels. Air temperatures fluctuated daily between 15 and 20°C.

The second trial confirmed the effectiveness of Eco₂fume® for thrips control, even for low rates (200 ppm) and short exposures of 24 hours (Table 2).

Table 2: Effect of rate and duration of exposure to Eco₂fume® (a.i. 2% phosphine) on onion thrips mortality for Trial 2 (means of 3 reps, counts on 20 onions per plot).

Phosphine rate (g/m ³)	No. of live thrips		No. of dead thrips	
	24 hrs	48 hrs	24 hrs	48 hrs
0	53	38	31	32
0.29	0	0	52	56
0.57	0	0	67	45
1	0	0	62	81
1.43	0	0	76	99

We also noted the number of bulbs within a plot that contained live and/or recently dead thrips (i.e. thought to have died during treatment). There was a mean of 70% of bulbs containing live and/or recently dead thrips (ranging from 55 to 95%).

Thrips numbers were much higher in this trial, adding confidence to the earlier work and confirming that 24 hour exposure times are effective for onion thrips fumigation. We did not check egg mortality nor measure the effects of Eco₂fume® on onion quality in this trial.

4.3 Trial 3

We checked phosphine levels in each barrel at the end of the first fumigation run using a Drager Phosphine Sensor. The 0.57 g/m³ rate had declined to 0.53 g/m³ after 48 and 72 hours. The 1.43 g/m³ rate had declined to 1.27 g/m³ after 48 hours and 1.10 g/m³ after 72 hours.

Temperatures in the barrels during fumigation were low, 12-14°C for the first run and 9-12°C for the second run.

Table 3 shows the effect of Eco₂fume® on egg mortality. Thrips numbers were very low as it was late in the season when the population had collapsed (despite bulb storage at 27°C). No adults or nymphs were found on the 48 and 72 hour treatments at the high phosphine rate.

We also found mites on the onions and made an assessment of their presence. No mites were found on the 72 hour 1.43 g phosphine/m³ treatment. It is possible that mites entered the store after treatment.

Table 3: Effect of rate and duration of exposure to Eco₂fume® (a.i. 2% phosphine) on onion thrips egg mortality and presence of mites for Trial 3 (means of 4 reps, counts of hatched adults and nymphs on 20 onions per plot 4 weeks after treatment)

Treatment		No. of live adults	No. of live nymphs	No. of plots with live mites
Phosphine (g/m ³)	Days			
0		3.5	2.25	4/4
0.57	2	1.25	0.25	3/4
1.43	2	0	0	2/4
0.57	3	0.25	0	3/4
1.43	3	0	0	0/4

Onion quality assessments indicated no difference between treatments (data not shown). All onions were rated as firm or very firm with no skin blemishes or rots. Flesh colour was rated normal.

5 Discussion

Phosphine killed adult thrips within 24 hours of treatment, even at the lowest rate of application. Exposure to 1.43 g/m³ for 48 or 72 hours was required to control thrips eggs. This result needs confirmation on a more active thrips population and should be carried out at higher temperatures (close to 20°C). A rate of 1 g/m³ for 72 hours controlled thrips eggs in a commercial-scale trial carried out at warm temperatures using onions with an active thrips population (Brash et al. 2002).

Practical issues not covered in this work, such as optimising fumigant distribution within a load of onions and measuring phosphine residues, need

to be investigated before developing recommendations for commercial practice.

6 Conclusion

Our trials show that low rates of Eco₂fume®, as low as 0.29 g/m³ for 24 hours, control adult onion thrips. Higher rates (1.43 g/m³) and longer exposure times (48 to 72 hours) are required to kill thrips eggs. The trial to investigate efficacy for the control of thrips egg hatch should be repeated when the thrips population is more active to confirm our findings.

7 Recommendations

Trial 3 should be repeated using 1.0 and 1.43 g phosphine/m³ when temperatures are warmer and the onion thrips population more active.

8 Acknowledgements

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9 References

- Brash, D.; Zhang, Z.; van Epenhuijsen, K.; Wood, R.; Wright, P. 2002: Commercial-scale fumigation trials for control of onion thrips on export onion. *Crop & Food Research Confidential Report 716*. New Zealand Institute for Crop & Food Research Limited, Palmerston North. 20 p.
- Carpenter, A. 2000: Eco₂fume® for onion fumigation. *Crop & Food Research Confidential Report 317*. New Zealand Institute for Crop & Food Research Limited, Palmerston North. 20 p.
- Carpenter, A.; Van Epenhuijsen, K.; Brash, D.; Sartie, A. 2002: Onion disinfestation for export onion. *Crop & Food Research Confidential Report 500*. New Zealand Institute for Crop & Food Research Limited, Palmerston North. 16 p.
- Karunaratne, C. 1996: The use of phosphine as a fumigant for insect disinfestation of cut flowers. PhD Thesis, Civil and Environmental Engineering, University of Melbourne.
- Karunaratne, C.; Moore, G. 1994: The methyl bromide alternative? *Australian Horticulture* 92: 38-40.