Post harvest disinfestation of export proteas

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Summary

A comparison of treatments for the post harvest control of spiders and earwigs in export proteas showed that a combination of permethrin (0.036 g a.i. m^{-3}) and dichlorvos (0.038 g a.i. m^{-3}) was more satisfactory than either permethrin alone or a combination of pyrethrins (0.008 g a.i. m^{-3}) and dichlorvos. Subsequent commercial use of the permethrin and dichlorvos treatment resulted in no detection of spiders or earwigs in proteas exported to Japan and U.S.A.

Introduction

Export of proteas, especially to Japan, has been hampered by the presence of live insects and spiders which has resulted in costly fumigation treatments at the port of entry and loss of quality due either to the treatment or to delays (Brinson 1987).

Most protea exporters conduct disinfestation treatments before packaging. An accepted treatment in South Africa has been the use of dichlorvos, either as a vapour treatment or by spray injection (Meynhardt 1976). More recently, methyl bromide was recommended, although some phytotoxicity was shown and not all insects and mites were completely controlled (Wit and van de Vrie 1985).

Fumigation tests in Australia with methyl bromide, carbon dioxide, nitrogen, sulphur dioxide, pyrethrins and dichlorvos, confirmed that methyl bromide reduced vase life of proteas and showed that a combination of pyrethrins and dichlorvos was the most suitable treatment (Maughan 1986). The combination was effective in killing a high percentage of the major pest species and did not affect vase life. However, some live arthropods, including spiders, could occasionally be found in export flowers and this did not satisfy the strict requirements of the Japanese market

The present work was aimed at finding a more satisfactory treatment for the control of the black house spider *Badumna insignis* (L. Koch) and the European earwig *Forficula auricularia* L., the most prevalent arthropods in cut proteas in Victoria (Brinson, pers. comm). The pyrethroid permethrin was tested because of its registration as a household space treatment for a range of pests including spiders.

Materials and methods

Tests were conducted in the coolroom at Protea Australia, Silvan, from October until December, 1987. The room had a volume of 32 m^3 and contained two-tiered wooden shelving on each side and in the centre. It was sealed and fitted with an exhaust fan. A thermostatically controlled fan heater was used for temperature control. An average temperature of 20°C (range 18-22°C) was maintained during the treatment time of two hours. The relative humidity varied in each test between means of 70 and 87%. Following treatment, the room was exhausted for half an hour (tests for dichlorvos using a Dräger detector showed that this was sufficient to remove all traces of the gas).

The treatments tested were (a) pyrethrins + dichlorvos (b) permethrin and (c) permethrin + dichlorvos each replicated five times. They were completely randomised over the two month period of the trial. Pyrethrins (as C.I.G. Pestigas$^{(R)}$) and dichlorvos (as C.I.G. Insectigas-D$^{(R)}$) came in gas cylinders and were introduced to the room through a nozzle giving a gas flow of 6 g sec^{-1}. Dosage was controlled by means of an automatic timer. A dosage of 0.008 g a.i. m^{-3} was used for pyrethrins and 0.038 g a.i. m^{-3} for dichlorvos. Permethrin (as Pea Beu Control) came in an aerosol pressure can with a lockable nozzle which allowed the contents to be exhausted. This gave a dosage of 0.036 g a.i. m^{-3}.

All tests were conducted on buckets of cut protea flowers. Space was made on the lower shelves (92 mm above the floor) for three large (69 x 59 x 8 mm) plastic trays on each of which was seated a bucket of eight flowers of *Protea magnifica* L. in water. These were located on each side of the room and in the centre. The sides of the trays were coated with Fluon (polytetrafluoroethylene) to prevent the spiders and earwigs from escaping.

The *P. magnifica* flowers contained some spiders (0-3 per bucket) and earwigs (0-8 per bucket) but they were insufficient and too variable for significant results. Therefore, 15 spiders and 15 earwigs were added to each test bucket of flowers and allowed to settle in for one hour before fumigation. These arthropods were obtained from a protea plantation on the morning prior to treatment.

Following treatment, all arthropods were collected from the test flowers, the trays and the water in the buckets and held separately in crumpled tissue in plastic vials with wire mesh lids for assessment of mortality after 24 and 48 hours. Similar numbers of untreated arthropods were also held in vials for assessment of control mortality. Analysis of variance procedures and a generalised linear model using a binomial error distribution were used to compare the three treatments.

Results

Both analyses gave similar interpretations and results from the analysis of variance are presented here.

The numbers and mortality of spiders and earwigs remaining in the flowers after each treatment are shown in Table 1. There was no significant difference between the treatments in the percentage of spiders remaining in the flowers or in their mortality after 24 h. There was a significantly lower ($P < 0.01$) percentage of earwigs in the flowers after the permethrin treatment compared with the other two treatments but the percentage mortality of these earwigs was also significantly lower ($P < 0.01$).

The mortality of all spiders and earwigs i.e. from the flowers, trays and buckets, is shown in Table 2. Both the permethrin and permethrin + dichlorvos treatments gave a significantly higher ($P < 0.01$) percentage mortality of spiders than the pyrethrins + dichlorvos treatment after 24 and 48 h. There was no significant difference between pyrethrins + dichlorvos and the other two treat-

Table 1. Mean percentage (dead + alive) and mortality (24h) of spiders and earwigs remaining in flowers after treatment.

Treatment	% remaining in flowers (dead + alive)		% mortality within flowers	
	Spiders	Earwigs	Spiders	Earwigs
Pyrethrins + Dichlorvos	36.1	14.3	80.6	83.2
Permethrin	24.3	4.7	94.2	41.7
Permethrin + Dichlorvos	28.5	18.2	88.0	96.8
L.S.D. (P=0.05)	20.5	7.0	20.8	19.3
(P=0.01)	28.7	9.7	29.2	27.5

Table 2. Mean percentage mortality of all spiders and earwigs at 24 and 48 h following treatment.

Treatment		Percentage Mortality			
		Spiders 24 h	48 h	Earwigs 24 h	48 h
Pyrethrins + Dichlorvos		83.7	87.3	94.6	96.4
Permethrin		96.0	98.8	93.3	93.3
Permethrin + Dichlorvos		96.7	97.5	99.1	99.4
L.S.D.	(P=0.05)	7.8	7.2	4.7	3.8
	(P=0.01)	10.9	10.1	6.6	5.4
Control[A]		1.9	2.7	0	0.3

[A] Not included in analysis

ments in the percentage mortality of earwigs, but permethrin + dichlorvos gave significantly higher mortality than permethrin at 24 h ($P < 0.05$) and 48 h ($P < 0.01$).

Discussion

Dichlorvos, as a 12 hour vapour treatment or an individual flower injection, was found in South Africa to give effective control of most insects (Meynhardt 1976). It was not tested on its own in these trials because of its relative ineffectiveness against spiders (Maughan 1986). Maughan's best treatment of pyrethrins + dichlorvos was, therefore, used as the standard for spider and earwig control. Her recommendation was for a treatment time of six hours but, as Protea Australia were obtaining reasonable results with pyrethrins + dichlorvos using a two hour treatment time, this was used in these tests.

A temperature of 20°C was chosen for the tests as a balance between a temperature high enough to give effective pest control over the relatively short treatment time of two hours but low enough not to damage the flowers. As it was, some stress may have been placed on the flowers in this experiment because the treatment room was also the coolroom and had to be heated from 5 to 20°C before treatment. Despite this, there was no visual evidence of shortened vase life either in the flowers used in the tests or in the export shipments by Protea Australia. In practice, however, it would be advisable for growers to fumigate when flowers are first delivered to the packing shed, before cooling them prior to packing.

Protea magnifica flowers were used in these tests because they were considered to be more infested with spiders and earwigs than most other species, due to the size and shape of their inflorescence. The compactness of the floral bracts also makes it more difficult to reach pests with fumigants or aerosols. The results obtained for *P. magnifica* should, therefore, be applicable to other *Protea* species and may be better for less compact flower heads.

The arthropods remaining in the flowers were assessed separately because preliminary tests had indicated that although permethrin did not give 100% control of earwigs, it did tend to drive them out of the flowers. The current tests showed that there was a significantly lower percentage of earwigs in the flowers after the permethrin treatment. However, the percentage mortality of these remaining earwigs was also significantly lower than in the other two treatments.

When the total mortality of spiders and earwigs from the flowers, the trays and the buckets was considered, the permethrin + dichlorvos treatment was significantly better than permethrin for earwig control and significantly better than pyrethrins + dichlorvos for spider control. Although complete mortality of spiders and earwigs was not achieved, the high mean levels attained (97.5% and 99.4% respectively after 48 h) should be sufficient to ensure that none are detected in export produce. This is supported by the fact that Protea Australia used the two hour permethrin + dichlorvos treatment for all export flowers to Japan and U.S.A. in the 1987/88 summer season and no spiders or earwigs were detected by the importers.

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