An evaluation of chemical and physical treatments to prevent Fuller's rose weevil oviposition on citrus fruit

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Summary

Seven insecticides and three sticky band trunk treatments were tested as barriers to prevent oviposition by Fuller's rose weevils, *Asynonychus cervinus*, (Boheman) on valencia orange fruit on skirt-pruned or unskirted trees. The use of trunk sticky bands alone significantly reduced the incidence of *A.cervinus* egg batches on fruit harvested after 9–13 months from 40–50% to about 10%. The addition of chemicals to sticky band treatments did not improve control and deltamethrin, bioresmethrin and azinphos-ethyl applied alone did not provide adequate exclusion of *A. cervinus* from trees. Skirt-pruning and trunk banding of citrus trees provide good prospects as a basis for a management strategy for *A. cervinus* based on non-chemical control options.

Introduction

Fuller's rose weevil (FRW), *Asynonychus cervinus* (Boheman), was first recorded on citrus in Australia in 1937 (Hely 1937). Until recently it was considered a minor pest of citrus and control measures were rarely required. Leaf damage from FRW is usually minor and often confined to the lower canopy. Similarly, root feeding by larvae does not appear to seriously affect tree health, vigour or production (Hely *et al.* 1988).

In 1985, Japanese inspectors found viable FRW egg masses under the calices of citrus imported from California (Haney *et al.* 1988). Since FRW is a quarantinable pest in Japan, all citrus fruit exported to that country must be free from viable FRW egg masses. Japan is an increasingly important export market for Australian citrus, and the presence of FRW in most Australian citrus groves poses a significant threat to further development of this market.

Since 1986, considerable effort, particularly by Californian entomologists has been directed towards development of an effective management program for FRW in citrus (Haney *et al.* 1987, 1988, Haney and Morse 1988, Coats and McCoy 1990, Lakin and Morse 1989). Most research has centered on foliar and trunk chemical spray treatments (Elmer 1960) and trunk sticky band treatments (Haney and Morse 1988). The latter strategy is based on the fact that FRW are flightless and therefore have to climb the trunk of skirt-pruned trees to gain access to fruit. Non-chemical or limited chemical applications to trunks of skirt-pruned trees are considered to offer possibilities in FRW management (Haney and Morse 1988).

In Australia research on FRW management is being conducted in north-western Victoria (Magarey *et al.* 1991) and in the Murrumbidgee Irrigation Area of southern New South Wales. This paper describes results of field trials conducted over two seasons evaluating physical and chemical treatments to exclude FRW from citrus trees in the MIA.

Table 1. Details of insecticides used in orchard trials in 1988 against Fuller's rose weevil.

Insecticide Trade name	Chemical name	Formulation	Rate and target
Lorsban®	chlorpyrifos	slow release granules 100g/kg	5% a.i./tree (sprinkled on ground)
Lorsban®	chlorpyrifos	slow release granules 100g/kg	10% a.i./tree (sprinkled on ground)
Lorsban®	chlorpyrifos	50% ec	1% a.i. trunk spray
	carbosulfan	slow release granules 100g/kg	5% a.i./tree (sprinkled on ground)
	carbosulfan	slow release granules 100g/kg	10% a.i./tree (sprinkled on ground)
Gusathion A®	azinphos-ethyl	40% ec	0.7% a.i. trunk spray
Gusathion A®	azinphos-ethyl	40% ec	1.25% a.i. trunk, foliage and ground spray
Gusathion A®	azinphos-methyl	50% wp	0.7% a.i. trunk spray
*Supracide®	methidathion	40% ec	1.25% a.i. trunk, foliage and ground spray

* used at Fm 1823 instead of 1.25% rate of azinphos-ethyl.

Materials and methods

The efficacy of seven insecticides and three sticky band trunk treatments in preventing FRW oviposition on orange fruit, *Citrus sinenis* L., was examined in orchard trials conducted in the MIA during 1988/89.

In 1988 trials were conducted on two farms in Griffith. At farm 1858 a block of 60 (6 rows × 10) mature valencia orange trees was selected within a larger grove. The block was skirt-pruned and kept weed-free during the trial. At farm 1823 a similar block of 60 valencias was used, but left unskirted. Trunk bands manufactured from heavy duty cloth tape and plastic sacking were applied to all trees in both blocks except controls. Bands were 10 cm wide, coated with Tanglefoot® (insect trapping adhesive) and stapled to trunks.

A randomized block design incorporating six single tree replicates of eight chemical treatments with sticky bands (Table 1), sticky band only and untreated control was used in each block. Treatments were applied until run-off on 20 January 1988 using a knapsack sprayer.

Evaluation of treatments occurred at harvest (February 1989) with 20 fruit per tree examined in the laboratory under a stereo-microscope for the presence of FRW egg batches.

In 1989 a further trial was conducted on a block of 30 (6 rows × 5) mature valencias at farm 864, Stanbridge near Leeton. Trees were skirt-pruned and the block was kept weed-free during the trial. Three insecticide trunk spray, (deltamethrin (10 g L^{-1}) 0.05% a.i., bioresmethrin (50 g L^{-1}) 0.05% a.i., azinphos-ethyl (400 g L^{-1}) 8.0% a.i.) and two sticky band (Stickem®, Tacgel®) treatments were used. A randomized block design containing five single tree replicates of each treatment was used.

Stickem® and Tacgel® were mixed with copper hydroxide (250 g CuOH per kg) and applied directly to tree trunks in bands about 15 cm wide. Copper hydroxide was used in an attempt to prevent *Phythophthora* problems which have been observed after direct application of Stickem® treatments to trees in California (Morse *et al.* 1988). Treatments were applied on 17 February 1989 with sprays applied until run-off.

Adult FRW population levels at farm 864 were monitored monthly during the trial period by assessing weevil numbers on 25 randomly selected trees adjacent to the trial site. At each visit tree canopies were beaten on two sides to dislodge weevils into a beating tray. Numbers of weevils trapped in sticky bands were also recorded and removed.

Evaluation of the trial was conducted in November 1989 with 30 fruit from each

Table 2. The effect of various chemical and sticky band treatments on the incidence of Fuller's rose weevil egg batches on valencia oranges at Farm 1858 and 1823.

Treatment: sticky band plus		Percentage of valencia fruit infested with FRW eggs batches skirt-pruned (F1858)	unskirted (F1823)
Chlorpyrifos granules	5 % a.i	8.3[a]	32.5[b]
Chlorpyrifos granules	10 % a.i	8.3[a]	27.5[c]
Chlorpyrifos ec	1 % a.i	3.3[a]	28.3[b]
Carbofuran granules	5 % a.i	8.3[a]	33.3[b]
Carbofuran granules	10 % a.i	10.8[a]	36.7[b]
azinphos-ethyl ec	0.7 % a.i	1.7[a]	45.0[b]
azinphos-ethyl ec	1.25 % a.i	12.5[a]	–
azinphos-methyl ec	0.7 % a.i	15.0[a]	32.5[b]
methidathion ec	1.25 % a.i	–	25.8[c]
Sticky band only	–	5.8[a]	38.8[b]
No band or chemical	–	40.8[b]	35.0[b]

Values followed by same letter not significantly different (P>0.05)

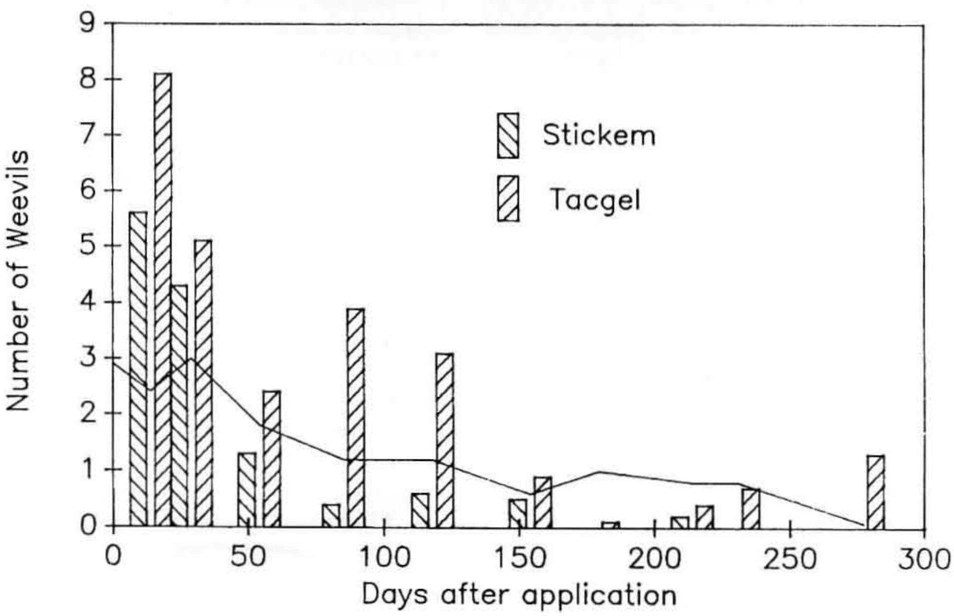

Figure 1. Mean numbers of adult Fuller's rose weevils trapped per sticky band at post-treatment intervals at Farm 864. The line plot represents mean number of weevils obtained from beating 25 trees adjacent to trial area.

tree harvested and examined in the laboratory for presence of FRW eggs. Fruit from both trials were harvested with calyx intact as FRW characteristically oviposits under the calyx (Morse *et al.* 1987).

Data were subjected to analysis of variance and LSD procedures.

Table 3. The effect of various chemical and sticky band trunk treatments on the incidence of Fuller's rose weevil egg batches on valencia oranges at Farm 864.

Treatment	No of egg batches/ 150 fruit
Stickem®	25[a]
Tacgel®	31[a]
deltamethrin	57[b]
bioresmethrin	51[b]
azinphos-ethyl	51[b]
untreated	77[b]

Values followed by same letter not significantly different (P>0.05)

Results

Data from trials conducted in 1988 and 1989 are presented in Tables 2 and 3, respectively. In 1988 trunk sticky bands alone or applied with insecticides on skirt-pruned trees significantly reduced the incidence of FRW egg batches on fruit harvested after 13 months (P<0.05). None of the insecticide treatments improved control over that obtained with trunk sticky bands alone. The incidence of eggs on fruit from insecticide treated, sticky banded and unskirted trees was generally not significantly different from untreated trees (Table 2).

In 1989 sticky band treatments resulted in a significantly lower incidence of FRW on fruit compared to chemically treated or untreated trees (p<0.05). Infestation was comparable in all chemically treated and untreated trees.

Numbers of weevils beaten from adjacent trees and found trapped in sticky bands declined steadily during the post-treatment period (Figure 1). The number of weevils trapped in Tacgel® bands was consistently greater than in Stickem® bands (P<0.05). There was no evidence that the sticky bands were phytotoxic to the trees during the trial or during the following 12 months.

Discussion

This study indicates skirt-pruning and trunk sticky bands can significantly reduce FRW oviposition on citrus fruit. Insecticides used in conjunction with sticky bands did not enhance control and their use alone did not provide adequate exclusion of FRW from trees. No treatments were successful on unskirted trees. Magarey *et al.* (1991) working on FRW in north-western Victoria reported no significant reduction in viable egg batches on skirted trees treated with sticky bands. However, in a laboratory bioassay sticky bands produced significantly higher mortality of weevils when compared to three synthetic pyrethroid treatments. In the same study deltamethrin (0.06% and 0.12% a.i.) and bioresmethrin (0.06% and 0.12% a.i.) applied to trunks of skirted trees did not significantly reduce egg batch numbers, which concurs with the results presented here. Magarey *et al.* (1991) suggested the reduced effectiveness of sticky bands in the field compared to the laboratory was due to contamination of bands by dust and debris.

Although skirt-pruned and sticky banded trees had a relatively low incidence of FRW eggs on fruit (a mean of 10% over both trials) it is unlikely that this will satisfy requirements for future citrus exports to Japan, which requires FRW-free fruit. However, it is possible that further improvements can be made to a management strategy based on skirt-pruning and sticky banding by a better understanding of FRW phenology. Recent research on FRW populations in the MIA and Sunraysia indicates weevils are rare in November/December prior to the emergence of a new generation in January (James unpublished observations, Madge *et al.* 1991). Clearly, banding and skirting needs to be done before weevil emergence to maximize effectiveness. In the current study FRW began emerging shortly before trials commenced.

The importance of skirting trees and preventing FRW from gaining access to fruit by routes other than the trunk, cannot be overemphasized. The effectiveness of sticky trunk bands relies upon the fact that FRW adults are flightless and have to climb into the tree canopy. Ladders and irrigation pipes can provide FRW with alternative access routes.

Haney and Morse (1988) working in California found two sticky materials (Stickem special extra® and Tack trap®) provided 100% exclusion of FRW for two months. Failure after this period was attributed to an accumulation of wind blown dust and dirt on the bands. This did not appear to be a problem in the current study although some thinning of sticky materials appeared to occur after heavy rain. The greater trapping efficacy of Tacgel® bands compared to Stickem® bands may indicate weevils are less able to detect and avoid the former treatment. However, this difference was not expressed in an effect on egg batch numbers.

Haney and Morse (1988) also found carbaryl, azinphos-ethyl and carbosulfan were effective as trunk-applied pesticides for up to 14 weeks. Magarey *et al*. (1991) showed the synthetic pyrethroid lambdacyhalothrin was also effective but did not determine its field persistence.

This study and those of Haney and Morse (1988) and Magarey *et al*. (1991) indicate that trunk sticky bands and skirt-pruning can be used as a basis for FRW management. Research into complementary strategies such as the use of entomopathogenic nematodes, and fungi to control FRW larvae is continuing in the United States and Australia. Research is also planned on ways to improve the natural enemy complex of FRW in Australian citrus. The wasp *Fidiobia citri* parasitizes FRW eggs and can be found in up to 50% of egg batches (James, unpublished observations). Other natural enemies also operate against FRW including general predators such as assassin bugs which are more prevalent in Queensland which does not appear to have a FRW problem in citrus. Enhancement of the FRW natural enemy complex is an option in inland citrus which is largely pesticide-free. Skirt pruning and trunk sticky bands maintain this status and future work should be directed towards development of the non-chemical management strategies outlined above.

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