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INTEGRATED PEST CONTROL IN VICTORIAN PEACH ORCHARDS: THE ROLE OF *STETHORUS* SPP. (COLEOPTERA: COCCINELLIDAE)

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Abstract

The importance of *Stethorus* spp. in controlling *Tetranychus urticae* Koch, was studied over three seasons in peach orchards in the Goulburn Valley, Victoria. In the early maturing cultivar (Riley), *Stethorus* spp. reduced the need for acaricide applications when less insecticide was used for the control of *Cydia molesta* Busck. Three species of *Stethorus* occurred, *S. vagans* Blackburn being the most abundant. No insecticide was required for the control of *C. molesta* between mid-October and early January provided adequate spraying was carried out in early spring and just before harvest.

Introduction

In south-eastern Australia the standard method of controlling the Oriental fruit moth, *Cydia molesta* Busck, and the light brown apple moth, *Epiphyas postvittana* Walker, in peach orchards is to spray every three or four weeks with either azinphos-methyl or carbaryl between October and March. This disrupts the natural control of the two-spotted mite *Tetranychus urticae* Koch, which is resistant to insecticides, by destroying its natural enemies, especially *Stethorus* spp. (Readshaw 1971, 1975a). Thus the mites have to be controlled at considerable cost with acaricides.

In South Australia, Richardson (1972) showed that by using malathion or parathion in only September and October, *C. molesta* could be controlled for the season. Because malathion and parathion are less persistent than azinphos-methyl and carbaryl, disruption of the *Stethorus* spp./*T. urticae* balance was reduced. This and the use of insecticide only in the spring permitted survival of *Stethorus* spp. during the more critical hot summer months, and enabled acaricides to be eliminated from the spray schedule over a three year period. Control of *T. urticae* was attributed to *Stethorus loxtoni* Britton & Lee, but *S. vagans* Kapur also became more abundant (Richardson 1972).

Similar parathion programmes were tried over three seasons (1972–1975) in Victoria's Goulburn Valley. Results from an orchard at Cobram showed that the phytoseiid *Typhlodromus occidentalis* Nesbitt, could be important in the control of *T. urticae* (Field 1976), but this paper concentrates on the role of *Stethorus* spp. in other orchards.

Materials and methods

Trial sites

Trials were carried out at Dhurringile, Undera and Toolamba in orchards where azinphos-methyl and various acaricides had been in regular use. The cultivars used at Dhurringile during 1972-1973 were the early-season "Riley" (1.2 ha), the mid-season "Golden Queen" (2.1 ha) and the late season "Pullar Cling" (1.4 ha). In the following two seasons only Rileys were re-used. Trials at Undera and Toolamba were carried out on the cultivar Golden Queen (2.0 ha for each block) during the second season.

Monitoring Pests and Predators

T. urticae and its predators

During the 1972-73 season 10 leaves were taken weekly from the inner lower canopy of each of 10 trees in the cultivar Riley. Leaves from the Golden Queens and Pullar Clings were sampled less frequently. The leaves were examined with a hand lens (× 10). In 1973-74 and 1974-75, 40 leaves were sampled fortnightly from each of five trees from the blocks at Dhurringile and Undera and examined with a stereomicroscope (× 8). All stages of *Stethorus* spp. and *T. urticae* excepting eggs of the latter were recorded.

C. molesta and *E. postvittana*

Peaks of activity of *C. molesta* were determined by counting moths caught in terpinyl acetate-brown sugar lures (Yetter and Steiner 1931). Insecticide applications were made as close as possible to the peak catches. Damage to fruit caused by *C. molesta* and *E. postvittana* was assessed by examining 5,000-10,000 fruit from each block, sampled as the harvested fruit was tipped onto the grader.

TABLE 1

SPRAY PROGRAMME[1], FRUIT DAMAGE CAUSED BY *C. MOLESTA* AND *E. POSTVITTANA* AND COST OF PEST CONTROL FOR THE SEASONS 1972-73—1974-75 ON THREE VARIETIES OF CANNING PEACH

Season	Property	Cultivar	Spray programme Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Fruit damage *C. molesta* (%)	*E. postvittana* (%)	Cost/ha[2] ($)
1972-73	Dhurringile	Riley	Cu	2P, 2Di Z	M, Z	D	P, Pr S	S, Di	P, B	0.93	0.29	—
		Golden Queen	Cu	2P, 2Di Z	P, M, Z	D	P, Pr S	S, B	AM, P 2B	0.55	0.22	—
		Pullar Cling	Cu	2P, 2Di Z	P, M, Z	D	P, Pr S	2S	P, S B	2.44	0.49	—
1973-74	Dhurringile	Riley	EO, Z B	2 ARP, Z B	ARP, Z		ARP	P, B 2Z		0.50	0.70	13,30
	Undera	Golden Queen	EO, Z B	2ARP B, Di	P, Z			P, ARP Pr	2B	0.12	0.16	35.98
		Golden Queen	Pi, Z B	2ARPh[1] B, Di	Ph, Z			Ph ARPh[2]	Pr, 2B	0.03	0.30	111.28
	Toolamba	Golden Queen	EO, Z PMC	PMC, Dt	AM, Z	AM, Z	AM, Pr Ct, Dt	AM, Pr	AM, Cy B	0.06	0.02	192.15
1974-75	Dhurringile	Riley	EO, Z	P, ARP Z, B	ARP 2Di	Di	Di	P, B		0.60[3]	2.26[4]	10.64
		Riley	EO, Z	Z, B	AM, 2Di	AM, Di	AM, Di	AM, B	Pr	0.12[3]	0.60[4]	101.24

[1] Chemicals used and their rates of application in amount of active ingredient/100 ml; AM, azinophosmethyl 0.04g; ARP, alternate row parathion 0.04g; ARPh[1] and ARPh[2], alternate row phosmet 0.05g and 0.1g respectively; B, benomyl 0.013g; Ct, captan 0.1g; Cu, copper oxychloride 0.2g; Cy, cyhexatin 0.02g; D, dicofol 0.03g; Di, dichlone 0.38g; Dt, dithianon 0.05g; EO, endrin in oil 0.028g endrin, and 1 ml oil; M, methomyl 0.023g; P, parathion 0.02g; Ph, phosmet 0.05g; Pi, pirimicarb 0.025g; PMC, phenyl mercuric chloride 0.008g; Pr, propargite 0.03g; S, sulphur 0.38g; Z, ziram 0.12g.

[2] Cost of chemicals used for control of *C. molesta*, *E. postvittana* and *T. urticae* only.

[3] Significantly different (P = 0.01) (arcsin proportion transformation)

[4] Significantly different (P = 0.01) (arcsin proportion transformation).

Pesticide treatments

All pesticides were applied with a high-volume air blast spray machinery delivering 3,000-4,000 l/ha. Details of the rates, frequency and timing of pesticide applications are given in Table 1. Fungicide treatments are also given in Table 1 because of the probability that some fungicides such as benomyl (Field 1978), have a depressing effect on mite numbers.

Results

The spray programmes, their cost/ha and the damage caused by *C. molesta* and *E. postvittana* are given in Table 1. Numbers of *T. urticae* and *Stethorus* spp. are shown graphically (Figs 1-3) as mean numbers of mites and predators (all stages excluding eggs), per leaf.

1972–73 Season

The objectives during this season were to assess if parathion could control *C. molesta* and *E. postvittana* and to determine the effect of this chemical on the numbers of *T. urticae* and its predators.

Parathion adequately controlled *C. molesta* and *E. postivittana* in the early-season cultivar Riley but did not control *C. molesta* in the late cultivar. A preharvest (February) application of azinphos-methyl on the mid-season fruit prevented an assessment of the effects of parathion alone being made (Table 1).

All three cultivars required two applications of acaricide, the first in November and the second in December, when parathion was applied for the control of *C. molesta*. *Stethorus* spp. were present in all cultivars during November and December but numbers declined following insecticide applications.

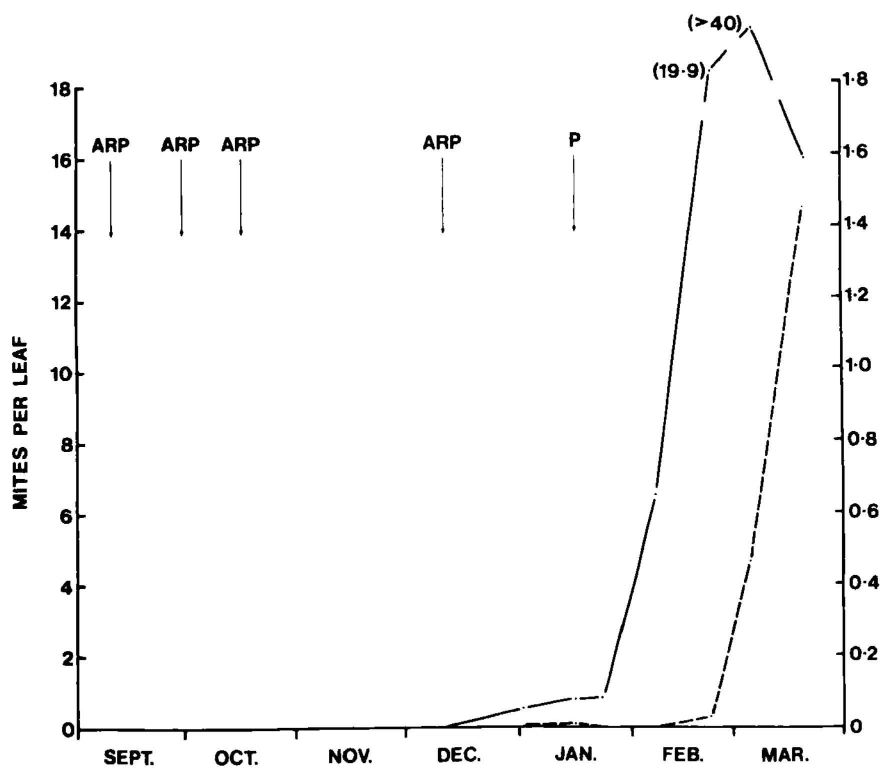

FIG. 1—Number per leaf of *T. urticae* (———) and its predators, *Stethorus* spp. (......), on the early season canning peach cv. Riley at Dhurringile during 1973-74. Arrows indicate treatment with: P, parathion; ARP, alternate row parathion. For treatment levels see Table 1.

1973–74 Season

At Dhurringile the objective was to determine if *Stethorus* spp. could contain *T. urticae* below high damage levels (estimated at a maximum of 20 mites per leaf prior to harvest) when only one or two applications of parathion were used to control *C. molesta* between the end of October and early February (harvest). Once again control of *C. molesta* and *E. postvittana* was achieved (Table 1). No acaricides were necessary and *Stethorus* spp. became abundant late in the season (Fig. 1).

The trial at Toolamba was a standard programme of monthly applications of azinphos-methyl and for comparison the trial at Undera aimed at achieving a marked reduction of *C. molesta* early in the season (September-October), followed by insecticide applications of either parathion or phosmet near harvest, timed on the basis of lure pot catches of *C. molesta*.

At Toolamba and Undera the control of *C. molesta* and *E. postivittana* was excellent (Table 1). At Toolamba, however three applications of acaricide were required in contrast to one application at Undera (Table 1, Fig. 2).

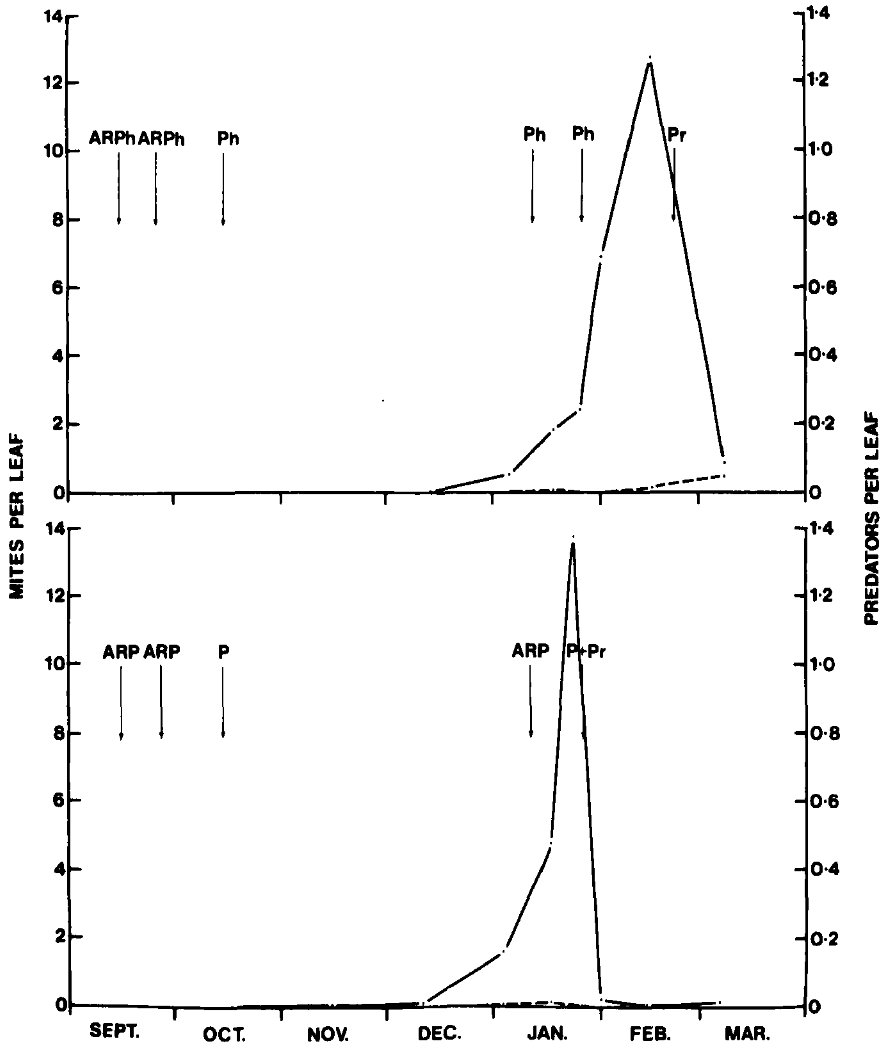

FIG. 2—Number per leaf of *T. urticae* (———) and its predators, *Stethorus* spp. (......), on the mid-season canning peach cv. Golden Queen, at Undera during 1973-74. Arrows indicate treatment with: Ph, phosmet; ARPh, alternate row phosmet; P, parathion; ARP, alternate row parathion; Pr, propargite. For treatment levels see Table 1.

1974–75 Season

The trials in this season were conducted only on the early-season cultivar. To compare the effects of azinphos-methyl and parathion schedules for the control of *C. molesta*, *E. postvittana* and *T. urticae*, half the early-season cultivar at Dhurringile received monthly applications of azinphos-methyl, and half received applications of parathion according to lure pot catches of *C. molesta.*

Control of *C. molesta* was adequate under both programmes but damage, apparently by *E. postvittana*, was significantly higher where parathion was used (Table 1). Some of this damage may have been caused by Fuller's rose weevil, *Pantomorus cervinus* Boheman, which was abundant in January. An acaricide application was required in February where azinphos-methyl was used, but no acaricide was needed in the parathion treated area where *Stethorus* spp. were present (Fig. 3).

Abundance of the three Stethorus *species*

Table 2 shows the numbers of *S. vagans*, *S. nigripes* and *S. loxtoni* during the three seasons at Dhurringile and Undera, together with data from orchards at Cobram and Invergordon. *S. vagans* appears to be the most abundant species in peach orchards throughout the Goulburn Valley.

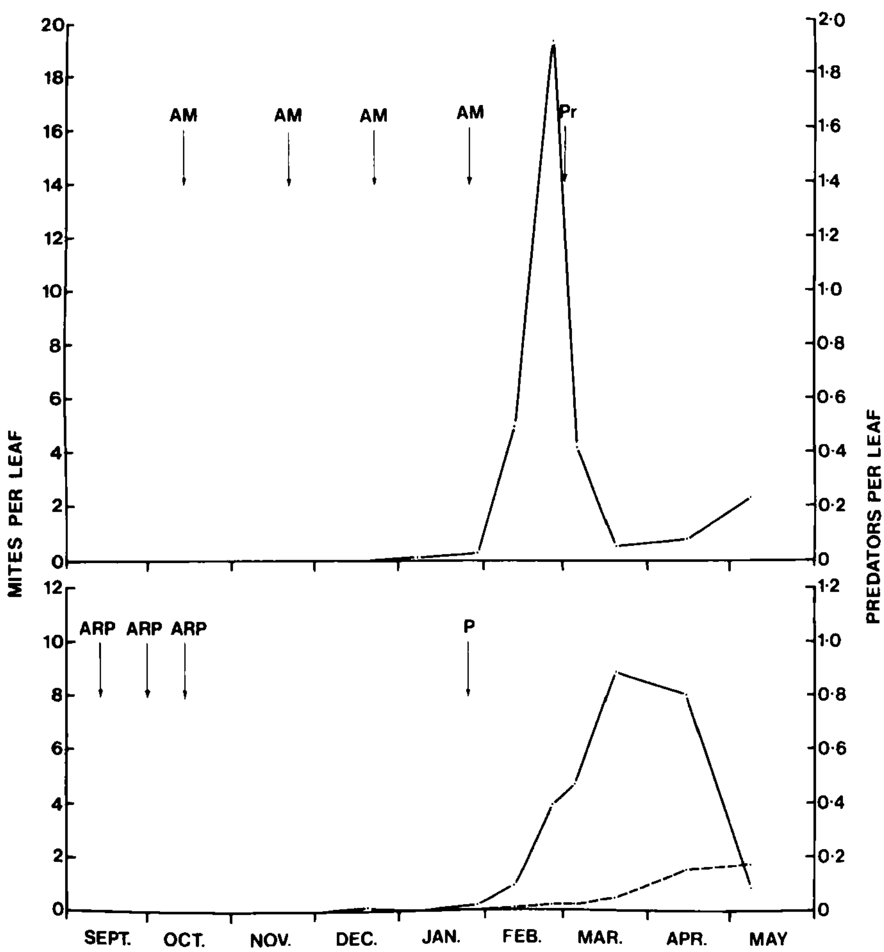

FIG. 3—Number per leaf of *T. urticae* (———) and its predators, *Stethorus* spp. (......), on the early season canning peach, cv. Riley, at Dhurringile during 1974-75. Arrows indicate treatment with: P, parathion; ARP, alternate row parathion; AM, azinphos-methyl; Pr, propargite. For treatment levels see Table 1.

TABLE 2

NUMBERS OF THE THREE SPECIES OF *STETHORUS* (LARVAE AND ADULTS) FOUND ON LEAVES IN FOUR GOULBURN VALLEY PEACH ORCHARDS DURING THREE SEASONS (1972-73, 1973-74 AND 1974-75)

Property	1972-73				1973-74				1974-75			
	S. vagans	*S. nigripes*	*S. loxtoni*	No. leaves	*S. vagans*	*S. nigripes*	*S. loxtoni*	No. leaves	*S. vagans*	*S. nigripes*	*S. loxtoni*	No. leaves
Dhurringile	144	4	17	4,900	162	55	87	2,000	26	36	8	4,400
Undera	6	0	1	4,700	7	1	8	3,600	2	0	5	13,000
Cobram	48	2	3	4,750	216	20	87	9,200	1	1	5	3,400
Invergordon	61	2	4	4,000		Not sampled				Not sampled		
Total	259	8	25	18,350	385	76	182	14,800	29	37	18	20,800

Economic appraisal of early spring control of C. molesta

Table 1 gives the total cost of pesticides used for control of *C. molesta, E. postvittana* and *T. urticae* in each block in 1973-74 and 1974-75. In 1973-74, the successful programmes at Dhurringile and Undera were inexpensive compared to the programme used at Toolamba. Although the monthly azinphos-methyl spray programme was carried out on a different orchard from the other trials, there was no reason to believe that costs were abnormally high.

In 1974-75 the cost of the monthly azinphos-methyl programme at Dhurringile ($19.64/ha/spray) was much more than the parathion programme ($2.66/ha/spray). In addition a further saving was made by not using the acaricide propargite ($22.68/ha/spray) with the parathion programme.

These benefits are reduced if the total insect damage to fruit is excessive (1% of a 25 tonne/ha crop has a value of approximately $30), if additional use of spray machinery during the season increases the total costs, or if costs are included for the maintenance of lure pots. At Dhurringile in 1974-75 fruit damage was 2.42% higher in the parathion block than in the azinphos-methyl block, costing $72.60/ha. Machinery usage was the same in both blocks and maintenance of lure pots was $3/ha making total costs $86.24/ha for the parathion block, still $15/ha less than the azinphos-methyl block.

Discussion

It appears that there is an overuse of insecticide in Victoria's canning peach industry. This study showed that for early- and mid-season cultivars, fewer sprays of cheaper pesticides will adequately control *C. molesta* and *E. postvittana* and may even reduce the need for acaricides. Moreover little or no insecticide is required during late spring and early summer if adequate spraying is carried out against the early spring and preharvest emergences of *C. molesta*. There is likely to be a greater requirement for preharvest fruit protection with later maturing cultivars. Similar results were obtained from canning peach orchards in South Australia (Richardson 1972) and at Cobram in the Goulburn Valley (Field 1976).

In all trials, whether parathion, phosmet or azinphos-methyl was used as a preharvest spray, the balance between *T. urticae* and its predators was upset, sufficiently in some cases to justify the use of an acaricide. If *T. urticae* becomes numerous after harvest, as they did at Dhurringile in 1974-75, the application of an acaricide may be uneconomic especially if *Stethorus* spp. have recolonized the orchard. High *T. urticae* numbers are more likely to occur after harvest of early cultivars where little preharvest insecticide is required compared to later cultivars. In many seasons a reduction in the use of acaricides on the early crop could then be achieved. Richardson (1972) however, was able to eliminate the need for acaricides from all cultivars. This may have been due to different environmental conditions occurring between South Australian and Victorian peach growing regions resulting in the use of fewer insecticides, and the dominance of *S. loxtoni* over the other species of *Stethorus*. *S. loxtoni* occurs in the hotter inland areas (Britton and Lee 1972) whereas *S. vagans* and *S. nigripes* prevail in the cooler regions (Readshaw 1975a). Although *S. loxtoni* was often abundant in the Goulburn Valley, *S. vagans* appears to be the dominant species.

One problem arising from this study was that certain pests may become more important when the level of insecticide use is reduced. For example, *E. postvittana* appeared as a major pest, and in one orchard *P. cervinus* appears in large numbers.

Because the use of insecticides will have to remain high during summer to achieve adequate control of fruit pests, there appears little scope for a large scale reduction in the use of acaricides in the Goulburn Valley resulting from predation of *T. urticae* by *Stethorus* spp. Also, despite the low cost and relatively short persistence of parathion on peach leaves (Brunson *et al.* 1962), its high mammalian toxicity (Martin 1971) and failure to control *C. molesta* in late season cultivars make this chemical unsuitable for regular use in peach orchards. However insecticide resistant predators such as the phytoseiid *T. occidentalis* may greatly assist in reducing the need for acaricides (Readshaw 1975b, Field 1978). Further studies will be aimed at encouraging the survival of *Stethorus* spp. during late spring and early summer and establishing an azinphos-methyl resistant strain of *T. occidentalis* for late summer control of *T. urticae*. Some of these studies have been reported (Field 1978).

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