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Long term response of Heteroptera in an apple orchard to different spray programmes

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Selective and non-selective insecticide and fungicide treatments were compared in season-long programmes in a Swiss apple orchard, for the control of arthropod and fungal pest complexes. The effects of these treatments on the European red mite, *Panonychus ulmi* (KOCH), and its predators were studied over a period of five years. Together with the predacious mite *Amblyseius finlandicus* (OUDEMANS) and the lady beetle *Stethorus punctillum* WEISE, several heteropterous species played an important role in keeping *P. ulmi* numbers below the damage threshold. Most important of them were anthocorids, of which *Orius minutus* (L.) was the most numerous species. About 10 species of mirids were present, but only *Blepharidopterus angulatus* FALLÉN showed some response to mite outbreaks. The number of nabids was negligible. The study demonstrated that integrated chemical and biological control of *P. ulmi* is possible through the combined effect of selective pesticides and the action of various beneficials.

The codling moth (CM), *Cydia pomonella* L., is the key insect pest in most orchards, but the indiscriminate use of pesticides for its control in the past has led to serious outbreaks of phytophagous mites. The purpose of this study was to select compounds that are toxic to phytophagous mites, mainly the European red mite (ERM), *Panonychus ulmi* (KOCH), and relatively innocuous to predators so that it would be possible to keep mite populations below the damage threshold. The evaluation of the importance of various heteropterous antagonists was part of this study.

MATERIALS AND METHODS

An orchard of twenty year old Golden Delicious trees which received the same fungicidal, acaricidal and aphicidal treatment over a period of five years was subdivided into three blocks of 28 trees each for different insecticide applications for CM control. Block A was sprayed with chlordimeform during the first year and with diflubenzuron for the following four years as examples of selective insecticides. Block B was treated with the broad spectrum compound azinphos-methyl, whilst block C was not sprayed at all for CM control. Table 1 lists details of all sprays.

Two new selective acaricides were used. These were the juvenoid type CGA 29170 against eggs and the dithiocarbonate CGA 79596 against mobile stages of the ERM. During the last three years scab and mildew were controlled by a mixed product of captan and etaconazole, the later compound having been proved to be selective on predacious mites (STREIBERT 1978).

Table 1: Schedule of pesticide treatments

Pest	Block	Treatments grams a.i./100 l	1977	1978	1979	1980	1981
Codling moth	A	Chlordimeform 50	6/23,7/5 7/22,8/5				
	A	Diflubenzuron 20(78-80),10(81)		7/3,8/4, 8/21	7/2,8/2	6/24,7/23, 8/18	6/9,7/7, 8/4
	B	Azinphos-methyl 30	6/23,7/5, 7/22,8/5	7/3,7/20, 8/4,8/21	7/2,7/19, 8/2,8/22	6/24,7/10, 7/23,8/5, 8/18,9/2	6/17,7/7, 7/21,8/4
	C	No insecticide					
European red mite	A B C	CGA 29'170 1/ 50 + oil 350		7/20 3/,8/21		3/12	3/31 3/31
	A B C	CGA 79'596 2/ 40			8/2		
	A B C	Cyhexatin 30					8/31 3/
Aphids	A B C	Pirimicarb 30(77/78),10(80)	4/4	6/20		5/2	
Scab (S)	A B C	Phaltan 60 - 100	3/25,4/4,4/14 4/25,5/5,8/22	4/7,4/17 4/26,5/5			8/28
	A B C	Mancozeb 160	5/17,5/31, 6/20,7/6,7/28				
	A B C	Captan 125		5/18,6/1,6/20 7/11,7/31, 8/29			
Mildew (M)	A B C	Sulfur (SU) 350	3/25,4/4,4/14 4/25,5/5,5/17 5/31,6/20,7/6 7/28,8/22(SU)	4/7,4/17, 4/26,5/5 (SU)			
	A B C	Bupirimate (BU) 20		5/18,6/20, 7/11,7/31, 8/29 (BU)			
M + S	A B C	Captan + Etaconazole (50 : 2) 52			4/5,4/12,4/23 5/3,5/14,5/25 6/4,6/18,7/2, 7/16,7/30, 8/13,8/27	4/11,4/22,5/2 5/13,5/23,6/3 6/18,7/2,7/24 8/18	4/6,4/15,4/28, 5/12,5/29,6/8, 6/22,7/13,8/4

1/ 5-(4'phenoxyphenoxy-1-pentin)

2/ 7-n-propylamino-6-nitro-4-trifluormethyl-1,3-benzo-dithiol-2-on dithiocarbonate

3/ only in the azinphos-methyl block

The heteropterous fauna was surveyed on twenty tagged trees in each block, ten of which were sampled alternatively at three weeks intervals, i. e. the same trees were resampled every sixth week. Samples were taken by beating ten branches at the outer edge of each tree three times into a funnel of 0.75 m^2.

RESULTS AND DISCUSSION

This paper concentrates on the Heteroptera. Effects of the treatments on other insect groups are reported elsewhere (SECHSER *et al.* 1984).

Mites serve as a principal food for many heteropterous species. During the first season in 1977 populations of the ERM were larger in the azinphos-methyl and control than in the chlordimeform block. Some suppression was achieved with phaltan and mancozeb, which have some miticidal effects, but these were insufficient to give full control (Fig. 1). After their replacement by captan during the second year, a tremendous resurgence of ERM occurred. Generally, mite populations are known to increase where captan is the only scab fungicide used (HULL *et al.* 1977). The mite problem was brought under control for the following three years by the combined effect of selective acaricides and several beneficial groups, except for some problems in the azinphos-methyl block.

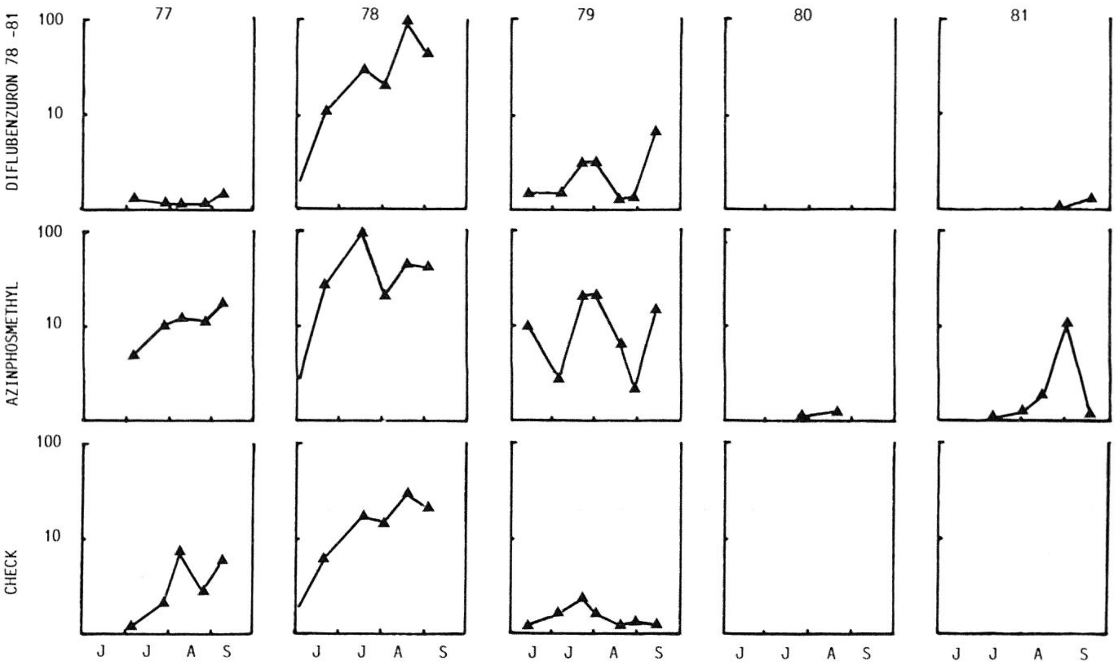

Fig. 1: Seasonal history of *Panonychus ulmi* populations under two different insecticide treatments and a check treatment over a five-year-period (1977–81), number of mobile stages per leaf.

Amongst the Heteroptera, anthocorids were the most important group, of which *Orius minutus* (L.) and *Anthocoris nemorum* (L.) were dominant. The latter species was also observed in British orchards to be more capable than any other heteropterous species to cope with rising ERM populations (SOLOMON 1982). In this study *O. minutus* averaged 85% of the whole anthocorid population over the five year period varying from 43.9 to 90.6% (Tab. 2). Representatives of the genus

Table 2: Percentages of *Orius minutus* of the whole anthocorid population

	Year 77	78	79	80	81
Chlordimeform 77 / Diflubenzuron 78 - 81	74,2	77,3	88,8	74,3	43,9
Azinphos-methyl	86,3	86,8	87,2	90,6	83,1
Check	90,1	80,6	87,1	79,3	77,6

Orius have repeatedly demonstrated their potential as specific mite predators (HOLDSWORTH 1972, PARRELLA *et al.* 1981).

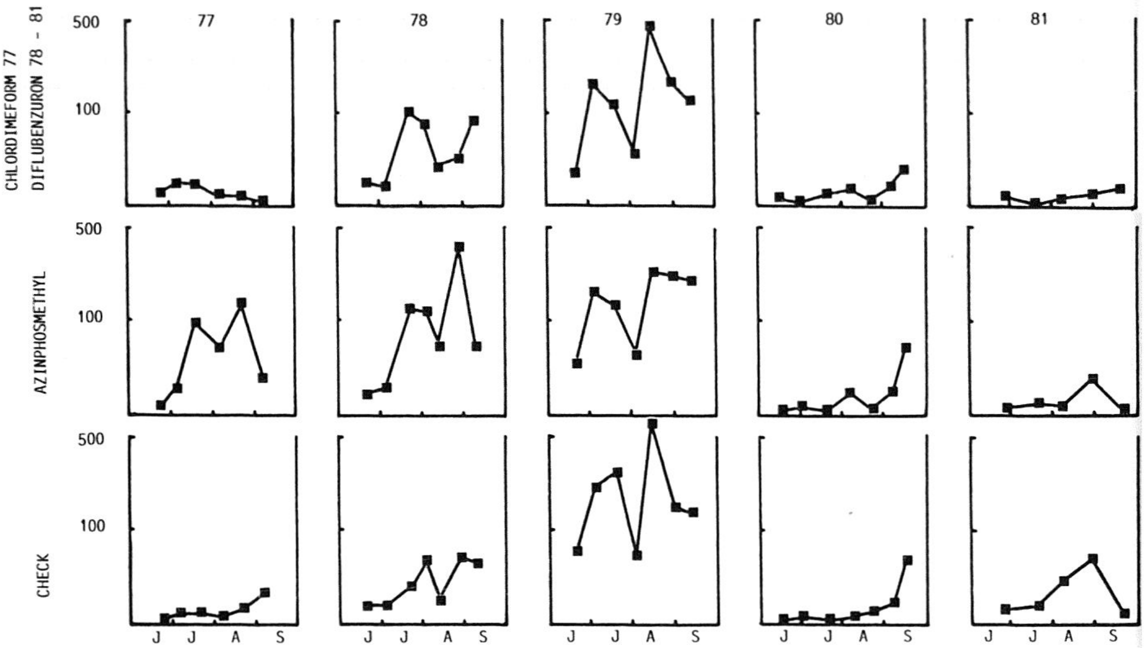

Fig. 2: Seasonal history of predacious anthocorid populations under two different insecticides treatments and a check treatment over a five-year-period (1977–81), number of mobile stages per 100 beaten branches.

The higher population level of ERM in the first year and the marked rise in the second year in the azinphos-methyl block led also to higher numbers of anthocorids (Fig. 2). They peaked in the third year, when the numbers of mites

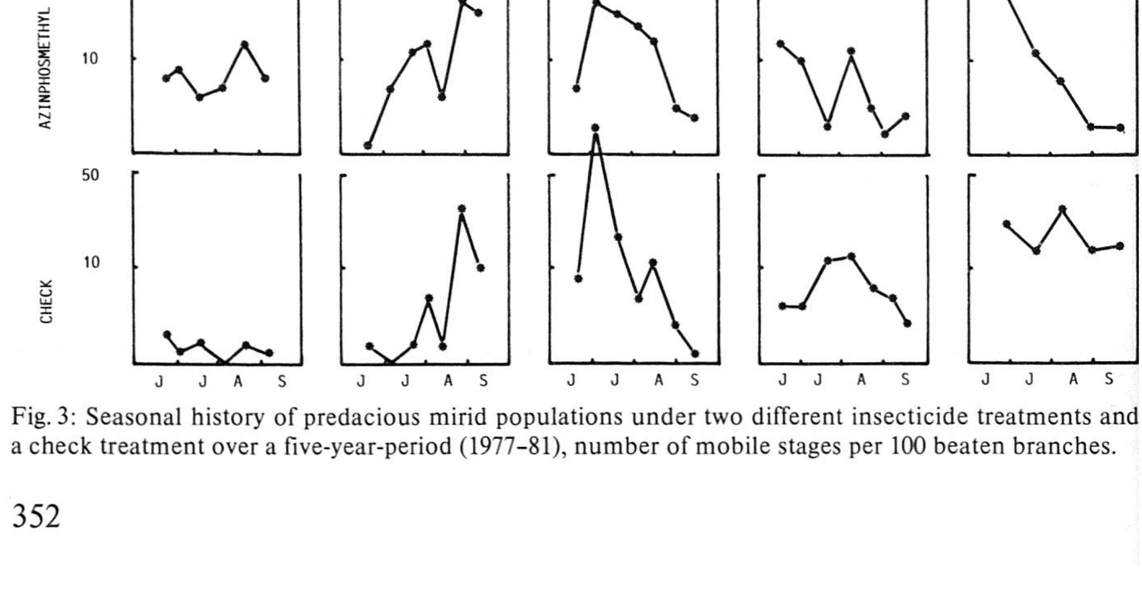

Fig. 3: Seasonal history of predacious mirid populations under two different insecticide treatments and a check treatment over a five-year-period (1977–81), number of mobile stages per 100 beaten branches.

were lower again. The high numbers of anthocorids by the end of the season in the third year led to the practical extinction of the ERM in the fourth year. The absence of ERM for long periods during the fifth season resulted again in fewer anthocorids.

The response of mirids to the population development of the ERM was less pronounced than with anthocorids (Fig. 3). The total number of mirids reached only about a tenth of those for the anthocorids. About 10 carnivorous mirid species were present and their frequency is summarized in Tab. 3. *Blepharidopterus angulatus* (FALL.), *Campylomma verbasci* MEY.-D. and *Malacocoris chlorizans* PZ. are known to prefer spider mites as food (SOLOMON 1982). In our study *B. angulatus* was the most numerous. This species may play the most important role amongst heteropterous mite predators in orchards (COLLYER 1952).

The mainly phytophagous mirid species *Psallus ambiguus* (FALL.) occurred in considerable numbers, but no economic damage could be observed.

The variety of mirid species found in this chemically treated orchard was rather unusual. One possible explanation for this phenomenon was certainly the use of many selective pesticides, which allowed for the survival of many more

Table 3: Frequency of mirid specimens on 500 to 700 beaten branches per season A: chlordimeform 1977, diflubenzuron 1978–81, B: azinphos-methyl, C: check. x = 1–10, xx = 10–20, xxx > 20 specimens.

	Year	77 (600)	78 (700)	79[a] (700)	80 (700)	81 (500)
Atractotomus mali	A	x	x		0	0
	B	0	x		0	0
	C	0	0		0	x
Blepharidopterus angulatus	A	0	x	xxx	xxx	x
	B	0	0	xxx	xxx	x
	C	0	0	xxx	xxx	x
Campylomma verbasci	A	x	x		0	0
	B	xxx	x		x	x
	C	x	0		x	0
Deraeocoris lutescens	A	x	xx		x	x
	B	xx	xxx		x	0
	C	x	xx		x	0
Heterotoma meriopterum	A	x	x		x	xx
	B	x	x		0	x
	C	0	x		0	x
Malacocoris chlorizans	A	x	x		0	x
	B	x	0		x	x
	C	0	0		x	xxx
Orthotylus marginalis	A	0	0		0	x
	B	0	0		0	xxx
	C	0	0		0	x
Phytocoris spp.	A	x	0		x	x
	B	x	x		0	x
	C	0	0		x	xxx
Pilophorus perplexus	A	0	x		x	x
	B	0	x		0	x
	C	0	0		x	xx
Other Miridae	A	x	x	xxx	xxx	x
	B	0	x	xxx	x	0
	C	x	xx	xxx	xx	x

[a] only Blepharidopterus angulatus identified in the counts

arthropod host species, particularly mites. But at least as important was certainly the close proximity of a deciduous forest which offered many ecological niches for the survival of a broad spectrum of insect species.

Other heteropterous families were present only in negligible numbers. Nabids were represented by *Himacerus apterus* (L.) and several *Nabis* spp. Of the phytophagous pentatomids a few specimens of *Pentatoma rufipes* (L.) were collected.

This long term study demonstrated that anthocorids and mirids can play an important role in suppressing mite populations below the damage threshold. The anthocorid *O. minutus* was particularly good at reducing heavy mite outbreaks, which were a risk during the transition period from a conventional to a more integrated orchard pest management.

ZUSAMMENFASSUNG

In einer Schweizer Apfelanlage wurden zur Bekämpfung von Schadarthropoden und Pilzkrankheiten verschiedene Spritzprogramme mit selektiven und nichtselektiven Insektiziden und Fungiziden verglichen. – Der Einfluss dieser Behandlungen auf die Rote Spinne, *Panonychus ulmi* (KOCH), und ihre Praedatoren wurde während eines Zeitraums von fünf Jahren verfolgt. Neben der Raubmilbe *Amblyseius finlandicus* (OUDEMANS) und der Coccinellide *Stethorus punctillum* WEISE spielten mehrere Wanzenarten eine wichtige Rolle, um *P. ulmi* unter der Schadschwelle zu halten. Die wichtigsten waren Anthocoriden, von denen *Orius minutus* (L.) am häufigsten vorkam. Daneben konnten noch ungefähr 10 Miridenarten festgestellt werden, von denen jedoch nur *Blepharidopterus angulatus* FALLÉN bis zu einem gewissen Grade auf Populationsschwankungen der Spinnmilben reagierte. Die Nabiden waren unbedeutend. – Diese Langzeitstudie zeigt, dass die integrierte chemische und biologische Bekämpfung von Spinnmilben mit Hilfe von selektiven Pflanzenschutzmitteln und Nutzarthropoden möglich ist.

RÉSUMÉ

On a comparé dans un verger de pommiers en Suisse divers programmes de traitements par des fongicides sélectifs et non sélectifs, contre des populations complexes d'arthropodes ravageurs et de maladies cryptogamiques. – L'influence de ces traitements sur l'acarien rouge, *Panonychus ulmi* (KOCH), et sur ses prédateurs a été suivie pendant une période de cinq ans. En plus de l'acarien prédateur *Amblyseius finlandicus* (OUDEMANS) et de la coccinelle *Stethorus punctillum* WEISE, plusieurs hétéroptères ont joué un rôle important en maintenant les populations de *P. ulmi* en dessous du seuil de tolérance. Les plus importants d'entre eux étaient les anthocorides, dont *Orius minutus* (L.) était l'espèce la plus abondante. La présence d'environ 10 espèces de mirides a été constatée, mais la population de *Blepharidopterus angulatus* FALLÉN a été la seule à réagir aux pullulations d'acarien. Les nabides étaient en quantité négligeable. – Les échantillonnages aux intervalles réguliers ont démontré que la lutte intégrée chimique et biologique de l'acarien rouge peut être obtenue par l'action combinée des pesticides sélectifs et des divers organismes auxiliaires.

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