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Damages on nectarines by thrips in northern Italy: monitoring and control on late attacks

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Abstract

Silvering of nectarine fruit is a kind of damage caused by thrips feeding on ripening fruit. It is due to thrips infestation occurring during a month before presumed harvest. This damage is more frequent and serious on brightly coloured varieties which ripen between the end of June and the end of July. A study of the control of thrips infestation on nectarines was carried out over a 3-year period in Emilia-Romagna Region (northern Italy). Thrips populations on sprouts were monitored starting from May up until the harvest in July. Over the last two years thrips populations were also sampled on fruit during the harvest. A significant correlation between the density of thrips populations on fruits and fruit damage was found. The thrips species recorded was *Frankliniella occidentalis* (Pergande), along with a variable percentage (0-55%) of other *Thrips* spp. over the 3-year period.

A total of five pesticides were evaluated (Acrinathrin, Chlorpyriphos-methyl, Ethofenprox, Phosmet and Spinosad). Acrinathrin and Spinosad proved to be most effective against thrips, particularly when a high relative abundance of thrips was present.

Key words: thrips, nectarine, *Frankliniella occidentalis*, monitoring, integrated control.

Introduction

In recent years the damage to nectarines from thrips infestations before harvesting has occurred rather often in Emilia-Romagna Region (northern Italy). Since the early nineties these thrips infestations have also been very common in southern Italy (Marullo, 1991; Guarino and Tocci, 1995) as well as in southern France and Spain (Nicolas and Kouta, 1992; Grasselly and Lacasa, 1995), causing heavy damage to fruits.

The most common damage to nectarines by thrips occurs when pests attack during blooming, causing russeting on the fruit surface. Silvering damage is caused by thrips feeding on fruit during the final swell of fruit phenology. When infestation is high and the damage to the fruit is widespread, it can have severe economic consequences. Damage can be more serious on brightly coloured varieties which ripen from the end of June to the end of July.

The species of thrips commonly known to infest nectarines in northern Italy are *Thrips major* Uzel and *Taeniothrips meridionalis* (Priesner) (Cravedi and Molinari, 1984). Recently, *Frankliniella occidentalis* (Pergande) has also been found among thrips infestations of nectarines close to harvest time in southern Italy, as well as in France and Spain (Guarino and Tocci, 1995; Nicolas, 1995; Grasselly and LaCasa, 1995). Currently *F. occidentalis* is the most common species found on nectarines in southern Italy (Marullo, 2001).

Thrips are very mobile small insects (ca. 1 mm), usually found on protected and humid parts of the vegetation. To detect thrips on nectarines it is necessary to look inside the young sprouts before the fruits swell and closer to harvest on fruits too. The insects feed on leaves and fruits in contact with protected areas *i.e.* leaves and stems.

The habits and high mobility of Thysanoptera made it impossible to use monitoring techniques such as frappage, water traps or direct counting without a proper study aimed at obtaining an appropriate assessment of infestation levels. A study of techniques for monitoring thrips associated with nectarines before harvesting was carried out in France (Rouzet and Breniaux, 1996) and more recently in northern Italy (Tommasini and Burgio, 2004). This latter study made it possible to formulate a simple and efficient method for monitoring thrips populations by recording the ratio of infested sprouts. Research carried out by Tommasini and Burgio (2004) also made it possible to ascertain that the most suitable period for controlling thrips and reducing fruit damage is before the peak of thrips population (when about 70% of sprouts are infested). To avoid economic losses, it is very useful to monitor thrips populations at least during the 30 days before the presumed date of harvesting, in order to evaluate the need to control the pests (Yonce *et al*., 1990; Grasselly *et al.*, 1995; Tommasini and Burgio, 2004). A study carried out in New Zealand by McLaren and Fraser (2001) showed that sampling of thrips has to be done at a defined height on the tree (1.5-1.8 m from the outer branches) and before 3:00pm in the afternoon.

Additional studies on thrips control few weeks before nectarine harvesting have been carried out in Italy (Cravedi *et al.*, 1995; Tavella *et al.*, 2006), Chile (Ripa *et al.*, 2001) and France (Nicolas and Kouta, 1992; Nicolas, 1995).

The occurrence of this new problem in northern Italy requires a study of how to better control the problem with the available and allowed pesticides.

Materials and methods

During the last three years' research, Big Top, an early harvest nectarine variety, was monitored for thrips infestation before harvest in province of Forlì-Cesena (northern Italy). Sampling was carried out by visually

counting the percentage of nectarine sprouts infested by thrips on a sample of 100 sprouts, according to the method defined by Tommasini and Burgio (2004), calculated with a binomial sampling methodology (Gerrard and Chiang, 1970). This statistical model can be used to develop a presence-absence sampling plan. Each year the sampling started early in May and was carried out up to harvesting time or for 2-3 weeks longer. Sampling was undertaken weekly and both adults and young instars of thrips were sampled.

In the orchard 6 treatments were planned with 4 replicates of 3 plants each on random plots. At about 70% of infected sprouts and according to the waiting period of pesticides, each replicate was treated with a different pesticide, chosen from those registered on nectarines and legally allowed in Italy (table 1). In 2004 the available commercial pesticide with the active ingredients (a.i.) Phosmet and Ethofenprox differed from those available and used the following year. However, the percentage of a.i. sprayed per surface unit was the same throughout the years.

Spraying was done by backpack sprayer and about 1,300 l/ha of water was used. After spraying, sampling was carried out on 100 sprouts/treatment (25/replicate).

In 2005 and 2006 before harvesting the number of thrips per fruit on a total of 100 fruits/treatment, was also sampled. Damage on fruits was checked at each harvest per year on a sample of 400 fruits/treatment. Fruit damage was evaluated based on the extent of silvering on fruits. Specifically, 3 classes were defined: i) no damage (class 0), ii) low damage (up to 1 cm^2 of surface damage) (class 1), iii) medium-high damage (over 1 cm^2 of surface damage) (class 2). Generally, medium-high damage corresponds to a decrease in the price of fruit on the market.

A sample of thrips collected during the trials was determined and the most abundant thrips species infesting nectarines before harvest were found (n. = circa 50 thrips/year).

Data were analysed by Anova ($P \leq 0.05$) and when differences were recorded, an LSD test was carried out ($P \leq 0.05$). Percentage data were transformed into arcsin and the number of thrips on fruit into $\log_{10}$ before the analysis.

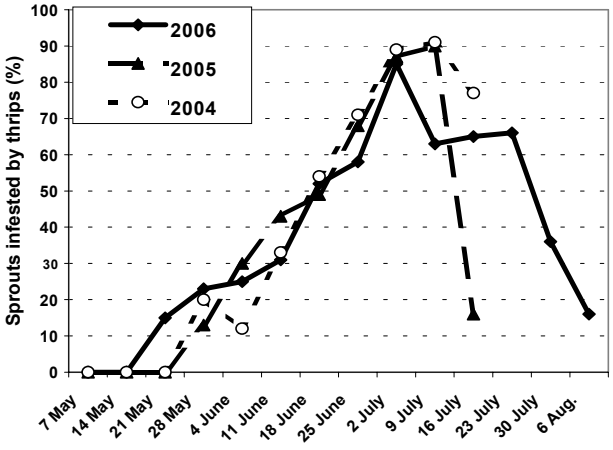

Figure 1. Trend of thrips infestation of nectarine sprouts during the three years.

Results and discussion

In figure 1 the mean percentages of sprouts infested by thrips on unsprayed trees over the 3–year period are shown. Despite little variation at the beginning of thrips infestation recorded during the 3 years of study, the amount of sprouts infested is very similar. The infestation usually started in the second half of May and increased up until the beginning of July; then it rapidly decreased to reach a very low percentage of sprouts infested in late July - early August, when the harvest was completed and almost all sprouts were wooden. The trend in the presence of thrips populations on nectarine sprouts is very similar to that recorded by Tommasini and Burgio (2004), where they compared many orchards in the same geographical area of this study.

Table 2 shows the mean number of thrips recorded per fruit during the first and second harvests on 100 fruits/treatment in 2005 and 2006, respectively. Thrips pressure was higher in 2006 than in 2005, as can be seen from the higher presence of thrips on the fruit. In 2005 there was no increase in thrips density between the first and second harvest, while an increase was recorded in 2006. A positive correlation was found between the num-

Table 1. Description of the treatments and dose of active ingredients applied per year.

Treatments	Dose	Waiting period (in Italy) (days)	Research Year			Date of spray		
			2004	2005	2006	2004	2005	2006
Acrinathrin (Rufast® E-flo)	80 ml/hl	7	*	*	*	22 June	23 June	27 June
Phosmet (Spada® EC)	300 ml/hl	14	*		*			
Spinosad (Laser®)	30 ml/hl	7	*	*	*			
Ethofenprox (Trebon® star)	100 ml/hl	7	*	*	*			
Chlorpyriphos-methyl (Reldan®)	350 ml/hl	15		*	*			
untreated	-	-	*	*	*			

Table 2. Mean number of thrips per fruit recorded during the harvests in 2005 and 2006. The different letter per column means a statistical difference between treatments (Anova and LSD, P ≤ 0.05).

	2005		2006	
	1st harvest (Mean ± s.e.)	2nd harvest (Mean ± s.e.)	1st harvest (Mean ± s.e.)	2nd harvest (Mean ± s.e.)
Untreated	2.3 ± 0.29 a	2.9 ± 0.86 a	4.4 ± 1.25 a	13.5 ± 3.45 a
Spinosad	0.3 ± 0.12 b	0.3 ± 0.03 c	0.1 ± 0.03 c	0.3 ± 0.07 b
Acrinathrin	0.4 ± 0.29 b	0.4 ± 0.37 c	1.5 ± 0.43 b	6.1 ± 1.52 a
Phosmet	-	-	4.1 ± 0.80 a	9.1 ± 4.24 a
Ethofenprox	1.8 ± 0.52 a	0.6 ± 0.22 bc	2.9 ± 1.25 ab	8.1 ± 2.28 a
Chlorpyriphos-methyl	1.3 ± 0.33 a	1.2 ± 0.29 b	2.4 ± 0.39 ab	9.0 ± 2.89 a

Table 3. Correlation coefficients (r) found between the number of thrips/fruit at harvest and the percentage of damaged fruits for each harvest and year.

	2005		2006	
	1st harvest	2nd harvest	1st harvest	2nd harvest
r	0.85	0.99	0.99	0.95
p	0.07	0.001	0.001	0.004

ber of thrips recorded on the fruit at harvest time and the percentage of fruit damaged for both harvest and year except for the first harvest in 2005 (table 3). In both 2005 and 2006 the only two treatments (Spinosad and Acrinathrin) showed a lower thrips infestation of fruit at the time of the first harvest compared to the untreated sample. For the second harvest in 2005 all pesticides influenced thrips infestation with a reduction of thrips on fruits compared to the untreated sample. In 2006, when the amount of thrips was generally higher compared to the previous year, only Spinosad still proved to be effective in reducing thrips at the second harvest.

The most common thrips species occurring in the experimental orchard was *F. occidentalis* (table 4) although its relative abundance varied from year to year. In the last years the presence of *F. occidentalis* in the surrounding area cultivated with nectarines was found to be on average 6% (Tommasini and Burgio, 2004), but more recently cases of heavy silvering damage to fruit are increasing, mainly in the hilly areas. A higher presence of *F. occidentalis* is also occuring in these orchards. In north-western Italy *Thrips fiscipennis* Haliday was found to be the dominant species on nectarine during ripening (Tavella *et al*., 2006).

Table 4. Relative abundance (%) of thrips species determined per year (n = 50) in the experimental orchard.

	2004	2005	2006
F. occidentalis	100	60	56
Thrips spp.	0	40	44

As described in tables 5, 6 and 7, the total amount of fruit damaged on the untreated sample was very high every year; in 2004 it reached 99.7% for the last harvest, 90.3% in 2005 and 100% in 2006, respectively. The heaviest economic damage was in 2004 and 2006, when high percentages of fruit were recorded in class 2.

Generally the amount of fruit damaged increased from the first to the second harvest and when there was a third harvest, as in 2006, damage increased even more. The number of harvests depends mainly on the amount of fruit available on the trees. In this study the checks at harvest time carried out during the years were done according to the grower's practice.

Due to the fact that nectarines commonly have multiple harvests, the persistence of a pesticide is very important in avoiding and increasing damage during the second and third harvests.

Table 5. Results of 2004: Percentage of fruits per class of damage (± s.e.) during the first and second harvests, respectively. A different letter per column means a statistical difference between treatments (Anova and LSD, P ≤ 0.05).

Damage class	1st harvest (6th July)			2nd harvest (12th July)		
	0	1	2	0	1	2
Acrinathrin	15.4 ± 3.55 b	73.6 ± 2.43 a	11.0 ± 3.31 b	1.9 ± 0.86 b	55.1 ± 4.32 ab	43.1 ± 4.03 b
Phosmet	0.9 ± 0.62 c	47.5 ± 9.63 c	51.6 ± 6.39 a	0.6 ± 0.37 b	36.9 ± 8.39 b	62.5 ± 8.22 a
Spinosad	30.6 ± 2.91 a	66.9 ± 2.04 ab	2.5 ± 1.15 b	28.3 ± 5.47 a	68.5 ± 4.61 a	3.2 ± 1.84 c
Ethofenprox	1.3 ± 0.53 c	50.9 ± 9.63 bc	47.8 ± 9.90 a	0.9 ± 0.55 b	36.0 ± 7.77 b	63.1 ± 8.29 a
Chlorpyriphos-methyl	-	-	-	-	-	-
Untreated	0.4 ± 0.43 c	48.5 ± 5.81 c	51.2 ± 6.06 a	0.3 ± 0.25 b	34.4 ± 6.76 b	65.3 ± 6.95 ab

Table 6. Results of 2005: Percentage of fruits per class of damage (± s.e.) during the first and second harvests, respectively. A different letter per column means a statistical difference between treatments (Anova and LSD, P ≤ 0.05).

Damage class	1st harvest (7th July)			2nd harvest (13th July)		
	0	1	2	0	1	2
Acrinathrin	68.8 ± 3.82 a	31.2 ± 3.82 c	0.0 ± 0.0 c	58.6 ± 3.76 a	39.7 ± 3.85 b	1.7 ± 0.81 c
Phosmet	-	-	-	-	-	-
Spinosad	63.9 ± 3.67 a	35.6 ± 3.42 c	0.5 ± 0.29 bc	65.1 ± 3.73 a	34.7 ± 3.83 b	0.3 ± 0.25 c
Ethofenprox	37.7 ± 6.95 b	58.8 ± 4.75 b	3.5 ± 2.26 b	25.5 ± 3.02 b	68.2 ± 3.89 a	6.3 ± 1.82 b
Chlorpyriphos-methyl	38.9 ± 6.54 b	59.2 ± 6.47 ab	1.8 ± 0.80 bc	26.0 ± 9.19 b	65.3 ± 7.12 a	8.7 ± 2.92 b
Untreated	17.5 ± 3.55 c	69.5 ± 2.68 a	13.0 ± 2.55 a	9.7 ± 1.50 c	61.0 ± 4.38 a	29.3 ± 3.81 a

Table 7. Results of 2006: Percentage of fruits per class of damage (± s.e.) during the first, second and third harvests, respectively. A different letter per column means a statistical difference between treatments (Anova and LSD, P ≤ 0.05).

Damage class	1st harvest (10th July)			2nd harvest (17th July)			3rd harvest (24th July)		
	0	1	2	0	1	2	0	1	2
Acrinathrin	23.5±5.97 b	58.4±2.82 ns	18.2±3.78 b	6.3±3.38 b	45.1±8.40 ns	48.6±10.89 b	1.2±0.70 bc	27.1±9.05 b	71.6±9.70 b
Phosmet	4.2±1.84 d	53.0±8.35 ns	42.8±9.71 a	1.0±0.71 b	26.8±11.07 ns	72.2±11.67 a	0.9±0.61 bc	21.5±12.52 bc	77.5±13.10 ab
Spinosad	63.8±5.98 a	34.5±4.52 ns	1.8±1.75 c	63.6±4.19 a	35.4±4.01 ns	1.0±0.57 c	39.7±4.95 a	55.5±4.23 a	4.7±0.78 c
Ethofenprox	11.3±3.32 c	56.7±5.43 ns	32.0±7.68 ab	1.8±0.87 b	34.4±10.97 ns	63.8±11.67 ab	0.6±0.63 bc	15.8±6.10 bc	83.6±6.10 ab
Chlorpyriphos-methyl	22.2±3.96 b	58.3±3.88 ns	19.5±5.60 b	3.3±1.51 b	41.8±8.78 ns	54.9±10.24 ab	1.3±0.56 b	20.2±7.0 bc	78.5±7.44 ab
Untreated	5.1±3.06 cd	50.6±9.66 ns	44.4±12.34 a	0.7±0.48 b	21.9±8.79 ns	77.4±9.25 a	0.0±0.0 c	7.8±3.2 c	92.2±3.20 a

The pesticides which were most effective at controlling thrips and limiting economic loss (class 2) to the fruit appear to be Spinosad and Acrinathrin (tables 5, 6 and 7). However, when thrips pressure is very high as it was in 2004 and 2006, Acrinathrin proved to be less persistent then Spinosad. This effect is very clear from the data in tables 5 and 7. During the second and third harvests in 2006, only Spinosad drastically reduced the percentage of damaged fruits. The effectiveness of Spinosad against *F. occidentalis* on nectarines before harvest was also recorded in Chile (Ripa *et al.*, 2001) and satisfactory results using Acrinathrin were also found in France (Nicolas and Kouta, 1992; Nicolas, 1995). In Italy other studies showed the efficacy of Spinosad and/or Acrinathrin against thrips on other crops like on table grapes (Moleas *et al.,* 1996; Caputo *et al.,* 2005), on lettuce (Gengotti and Censi, 2006) and on nectarine against *T. fuscipennis* (Tavella *et al*., 2006).

Chlorpyriphos-methyl showed a reduction of fruit damaged compared to untreated samples in 2005, but it seems to be less effective than Spinosad and Acrinathrin. With higher thrips pressure such as occurred in 2006, its efficacy dramatically decreased and only during the first harvest did it show a reduction of fruit in class 2. Phosmet and Ethofenprox appear not to be effective against thrips in this trial, as no differences between these active ingredients and the untreated sample were recorded in 2004 and 2006 when thrips infestation was very high.

Conclusions

In the nectarine orchard where this study was undertaken the most abundant thrips species was *F. occidentalis*. This invasive species were first detected in this area on nectarines by Tommasini and Burgio (2004) and its presence seems to be increasing in recent years, whereas it was previously known mostly as a pest on vegetables and ornamental crops in northern Italy. Monitoring the infesting thrips species on nectarines is an important step toward defining an efficient control strategy, due to the fact that *F.occidentalis* is already resistant and in general easily develops resistance to many pesticides (Espinosa *et al.*, 2002). Furthermore, other thrips species commonly occurring on nectarines are generally more sensitive to insecticides.

Spinosad and Acrinathrin proved to be the most effective of the pesticides evaluated against thrips, but Spinosad appears to be more persistent and more effective on the second and third harvests when thrips pressure is very high.

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Mention of a proprietary product does not constitute an endorsement or recommendation by the authors.

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