INFLUENCE OF TEMPERATURE ON TOXICITY OF DIAZINON TO GREEDY SCALE

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SUMMARY

Post treatment temperature effects on the toxicity of diazinon to 10 day old first instar greedy scale (*Hemiberlesia rapax*) were investigated using a laboratory dipping technique. At 20 °C LC_{50} values stabilised around the overall mean of 0.14 g/100 litres irrespective of assessment interval from 7-65 days. This same critical concentration was achieved at 15, 10 and 5 °C by at least 32, 32 and 65 days respectively. Low temperatures therefore influenced the time taken for the full expression of mortality but not the final level achieved.

INTRODUCTION

Dormant season and pre-blossom insecticide sprays are commonly used to 'clean-up' over-wintering armoured scale (Hemiptera: Diaspididae) on kiwifruit. Applying insecticides in winter or spring avoids residues on fruit and gives improved coverage of woody parts of the vine which may harbour scale. Temperatures over the winter and spring can vary markedly throughout kiwifruit growing regions in New Zealand. For example, temperature normals in July and August are 8 °C in Nelson and 10 to 11 °C in Tauranga or Kerikeri. Temperature normals gradually rise over September and October with November normals 14 °C in Nelson and 16 °C in Tauranga and Kerikeri.

Temperature can influence the efficacy of insecticides against insects, with organophosphate insecticides such as diazinon generally more toxic at higher temperatures and pyrethroids more toxic at lower temperatures (Busvine 1971; Turnbull and Harris 1986). If temperature can similarly influence the efficacy of insecticides against armoured scale there may be benefits in applying clean-up sprays during specific temperature periods. The objective of this study was to investigate the influence of temperature on the toxicity of diazinon against armoured scale.

MATERIALS AND METHODS

The laboratory toxicity testing procedure employed in this study was similar to that used to determine the toxicity of diazinon and other pesticides to greedy scale (Blank and Olson 1987, 1989, 1990). The greedy scale colony was also the same as used in these other studies. Potatoes infested with 10 day old white caps were dipped for 5 seconds in a range of at least seven diazinon (Basudin 800 EC) concentrations in addition to a control which was dipped in water. Trial 1 investigated the influence of 5 and 20 °C post-dipping temperatures on mortality and 30 scale from each potato were assessed for mortality after 7, 14 and 21 days. Trial 2 investigated the influence of 5, 10, 15 and 20 °C temperatures and 30 to 50 scale were assessed for mortality from each potato after 32, 39, 51 and 65 days. There were three repeats (potatoes) per treatment. Scale were considered dead when the normally yellow and turgid body of the scale became dark brown, shrivelled and dry. Log probit regression analysis was used to calculate LC_{50} critical concentrations and 95% confidence intervals. This analysis took into account Abbott's formula (Busvine 1971) for correcting for control mortality which did not exceed 25%. The 95% confidence intervals were used to determine significant differences ($P=0.05$) between treatments.

RESULTS

Scale development proceeded faster at warmer temperatures with few yellow caps (second instar) present at 5 °C after 21 days in Trial 1 or 65 days in Trial 2 (Table 1).
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TABLE 1: Proportion of different white cap (WC), yellow cap (YC) and black cap (BC) stages recovered on untreated potatoes held at various temperatures after various assessment intervals.

Temp (°C)	WC	YC	WC	YC	WC	YC	BC	WC	YC	BC
Trial 1	7 days		14 days		21 days					
5	100	0	100	0	94	6	0			
20	99	1	83	17	27	73	0			
Trial 2	32 days		39 days		51 days			65 days		
5	100	0	100	0	100	0	0	97	3	0
10	91	9	89	9	63	37	0	31	69	0
15	79	21	40	60	10	90	0	4	64	32
20	86	14	66	34	1	78	21	1	15	85

Whilst there is some lack of conformity at higher temperatures, yellow caps were the dominant stage after 65 days at 10°C, 39 days at 15°C and 21 days at 20°C.

The critical concentration values and slopes of the probit regression lines for each of the assessment intervals and temperatures tested are shown in Table 2. Probit regression lines could not be constructed for toxicity tests run at 5°C for 7, 14, 21 and 32 day assessment intervals because of insufficient mortality. Toxicity tests run at 5°C for later assessment intervals gave flat slopes and LC_{50} which were significantly different ($P < 0.05$) between assessments.

Toxicity tests run at 10°C gave LC_{50} values which declined with time but they did not differ significantly from those obtained at 15 and 20°C.

TABLE 2: Total numbers of white cap stages tested (n) using diazinon, critical concentration levels (95% confidence intervals) and slopes of the logarithm concentration probit regression curves at four post-treatment temperatures and seven assessment intervals.

Assessment intervals (days)	Temp (°C)	n	LC_{50} (95% CI) (g ai/100 litres)	Slope $\pm$ SE
Trial 1				
7	20	800	0.14 (0.09-0.22)	2.0 $\pm$ 0.1
14	20	800	0.13 (0.08-0.20)	2.0 $\pm$ 0.1
21	20	800	0.11 (0.07-0.17)	2.3 $\pm$ 0.2
Trial 2				
32	10	550	0.25 (0.13-0.57)	1.7 $\pm$ 0.1
	15	550	0.16 (0.09-0.30)	2.0 $\pm$ 0.1
	20	600	0.19 (0.11-0.35)	2.0 $\pm$ 0.2
39	5	800	5.28 (1.68-416)	0.8 $\pm$ 0.1
	10	800	0.21 (0.16-0.27)	2.8 $\pm$ 0.2
	15	800	0.17 (0.11-0.26)	2.4 $\pm$ 0.1
	20	900	0.15 (0.11-0.22)	2.6 $\pm$ 0.2
51	5	1200	0.26 (0.15-0.42)	1.3 $\pm$ 0.1
	10	1150	0.14 (0.09-0.22)	2.0 $\pm$ 0.1
	15	1150	0.10 (0.06-0.16)	2.0 $\pm$ 0.1
	20	1200	0.09 (0.06-0.14)	1.9 $\pm$ 0.1
65	5	1200	0.13 (0.07-0.22)	1.5 $\pm$ 0.1
	10	1100	0.13 (0.09-0.20)	2.1 $\pm$ 0.1
	15	1100	0.15 (0.09-0.26)	2.7 $\pm$ 0.2
	20	1050	0.15 (0.09-0.30)	2.0 $\pm$ 0.1

The overall mean LC₅₀ from all the toxicity tests run at 20°C was 0.14 g/100 litres (SEM = 0.01). This critical concentration was achieved after 7 days at 20°C with some variation about this value in later assessments. This same critical concentration was achieved (within the 95% confidence limits) at 15, 10 and 5°C by at least 32, 32 and 65 days respectively.

DISCUSSION

In these studies temperature influenced the time taken to achieve mortality in a similar manner to its influence on development rate. Temperature influenced the time for the full expression of scale mortality, by affecting either the speed at which mortality occurred, or the rate of desiccation and breakdown after death. Both these criteria are used to assess mortality of these immobile insects.

At temperatures of 20°C maximum toxicity responses were obtained over 7-65 days. The choice of assessment interval is therefore not critical at 20°C, although the 14-21 day interval employed in other studies (Blank and Olson 1987, 1989, 1990) may be a useful standard.

It is of interest that the sensitivity of this greedy scale colony to diazinon has declined from the LC₅₀ value of 0.3 g/100 litres obtained by Blank and Olson (1987) to the 0.14 g/100 litres of this study.

These laboratory studies give some guide to the assessment interval required for evaluation of field sprays over the winter-spring period (Blank and Olson 1988). A minimum period of 4 to 5 weeks would be prudent, especially as the large overwintering mature stages are present, and particularly during periods of low temperatures and high rainfall. The changes in mortality with time as described by Tomkins *et al* (1986) may simply be a measure of the influence of low temperatures on the expression of the mortality response.

It is concluded that kiwifruit growers should be confident in achieving similar levels of armoured scale control using organophosphate insecticides under any of the temperature conditions experienced over the winter-spring period in kiwifruit growing regions of New Zealand.

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