EFFECT OF PHEROMONE TRAP POSITION AND COLOUR ON TOMATO FRUITWORM MOTHS AND BUMBLEBEES

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SUMMARY

Field experiments tested the effect of trap position and trap colour on the capture of tomato fruitworm moths (*Helicoverpa armigera* (Hübner)) and bumble bees (*Bombus* spp.). Proximity to the edge of the crop and wind speed affected moth catch. Trap interference was demonstrated between traps 20 and 50 m apart, indicating that pheromone traps should be located 50 m within the crop on the prevailing upwind side of the crop. Standard yellow and white traps regularly caught bumble bees. All-green traps caught minimal bumble bees but also caught fewer moths. Green traps can be used in the processing tomato Integrated Pest Management (IPM) programme to initiate scouting for tomato fruitworm larvae at a threshold of five tomato fruitworm moths/day.

Keywords: pheromone traps, tomato fruitworm, *Helicoverpa armigera*, bumble bees, *Bombus* spp., Integrated Pest Management

INTRODUCTION

The IPM programme developed by Crop & Food Research for processing tomato crops involves using plastic funnel and bucket pheromone traps (International Pheromone Systems and Agrisense-BCS) to monitor male tomato fruitworm moth populations. Moth catch data are used to time the initiation of crop scouting for the damaging larval stages of tomato fruitworm (Walker and Cameron 1990).

The funnel and bucket trap is considered to be effective, durable, easily serviced and target specific (Adams *et al.* 1989) and useful for survey work (Mitchell *et al.* 1985). However, small differences in the placement of pheromone traps in or around the crop can greatly affect moth catch (Lewis 1978). Moths congregate in areas where there are suitable hosts, so pheromone traps should be located inside, rather than outside, these areas (Gregg and Wilson 1991). The measurement of pheromone trap interference, defined as pheromone plumes from two or more traps overlapping and competing for the moths within the overlap, gives an indication of how far a pheromone is disseminating from the traps. This information can then be used to determine the optimum position of a trap in a crop.

The funnel and bucket trap most commonly used is yellow (funnel) and white (bucket) (yellow trap). These traps have been observed to catch stinging Hymenoptera (Adams *et al.* 1989), predominantly bumble bees (*Bombus* spp.) (Mitchell *et al.* 1989; Herman *et al.* unpubl. data).

Experiments were run in Gisborne processing tomato crops over two seasons to determine where pheromone traps should be placed in fields and the effect of trap colour on the catches of male tomato fruitworm moths and bumble bees.

MATERIALS AND METHODS

In each experiment, pheromone traps were mounted on a metal stand 750 mm above the ground, were baited with a pheromone cap (impregnated with 500 µg of a pheromone blend described by Rothschild *et al.* 1982) and had a toxicant strip (dichlorvos) in the bucket to kill all specimens captured. The traps were emptied twice a week, unless otherwise stated, and the number of moths and bumble bees caught was

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recorded. All data were square-root transformed and subjected to an analysis of variance (Minitab), where appropriate.

Trap position

Trial 1 (run in 1992/93) was designed to relate trap catch to position in the crop as defined by the prevailing northerly wind. Three pairs of plastic cone and bucket traps were set up in each of two tomato crops. Each pair consisted of a yellow trap and a green trap in adjacent beds (approximately 1.5 m apart). One pair was at the top of the crop (upwind) approximately 30 m in from the crop edge, the second pair was in the middle of the crop and the third pair was approximately 30 m from the lower crop edge (downwind). There was approximately 100 m between each location. To study the effect of trap position in the crop, data for moth catch/day were compared using the sum of each pair of traps.

Trial 2 (1993/94) examined the effects of trap position in a crop by attempting to measure interference between traps. Two lines (100 m apart) of five pheromone traps were placed down the crop in line with the prevailing wind. The distances between the traps in a line were 20, 50, 100 and 200 m. The traps were emptied daily, for 7 days, and their positions were rotated daily along each line to remove possible trap bias on moth catch.

Trial 3 (1993/94) refined the measure of interference by comparing the moth catch in a single trap to that from a group of four adjacent traps at least 200 m away in the same crop. The group of traps was arranged in a square with the length of the side of the square changing every second day from 20 to 50 to 100 m. The sites of the single trap and group of traps was alternated daily so that each combination occurred at each site. The trial ran for 6 nights.

For both Trials 2 and 3, the average nightly wind speed and wind direction data (7pm - 7am) were obtained from a meteorological station approximately 1 km from the trial site.

Trap colour

The effect of trap colour was examined using adjacent and separated traps. The moth catch from traps in Trial 1 (above) provided a comparison for adjacent traps of different colour. A second colour comparison, for moth catches in separated traps, was run in 1992/93 in four late season crops. A yellow trap and a green trap was set up in each crop across the prevailing wind, at least 50 m apart. In 1993/94 a further comparison of trap colour was carried out with a yellow and a green trap being set up in each of three mid-season and three late season tomato crops. The traps were placed 100 m apart across the prevailing wind in each crop. The relationship between the number of moths caught in different colour traps was determined from the regression of the square root of the data collected each time the traps were emptied.

Bumble bees

The number of bumble bees caught in different coloured pheromone traps was recorded as part of Trial 1.

RESULTS AND DISCUSSION

Trap position

Trial 1 confirmed that moth catch in traps near the edge of a crop can be lower than in traps located centrally. The trap at the upwind site caught significantly ($P < 0.05$) fewer moths than traps at the middle and downwind sites (Table 1). This was probably due to a poplar shelter belt on the upwind fenceline of one crop which sheltered the upwind trap from the wind and influenced the dissemination of pheromone from the trap. Wilson and Morton (1989) demonstrated that variation in *H. armigera* and *H. punctigera* moth catch could be minimised by locating the pheromone traps 40 m within cotton crops rather than on the edge. Witz *et al.* (1992) also found that pheromone traps on the border of cotton crops caught fewer cotton bollworm moths (*H. zea*) than traps in the crop.

No significant difference was found in moth catch between pheromone traps (Trial 2) varying distances apart, implying no interference between the traps and giving no indication of how far into a crop the pheromone traps should be placed (Table 1).

Figure 1: Relationship between tomato fruitworm moth catches in green and yellow pheromone traps (square root transformation).

Wilson and Morton (1989) found that wind speed and direction had a large effect on trap catch. The average nightly wind speed during Trial 2 was 0.45 m/s and this may have been too gentle for good dissemination of pheromone from the traps. Gregg and Wilson (1991) determined that there was a minimum wind speed threshold of 0.7 m/s for *Heliothis* moth catches and Morton *et al.* (1981) reported lower *Heliothis armiger* moth catches at wind speeds averaging 0.8 m/s compared 1.3 m/s. The wind during Trial 2 was consistently from a NE direction across the two trap lines (ie. not the prevailing wind direction), which also obstructed efforts to detect trap interference.

Dent and Pawar (1988) demonstrated higher pheromone trap catches in wind speeds between 1.4 m/s and 2.8 m/s. The average nightly wind speed during Trial 3, of 1.6 m/s fell within this range and larger moth catches were recorded. The trial design minimised any effect that variation in wind direction may have had on moth catch.

In Trial 3, the difference in moth catch between traps in a group and the single trap decreased as the distance between the traps within the group increased (Table 1). Interference occurred between traps when they were 20 and 50 m apart. There was also some evidence of trap interference in raw data from Trial 3 (not presented) showing that traps 100 m upwind can influence the catch in traps located downwind.

In the processing tomato IPM programme, we have previously positioned the traps on the prevailing upwind side of the crop so the pheromone plume mainly draws from the moth population within the crop. Ideally, the traps should be placed in the centre of the crop. However, there is a trade-off between trap service time and trap location. The further the trap is into a crop the longer it takes to service it. This work shows that pheromone can disseminate at least 50 m from the trap, depending on wind speed and direction. Where possible, traps should be at least 50 m into the crop. Failing this, traps should be on the prevailing upwind side of the crop as far away from the edge of the crop as possible.

Trap colour

Green traps caught 58% fewer tomato fruitworm moths than yellow traps ($P < 0.05$) (Fig. 1). These results are consistent with records for other noctuids. Hendrix and Showers (1990) reported that yellow traps caught four times as many black cutworm moths (*Agrotis ipsilon* (Hufnagel)) and armyworm moths (*Pseudaletia unipuncta* (Haworth)) as green traps. Mitchell *et al.* (1989) found that green traps caught signi-

TABLE 1: Tomato fruitworm moths caught in pheromone traps at different locations in tomato crops over two seasons.

		Trap site				
		Upwind	Mid crop		Downwind	
Trial 1		1.0 a ¹	1.9 b		2.1 b	
Moth catch/day SEM		0.28	0.33		0.35	
Trial 2		Distance between traps				
		0	20	50	100	200
Moth catch/day SEM		2.2 0.25	2.1 0.24	2.0 0.20	2.1 0.33	2.4 NS ² 0.35
Trial 3		Distance between traps in the square				
		20	50	100		
Moth catch/day	Group of four traps	3.1	2.5		2.6	
	Single trap	5.3	3.5		2.7	

¹ Numbers in a row followed by the same letter are not significantly different ($p > 0.05$)

² Not significantly different ($P > 0.05$)

ificantly fewer velvetbean moths (*Anticarsia gemmatilis* Hübner) and fall armyworm moths (*Spodoptera frugiperda* (J.E. Smith)). Pair *et al.* (1989) found that yellow traps caught twice as many fall armyworm moths than green traps. In our experiments, the ratio of the capture of tomato fruitworm moths in green traps : yellow traps was consistent over the range of moth densities sampled. This enables a correction factor of 0.58 to be applied to the yellow trap threshold of the processing tomato IPM programme. Previous comparisons between trap catches and larval populations (Walker and Cameron 1990; Herman *et al.* unpubl. data) show that this trap catch threshold is a useful predictor of initial tomato fruitworm larval infestations in processing tomato crops. Further research showed that trap catches are also a reliable predictor of variations in the seasonal development of tomato fruitworm populations (Cameron *et al.* unpubl. data). From this it is recommended that scouting for tomato fruitworm larvae should be initiated when moth catch reaches five moths/day using green traps.

Bumble bees

The mean catch of 1.09 bumble bees caught in yellow traps was significantly greater ($P < 0.05$) than the 0.02 bumble bees caught in green traps. Gross and Carpenter (1991), Hendrix and Showers (1990) and Hamilton *et al.* (1971) all found that green traps caught significantly fewer bumble bees than yellow traps.

An average of 1 bumble bee/day was caught in the yellow trap with a maximum of 7.4 bumble bees being caught on one day (raw data). Only one bumble bee was caught in the green traps (Trial 1) and the occasional capture of single bumble bees in green traps was consistent with observations in the other trials.

To ensure that bumble bee populations are not affected by pheromone traps used in the processing tomato IPM programme, green pheromone traps should be used to monitor tomato fruitworm populations.

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