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EFFECT OF TRAP HEIGHT AND SPACING IN RELATION TO CROP HEIGHT ON CATCHES OF THE MILLET STEMBORER, *CONIESTA IGNEFUSALIS* MALES

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Abstract—Studies were conducted using a water-based trap baited with the synthetic female sex pheromone to gain further understanding on the effect of trap height and spacing in relation to crop height on catches of males of the millet stemborer, *Coniesta ignefusalis* (Hampson) (Lepidoptera: Pyralidae). Regardless of crop height, catches were greatest at trap heights of 0.10 and 0.50 m when the traps were stacked vertically. When traps were sited singly at 50 m spacing there was no significant difference in catches at the different heights. When trap spacing was varied from 50, 15, 5, 1 to 0 m, male moth catches in traps increased at lower trap heights, regardless of crop height. Comparison of catches in light traps and pheromone-baited traps showed a significant positive correlation. These findings have implications for both monitoring and development of millet stemborer control systems through mating disruption and mass trapping.

Key Words: pheromone, stemborer, *Coniesta ignefusalis*, millet, trap, pest management

Résumé—Des études ont été menées utilisant un piège à eau appâtée avec la phéromone sexuelle afin de mieux cerner l'effet de la hauteur des pièges et de leur espacement par rapport à la hauteur des plantes de mil sur la capture des mâles du foreur de tige de mil, *Coniesta ignefusalis* (Hampson) (Lepidoptera: Pyralidae). Les résultats montrent que la capture était meilleure avec les hauteurs de pièges de 0.10 à 0.50 m, quelque soit la hauteur des plantes, si ces pièges sont positionnés verticalement à un site. Un espacement des pièges de 50 m indique généralement une différence de captures non significative selon les hauteurs de pièges et de plantes. Cependant, une variation progressive de l'espacement entre pièges allant de 50 m, 15, 5, 1, à 0 m (pièges empilés verticalement en un site) entraine des captures plus importantes au niveau des pièges du bas. Une comparaison entre les captures au piège lumineux et au piège à phéromone montre une correlation positive. Ces résultats ont une portée dans la surveillance et le dévelopment des méthodes de lutte se basant sur le piègeage en masse et la perturbation des accouplements par methode de confusion.

Mots Clés: phéromone, foreurs de tiges, *Coniesta ignefusalis*, mil, piège, lutte intégrée

INTRODUCTION

Pheromone-baited traps as relevant tools for monitoring populations of crop pests, are now well established (Nesbitt 1978; Campion and Nesbitt, 1981). They offer an alternative to light traps for timing of the application of control measures (Campion et al., 1976) and ought to be ideal for developing countries, due to their low cost and species specificity (Campion et al., 1987).

Trap design is crucial in field testing for identification of pheromone component ratios,

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accurate pest population assessment and for successful control by mass trapping (Cork et al., 1988; Campion et al., 1987; McVeigh et al., 1979). Birch and Haynes (1982), have described implications on trap parameters of specific pest behaviour (i.e. escape strategies from trap, and environmental factors in trap efficiency). Different trap designs have been used to match different pest behaviour (Campion et al., 1974; Youm et al., 1993; Youm and Beevor, 1995).

Studies to develop pheromone technology as an integrated management component for the millet stemborer, *Coniesta ignefusalis*, (Hampson) a key pest of pearl millet, are fairly recent. A water-oil trap baited with the attractive blend of female sex pheromone was reported to have good potential as a monitoring tool (Youm et al., 1993). Subsequent studies were conducted to improve the trap's efficiency relative to available commercial traps through the optimisation of trap parameters (Youm and Beevor, 1995). In addition, initial studies to assess effects of trap height and crop height on catches of *C. ignefusalis* males yielded different results based on trap configuration (Youm and Beevor, 1995).

The study reported here sought to elucidate the complex interactions and dynamics of *C. ignefusalis* catches in relation to trap height and spacing and crop height. Furthermore, moth catches in pheromone-baited water-oil traps were compared with catches in light traps to determine their relative efficiency in population monitoring.

Materials and Methods

Experiments were set up in farmers' millet fields at Deybon and Bellare near the ICRISAT Sahelian Center at Sadoré, about 45 km South of Niamey, Niger. Water-oil traps were baited with pheromone dispensers described below. Trap catches were monitored at different trap and crop heights during studies conducted from 5 July to 23 September 1993 during the rainy season. The efficacies of pheromone-baited traps and light traps in monitoring moth populations were compared in on-station experiments from 1992–1994.

Water-oil traps and pheromone dispensers

Water-oil traps were similar to that described by Youm and Beevor (1995) and consisted of aluminum trays (32-cm diameter and 4 cm deep), filled with water (about 1.5 l) containing about 10–20 ml of Total rubia S-40 oil (SIFAL, RCI) as a surfactant, and a 21-cm diameter shade suspended 5 cm above the tray. Trap support was a 40 x 40 cm brownish non-glossy wooden shelf fixed to a wooden stake (Fig. 1). Traps were baited with pheromone dispensers consisting of polythene vials 32 by 15 by 2 mm thick (Agrisense-BCS) impregnated with the optimum pheromone blend comprised of (Z)-7-dodecen-1-ol (Z7-12:OH) (500 µg), (Z)-5-decen-1-ol (Z5-10:OH) (25 µg), (Z)-7-dodecen-1-al (Z7-12: CHO) (16.67 µg) and an equivalent amount of butylated hydroxytoluene (BHT) antioxidant (Youm and Beevor, 1995) The pheromone components were prepared at the Natural Resources Institute (NRI), Chatham, UK and were >99.9% isomerically pure. Dispensers were suspended from the underside of the shade on a small wire with an end loop that was extended through the lid and tied to the horizontal wooden supporting handle.

Light traps

Light traps consisted of a mercury vapour bulb (250 W), mounted on top of a 3 x 3 x 3 m screen cage with a screen door (easily opened and closed) on one side for access to moths caught inside. Moths attracted by light were drawn into the cage through a plastic tube. The light bulb was switched on/off by an automatic photosensitive cell at dusk and dawn. Moths caught were counted daily. The number of traps was 1–3 light traps and 5 pheromone-baited traps. Pheromone traps were 300–500 m from the nearest light trap.

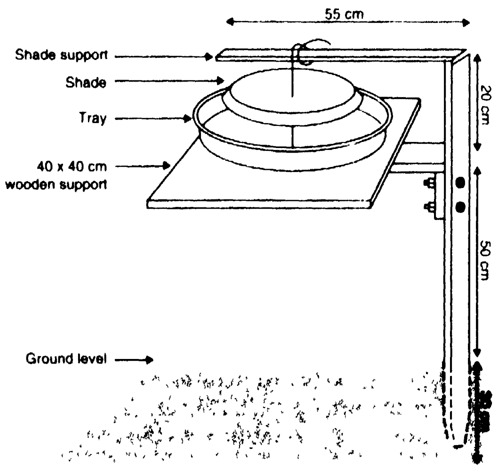

Fig. 1. Water-based pheromone trap for monitoring *C. ignefusalis* (Youm and Beevor, 1995)

Experimental design

Effects of trap height and crop height

Catches in water-oil traps were recorded at four trap heights (treatments) of 0.1, 0.5, 1.3, and 2 m above ground level. This experiment was conducted at different crop heights during crop growth with traps stacked vertically at one site as described by Youm and Beevor (1995).

Effects of trap spacing

In the other set of experiments trap heights of 0.1, 0.5, 1.3, and 2 m were used. However, trap spacing was varied from 0 (traps stacked vertically) to 50 m using the same crop height to determine the effect of trap spacing on male moth catches. Four traps were placed at each corner of a square. Each night, all traps were rotated clockwise so that each trap height occupied each site twice, with each trial running for 8 nights. Crop heights were measured in a 5-m radius around one trap in each block. Catches of male moths were recorded each day. There were three replicates spaced at least 100 m apart. The water-oil level was checked daily and topped up as necessary.

Population monitoring using light traps and pheromone traps

Water-oil traps baited with pheromone dispensers as described above were placed at 0.5 m above the ground both on-station and on-farm. Daily moth catches from the on-station light traps were recorded.

Data analysis

Moth catch data were transformed to the natural log scale as $Y_t = \mathrm{Log}(y+1)$, where y is the number of moths caught per trap per night. Data from each experiment were subjected to an analysis of variance (ANOVA) and means separated using the least significant difference (LSD) test. The relationships between catches in light traps and pheromone traps were determined using a linear regression (SAS Institute, 1987).

RESULTS

Effects of trap height and crop height

When traps are stacked vertically at one site (0-m trap spacing), significantly higher catches of

Table 1. Effect of trap height in relation to crop height on catches of male *C. ignefusalis* moths in water-oil traps stacked vertically[1]

Trap height (m)	Crop height (m) 0.13 Total[2]	0.13 X ± SE	0.45 Total[2]	0.45 X ± SE	1.92 Total[2]	1.92 X ± SE
0.1	663	27.62 a ± 3.95	91	3.80 a ± 0.52	758	30.7 a ± 8.2
0.5	110	4.58 b ± 0.75	17	0.70 b ± 0.25	455	18.9 a ± 3.8
1.3	3	0.12 c ± 0.09	0	0.00 c ± 0.00	83	3.4 b ± 1.5
2.0	1	0.04 c ± 0.04	1	0.04 c ± 0.04	33	1.4 c ± 1.0

[1]Within a column, means followed by the same letter are not significantly different ($P > 0.05$, LSD test).
[2]Numbers are based on 24 trap nights.

Table 2. Effect of trap height in relation to crop height on catches of male *C. ignefusalis* moths in water-oil traps, single traps at each site and spaced 50 m from each other[1]

Trap height (m)	Crop height (m) 0.13 Total[2]	0.13 X ± SE	0.45 Total[2]	0.45 X ± SE	1.92 Total[2]	1.92 X ± SE
0.1	745	31.0 a ± 5.1	67	2.8 a ± 0.5	869	36.2 a ± 7.6
0.5	578	24.1 a ± 3.4	66	2.7 a ± 0.7	978	40.7 a ± 7.7
1.3	485	20.2 a ± 3.9	61	2.5 a ± 0.8	912	38.0 a ± 6.0
2.0	307	12.8 b ± 3.2	45	1.9 a ± 0.5	755	31.4 a ± 5.6

[1]Within a column, means followed by the same letter are not significantly different ($P > 0.05$, LSD test).
[2]Numbers are based on 24 trap nights.

Table 3. Effect of trap height in relation to trap spacing on catches of male *C. ignefusalis* moths monitored in water-oil traps at the same crop height of 1.92 m[1]

Trap height (m)	Distance between traps (m): 0		1		5		15		50	
	Total[2,3]	X ± SE	Total[2]	X ± SE	Total[2]	X ± SE	Total[2]	X ± SE	Total[2,4]	X ± SE
0.1	758	30.7 a ± 8.2	67	2.9 a ± 0.6	58	2.5 a ± 0.5	272	11.3 a ± 2.6	869	36.2 a ± 7.6
0.5	455	18.9 a ± 3.8	104	4.3 a ± 1.0	59	2.6 ab ± 0.6	228	9.9 a ± 2.0	978	40.7 a ± 7.7
1.3	83	3.4 b ± 1.5	17	0.7 b ± 0.2	28	1.2 bc ± 0.3	187	7.7 a ± 1.4	912	38.0 a ± 6.0
2.0	33	1.4 c ± 1.0	11	0.4 b ± 0.2	20	0.8 c ± 0.2	117	5.1 b ± 1.0	755	31.4 a ± 5.6

[1]Within a column, means followed by the same letter are not significantly different ($P > 0.05$, LSD test)
[2]Numbers are based on 24 trap nights
[3]From Table 1, at crop height 1.92 m.
[4]From Table 2, at crop height 1.92 m.

male *C. ignefusalis* occurred in lower traps at 0.1 and 0.5 m, than those at 1.3 or 2 m above the ground. This trend was consistent regardless of crop height (Table 1). This confirms the results of Youm and Beevor (1995) using crop heights of 0.44, 0.79, 1.31, and 1.63 m.

When traps were positioned singly and spaced at 50 m, there was no significant difference in male moth catches regardless of crop height (Table 2). The only exception occurred when fewer moths were caught at a trap height of 2.0 m when the crop was at 0.13 m, than at trap heights of 0.10, 0.50, and 1.3. Youm and Beevor (1995) reported similar results even at very high crop heights with no significant differences in moth catches in traps spaced at 25 m and at crop heights of 1, 1.5 and 2.9 m.

Effect of trap spacing

Trap catches measured at the crop height of 1.92 in Table 1 and Table 2 (0-m and 50-m trap spacing respectively) were compared with catches for trap spacing of 1, 5 and 15 m at a crop height of 1.92 m. When the trap spacing was 0 and 1 m, the number of moths caught was significantly higher at trap heights of 0.10 and 0.50 (Table 3). However, when trap spacing was 5 and 15 m, catches progressively increased in trap heights of 1.3 and 2.0. At 50-m trap spacing and crop height of 1.92 m, there were no significant differences in trap catches at any trap height.

Population monitoring using light traps and pheromone-baited traps

Linear regressions of moth catches in pheromone traps against catches in light traps from transformed data showed that captures in pheromone-baited traps were closely related to

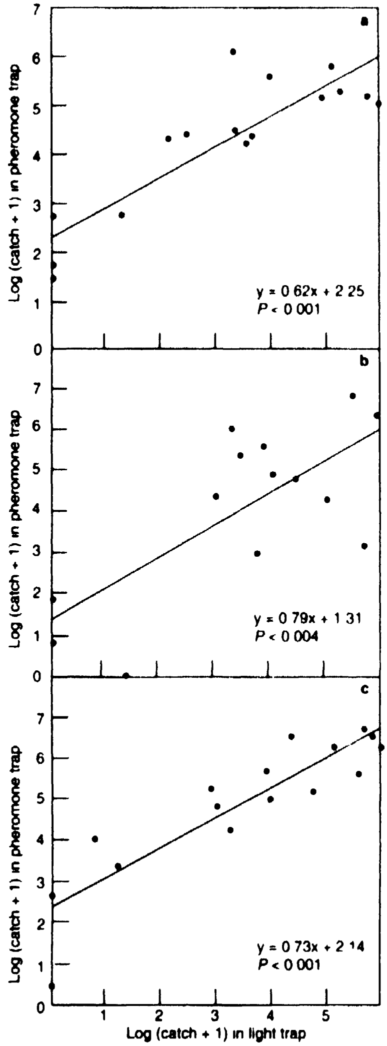

Fig. 2. Male *C. ignefusalis* catches in pheromone traps plotted against catches in light traps, in 10 day intervals, during rainy seasons 1992 (A), 1993 (B) and 1994 (C) at ISC station, Sadoré, Niger

catches in light traps for 1992 (Y = 0 62x + 2 25, $P < 0.001$), 1993 (Y = 0 79x + 1 31, $P < 0.004$), and 1994 (Y = 0 73x + 2 14, $P < 0.001$) (Fig 2)

Discussion

The results reported here confirm the findings of Youm and Beevor (1995) and provide further understanding on the effects of trap height and spacing in relation to crop height on catches of male *Coniesta ignefusalis* Catches of male moths were optimum at trap heights of 0 10 and 0 50 regardless of crop height when traps were stacked vertically in one site Spacing traps at 50 m resulted in equal numbers of moths being caught at any trap height regardless of crop height Youm and Beevor (1995) indicated that moths were caught at lower trap heights when given a choice, indicating that male moths are low flyers and normally conduct mate-searching at a height between 0 10 and 0 50 m above the ground When traps were spaced at 25 m (Youm and Beevor, 1995) and 50 m as reported here, equal numbers of moths were caught at all trap heights It may be possible that the direction of pheromone plume may have interfered, thus favouring catches at lower trap heights At between 0 and 15 m trap spacing, catches of the lower traps were higher than at trap heights of 1 3 and 2 0 m These results indicate that *C ignefusalis* trapping systems can be effective at any crop height and trap height, in a non-choice situation However, in a choice-situation, a trap height of 0 50 m is more effective (Youm and Beevor, 1995) and is recommended for use in future studies and population monitoring

For monitoring of moth population using pheromone-baited traps, a trap height no higher than 0 50 m is recommended, given that it is easier to place and handle traps at that height, and it is also the normal height for moth mating

There was a good correlation between trap catches in pheromone and light traps from mid-June to the first week of October Our results have also shown that early- and late-season (first and second weeks of June and second week of October) moths populations are generally very low (depending on the onset of rainfall), and although some catches are recorded in pheromone traps, they are seldom detected in light traps (Fig 2) This provides further evidence of pheromone trap efficiency at very low moth populations and supports their use to detect early pest infestation (Campion and Nesbitt, 1981) Because of the ease of use of pheromone traps and their low cost, and the possibility of using them even in remote village farms since no artificial light is required, the water-oil trap baited with the optimum blend of *C ignefusalis* pheromone is highly recommended for use both on-station and on-farm This trap can also be used to assess mass trapping as a means of controlling the millet stemborer

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References

Birch M C , Haynes K F (1982) *Insect Pheromones* The Institute of Studies in Biology Edward Arnold Limited London, UK

Campion D G, Hall D R and Prevett P F (1987) Use of pheromones in crop and stored products pest management Control and monitoring *Insect Sci Applic* 8, 737–741

Campion D G , Odiyo P O Mushi A M , Hall D R , Lester, R and Nesbitt B F (1976) Field tests with the synthetic sex pheromone of the African armyworm *Miscellaneous report No 25* Ministry of Overseas Development Centre for Overseas Pest Research, College House Wrights Lane London W8 5SJ, UK

Campion D G , Bettany B W , Nesbitt B F , Beevor P S , Lester R , and Poppi R G (1974) Field studies of the female sex pheromone of the cotton leafworm *Spodoptera littoralis* (Boisd) in Cyprus *Bull Entomol Res* 64, 89–96

Campion D G and Nesbitt B F (1981) Lepidopteran sex pheromones and pest management in developing countries *Trop Pest Manage* 27, 53–61

Cork A , Chamberlain D J , Beevor P S , Hall D R , Nesbitt B F , Campion D G and Attique M R (1988) Components of female sex pheromone of spotted bollworm, *Earias vitella* F (Lepidoptera Noctuidae) Identification and field evaluation in Pakistan *J Chem Ecol* 14 , 929–945

McVeigh L J , Paton E M and Hall D R (1979) Factors affecting the performance of pheromone traps for male *Spodoptera littoralis* 2, 409–419 In *Proceedings of the 1979 British Crop Protection Conference — Pests* *and Diseases*. British Crop Protection Council, London.

Nesbitt B. F. (1978) A review of work on insect pheromones at the Tropical Products Institute. *Trop. Sci.* 20, 1–10.

Youm O., Beevor P. S. and Hall D. R. (1993) Trap design studies with the pheromone of *Coniesta ignefusalis* (Hampson) (Lepidoptera: Pyralidae) in sub-Saharan Africa. *Proceedings Working Group Meeting IOBC/WPRS Bull.* 16, 58–63.

Youm O. and Beevor P. S. (1995) Field evaluation of pheromone-baited traps for *Coniesta ignefusalis* (Lepidoptera: Pyralidae) in Niger. *J. Econ. Entomol.* 88, 65–69.