Tropical Pest Management
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ttpm19

The development of sex pheromone trapping of Heliothis armigera at ICRISAT, India

C. S. Pawar [a] , S. Sithanantham [a] , V. S. Bhatnagar [a b] , C. P. Srivastava [a] & W. Reed [a]
[a] International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) , Patancheru P. O., Andhra Pradesh, 502 324, India
[b] FAO/CILSS IPM Project , B. P. 281, Kaolack, Senegal
Published online: 13 Nov 2008.

To cite this article: C. S. Pawar , S. Sithanantham , V. S. Bhatnagar , C. P. Srivastava & W. Reed (1988) The development of sex pheromone trapping of Heliothis armigera at ICRISAT, India, Tropical Pest Management, 34:1, 39-43, DOI: 10.1080/09670878809371203

To link to this article: http://dx.doi.org/10.1080/09670878809371203

TROPICAL PEST MANAGEMENT, 1988, 34(1) 39–43

The development of sex pheromone trapping of *Heliothis armigera* at ICRISAT, India

(*Keywords: Heliothis armigera*, pheromones, traps)

C. S PAWAR, S. SITHANANTHAM, V. S. BHATNAGAR†, C. P. SRIVASTAVA and W. REED

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru P. O., Andhra Pradesh 502 324, India

Abstract. The development of a trapping system for monitoring *Heliothis armigera* male moths using a synthetic sex pheromone attractant at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India, is described. This work started in 1977 using virgin females as baits but the Tropical Products Institute of London subsequently provided synthetic pheromone mixtures that attracted many more moths. These were initially dispensed through polythene vials but field tests showed that rubber septa on which pheromone was adsorbed were far more attractive. Eventually, small rubber burette stoppers, on which 2 mg of the pheromone was adsorbed, were adopted as the standard lures. Tests showed that these lures attracted moths for several months but that 4 weeks was the optimum use period. Several designs of traps were constructed and evaluated. Dry traps, particularly funnel types, were more effective than sticky traps. A white funnel trap was most efficient and was adopted as the ICRISAT standard trap. Subsequent research showed that the incorporation of a perforated baffle around the lure greatly increased catches. Traps placed just above the crop canopy in sorghum, millet, pigeonpea, chickpea, and groundnut caught more moths than at other heights. Dichlorvos used as a fumigant did not decrease catches and killed moths for over 4 weeks. ICRISAT standard traps are being used in a network to study the populations of *H. armigera* and their movements across the Indian subcontinent.

Introduction

Heliothis armigera (Hubner), (Lepidoptera: Noctuidae) is being studied intensively at the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) at Patancheru, A. P., India (18° N 78° E). This insect is a pest of all five of ICRISAT's mandate crops: pigeonpea, chickpea, groundnut, sorghum, and pearl millet (Bhatnagar *et al.*, 1982). Research on the use of sex attraction for trapping this insect was initiated at ICRISAT in 1977. This paper describes the early work on sex attraction and the use of synthetic sex pheromone for trapping *H. armigera* at ICRISAT during 1977–83.

Trapping development

Synthetic pheromone development

The pheromone trapping of *H. armigera* male moths at ICRISAT was initiated in 1977 with the use of field traps containing virgin female moths. Varying numbers of these were kept in wire gauze cages that were placed in a variety of sticky and water traps, which were operated through the night in the field. When such traps were operated through the peak *H. armigera* infestation periods at ICRISAT (August–April), they caught on average less than one male moth per trap night, with a maximum of 3 moths in one night.

ICRISAT then collaborated with the pheromone research team of the Tropical Products Institute (TPI), London, UK, (now part of the Tropical Development and Research Institute, TDRI), in developing a synthetic sex-pheromone. Several batches of *H. armigera* pupae were sent to TPI for their chemical isolation and identification, and they in turn supplied a series of candidate synthetic mimics to ICRISAT for field testing. Among the synthetic products received during 1979–80, a mixture of 97% (Z)-11-Hexadecenal and 3% (Z)-9-Hexadecenal (Nesbitt *et al.*, 1980) was found to attract more male moths to the traps than did the virgin females.

Pheromone dispensers

In 1980, polythene vials containing (Z)-11-Hexadecenal were found to attract very few *H. armigera* male moths except when the pheromone load was increased ten times, to 10 mg. At this very high loading rate the vials attracted almost as many male moths as did the virgin females. Later in 1980, ICRISAT tested the pheromone in vials and adsorbed on white rubber septa, both with 1 mg loading. The trial was conducted over 4 weeks (22 December–18 January) with one replicate in pigeonpea and the other in chickpea. The traps containing the septa caught an average of 5·0 moths per trap night while the traps containing the vials caught 0·6 moths per trap night (S. E. M. ± 0·40). We subsequently adopted the use of these septa in all our traps from 1981 to 1983.

In this, and in all the other field tests that are reported in this paper, the positions of the traps were interchanged clockwise at regular intervals throughout each test to minimize any location effects on the catches.

Unfortunately, the large white rubber septa were not readily obtainable and in their place relatively cheaper small white rubber burette stoppers supplied by TPI were used as dispensers from 1983. These stoppers containing 2 mg pheromone were found comparable with large rubber septa containing 1 mg pheromone in tests carried out over 12 weeks (28 January–21 April) in open fields at ICRISAT Center and at Hisar in northern India (Table 1). The rubber burette stoppers loaded with 2 mg pheromone mix were then

†FAO/CILSS IPM Project, B. P. 281, Kaolack, Senegal.

adopted as the standard lures for routine monitoring of *H. armigera* with ICRISAT standard traps.

Table 1. Mean catches of H. armigera *per trap night in pheromone traps with two different dispensers and pheromone loadings, ICRISAT Center, 1983.*

ICRISAT locations	Dispensers and pheromone loadings		
	Large rubber septa (1 mg)	Small rubber stopper (1 mg)	Small rubber stopper (2 mg)
Patancheru[a] (18° N 78° E)	2·2 (±0·41)	1·4 (±0·29)	2·4 (±0·51)
Hisar[b] (29° N 76° E)	40·4 (±10·99)	33·4 (±9·00)	47·1 (±12·11)

[a] based on 4 replications
[b] based on 2 replications
Standard error in parentheses.

Longevity of pheromone in the fields

Observations in 1980–81 indicated that the large white rubber septa loaded with 1 mg pheromone mix were attractive to male *H. armigera* moths even after 3 months of continual field exposure. In a trial in 1981–82 we recorded catches over 12 weeks (9 December–2 March) in traps baited with septa that had been exposed previously for a range of periods. One set of these traps was placed in a pigeonpea crop and the other in a chickpea crop. The continued exposure of septa in the field led to a progressive reduction in catches, with a particularly large reduction occurring after the septa had been exposed for more than 6 weeks (Table 2). As a result of this and other tests it was decided that the septa should be renewed after 4 weeks exposure. This period was chosen based upon effectiveness, economics and convenience.

Table 2. Mean catches of H. armigera *in pheromone traps baited with septa aged for different periods, ICRISAT Center, 1981–82.*

Age of septa (days)	Moths per trap night
0–14	11·2
15–28	9·7
29–42	6·7
43–56	2·5
57–70	1·9
71–84	1·0
S. E. M	±0·76

Trap development

Trap designs.. Several trap designs, including those reported to be efficient by other workers, were tested in a series of experiments starting in 1977 at ICRISAT (Pawar *et al.*, 1984). The first tests using virgin female *H. armigera* moths as lures, were of sticky traps of various designs and of a water pan trap. The catches in these tests were generally low and the differences in catches in different traps were inconsistent and non-significant.

In subsequent tests in 1980, the dry funnel trap (Figure 1) supplied by Center for Overseas Pest Research COPR, London, and a similar but larger trap prepared at ICRISAT caught at least as many moths as the sticky traps. As the dry funnel traps were much easier to maintain, and catches in these could be more easily recorded and removed, further development was concentrated on these traps.

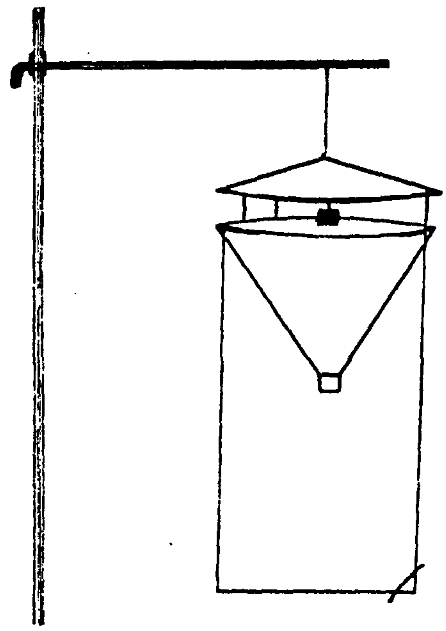

Figure 1. COPR dry funnel trap: a yellow plastic funnel (diameter 17 cm) with a hood of the same material at a clearnace of 2·5 cm. The pheromone source is suspended below the hood at the centre, and moths are caught in the polythene bag wired below the funnel.

In 1981–82, after a series of tests, the plastic plate in the locally fabricated dry funnel trap was replaced with an aluminium plate, which was fixed by a nut and bolt to the support strut. The gap between the plate and funnel was increased from 2·5 cm to 5 cm. The resulting trap (Figure 2) was more durable and the septa could be replaced more easily. This trap was subsequently used extensively both within ICRISAT and by others, and has been designated the ICRISAT standard trap.

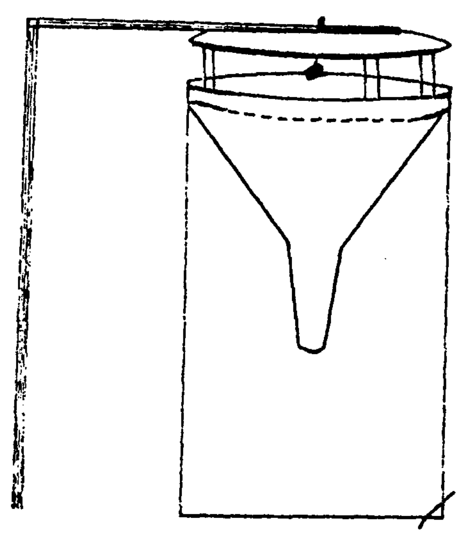

Figure 2. ICRISAT standard trap: a white plastic funnel (diameter 21 cm) with an aluminium plate rivetted above at a clearance of 5 cm. The trap is fixed with a nut and bolt and pheromone source is suspended below the plate at the centre. Moths are retained in the polythene bag wired below the funnel.

This trap was later compared with five other traps including inverted and metallic versions of the standard trap and two sleeve traps modified after Neumark and Teich (1978). In a test over 12 weeks (5 November–27 January) in 1981–82, with one replicate in pigeonpea and the other in chickpea, the ICRISAT standard trap baited with white rubber septum (1 mg pheromone) caught far more moths (10·0 moths per night) than other traps (2·3 moths per night) except for the trap modified by inserting a slotted, conical yellow plastic baffle around the pheromone septum in the standard trap (Figure 3), which caught the maximum (19·6 per night). This modification had been made following a series of night time observations which showed that many more moths were attracted to the ICRISAT standard trap than were caught. Some of these moths flew through the trap past the septa. The slotted baffle was assumed to divert the moths down into the funnel, increasing trap efficiency.

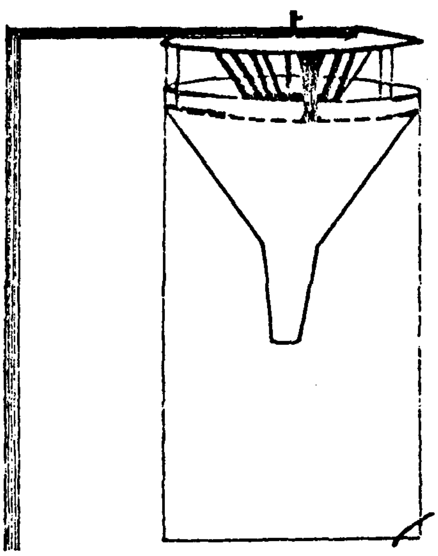

Figure 3. ICRISAT standard trap modified by inserting a perforated small yellow funnel (diameter 15 cm) around the pheromone. This funnel is secured to the aluminium plate after the placement of pheromone source below the plate.

Although this modification has been shown repeatedly to increase catches substantially, it has not been adopted for the standard trap because (a) it increases the cost; (b) makes changing the septa more difficult; and (c) a long term study using standard traps in a large network (covering India, Pakistan, Bangladesh, and Srilanka) had already been initiated and any changes in the trap design would complicate the interpretation of the data.

Subsequently, a wind vane trap and a Texas trap (Hartstack *et al.*, 1979) in which the moths had to move upwards to be caught were tested at ICRISAT. In an unreplicated trial over 12 weeks (16 November–7 February) in 1982–83 these traps were compared with the ICRISAT standard trap (Figure 2) and its baffle modified version (Figure 3). The mean catches per night in the first two traps were 5·0(± 1·42) and 0·3(± 0·08) as against 17·6(± 4·94) and 67·7(± 15·19) in the latter two traps.

Here the traps in which the moths moved downwards to be trapped (Figures 2 and 3) caught far more than the traps in which the moths moved upwards and which had been found highly efficient in the USA. These results indicated that the behaviour of the moths of *H. armigera* may differ from that of *H. zea* and *H. virescens* in responding to the same pheromone trap design.

Trap colours. Heliothis spp. moths have been reported to respond to different colours (Hendricks *et al.*, 1972 and 1975). In a trial from 1 December 1980 to 9 January 1981, four traps were tested unreplicated over 40 nights. The mean catches per night in this trial were 2·9(± 0·50) in white, 1·2(± 0·19) in orange, 0·9(±0·21) in blue, and 0·9(± 0·23) in green funnel traps. In another trial from 15 September 1982 to 18 January 1983, ICRISAT standard traps incorporating funnels of six different colours were compared in two replications over 18 weeks (in a groundnut crop for the first 6 weeks and then in a chickpea crop). The mean catches per night were 5·5 in white, 2·6 in red, 2·5 in yellow, 2·4 in green, 1·9 in black and 1·5 in orange funnel traps, with a standard error of ± 0·49.

In both these trials the traps incorporating white funnels caught significantly more moths than did traps incorporating funnels of other colours. This observation, however, differed from that of Hendrick et al. (1972) for *H. virescens*, who recorded more moths in carton traps painted fluorescent orange, green, and tangerine than cerise or yellow. The funnels of our traps were not painted but they all had original reflective colours.

Trap height. In 1978, virgin female baited sticky traps were tested at five different heights above ground in two replications on bunds between crops over a two-week period (7 November–20 November). The total numbers of male *H. armigera* moths caught were 4 at 0·4 m, 117 at 2·1 m, 15 at 3·8 m, 6 at 5·5 m, and 2 at 7·6 m. However, in 1980 tests of traps in chickpea and pigeonpea crops showed that maximum catches were obtained when the traps were about 1 m above the crop canopy, equivalent to a height above ground of just over 1 m in chickpea and almost 3 m in pigeonpea.

In 1982–83, traps were placed at 1 m, 2 m and 3 m above ground level in sorghum, millet and groundnut (10 August–4 October), and pigeonpea and chickpea (10 November–3 January) crops for 8 weeks, with two replications in each crop. The mean catches of moths obtained in these traps were as given in Table 3.

Table 3. Mean catches of H. armigera *in ICRISAT standard traps fixed at different heights above ground level in ICRISAT mandate crops, ICRISAT Center, 1982–83.*

Crops	Crop height (m)	Moths per trap night in traps at 1 m	2 m	3 m	s. e. m. ±
Sorghum	1·8	0·2	1·0	1·4	0·24
Millet	1·5	0·4	1·7	1·0	0·31
Groundnut	0·3	3·9	1·6	1·0	0·20
Pigeonpea	2·1	0·2	9·8	29·0	1·26
Chickpea	0·3	8·3	7·2	4·6	0·23

It can be seen that the maximum catches in the tall crops (sorghum, millet, and pigeonpea) were in traps at 2–3 m above ground level but in the short crops (groundnut and chickpea) at 1 m above ground level. Thus it was the height of the trap in relation to the crop canopy rather than the height above ground level that influenced the catches.

Use of insecticide in the trap bag

In the ICRISAT standard trap the moths are caught in a transparent polythene bag attached to the funnel. In 1982, the use of insecticides inside the bags was tested to determine whether these would help kill all the trapped moths easily and so make recording quicker and easier, and also whether the insecticide vapour would reduce the numbers of moths entering the traps. In this trial there were six treatments including the control. Four treatments had 1 g active ingredient of different insecticides coated on the inside of the bag and one had a small open vial containing 3 g a.i. of dichlorvos taped to the outer wall of the funnel. There were two replicates conducted in a groundnut crop for 4 weeks (26 March–27 April) in 1982. The mean weekly catches of moths obtained in each treatment were as in Table 4. The insecticides had no significant effect on the catches, but by the end of the 4th week only the traps with dichlorvos in glass vials gave a satisfactory mortality of the moths. The recording and emptying of the traps, where all or most of the moths were dead, was relatively easy.

Conclusion

Collaborative research involving contributions from several scientists at ICRISAT and TDRI has resulted in the development of an effective synthetic pheromone, a dispenser, a trap design and a trapping methodology which combine to give substantial catches of *H. armigera* male moths in the field. Up to 762 moths have been caught in one trap night. It is unlikely that pheromones could be used for economic control of *Heliothis* spp. through mass trapping or by confusion techniques (McLaughlin and Mitchell, 1982). However, records from traps might be of value in monitoring populations of *H. armigera* and for predicting the need for insecticide use. Before pheromone traps can be used, the relationship between the trap catches and other means of measuring of *H. armigera* populations, including counts on crops and light trap catches, must be determined and the factors that influence the pheromone trap catches must be identified and evaluated. Such research is now in progress at ICRISAT.

Acknowledgements

The authors are grateful to the staff of the Pulse Entomology and Cropping Systems Entomology subprograms, ICRISAT, for their help in recording the moths in traps, and to the staff of TDRI, particularly Dr B. F. Nesbitt, for providing the pheromone septa.

References

BHATNAGAR, V. S., LATEEF, S. S., SITHANANTHAM, S., PAWAR, C. S. and REED, W., 1982. Research on *Heliothis* at ICRISAT. pp.385–396. In *Proceedings of the International Workshop on Heliothis* Management, 15–20 November 1981, ICRISAT Center, Patancheru, A. P., India: ICRISAT.

HARTSTACK, A. W., HENDRICKS, D. E., LOPEZ, T. D., STADEBACHER, E. A., PHILLIPS, J. R. and WITZ, J. A., 1979. Adult sampling. pp. 105–131. In *Economic Thresholds and sampling of* Heliothis *species. Southern Cooperative Series Bulletin* **231**, USA.

HENDRICKS, D. E., HOLLINGSWORTH, J. P. and HARTSTACK, A. W. Jr., 1972. Catch of tobacco budworm moths influenced by color of sex-lure traps. *Environmental Entomology*. **1**, 48–51.

HENDRICKS, D. E., LINGREN, P. D. and HOLLINGSWORTH, J. P., 1975. Numbers of bollworms, tobacco budworms, and cotton leafworms caught in traps equipped with fluorescent lamps of five colours. *Journal of Economic Entomology*. **68**(5), 645–49.

MCLAUGHLIN, J. R. and MITCHELL, E. R., 1982. Practical development of pheromones in *Heliothis* Management. pp. 309–318. In *Proceedings of the International Workshop on Heliothis* Management, 15–20 November 1981, ICRISAT Center, Patancheru, A. P., India: ICRISAT.

NESBITT, B. F., BEEVOR, P. S., HALL, D. R. and LESTER, R., 1980. (Z)-9-Hexadecenal: a minor component of the female sex pheromone of *Heliothis armigera* (Hubner) (Lepidoptera, Noctuidae). *Entomologia Experimentalis et Applicata*. **27**, 306–308.

Table 4. Mean weekly catches and mortalities of Heliothis armigera *in pheromone traps treated with insecticides, ICRISAT Center, 1982.*

Week	Control	Insecticides				
		DDT	Endosulfan	Cypermethrin	Dichlorvos	Dichlorvos in vial
I	39·0	46·5	32·5	31·0	37·0	37·0
		(60·4)	(96·9)	(86·0)	(63·4)	(100·0)
II	40·0	40·0	27·0	22·5	48·0	25·5
		(50·7)	(86·5)	(70·0)	(57·8)	(98·0)
III	12·0	31·0	28·0	12·0	18·0	44·0
		(44·1)	(61·4)	(66·7)	(40·1)	(97·0)
IV	15·5	23·5	14·5	24·5	20·0	31·5
		(45·8)	(50·4)	(66·1)	(33·6)	(98·2)
Mean	26·6	35·3	25·5	22·5	30·8	34·5
s. e. m.			± 5·95			

Figures in parentheses are percentage mortalities of the moths corrected for mortalities in the control.

NEUMARK, S., and TEICH, I., 1978. Silicate powders in a new type of an open dry pheromone trap to capture male moths of *Spodoptera littoralis* more efficiently. *Hassadeh*. **58**, 1004–1006 (in Hebrew).

PAWAR, C. S., SITHANANTHAM, S., SHARMA, H. C., TANEJA, S. L., AMIN, P. W., LEUSCHNER, K., and REED, W., 1984. Use and development of insects traps at ICRISAT. pp. 133–151. In *Proceedings of the National Seminar on Use of Traps for Pest/Vector Research and Control*, 10–11 March 1984, BCKV, Kalyani, West Bengal, India.

SPARKS, A. N., RAULSTON, J. R., LINGREN, P. D., CARPENTER, J, E., KLUN, J. A. and MULLINIX, B. G., 1979. Field response of male *Heliothis virescens* to pheromonal stimuli and traps. *Bulletin of the Entomological Society of America*, 268–274.