Hexapoda (*Insecta indica*)

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Pheromone-based trapping technology for insect pest management in vegetable crops: mini review

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ABSTRACT: The vegetable farming communities in India and elsewhere in the tropics are in urgent need to adopt safer alternative pest control technologies so to replace chemical insecticides use so to ensure marketability and better margins from their crop produce. Of course, other bio-intensive methods like release of mass produced insect biocontrol agents like Trichogramma and wider choice among biopesticides-both botanical and microbial-are already locally available and adoptable as eco-safe pest control options. The present mini-review is on recent and ongoing R&D in vegetable insect pest trapping systems, which includes choice of more efficient trap designs and lure dispenser options for moth pheromones and blending of para-pheromone-lures to trap Tephritid fruit flies for pest monitoring and mass trapping purposes.

The adult moths of a wide range of caterpillar pests attacking our vegetable crops as borers and defoliators need to be more efficiently trapped for monitoring or mass trapping impact. Our research has shown the need and scope to select more appropriate trap designs so to maximise the moth catches. Clearly the funnel /sleeve traps are superior for trapping the stout- bodied (Fam:Noctuidae) moths like *Helicoverpa* and *Spodoptera*, whereas the same trap type is very inefficient for the smaller sized (Fam:*Crambidae*) moths like *Leucinodes* (on brinjal). To tackle this constraint, improved Delta traps (design patent approved as Delta Plus) have been developed ,which feature extra access windows on sides ,so to attract more moths and to also minimise male moth escape from the trap vicinity.

The future R&D thrusts may include other smaller moth families as Plutellidae (eg. *Plutella xylostella*) and Nolidae (eg. *Earias vitella*), Such species coverage to also be extended to comparing the two major fruitfly species complexes led by *Bactorcera dorsalis* and *Bactrocera cucurbitae*. Another key R&D focus

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could be pheromone trapping impact maximisation by selection of locally attractive blend ratios and optimizing the pheromone loading in the dispenser which can enhance the cost-effectiveness of the lures in the traps. In case of pheromone blend composition being found variable for any target pest, there is scope to avail blend choice kits for quick local testing and selection, so to ensure adequate moth catches. This mini-review is thus covering both the current status and the future R%D priorities so to promote the adoption of such consumer-safe technologies among our vegetable farmers.

Key words: vegetables, insect traps, pheromone, para-pheromone, sticky trap, light trap

Introduction

Vegetables are good sources of proteins, vitamins minerals and carbohydrates, besides some also possess high medicinal value Vegetable cultivation is an important and alternative source of income, especially in urban and suburban areas. More than 40 different vegetable crops belonging to different groups, namely, solanaceous, cucurbitaceous, leguminous, cruciferous (cole crops) and tuber crops, are grown in India, which is the second largest producer of vegetables next to China. India ranks first in production of okra among vegetables and second in potatoes, onions, cauliflowers, brinjal, cabbages, etc. Insect pest management in vegetable crops is at cross roads today in India since growers are to limit pest control methods which are market-compliant and ensure consumer-safe produce. The tendency for over-dependence on chemical insecticide use is being given up due to the several negative impacts being experienced in ecosystem biodiversity and consumer-safety, besides operators health risks.

While bio-intensive methods like release of mass produced insect biocontrol agents like *Trichogramma* and wide choice being available among *biopesticides*- both botanical and microbial-, the recent focus has been on insect pest trapping systems, which includes deployment of moth pheromones as well para-pheromones for Tephritid fruit flies, besides sticky traps for sucking insects /vectors and also light traps for multi-pest monitoring. More recently the potential for using pheromone-based trapping technology applicable to selected vegetable crop was reviewed by Sithanantham (2017).This mini review is focussed on more recent findings of value in insect pheromone trapping technology and future R&D thrusts needed to promote eco-friendly insect pest management in our vegetable crops.

1. Moth pheromones-based trapping

Most of our vegetable crops are prone to damage by caterpillar pests as borers or defoliators or miners. The list below illustrates the common lepidopteran pests in India for which pheromones are presently commercially available.

Table 1. List of Lepidopterous pests of vegetables amenable to pheromone trapping

Family	Total species	Common name	Scientific name	Target crops
Noctuidae	37	Fruit borer	*Helicoverpa armigera*	Tomato, chlli, okra
		Tobacco caterpillar	*Spodoptera litura*	Tomato, chilli, cabbage
Crambidae	24	Shoot and fruit borer	*Leucinodes orbonalis*	Brinjal
Gelchiidae	15	Tuber borer	*Phthorimaea operculella*	Potato
Nolidae	9	Fruit borer	*Earias vitella*	Okra
Plutellidae	1	Diamond backmoth	*Plutella xylostella*	Crucifer vegetables

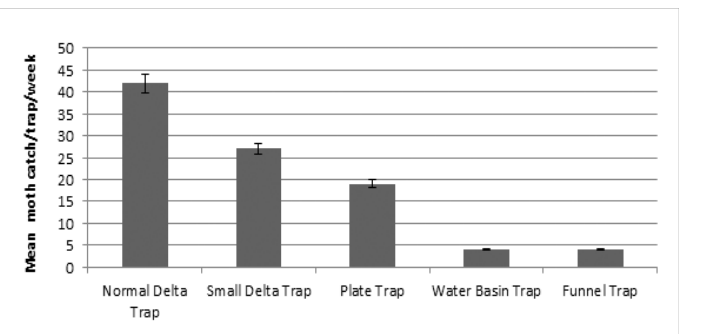
Source: Gauarav and Ramamoorthy.2009.

For brinjal shoot and fruit borer as case study, the use of different sex pheromone traps had been recommended as an eco-friendly tool for monitoring and mass trapping of *L. orbonalis* (Su *et al*., 2004). Early observations in India by Nandagopal *et.al.,* (2010) had shown the patterns in male moth behaviour in response to the lure by night studies, suggestive of male escape tendency and scope for minimising such escape by choice of suitable tap designs was indicated.

Further R&D at Sun Agro Biotech Research Centre, Chennai evaluated the scope for improving the trap design and lure dispensers systems for the pheromone trap catch of *L. Orbonalis* (Preethi *et.al.,* 2014a) while also characterizing the biology attributes among different geographical pest populations (Preethi *et.al.,* 2014b).

Prabakaran *et.al.*, (2017) further confirmed the superiority of delta traps over the other trap types-water basin, plate and funnel-in significantly improving the moth catches. The results from this study to improve trap catches with Delta traps for pheromone trapping of *L. orbonalis* moths is illustrated in Fig.1.

Fig.1. Moth caches of Leucinodes orbonalis in Delta trap versus other trap types in brinjal (Source: Prabakaran *et.al.,* 2017)



It was confirmed that the improved delta trap (patent-filed as Delta-Plus) was superior to water basin trap in terms of both catch efficiency and also in being more user-friendly. The attribute of additional access vents in three different combinations of dimensions and vent numbers, all were associated with significantly more moth catches compared to delta trap without them (Prabakaran *et.al.,*2017). Further, these traps can catch 3-4 times more moths for the same amount of pheromone dispensed in the trap.

The close-up of the Delta trap and the moth catches are illustrated in Plate1-1 and 1-2 below:

Plate.1-1. Delta trap design features

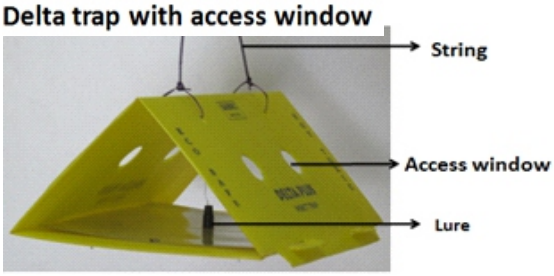


Plate.1-2.Close up of moth catches in the Delta trap sticky arena

2. Fruitfly trapping with para paheromone

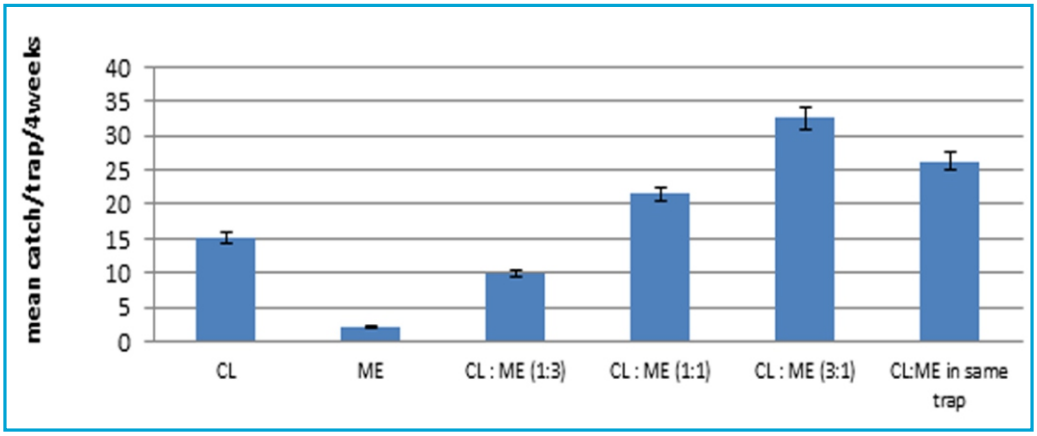
The melon fruit fly, *B.cucurbitae*is known to occur not only in India but also in Myanmar, Malaysia, Thailand, the Philippines, southern China, Taiwan, East Africa, Guam, and the Commonwealth of the Northern Mariana Islands, Papua New Guinea, Solomon Islands and the Hawaiian Islands. In India, the commonly grown cucurbitaceous vegetables like bitter gourd, snake gourd, ribbed gourd, ash gourd, pumpkin, cucumber, gherkin, squash, watermelon and musk melon are all prone to damage by Tephritid fruit flies and the loss in marketable yield of cucurbit vegetables due to cucurbit fruit flies (mainly *Bactrocera cucurbitae* complex) is estimated to range between 30 to 100% (Dhillon*et al.,* 2005).

World over, the para-pheromone- cue-lure (CL) is being recommended for trapping the melon fly, *Bactrocera. cucurbitae*, whereas methyl eugenol (ME) has been used for detection of the oriental fruit fly, *B dorsalis* (.n Hawaii, the option of deploying both ME and CL in the same trap so to minimize time spent in inspecting traps for large area monitoring has been explored by Shelly *et al.,* 2004. Such mixture of methyl eugenol and cue-lure attractant traps have been found promising for monitoring and mass trapping of *B. dorsalis* and *B. cucurbitae* males in bitter gourd (Vargas *et al.*, 2010). There is no universal trap type suited for fruit flies.

Based on our R&D it was possible to enhance the trap catches of *B. cucurbitae* significantly in trap systems by blending CL and ME in selected ratios (Amsa *et.al.,* 2015)**.** More recent studies have shown that the different blend ratios of CL with ME could differentially attract not only the melon fly in greater numbers but also attract the oriental fruit fly-*B. dorsalis* which is also known to infest several cucurbitaceous and solanaceous vegetables. In the CL: ME blend ratio of 1:3, the combined catch of adults of both *B. cucurbitae* and *B. dorsalis* was nearly 100percent more compared to the total catches with CL alone (Amsa and Sithanantham, 2017).

These promising results are illustrated in Fig.2.

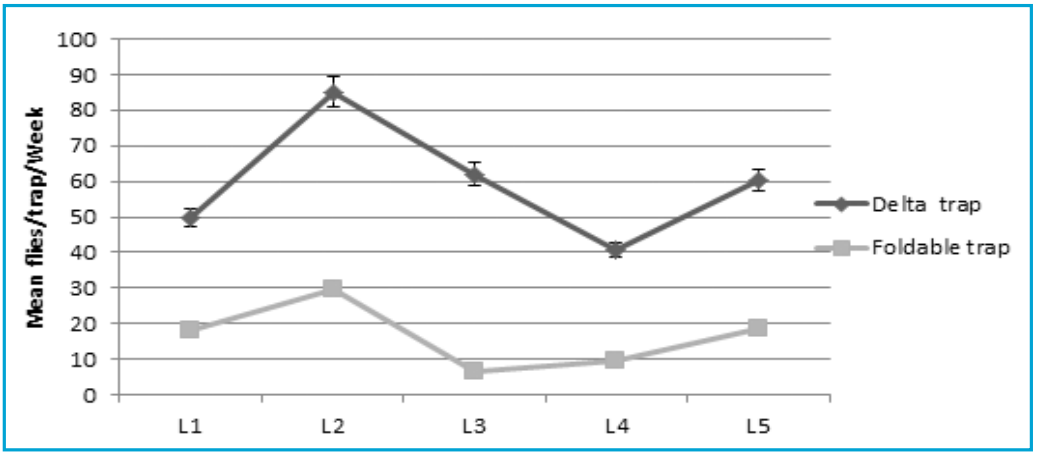
Fig.2. Effect of blending Cue-lure with methyl eugenal on the catch of melon fruit flies



Thus it is now shown possible to adopt flexible blend ratio regimes for CL and ME, both for cost-effectively trapping the melon fruit flies and also freely trapping the oriental fruit fly which can occur as mixed infestation among cucurbit and solanaceous vegetables in and around the cucurbit farms.

We have demonstrated the superiority of Delta trap over the locally used foldable (single-season type) funnel traps for melon fruitfly in export gherkin crop, as shown in Fig.3.

Fig 3: Overall weekly melon fruit flies trapped in Gherkin- Delta Vs Foldable trap

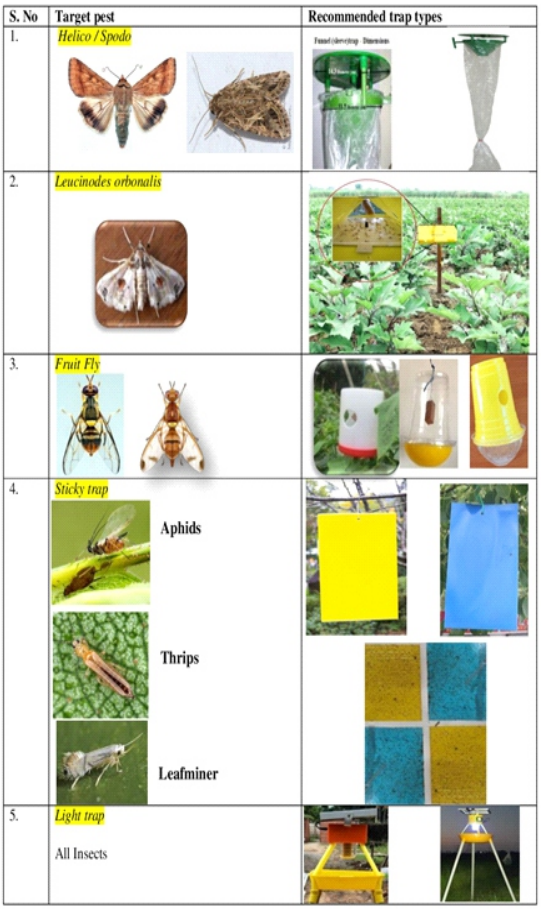


In addition to our R&D efforts mentioned above, several workers have similarly contributed to these theme areas which are available in many Indian journals concerned. Our R&D team has recently also undertaken comparison for melon fly catches in standard plastic white jar traps versus a cheaper transparent inverted or yellow inverted tumbler model in export gherkin crop.

3. Traps use for monitoring versus mass trapping

The other upcoming theme is to shift the use of olfaction-based trapping system from monitoring to mass trapping. The utility of monitoring traps as tool to guide in detecting peaks and in control action decision/timing is often inadequate since related guidelines on thresholds tend to vary with trap efficiency. The potential benefit of simply placing more (10-20 times) traps (referred to as mas mass trapping) approach offers more promising and cost-effective control option that can more directly reducing/avoiding the need for chemical pesticide use by effectively suppressing the pest build up in most of our seasonal vegetable crops . In Gujarat, sex pheromone based IPM technology involving mass trapping through using plastic funnel baited with pheromone @ 100 traps/ha has been recommended for vegetable crops. Mass trapping with pheromone and light traps from 7 days before transplanting to trap Tuta moths on tomato in the green house is also recommended.

Plate. 2. Insect Pheromone Trap



Conclusion

Insect traps are currently available for monitoring and/or mass trapping most of the major insect pests on vegetable crops in India. These can be cost-effectively deployed so to rationalise/replace chemical insecticide use, so promoting the production and marketing of consumer-safe produce. Pheromone trap designs for different moth pests can be chosen for their appropriateness to the target species and also to minimise moth escape, while blending of the para-pheromone lures for vegetable fruit flies offers another promising tool. Traps are emerging as an important IPM component for market-focus cultivation of our diverse vegetable crops in India.

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