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Studies on Use of TNAU- UV Light Trap for Management of Phosphine Resistance in *Lasioderma serricorne* (F.) (Coleoptera:Anobiidae) in Turmeric Warehouses

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***Lasioderma serricorne* (F.) commonly called cigarette beetle is a cosmopolitan, polyphagous and major insect pest of stored turmeric that is known to be resistant to the phosphine fumigation. Practical studies were carried out to assess the efficacy of TNAU UV-Light Trap in mass trapping of *L. serricorne* during the pre and post fumigation periods and its role in phosphine resistance management in *L. serricorne* in turmeric warehouses. Adult beetles collected from UV light traps before and after fumigation were tested through bioassay on the basis of the response of adults to discriminating concentration of 0.07mg L^{-1} for 24 h exposure period using modified FAO method (FAO, 1975). The results of the present study showed that, the mean number of adults caught per trap/day before and after fumigation ranged from 52.7 to 83.5 and 9.6 to 18.2 beetles per light trap, respectively. The bioassay results showed that, the phosphine resistance level in *L. serricorne* collected from UV- Light traps ten days before and after fumigation ranged from 52.85 to 65.37 and 68.24 to 76.53 per cent, respectively. Further, the beetles caught in large numbers in light traps during the post fumigation period were found to be more resistant to phosphine than the pre fumigation population. Hence, UV- Light trap can be used as one of the resistance management strategy for phosphine resistance in *L. serricorne* in turmeric warehouses since mass trapping of *L. serricorne* was recorded in TNAU- UV Light trap during pre and post fumigation periods.**

Key words: TNAU UV- Light trap, *Lasioderma serricorne*, Fumigation, Phosphine resistance, Turmeric warehouses.

Light traps have been widely used to attract stored product insects. Stermer (1959 and 1966) showed that majority of stored produce insects were attracted to light of wavelength between 280 and 600nm. *L. serricorne* are often found near the windows of food factories and storehouses, indicating positive phototaxis and several studies have shown positive phototaxis towards ultraviolet (UV) light (Kirkpatrick *et al.* 1970; Soderstrom 1970). TNAU UV- Light trap has been recommended for management of *Tribolium castaneum* (Herbst) and *Rhizopertha dominica* (Fabricius) in grain storage warehouses (Mohan *et al.,* 1994). They also suggested that a 4W UV light (peak emission 250 nm) trap set at 1.5 m above ground level in the alleyways and corners of rice warehouse will show maximum attraction of *R. dominica.* Katsuki *et al.* (2013) showed that UV and blue LEDs effectively trapped both sexes of *L. serricorne* irrespective of mating condition. They also recorded that UV LED was consistently most attractive than other wavelengths.

Lasioderma serricorne (F.), cigarette beetle or tropical warehouse beetle is a serious insect pest of post harvest agricultural products worldwide (Arbogast 1991). It utilizes dried plant materials, several grains, spices, and postharvest stored food products for its larval development. Adults have short life, during which time they mate, locate suitable larval food, lay eggs and then die. The larvae cause damage to products by consuming and degrade the quality of the product to the point of economic loss. Insect pests are one of the major constraints for quality deterioration of stored turmeric. *L. serricorne* attacks dried turmeric rhizomes in storage causing huge losses to the extent of 39.8 per cent (Kavadia *et al.,* 1978). Female cigarette beetles attracted by the odour of stored products (Kohno *et al.,* 1983) oviposit in these products. Hatched larvae feed on stored products and cause damage to them (Howe, 1957). Larva bores extensively through dry turmeric rhizomes, deteriorates rhizome quality and reduces the nutritional and medicinal value of stored turmeric. Srinath and Prasad (1975) found that out of 115 market samples of stored turmeric collected across India, 88 were infested with the cigarette beetle.

Fumigation with phosphine gas is the most widely followed management strategy against *L. serricorne* in turmeric storage. However, continuous and indiscriminate use of phosphine, improper fumigation resulted in the development of resistance to this fumigant in *L. serricorne*. Resistance to phosphine poses threat to effective control of this pest. Recently, phosphine resistance in cigarette beetle has been confirmed in all parts of the world (Rajendran and Narasimhan, 1994; Zettler and Keever, 1994; Hori

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and Kasaishi, 2005; Savvidou *et al.,* 2003 and Saglam *et al.,* 2015).

Trapping methods are more sensitive than grain samples and infestation can be often detected much earlier with traps than with spear sampling or sieving (Reed *et al.,* 2001). Since adults of *L. serricorne* are short lived and emerging females actively search for suitable site for oviposition, trapping of the resistant beetles emerging after fumigation by using UV light trap may help in effective management of phosphine resistance. Hence, the present study was carried out to assess the role of TNAU UV- Light trap in phosphine resistance management in *L. serricorne* in turmeric warehouses.

Materials and Methods

The TNAU- UV light trap is a multidirectional trap with four baffles mainly consisting of an ultra-violet source (4W germicidal lamp). The UV lamp of 20 cm long produces ultra-violet rays of peak emission around 250 nanometer. The light is fitted vertically at the centre of the baffles raised over a steel funnel of 310 mm diameter at the top and 35 mm diameter at the bottom. The bottom end of the funnel is attached with a transparent plastic container for collecting the trapped insects. To hang the unit at desired points, a hook is provided at the top of the trap. The unit is also provided with a tripod stand (Mohan *et al.,* 1994).

Studies were conducted in turmeric storage warehouses (60 x 20 x 5m) of M/s. Ulavan Producers Company, Erode, Tamil Nadu, India using TNAU- UV Light Trap to test its role in resistance management in *L. serricorne*. Three UV light traps were installed at 1.5m above ground level in turmeric warehouse, two traps near the corners (Trap 1 and 3) and one (Trap 2) at the centre of the warehouse. The traps were operated during night (18:00 to 06:00 hrs). Observations were recorded on the number of beetles trapped per trap on daily basis continuously for ten days before and after fumigation. The experiment was conducted for a period of three months during July- September, 2015. The trapped insects were identified by visual observation using microscope and confirmed as *L. serricorne* based on antennal characteristics (Howe, 1957). Cover fumigation of stacks with aluminium phosphide (Celphos®) tablets (3g) at three tablets/ tonne with 7 days exposure period was done when there was a steady increase in the light trap catch and when beetle activity was noticed on the bags.

Further, the adults collected from UV light trap were brought to Postgraduate Laboratory, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore for mass culturing. Mass culturing was done in 2.0 kg plastic container along with 500 gm of wheat flour + 5% Yeast and kept for oviposition at room temperature of 30^{0}C and 60% relative humidity to obtain sufficient number of insects for resistance bioassay. The new batch of (next generation) adults emerged from the culture with uniform age were used for the phosphine resistance bioassay. Phosphine gas was generated in a gas generation chamber and volume of dessicator was measured by following the procedure as described by Sonai Rajan *et al.,* (2015). The correct phosphine gas volume for injection was determined based on weight by volume basis, which was previously described by FAO Method No. 16 (FAO, 1975).

$$d_1\,(\mu l) = \frac{298 \times x_1\,(mg/l) \times v_1\,(l) \times 22.414 \times 1000 \times 1000 \times 100}{273 \times 1000 \times 33.9977 (\text{GMW of phosphine}) \times 86}$$

Where, d_1 (µl) = Volume of phosphine gas required for injection; x_1 (mg/l) = Required dose of phosphine in desiccator; v_1 (l) = Volume of the desiccator; GMW= Gram Molecular Weight

The level of phosphine resistance was determined for the progeny of trapped insects using a modified FAO method (FAO, 1975). Adult insects of *L. serricorne* were fumigated with a discriminating concentration of phosphine gas 0.07 mg L^{-1}over 24 h exposure. The bioassay was performed at room temperature of 30^{0}C and 60% relative humidity. Each resistance bioassay test was replicated thrice along with control for each population and fifty adult insects were released per replication. After exposure, the insects were provided with small quantity of culture medium for a week and moved to recovery room. Adult mortality was determined after seven days from the end of the exposure period. The observation on number of insects responding *i.e.* insects showing any movements were considered to be alive and others as dead. Mortality response data were calculated using Abbots formula (Abbot, 1925), to eliminate the influence of mortality, which was not greater than 10% in these experiments. The resistance percentage was worked out by the formula, Resistance percentage (R) = (100-CM) ± SE, where, CM = Corrected Mortality; SE = Standard Error. Pooled binomial standard error was calculated by using the formula, SE = Stdev / $\sqrt{n}$. The data obtained were analysed statistically by MS-Excell.

Results and Discussion

The results showed that the mean number of beetles caught per light trap per day during the pre and post fumigation period ranges from 52.7 to 83.5 and 9.6 to 18.2 beetles per trap, respectively. During the post fumigation period, even though the pest population was low, the mean number of beetles caught per trap ranged from 9.6 to 18.2 (Table 1). This shows that light traps are more efficient in mass trapping of *L. serricorne* during post fumigation period in turmeric warehouses. The mean number of beetles caught in the light traps set at warehouse corners was relatively higher than light trap fixed in the centre of the warehouse. The emission of UV rays from the light, coupled with good reflection of light by the white walls near corners, might have resulted in a higher catch compared to warehouse centre. The results of the present study are in accordance with Mohan *et al.* (1994) who found that TNAU- UV Light trap was effective in mass trapping of *R. dominica* during post fumigation periods in rice warehouses. Katsuki *et al.* (2013) showed that UV and blue LEDs effectively trapped both sexes of *L. serricorne* irrespective of mating condition. They also revealed that UV wavelength was consistently most attractive than other wavelengths. Stermer (1959, 1966) showed that majority of stored produce insects were attracted to light of wavelength between 280 and 600nm.

Table 1. Mean number of adult *L. serricorne* caught in UV- Light traps before and after fumigation with phosphine in turmeric warehouse at Erode.

Light Trap no.	Mean number of insects per light trap/day (Mean of 20 observations ± SE)	
	Before fumigation	After fumigation
Trap 1	74.6 ± 0.71	18.2 ± 0.95
Trap 2	52.7 ± 1.05	9.6 ± 1.33
Trap 3	83.5 ± 0.60	16.8 ± 1.54
Mean	70.27 ± 0.79	14.87 ± 1.27

The phosphine bioassay results showed that the populations collected from UV-light traps at 10 days before and after fumigation had marked difference in the frequency of phosphine resistance. The resistance percentage of pre-fumigated population ranged from 52.85 to 65.37 per cent, while that of post fumigation population ranged from 68.24 to 76.53 per cent (Table 2). The high frequency of phosphine resistance in the post fumigation population may be due to less number of susceptible individuals compared to pre fumigation population.

Table 2. Phosphine resistance level in *L. serricorne* collected from UV light traps before and after fumigation with phosphine in turmeric warehouse at Erode.

Light Trap no.	Per cent resistance (Mean ± SE)	
	Before fumigation	After fumigation
Trap 1	54.12 ± 1.15	68.24 ± 1.76
Trap 2	65.37 ± 0.58	72.36 ± 0.53
Trap 3	52.85 ± 1.07	76.53 ± 0.88

These resistant individuals (survivors of fumigation), when left uncontrolled, will multiply in large numbers and increase the resistance frequency in the subsequent generations. Phosphine resistance can be effectively managed by mass trapping of resistant *L. serricorne* during the post fumigation periods. Mass trapping of resistant adult *L. serricorne* during the post fumigation period can be done using TNAU UV Light trap as the post fumigation light trap catch ranged from 9.6 to 18.2 beetles / trap/ day. The present results revealed that UV light traps are more efficient in trapping the Phosphine resistant *L. serricorne* populations during the post fumigation period in turmeric warehouses.

Conclusion

TNAU UV-light traps were found to be more efficient in mass trapping of *L. serricorne* both in pre and post fumigation periods. The mean number of beetles caught per light trap per day during the pre and post fumigation period ranges from 52.7 to 83.5 and 9.6 to 18.2 per trap, respectively. Further, the frequency of phosphine resistance was higher in *L. serricorne* populations collected from UV light trap after fumigation than those collected before fumigation. Hence, TNAU UV- light trap can be recommended as one of the phosphine resistance management strategy for *L. serricorne* in turmeric warehouses, especially during the post fumigation period.

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