Young Scientists' Circle

# Semiochemical approach to control Brinjal Fruit and Shoot Borer-*Leucinodes orbonalis* Guenee : A novel approach to global insect pest management

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Modern day, there are so many challenges for the farmers in agriculture including both biotic and abiotic stressors such as climate change, diseases and pest control. Brinjal plant (*Solanum melongena*) is an economically important plant grown in Asian countries. It contains various bioactive secondary metabolites which provide significant health benefits for the consumers.[1] In recent years, production of brinjal is under imminent threat due to the increased management cost of insect pest *Leucinodes orbonalis* Guenee- Brinjal Fruit and Shoot Borer (BFSB), which is considered to be the key insect pest that attacks brinjal plant. At present, farmers are completely dependent on chemical insecticides to control this pest and attempt to produce damage-free marketable brinjals.[2] Insects such as BFSB, which has extremely diverse adaptations such as hidden and protected lifestyles in adult stage and concealed habits in the larval stage cannot be easily controlled with cover sprays of insecticides. Indiscriminate use of synthetic chemicals causes many unwarranted problems.[3] Therefore, there is an urgent need to develop an environmentally friendly method that can be used to control the BFSB in brinjal plant. Crop protection through semiochemical approach has gained wide popularity in the present-day demand for safe, pesticide-free products. Semiochemicals are considered as safe and eco-friendly molecules due to their natural origin and low persistency in the environment. Contrary to chemical insecticides, insects find it difficult to develop resistance against volatile semiochemicals as semiochemicals work by a non-toxic mode of action through modifying the insect pest's behavior.[4] Semiochemicals are defined as chemicals that are emitted by living organisms which could induce a behavioral or physiological response in other individuals. Semiochemical communication is divided into two broader classes: (a) pheromones mediated intraspecific communication which occurs between individuals of the same species (b) allelochemicals mediated interspecific communication which occurs among individuals of different species.[5]

Previous studies reported that female BFSB produced sex pheromone-baited traps attracted the male insects of BFSB in the field and achieved significant reduction in the pest population.[6] There is evidence suggesting that ecological interaction, especially odours between insect pest and their host will aid in the development of most effective insect pest control strategies.[7] Plants synthesize and emit a wide range of volatile organic compounds which act as chemical signals and produce a wide range of behavioral responses in insects. Some studies reported that the behaviour of the larvae or adult or both stages of the insects can be influenced by plant volatiles.[8] Further, a large number of attractive volatile organic compounds released by plants can pose a challenge for herbivore insects to navigate towards their host plants. Therefore, the relationship between the insect pests and volatile semiochemicals of the host plants have been studied well and recognized as an important communication system within insect species, which can modify the insects' behavior.[9] In some plants, these volatile organic compounds are the key compounds that are involved in the attraction of insect pests. In addition, the synergism between insect pheromones and plant volatiles can increase the attraction of insect pest, offering new strategies for the development of more effective and reliable pest control programs. Volatile mediated foraging behavior is important in insect pests when they target host plants. In my research, we combined both sex pheromone from the insect pest and the volatiles from the host plant to synergize the *L. orbonalis*' attraction to the sex pheromone. No research has described the *L. orbonalis*' response to host plant volatiles. Our goal was to improve a trap catch of the adult *L. orbonalis* by using host plant volatiles with the combination of pheromone as a new formulation.

Initially, samples of brinjal plant ("Lena iri" variety) leaves, shoots, fruits and flowers were collected separately from an unsprayed brinjal field at Agriculture Research Station, Kandakuliya, Kalpitiya. Insects were rare at the laboratory using infested brinjal fruits collected from the market. Host plant volatiles from the different parts of brinjal plant were collected using steam distillation method and insects' volatiles were captured on Super Q. We evaluated the effects of host plant volatiles obtained from different parts of brinjal plant on the behavioral responses of adult *L. orbonalis* males, virgin females and gravid females separately in the absence of visual cues or pheromone signals using two-choice and multiple-choice bioassay methods. Further, we identified the male *L. orbonalis* attraction to the female produced sex pheromone blend. Subsequently, we evaluated the synergism between the host plant volatiles and the sex pheromone in the attraction of *L. orbonalis* males in laboratory level. Furthermore, we analyzed the volatile chemical constituents present in different parts of the host plant brinjal as well as in the sex pheromone extracted from the virgin females using GC-FID and GC-MS. Finally, we conducted a green-house assay to show the synergism between the host plant volatiles and sex pheromone in the attraction of *L. orbonalis*. The simple water bottle trap was used to catch the insects in our greenhouse experiments. Sex pheromone was used alone and in combination with host plant volatiles for possible enhancement of attraction.

The present bioassay guided study conducted in a short-range Y-shaped olfactometer revealed that adult male and female insects were attracted to the volatiles of brinjal fruits, leaves and shoots but not for the volatiles from flowers. *L. orbonalis* feed primarily and oviposit solely on shoots and leaves. Therefore, it is possible that the attractive compounds present in the leaf and shoot are absent from flowers, alternatively, the amount of volatiles being released from the flowers may have been below the behavioral threshold for response. Gravid female insects are highly attracted to the host plant volatiles than virgin female and male insects. The multiple-choice bioassay revealed that all three types of adult insects are highly attracted to the volatiles from fruits. This study reports for the first time the entire volatile profile of different parts of the brinjal plant. GC-MS analysis of plant volatiles showed that the volatile compounds belonging to different classes of organic compounds: hydrocarbons, green leaf volatiles (aldehydes, esters), alcohols, fatty acids and other volatiles. Chemical investigation of the pheromone emitted by adult females revealed the presence of (E)-11-hexadecenyl acetate as major compound while tracer amounts of (E)-11-hexadecen-1-ol; which attracted the adult male insects. Further, two-choice olfactometer experiments showed that all three types of volatiles from the host plant increased the attraction of male insects to the sex pheromone blend. In addition, the volatiles from brinjal fruits significantly increased the male attraction to the pheromone blend. Preliminary green-house experiments using host plant volatiles and sex pheromone blends as lure incorporated in a water bottle trap identified that the host plant volatiles individually not effective as field attractants while the combination of pheromone showed high activity in the greenhouse experiments. Combination of sex pheromone and host plant fruit volatile blend successfully lured male insects as well as female insects to this trap. This could be explained in terms of synergetic action of the above attractants. This study revealed that the chemical investigation of female produced sex pheromones of *L. orbonalis* and entire volatile chemical profile of various parts from the host plant brinjal.

The present study has led to identify an ecologically friendly control system for the brinjal fruit and shoot borer; *L. orbonalis*. Although this is a preliminary study, our result supports the idea that the interaction between host plant volatiles and insect pest should receive more attention. Results of this study will be helpful in designing research studies to develop integrated pest management due to the impact of these host plant volatiles on insect pests. Additionally, further studies need to be conducted to elucidate the synergism between insect pheromones and host plant odours in natural field conditions to increase the attraction of insect pest and it would offer new strategies for biological control of this insect pest. New research in this area will shed light on this and other issues relevant to the development of eco-friendly trapping systems for the monitoring and management of *L. orbonalis*.

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# Unraveling the bioactivity of peptide-based nano systems in tumourgenesis

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Antimicrobial peptides (AMPs) are known as natural antibiotics produced by animals, plants, and bacteria. Even though AMPs have been identified as the most promising alternative to conventional molecules used against infections, some of them may have other activities such as defense mechanisms, or even regenerative. Moreover, the reported studies show the broad spectrum of cytotoxic activity against various types of cancer cells by these peptides. When considering the cell targets, some peptides active against microbial and cancer cells while not being active against healthy mammalian cells, such as magainins.[1] Some are active against all three types of cells including microbial, normal, and cancerous such as human neutrophil defensins HNP-1.[2] Although ACPs are expected to be selective toward tumor cells without impairing the normal cells, the development of a selective ACP has been regarded as a therapeutic strategy to explore.

From a structural point of view, the peptide with anti-cancer activities (ACPs) contain 5–50 amino acid chains and are generally composed of α-helices, β-sheets, or both.[3] Concerning the ACPs anticancer effects, it may generally occur by membranolytic mechanisms.[4] The anticancer activity is dependent on the peptide amphipathicity, hydrophobicity, as well as on the target membrane features such as protein receptors,[5] which in turn modulate the peptides' selectivity and toxicity.

However, the use of peptides as therapeutics has been limited by low bioavailability, poor stability to