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Oviposition behaviour of tobacco caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) on different host plants

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Abstract
Spodoptera litura Fabricius (Lepidoptera: Noctuidae), is a polyphagous destructive pest of subtropical and tropical agriculture. It is commonly known as Indian leafworm, or tobacco caterpillar, tobacco cutworm, and tobacco armyworm Oviposition preferences of tobacco caterpillar *Spodoptera litura* were evaluated on four host plants groundnut, (*Arachis hypogaea* L.), brown mustard (*Brassica juncea* L.), sunflower (*Helianthus annuus* L.) and maize (*Zea mays* L.) in no-choice and two choice tests under laboratory conditions. In no-choice test sunflower significantly elicited a positive oviposition preference, while mustard, groundnut and maize significantly deterred tobacco caterpillar oviposition. In choice tests a notable interaction among plants produced considerable shift in the oviposition preference. Tobacco caterpillar females preferred mustard and ground nut in the presence of less attractive maize. Information of hierarchies of host plant oviposition preference by tobacco caterpillar females will be useful in developing strategies for the management of this pest.

Keywords: *Spodoptera litura*, host plants, oviposition.

1. Introduction
The tobacco caterpillar *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) is a polyphagous devastating pest of numerous wild and cultivated plants throughout the world. It has been reported to attack more than 150 species of agricultural crops distributed in 44 families worldwide [10]. Important crops attacked by this insect include cotton, groundnut, tobacco, maize, mung bean, potatoes, soybean, rice, sunflower, tomato etc. In India it has been reported to attack over 60 cultivated plant species [6], and production losses of about 26-100% in groundnut and tobacco production [4, 1, 5]. Management of this insect has been largely based on insecticides, but the development of resistance to most insecticides and associated environmental problem has necessitated searching for some alternative method for its control with minimum negative environmental impacts [2, 10].
Development of effective alternative strategies requires a thorough understanding about the biological relationships of pest with various host plants. A very important aspect of such relationship is that of host preference for oviposition but the knowledge on this with respect to *S. litura* is limited. The objectives of our study to evaluate oviposition preference of tobacco caterpillar *S. litura* on selected economically important crop plants, i.e. groundnut, *Arachis hypogaea* L. (family: Leguminosae), brown mustard *Brassica juncea* L. (family: Brassicaceae), sunflower *Helianthus annuus* L. (family: Asteraceae) and maize *Zea mays* L. (family: Poaceae) grown in India. Our study will provide information, which may prove to be valuable in developing strategies for the management of this pest.

2. Materials and Methods
2.1. Test plants
The germplasm of groundnut, *Arachis hypogaea* L. (99004) was obtained from gene bank of ICRISAT (A. P.), India and seeds of Sunflower, *Helianthus annuus* L. (MODERN), Brown mustard, *Brassica juncea* L. (PUSA JAI KISAN), and maize, *Zea mays* L. (GSF2) were procured from National Seed Corporation (NSC), PUSA, New Delhi, Government of India. These seeds were grown in separate field plots of Zoology Department, University of Delhi, Delhi, under standard farm practices in pesticide free condition. Freshly excised plant leaves of required plant varieties were used for oviposition experiments.

2.2. Insects

S. litura adults were obtained from the colony maintained at the insect behaviour laboratory, University of Delhi. They had been reared on castor leaves at temperature of 27 ± 2 ºC and 65 ± 5%, relative humidity with 14:10 light/dark cycle.

2.3. Oviposition bioassay: Freshly excised twigs containing leaves were taken from the plant grown in the field plots of Department of Zoology. Surface area of desired leaves of different plant varieties were kept approximately same every time**.** The stem of twig was dipped in water, kept in reagent bottle (125 ml) so as to stop wilting of plant parts. The mouth of reagent bottle was plugged tightly with cotton, which in turn was wrapped with aluminum foil. In case of single-choice test, the ovipositional response of females for the leaves was evaluated in the laboratory by replacing the leaf twig of desired plant in the centre of oviposition cage (20 x 20 x 20cm). In two-choice bioassay, leaf twigs of desired plants were placed near the round window at opposite end walls inside the oviposition cage (45 x 20 x 20 cm).

Five pairs of moths (5 female and 5 male), brought together in the mating cage previous night, were released at 19.00 h in the oviposition cage. Following morning moths were removed from the cage and number of eggs lay on leaves, and elsewhere in the oviposition cage was counted. Each female was used only once, and each test was replicated 5 times, having five pairs of insects. The ovipositional preference of *S. litura* for leaves of various test plants was compared on the basis of (i) proportion of total number of eggs laid on the plant surface that was calculated as: [No. of eggs laid on the leaf/Total no. of eggs laid] x 100 (ii) relative suitability of leaves of different test plants that was calculated on the basis of ovipositional preference index (OPI) [7] [(number of eggs laid on side (A)) – (number of eggs laid on side (B))]/ [(number of eggs laid on side (A)) + (number of eggs laid on side (B))] x 100.

2.4. Statistical analysis

All statistical analysis was based on either actual number of eggs laid by the females or as mean percentage of eggs laid. The data under single and two choice conditions were analyzed by paired t-test. The ovipositional preference index value in both single and two choice conditions were checked for normality and homogeneity of variance and subjected to one-way analysis of variance (ANOVA) followed by Tukey's test. All the statistical analyses were carried out using computer statistical program [9].

3. Results and Discussion

In the laboratory test using excised leaves *S. litura* females laid significantly higher number of eggs on sunflower and lower on maize leaves. Mean ovipositional response of females on leaves have followed the hierarchy of Sunflower> Mustard> Groundnut> Maize ($F=59.1$; $df=3,16$; $p<0.001$) (Fig.1). Positive oviposition preference index value to sunflower leaves indicated that the sunflower significantly attracted the tobacco armyworm females for egg laying. Significantly negative oviposition preference index values suggested that tobacco caterpillar females were deterred form laying eggs on maize, groundnut and mustard leaves in no-choice laboratory conditions ($F= 285.22$; $df = 3,16$; $p<0.001$) (Fig.2).

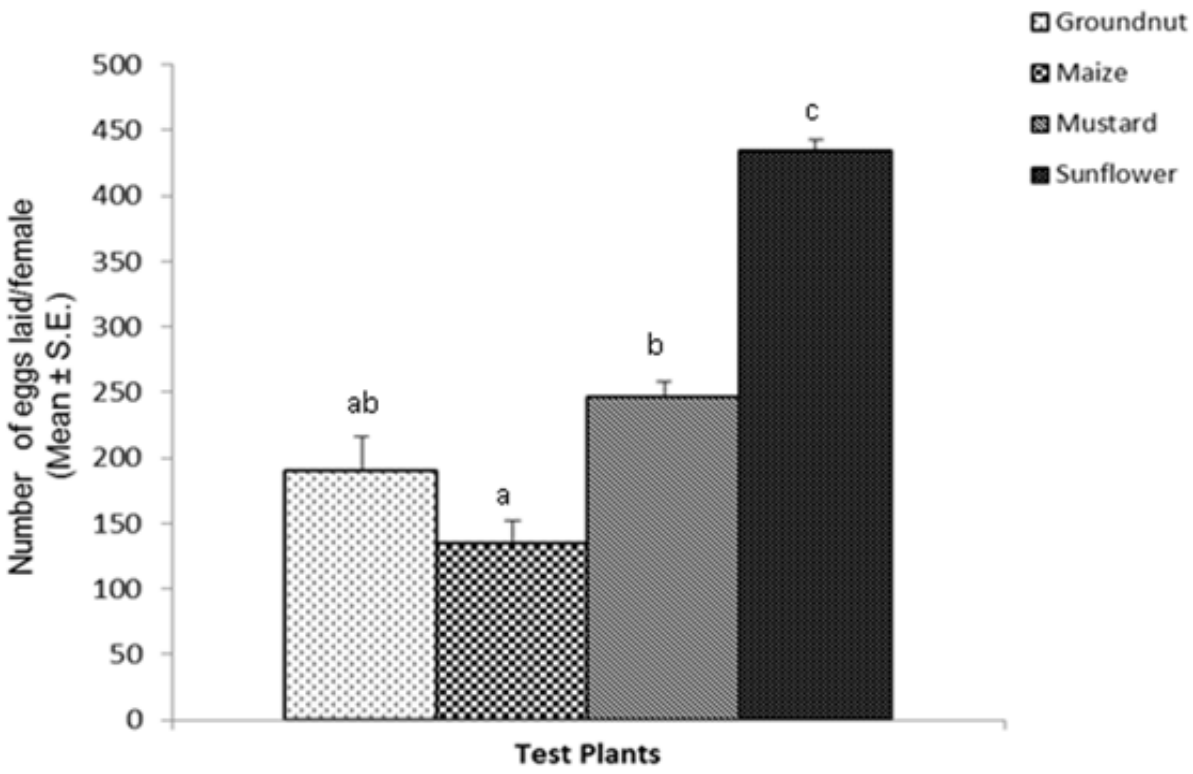

Fig 1: Ovipositional response of *S. litura* females towards leaves of different test plants in no-choice condition (Bars having different letters indicate significant difference in response)**.**

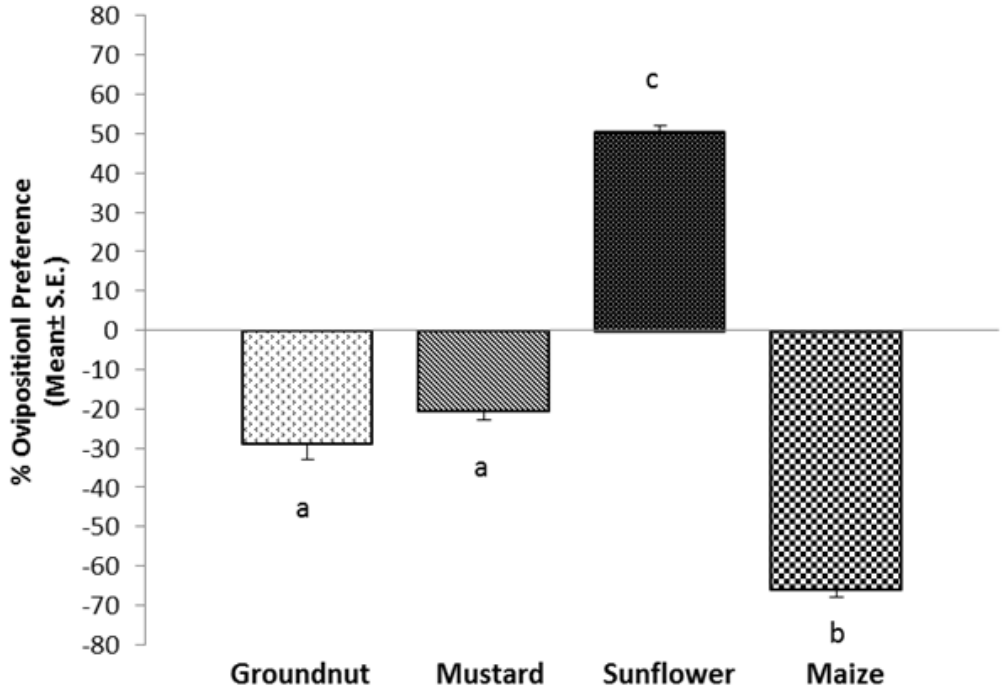

Fig 2: Oviposition preference index of *S. litura* females towards leaves of different test plants in no-choice condition (Bars having different letters indicate significant difference in response)**.**

The oviposition response of *S. litura* females to host plant leaves in two-choice test was consistent with no-choice test (Fig. 3). Females laid more number of eggs on sunflower compared to mustard, maize and groundnut. The average number of eggs laid by females on mustard plants was significantly higher than on groundnut and maize. Oviposition on groundnut was higher as compared to those for maize plant ($p<0.01$)**.**

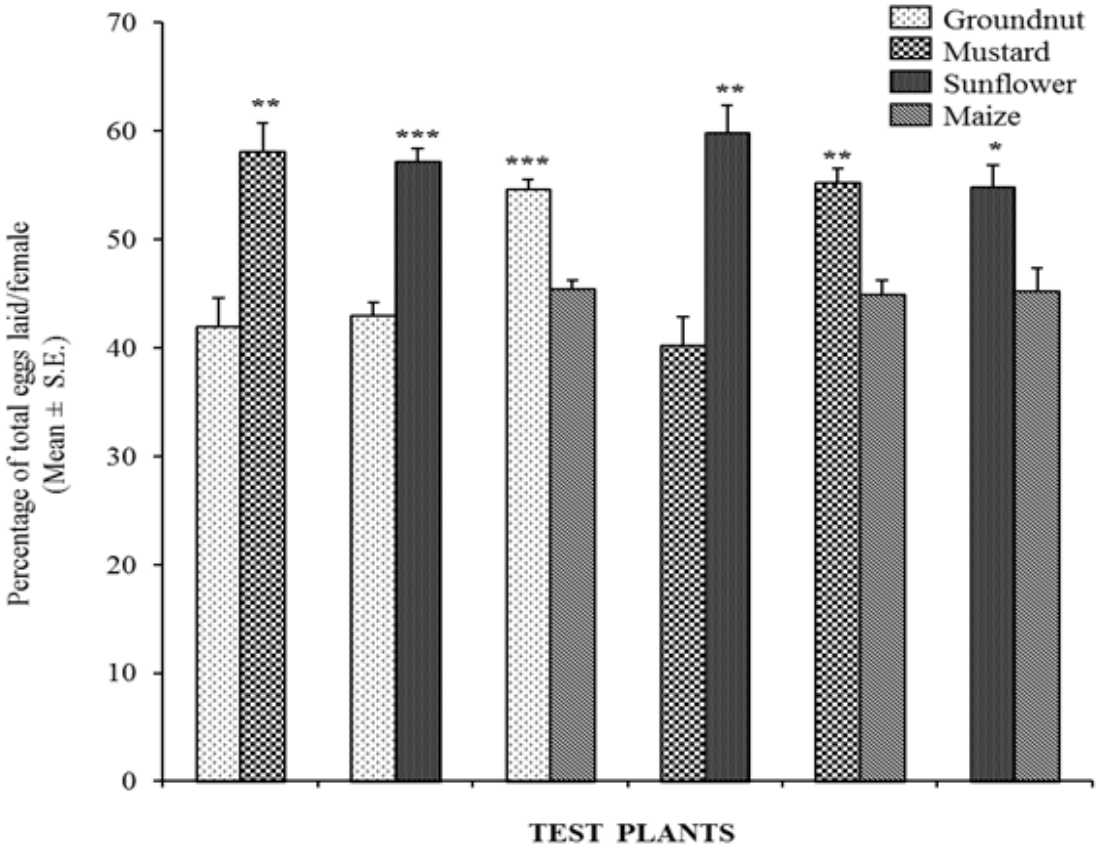

Fig 3: Ovipositional response of *S. litura* females towards leaves of different test plants in two-choice condition. (Asterisks above the bars indicate significant difference between response of moths for stimulus and elsewhere at * $p<0.05$, ** $p<0.01$, *** $p<0.001$)

The positive oviposition index value reveals that the sunflower significantly stimulated the oviposition**.** An oviposition preference index value for mustard was positive when paired with groundnut and maize, but was significantly negative when paired with sunflower. In contrast, oviposition preference index values for maize were significantly negative in all combinations (F= 5.97; df = 5,24; p<0.001) (Fig.4).

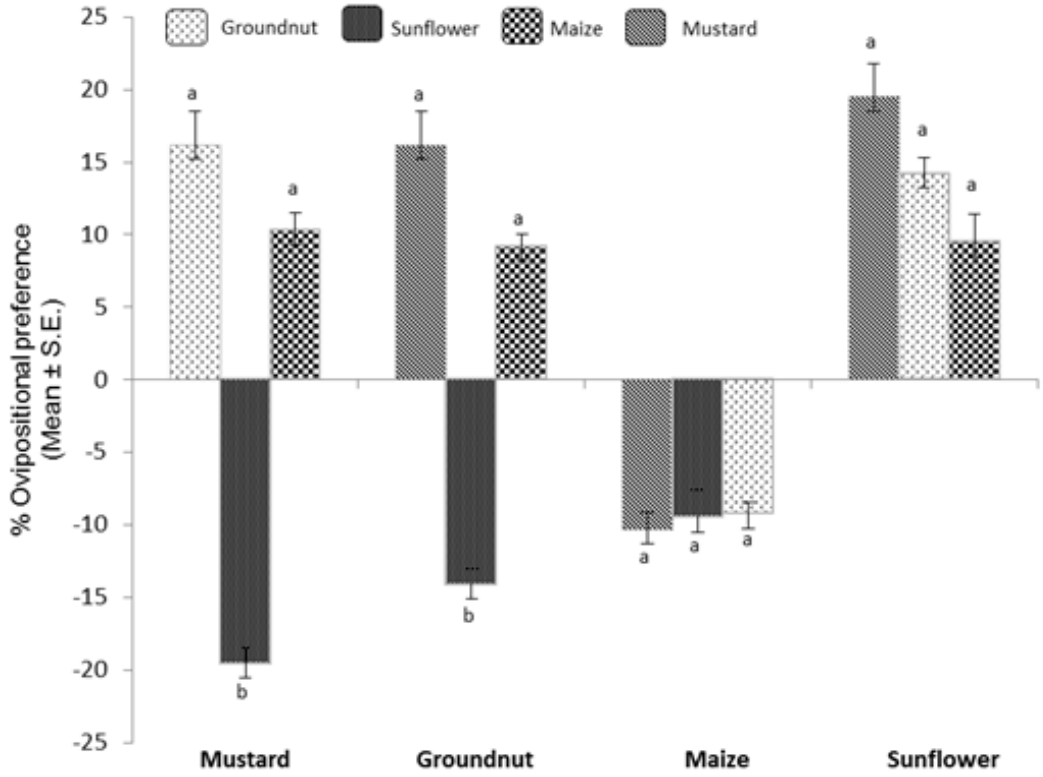

Fig 4: Oviposition preference index of *S. litura* females towards leaves of different test plants in two-choice condition (Bars having different letters indicate significant difference in response)**.**

Being a polyphagous insect it has been inferred that *Spodoptera spp.* lay eggs indiscriminately on any available plant species [3]. However, our result clearly showed that the moths exhibited preference among the four-host plant tested. In no-choice test the sunflower leaf was clearly attractive for tobacco caterpillar oviposition. In contrast, female laid significantly more eggs on cage wall than on mustard, groundnut and maize leaves, suggesting that the cues from these plant were not solely inhibiting the oviposition but were deterred the female form egg laying. Result of two choice tests further confirmed the hierarchy of preference of moths. Females laid more eggs on sunflower followed by mustard and groundnut. Maize plant was clearly less attractive for oviposition. Similar observations of hierarchical preference in oviposition for plants have also been reported in *S. exigua* for *Chrysanthemum*, tomato, *Gerbera*, and *Geranium* [13, 14, 16, 17], cotton and pigweed [11, 15]. Greenberg *et al*. [8] reported that the beet army worm *S. exigua* laid highest proportion of eggs on pigweed as compared to cotton, bell pepper, sunflower and cabbage in two, three and five-choice condition. Result also indicates the interactions among plant types in pair influenced oviposition behaviour of tobacco caterpillar. The female's preference for mustard and groundnut changed positively in response to maize. This could be due to negative cues from the maize made the mustard and groundnut more attractive.

The nature of the host plant cues for eliciting behavioural responses from insects could be chemical, tactile, visual, or some combinations. Since *S. litura* is nocturnal moth the role of visual cues in selection of host plant for oviposition may be minimum, and as such role of chemical and tactile cues are most important in host plant discrimination and oviposition. This is also evolutionary important that ovipositional preferences hierarchy of females should correspond with the nutritive value of the potential hosts for sustenance of next progeny. Knowledge of hierarchies of host plant oviposition preferences by armyworm females will be useful in designing cultural management strategies, which may include trap cropping. Wild and cultivated host plants of *Spodoptera* spp. serve as important reservoirs for populations for subsequent infestation of other crops. Successful management of these populations, and especially avoidance of severe outbreaks, will require a more complete understanding of armyworm ecology in the diverse ecological system within which crops are grown.

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