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Bioefficacy of plant extracts against *Spodoptera litura* fab. (Lepidoptera: Noctuidae)

AM Bhosale
Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India

Abstract
Bioefficacy of plant extracts of four plant species *Azadirachta indica* A. Juss., *Eucalyptus obliqua* L'Hér., *Vitex negundo* L. and *Annona squamosa* L. were evaluated for their antifeedant activity as well as field efficacy against *Spodoptera litura* Fab. *A. indica*, *A. squamosa* and *V. negundo* showed 0.03, 0.04 and 0.05 g food utilization at 200 ppm concentration for *A. indica* whereas at 300 ppm concentration of both *A. squamosa* and *V. negundo*. The field efficacy was calculated by analysing the corrected mortality of targeted pest species and found both *A. indica* and *V. negundo* were potent biopesticides over all four study areas however, *A. squamosa* showed moderate while *E. obliqua* revealed least results. Nevertheless, *A. indica*, *A. squamosa* and *V. negundo* are having effective pesticidal properties.

Keywords: botanicals, antifeedant, bioefficacy, biocontrol, *Spodoptera litura*

Introduction
The Gram pod borer *Spodoptera litura* Fab. is cosmopolitan and polyphagus pest. It is widely distributed in India. It is serious pest of vegetables as well as pulse crops, hence having crucial importance in pest management strategies. In view of the migratory nature of moths the pest spreads rapidly from one ecosystem to another hence the incidences of the pest are seen all the year, severe damage is however caused during October to November in many parts of south India (Atwal and Dhaliwal, 1997) [3].

India is primarily agricultural country with varied agroclimatic zones having the climatic conditions favorable for the development of pest population. The *S. litura* involves in the economy of the farmers. In recent times it has become very serious in pulses as well as vegetable growing areas of country. The use of conventional insecticide has raised some concern about their threat to the environment and development of resistance in insects and also residual problem in environment (Hu *et al.*, 1993; Bhosale, 2014) [10, 5], there is a potent need for the development of safer, alternative crop protectants such as botanical insecticides for the pest control programme. Plants are rich sources of natural substances that can be utilized in the pest control with development of environmental method (Sadek, 2003) [21].

The application of botanicals is now developing major importance in ecofriendly crop protection and protects the environment from pesticidal pollution, which considered as global threat. Hence there is need to focus on the future of botanical pesticides with special references to control Lepidopteran pests. There is need to develop an appropriate method like direct spray applications of the various plant materials or use of botanical based synthetic pesticidal formulations which having pest control properties and also safe to non-target organisms. Therefore, attempts have been made *in-vitro* as well as *in-vivo* application of botanicals for the Lepidopteran pest *S. litura*.

There are so many insecticides which are used against *S. litura.* But the problems associated with the use of conventional broad-spectrum insecticides have stimulated the search for effective, ecofriendly, plant-based agrochemicals. Many secondary metabolites interfere with the feeding, development, diapause, reproduction and behavior of insects. Biological control of different pests with biocontrol agents enhance the crop yield and also improve the quality of produce with least residual problem (Bhosale, 2014) [5]. The search for plant derived chemicals that having insecticidal, antifeedant or growth inhibition activity can be used as crop protectant which begins with the screening of plant extracts (Ho *et al*. 1997, Kelm *et al*. 1997, Kamakshi *et al*. 2000) [9, 14, 13].

Azadirectin is systemic and translocated pesticide and therefore it goes in tissue of treated plant & silently works as feeding insects besides it also affects by contact on target pest. It is also known to work on aquatic species such as mosquito (Alouani *et al*. 2009) [2]. The azadirectin from neem product derivative reported to provide broad spectrum control but less toxic to natural enemies of insect pest (Schmuttere, 1990) [23]. In other words, natural enemies or predators are safe to feed on the pest species.

Several workers (Koul 1985, Singh *et al*. 1985, Hu *et al.* 1993, Jeyakumar and Gupta; 1999, Juan and Sans; 2000, Rajput *et al*. 2003, Alouani *et al*. 2009, Shah *et al*. 2013, Bhosale 2014) [16, 25, 10, 11, 12, 19, 2, 24, 5] contributed for the control of Lepidopteran agricultural pests with the help of botanicals.

The insecticides besides controlling the pests, damaging environment therefore, there is need to control the pest ecofriendly. Hence, the attempt has been done to control *S. litura* by using plant extracts of four botanicals *viz*, Neem *Azadirachta indica* A.Juss., Nilgiri *Eucalyptus obliqua* L'Hér., Nirgudi *Vitex negundo* L. and Custard apple *Annona squamosa* L.

Materials and Methods
S. litura was reared in the laboratory with the two

consecutive generations and later generation of host species were used for study. Rearing of host species should be conducted separately in plastic jars covered with muslin cloth for aeration. Third instar caterpillars of *S. litura* were used for the bioassay with the botanicals. Plant materials used for the experiment were collected from the bunds of fields of adjoining areas.

Preparation and Extraction of Plant material

Plant extracts were prepared in laboratory by harvesting leaves from all plant species and separated from their petioles at the base of leaf blade. The leaves after collections were brought in the laboratory. Leaves were washed with distilled water to remove dust and other contaminants. The cleaned leaves were air dried for 4 to 5 days at room temperature (28 $\pm 2^0_C$) until all moisture content was evaporated. The dried leaves were pulverized with the help of electric grinder and 25 g of powder were subjected in the Soxhlet apparatus using acetone (250 mL) as a solvent for each test material (Deshmukh and Borle, 1975) [6]. The extraction proceeded up to 6 to 8 hours at room temperature. The extract was filtered using Whatman's filter paper No. 42 and used as stock solution. The stock solution was dissolved in distilled water and desired concentrations (100, 200, 300, 400, 500 ppm) were prepared.

Bioassay of plant extracts

The caterpillars of *S. litura* were collected from soybean fields of adjoining areas of Kolhapur region. The rearing was carried out in laboratory, feeding was given daily by providing freshly treated leaves and cleaning was done periodically. During rearing necessary hygienic conditions were kept in rearing room. The 20 third instar caterpillars of *S. litura* were starved for 5 hours. The leaves were weighed accurately and sprayed with appropriate concentration of plant extracts while, leaves of control treatment were sprayed with distilled water and the treated leaves were air dried. The treatments were replicated five times for confirming the results. The treated caterpillars were kept under supervision till it undergoes for pupation. During experiment the leaves provided, leaves left over and weight of excreta of caterpillars were weighed accurately on electronic balance. Calculate the food consumption (FC), by subtracting weight of leaves supplied to weight of leaves left over and food utilization (FU), by subtracting food consumed and weight of excreta.

Field efficacy of botanicals

The experiments were conducted in major soybean growing areas of Kolhapur region of Maharashtra like Kagal, Panhala, Jaysingpur and Ichalkaranji and that can be termed as Block No. 1, 2, 3 and 4 respectively during further experiment. The trials were arranged in Randomized block design and replicated five times for confirming results. The selected plots were treated with the botanicals at the optimum concentrations at maximum mortality dose during *in-vitro* analysis. During experiment use of pesticides in the selected block was restricted and other routine cultural operations were performed. The 20 caterpillars from each treated plot were collected, kept in the laboratory and reared up to death or completion of lifecycle by giving untreated foodstuff to check the effect of botanicals. The corrected mortality of host species was also analyzed by Abbott's formula (Abbott, 1925) [1] to determine the potent botanical for the control of *S. litura*.

$$\% \text{ corrected mortality} = \frac{\% \text{ Kill in treated - } \% \text{ Kill in control}}{100 - \% \text{ Kill in control}} \times 100$$

Statistical analysis

The statistical analysis was made by one way ANOVA using the statistical software package SAS 9.3(32) English. The percent values were transformed to arcsine values before analysis.

Results and discussion

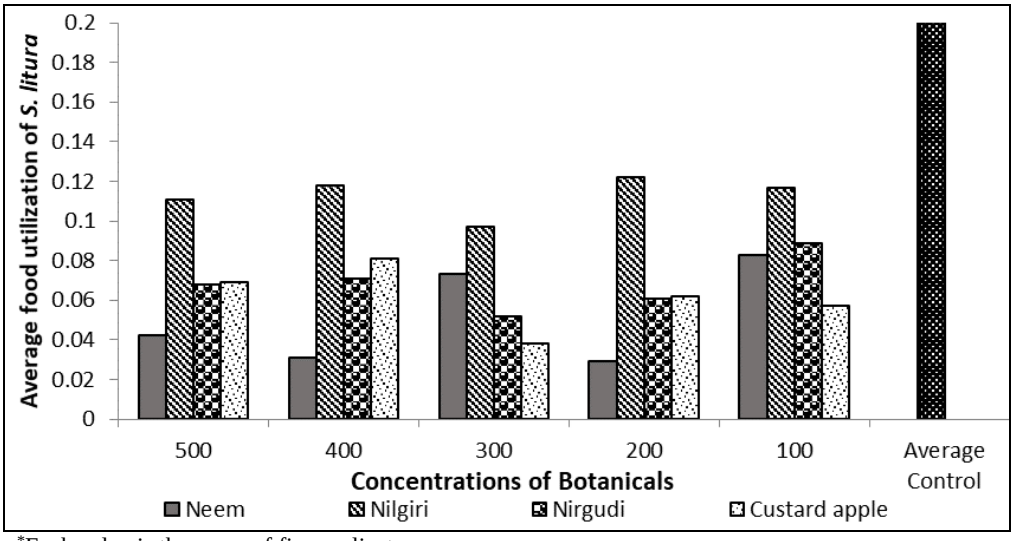
The result of botanicals against food consumption and food utilization of *S. litura* was recorded on table 1 and fig. 1. The result indicated that, the Neem depicts potent antifeedant property with lowest concentration (200 ppm) whereas, extracts of Nilgiri, Nirgudi and Custard apple exhibits antifeedant property at concentration of 300 ppm. All the botanicals tested for the experiment perceives antifeeding property towards Lepidopteran pests however further investigation have necessary to initiate use of these botanicals in Integrated Pest Management strategies.

Table 1: Food consumption and Food utilization of *S. litura* against botanicals

Sr. No.	Treatment	Concentrations (mg/L)	Average Food consumption (FC) (g)	Weight of Excreta (g)	Average Food utilization (FU) (g)
1.	Neem *Azadirachta indica* A.Juss.	500	0.22^{b}	0.18^{c}	0.04^{b}
		400	0.24^{b}	0.21^{bc}	0.03^{b}
		300	0.28^{ab}	0.24^{a}	0.03^{b}
		200	0.36^{a}	0.33^{a}	0.03^{b}
		100	0.28^{ab}	0.20^{c}	0.08^{b}
2.	Nilgiri *Eucalyptus obliqua* L'Hér.	500	0.19^{b}	0.08^{c}	0.11^{b}
		400	0.26^{ab}	0.15^{b}	0.12^{ab}
		300	0.30^{a}	0.21^{a}	0.10^{b}
		200	0.21^{ab}	0.10^{c}	0.12^{ab}
		100	0.18^{b}	0.06^{cd}	0.12^{ab}
3.	Nirgudi *Vitex negundo* L.	500	0.11^{c}	0.05^{c}	0.07^{b}
		400	0.20^{bc}	0.13^{b}	0.07^{b}
		300	0.32^{a}	0.26^{a}	0.05^{b}
		200	0.20^{bc}	0.14^{b}	0.06^{b}
		100	0.22^{b}	0.13^{b}	0.09^{b}

4.	Custard apple *Annona squamosa* L.	500	0.18[bc]	0.11[c]	0.07[bc]
		400	0.25[ab]	0.17[bc]	0.08[abc]
		300	0.16[c]	0.12[c]	0.04[c]
		200	0.26[ab]	0.20[ab]	0.06[ab]
		100	0.31[a]	0.26[a]	0.06[a]
5.	Control	-	0.23[d]	0.02[d]	0.21[abc]
6.	CD 5%		0.09	0.03	0.10

*The data presented are the mean of five replicates. Different letters indicate the significant difference (One way ANOVA) P<0.05 Tukey's standardized range (HSD) test.



*Each value is the mean of five replicates

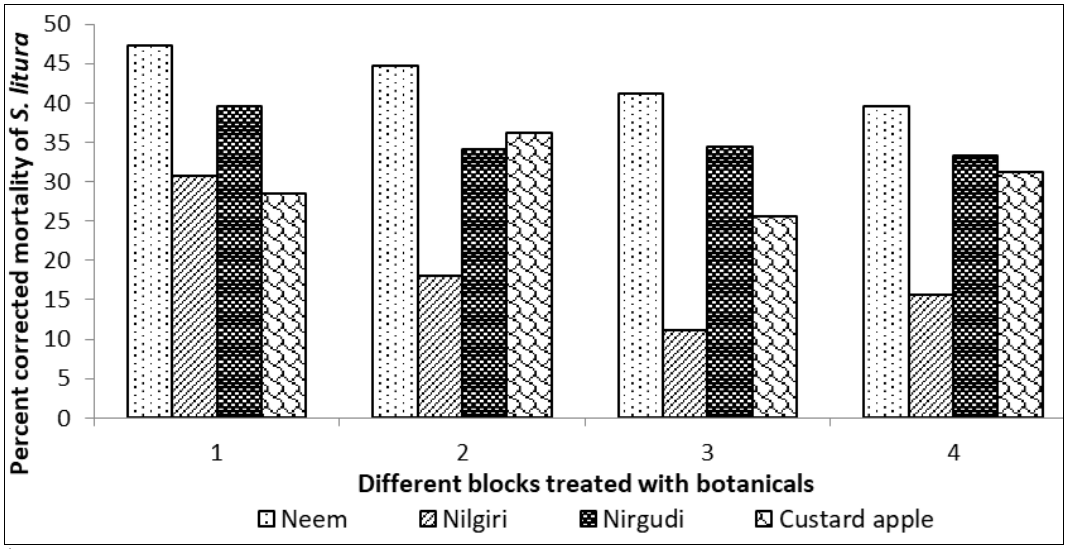
Fig 1: Effect of botanicals on Food utilization of *S. litura*

The field efficacy of botanicals against *S. litura* was tabulated in table II and fig. 2. The results showed that likely laboratory analysis Neem extract have highest corrected percent mortality with 47.25, 44.68, 41.11 and 39.58 for Kagal, Panhala, Jaysingpur and Ichalkaranji region respectively. Nilgiri extract having least corrected mortality with 30.77, 18.09, 11.11 and 15.63 percent for above mentioned regions respectively. Nirgudi and Custard apple extracts having moderate results with 39.56, 34.04, 34.44, 33.33 and 28.56, 36.17, 25.56, 31.25 for Kagal, Panhala, Jaysingpur and Ichalkaranji region respectively. From the results it can be concluded that Neem having potent insecticidal activity against Lepidopteran pest followed by Nirgudi, Custard apple and Nilgiri.

Table 2: Field efficacy of botanicals against *S. litura*

Sr. No.	Treatment	Block No.	Percent Mortality	Corrected% Mortality
1.	Neem *A. indica*	1	52.00[a]	47.25[a]
		2	48.00[a]	44.68[a]
		3	47.00[a]	41.11[a]
		4	42.00[a]	39.58[a]
2.	Nilgiri *E. obliqua*	1	37.00[a]	30.77[a]
		2	23.00[ab]	18.09[ab]
		3	20.00[bc]	11.11[bc]
		4	19.00[ab]	15.63[ab]
3.	Nirgudi *V. negundo*	1	45.00[a]	39.56[a]
		2	38.00[a]	34.04[a]
		3	41.00[a]	34.44[a]
		4	36.00[a]	33.33[a]
4.	Custard apple *A. squamosal*	1	35.00[a]	28.56[a]
		2	40.00[a]	36.17[a]
		3	33.00[ab]	25.56[ab]
		4	34.00[a]	31.25[a]
5.	Control	1	9.00[b]	-
		2	6.00[b]	-
		3	10.00[c]	-
		4	4.00[b]	-
6.	CD 5%		5.01	4.04

*The data presented are the mean of five replicates. Different letters indicate the significant difference (One way ANOVA) P<0.05 Tukey's standardized range (HSD) test.



*Each value is the mean of five replicates

Fig 2: Field efficacy of botanicals with corrected mortality of *S. litura*

The similar findings were obtained by Schmuttere (1990) and Sadek (2003) [21] while studied mortality of *Spodoptera* sp. by using leaf extract of *A. indica* and *Adhatoda vasica* Nees respectively. Lulie and Raja (2012), studied the effect of aqueous extract of *A. indica* with seeds kernel (NSKE) and mixed with leaves of *Milletia ferruginea*, Hochst and *Croton macrostachyus* Hochst was tested against *Helicoverpa armigera* (Hubner). Antifeedant activity was tested against 4th instar larvae in the laboratory and 5% concentration was tested under field condition. They found NSKE alone exhibits maximum results compared to mixture.

Dhaliwal and Koul (2007) [7] reported antifeedant effect of 5% NSKE on *H. armigera* which curtailed egg laying, number of larvae and pod damage. Khanna *et al.* (2009) [15] studied some microbial and botanical pesticides against *H. armigera* in chickpea and concluded that treatment of 5% NSKE + Endosulfan 35 EC at half recommended dose 1.25 litre/ha exhibited the least pest population. Ramteke *et al.* (2002) [20] also applied NSKE (5%) and neem extract (300 ppm) and found reduction in pest population, pod damage and ultimately high yield of chickpea as compared to control. Similar findings were noticed at 200 ppm concentration with neem extract.

Dwivedi and Venugopalan (2001) [8], studied seven plant extracts *Tamarindus indica* Linn., *Ficus indica* Linn., *Ficus religiosa* Linn., *Tabernaemontana livaricate* Linn., *Murraya koenigii* Linn., *Chenopodium album* Linn. and *Syzygium cuminii* Linn. to evaluate their ovicidal activity against *Callosobruchus chinensis* (L.). They concluded that leaf extracts of *T. livaricate*, *M. koenigii*, *C. album* and *S. cuminii* showed potent ovicidal action against *C. chinensis*. Packiam *et al.* (2012) [18], evaluated ovicidal activity of botanical formulations against *H. armigera* and *S. litura* Fabricius. Similarly, Baskar *et al*. (2011) [4] studied efficacy of plant extracts against *S. litura*.

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