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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(5): 38-40

www.thepharmajournal.com
Received: 28-03-2022
Accepted: 30-04-2022

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Comparative efficacy of cypermethrin with combination of different botanicals against brinjal shoot and fruit borer (*Leucinodes orbonalis*) on Brinjal

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Abstract
The present investigation was conducted during July to December 2017 at Central Research Farm, SHUATS, Naini, Allahabad. Three applications of seven different Botanicals with Cypermethrin viz Neem oil 2% + Cypermethrin10EC, NSKE 5% + Cypermethrin10EC, Garlic bulb Extract 5% + Cypermethrin 10EC, Neem leaf extract 10% + Cypermethrin10EC, Custard apple leaf extract 10% + Cypermethrin 10EC, Pungam oil 2% + Cypermethrin10EC, Cypermethrin10EC(check) were evaluated against shoot and fruit borer, *Leucinodes orbonalis*. Minimum per cent of shoot infestation, fruit infestation and B:C ratio were recorded in cypermethrin (check) with (11.67%, 13.39% and 1:11.15) followed by Pungam oil + Cypermethrin (14.01%, 14.12% and 1:10.84), NSKE + Cypermethrin (111.69%, 16.64% and 1:9.57) Garlic bulb Extract + Cypermethrin (13.64, 16.97% and 1:9.98) Neem oil + Cypermethrin (14.78%, 17.02% and 1:7.60) Custard apple leaf extract + Cypermethrin (14.78%, 17.50% and 1:8.66) Neem leaf extract + Cypermethrin (14.70%, 17.63% and 1:8.04) untreated control (25.55%, 26.46%) respectively.

Keywords: *Leucinodes orbonalis***,** benefit cost ratio, brinjal, efficacy

Introduction
Vegetable cultivation is one of the most profitable and dynamic branches of agriculture. It has become an important source of income for both farmers and field labours serving as a vehicle for reducing poverty in rural areas. Brinjal (*Solanum melongena* L.) is one of the widely used vegetable crops by most of the people and is popular in many countries *viz.* Central South and South East Asia some parts of Africa and Central America (Harish *et al.*, 2011) [1]. It is native of India and is grown throughout the country (Pareet *et al.*, 2006) [2]. It is an important vegetable grown in all the seasons. Brinjal is also known as eggplant is referred a "King of vegetables" originated from India and now grown as a vegetable throughout the tropical sub-tropical and warm temperate areas of the world.

Brinjal botanically known as *Solanum melongena* L. (2n=24) popularly known as eggplant belongs to family Solanaceae and India is its center of origin and diversity (Vavilov, 1931 and Bahaduri, 1951) [3, 4]. It is a popular and principle fruit vegetable grown in India and other parts of the tropical and subtropical world but in temperate regions, it is grown mainly during warm season (Rai *et al*., 1995) [5]. Apart from India, the other major brinjal growing countries are China, Turkey, Japan, Italy, Indonesia, Iraq, Syria, Spain, and Phillippines. Brinjal is one of the most commonly grown vegetable crop in the country. India produces about 7.676 MT of brinjal from an area of 0.472 M ha with an average productivity of 16.3 mt/ha. The brinjal-producing states are Odisha, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra and Uttar Pradesh. Brinjal has ayurvedic medicinal properties and white brinjal is good for diabetic patients. It is also a source of vitamins A, C, and minerals. (Source: NCPAH).

Like any other crops, brinjal is also attacked by a number of insect pests at various stages of its growth, which affects the cultivation of brinjal and act as a limiting factor in the profitable cultivation of brinjal crop. The crop is attacked by about 140 species of insect and non insect pests belonging to 50 families. Out of which numerous insect pests *viz.* shoot and fruit borer, (*Leucinodes orbonalis* Guenee), leaf hopper (*Amrasca biguttula bigttula*), aphid (*Aphid gossypii*), Hadda beetle (*Epilachna* spp.) and brinjal stem borer (*Euzophera particrlla* Rag) have been reported as important pests of the brinjal by (Butani and Jotwani 1984) [7]. *Leucinodes orbonalis* Guenee (Lepidoptera: Pyraustidae), causes significant losses to the tune of 70% (Sandanayake and Edirisinghe, 1992) [8].

Due to its fast reproductive potential, quick turnover of generation and most common cultivation of brinjal in both wet and dry season, this pest poses a serious threat. In early stages of the crop growth, larvae of brinjal BSFB, *L. orbonalis*, bores into the shoots resulting in dropping, withering and drying if the affected shoots. During the reproductive stage, tiny larvae bore into the flower buds and fruits, the bored holes are invariably plugged with excreta. The infested fruits become unfit for consumption due to loss of quality and lose their market value. In India, damage levels of the pest have been noticed in different regions resulting considerable damage to the fruits. It is generally severe in the July transplanted crop and estimated economic injury level to 6% infestation (AVRDC, 2003) [9]

Materials and Methods

The experiment was conducted at central research field of Department of Entomology, Naini Agricultural Institute, SHUATS, Allahabad during kharif season of 2017. The trial was laid out in the randomized block design with eight treatments and three replications. The brinjal variety pusa purple long was transplanted on 7 Aug., 2017 at 60 x 45 cm spacing. The plot size was kept 2 x 2 m. All recommended packages and practices were followed to raise the crop, except plant protection measures.The Botanicals combination treatments viz. Neem oil + Cypermethrin, NSKE + Cypermethrin, Garlic bulb Extract + Cypermethrin, Neem leaf extract + Cypermethrin, Custard apple leaf extract + Cypermethrin, Pungam oil + Cypermethrin, Cypermethrin (check) Untreated(Control), were evaluated.

From each plot five plants were selected randomly and labeled for recording observations. As soon as the infestation of pest on the shoot was initiated, the observations on the total number of shoots and number of infested shoots (firs spray) and fruit infestation (second and third spray) of five observational plants from each treatment replication wise were recorded at 3, 7 and 14 days after imposing treatments. The data recorded in the different treatments were subjected to statistical analysis after suitable transformation by following standard procedures of RBD experiment.

Results and Discussion

Efficacy of different insecticides on the incidence of *L. orbonalis* is presented in table 1 showed that all the treatments were significantly superior in reducing the infestation of shoot and fruit borer resulting in increasing the yield, significantly as compared to control. The minimum shoot damage (11.67%) was recorded in the plot treated with (Check) Cypermethrin (10 EC) @ 2 ml/lit followed by NSKE + Cypermethrin, where 11.69 per cent shoot damage was recorded Garlic bulb extract + Cypermethrin was also effective which gave 13.64 per cent shoot damage The next treatments in order of effectiveness were Pungam oil + Cypermethrin, Neem leaf extract + Cypermethrin Neem oil + Cypermethrin and Custard apple leaf extract + Cypermethrin which 14.01, 14.70,14.78 and 14.78 per cent shoot damage was recorded, separately. The maximum shoot damage (25.55%) was recorded in control plot.

The pooled data for second and third spray shows that minimum fruit per cent damage recorded in (check) Cypermethrin (10 EC) was 13.39 followed by Pungam oil + Cypermethrin 14.12, NSKE + Cypermethrin 16.64, Garlic bulb extract + Cypermethrin 16.97, Neem oil + Cypermethrin 17.02, Custard apple leaf extract + Cypermethrin 17.50 and Neem leaf extract + Cypermethri 17.63. The highest per cent fruit damage was recorded in control 25.82. The present findings are in agreement with the results of many researchers (Kumar *et al.* 2017; Pandey *et al.*, 2017) [10, 11] who also reported that cypermethrin as most effective chemical and is comparable to Pungam oil + Cypermethrin.

Table 1: Efficacy of Cypermethrin with combination of different Botanicals against Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis*) on Brinjal during Kharif Season of 2017

Treatments		Shoot infestation (%)	Fruit infestation (%)		Pooled mean of fruit infestation
		1st spray	2nd spray	3rd spray	
T_0	Untreated	25.55 (30.35)	26.46 (30.91)	25.19 (30.11)	25.82 (30.54)
T_1	Neem oil 2% + cypermethrin 10 EC	14.78 (22.47)	17.06 (24.30)	16.98 (24.30)	17.02 (24.36)
T_2	NSKE 5% + cypermethrin 10 EC	11.69 (19.96)	16.08 (23.57)	17.20 (24.47)	16.64 (24.07)
T_3	Garlic bulb extract 5% + cypermethrin 10 EC	13.64 (21.64)	17.14 (24.45)	16.81 (24.14)	16.97 (24.33)
T_4	Neem leaf extract 10% + cypermethrin 10 EC	14.70 (22.51)	17.77 (24.88)	17.49 (24.67)	17.63 (24.82)
T_5	Custard apple leaf extract 10% + cypermethrin 10 EC	14.78 (22.59)	17.08 (24.38)	17.92 (25.03)	17.50 (24.72)
T_6	Pungam oil 2% + cypermethrin 10 EC	14.01 (21.90)	15.15 (22.83)	13.09 (21.03)	14.12 (24.05)
T_7	cypermethrin 10 EC	11.67 (19.88)	15.04 (22.74)	11.74 (19.99)	13.39 (21.42)
Over all mean		15.10	17.75	17.05	17.38
F- test		S	S	S	S
S.Ed. (±)		1.023	1.091	0.606	0.516
C. D. (P=0.05)		2.580	2.526	1.987	2.474

*Figures in parenthesis are arc sin transformed values

Table 2: Yield of treatments along with incremental cost benefit ratio.

S. No.	Treatment	Yield of treatments along with incremental cost benefit ratio.					
		Yield q/hd	Increase in yield over Control (q/hq)	Value of Increased yield ₹/hq (B)	Total cost ₹/ hq (A)	Incrimental Benefit (C= B-A)	ICBR (C/A)
T0	Untreated	11.50	-	-	-	-	-
T1	Neem oil 2% + cypermethrin 10 EC	24.00	13.50	16200	1882	14318	1:7.60
T2	NSKE 5% + cypermethrin 10 EC	28.25	16.75	20100	1900	18200	1:9.57
T3	Garlic bulb extract 5% + cypermethrin 10 EC	28.25	16.75	20100	1830	18270	1:9.98
T4	Neem leaf extract 10% + cypermethrin 10 EC	26.25	14.75	17700	1956	15744	1:8.04
T5	Custard apple leaf extract 10% + cypermethrin 10 EC	25.75	14.25	17100	1770	15330	1:8.66
T6	Pungam oil 2% + cypermethrin 10 EC	29.50	18.00	21600	1824	19776	1:10.84
T7	cypermethrin 10 EC	30.75	19.25	23100	1900	21200	1:11.15

The yields among the treatment were significant over control. The highest yield and benefit cost ratio was recorded in Cypermethrin (check) (30.75/ha and 1:11.15) supported by (Rahman *et al*., 2014) [12]; calculated the ICBR 1:8.14, (Bhavat and Magar, 2017) [13] concluded that ICBR was highest in cypermethrin. followed by Pungam oil + Cypermethrin (29.50q/ha and 1:10.84), Garlic bulb extract + cypermethrin (28.25q/ha and 1:9.98), NSKE + cypermethrin (28.25q/ha and 1:9.57), were best three among treatments Pungam oil + Cypermethrin is a valuable combination pesticide in the management of *L. orbonalis*. This was supported (Kumar *et al.* 2017) [10]. And these can be used alternatively for the management of brinjal pests. (Table 2)

From the critical analysis of the present findings it can be concluded that different Botanicals with Cypermethrin pesticides like Pungam oil + Cypermethrin, Neem oil + Cypermethrin, NSKE + Cypermethrin, Custard apple leaf extract + Cypermethrin, were showing good result against *Leucinodes orbonalis* and can be used instead of chemical insecticides which causes environmental and ecological dent. It also has potential to be included in integrated pest management.

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