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Comparative efficacy and economics of certain insecticides against spotted pod borer [*Maruca vitrata* (Geyer)] on blackgram (*Vigna mungo* L.)

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Abstract
The field experiment was undertaken at SHUATS central research field, Prayagraj, Uttar Pradesh, India during *kharif*, 2021 containing seven treatments viz, Triazophos 40% EC (T1), Chlorantraniliprole 18.50% SC (T2), Spinosad 45% SC (T3), Azadirachtin 0.03% EC (T4), lambda cyhalothrin 5% EC (T5), Azadirachtin 14.5% SC (T6) Flubendiamide 39.35% SC (T7), control (T0) in RBD with three replications aiming to evaluate their efficacy of selected insecticides against pod borer, *Maruca vitrata*. Data was taken on black gram pod with number of larvae per infested pod and calculated larval mean reduction. The mean larval reduction of black gram pod borer *Maruca vitrata* on third, seventh and fourteen days after spraying revealed that the treatments Triazophos 40% EC (T1), Chlorantraniliprole 18.50% SC (T2), Spinosad 45% SC (T3), Azadirachtin 0.03% EC (T4), lambda cyhalothrin 5% EC (T5), Indoxacarb 14.5% SC (T6) Flubendiamide 39.35% SC (T7), were found superior over all the treatment first and second sprays respectively. Flubendiamide 39.35% SC (T7) gave maximum larval mean reduction followed by Chlorantraniliprole 18.50% SC (T4). When cost benefit ratio was worked out, interesting result was achieved. Among all the treatments, the best and most economical treatment was Flubendiamide 39.35% SC (T7) (1:2.77) followed by Chlorantraniliprole 18.50% SC (T4). (1:2.44).

Keywords: Black gram, efficacy, insecticides, *Maruca vitrata*, spotted pod borer, *Vigna mungo*

Introduction

The word "pulses" commonly known as peas, beans or lentils. India is the world's largest producer of pulses. In a country like India where a large population is vegetarian, pulses are the cheap and best source of proteins. They have emerged as the most important crop which has been cultivated by human since ancient times. They have become very important in our daily diet. At least one of these pulses' chickpea, mung bean, urd bean, tur. pea is found in the menu of most of the Indian families every day. Pulses being a rich source of protein constitute an integral part of the vegetarian diet of the Indian people to overcome the malnutrition problem. Pulses are important food crops due to their high protein and essential amino acid content. Like many leguminous crops, pulses play important role in crop rotation due to their ability to fix nitrogen (Reddy., 2009) [8].

Black gram (*Vigna mungo* L.), is one of the important pulses crops, grown throughout the country. The crop is resistant to adverse climatic conditions and improve the soil fertility by fixing atmospheric nitrogen in the soil. It has been reported that the crop produces equivalent to 22.10 kg of N/ha., which has been estimated to be supplement of 59 thousand tonnes of urea annually. The pulse 'Black gram' plays an important role in Indian diet, as it contains vegetable protein and supplement to cereal-based diet. It contains about 26% protein, which is almost three times that of cereals and other minerals and vitamins. Besides, it is also used as nutritive fodder, specially for milch animals. In addition, being an important source of human food and animal feed, it also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Being a drought resistant crop, it is suitable for dry land farming and predominantly used as an intercrop with other crops. This crop is itself a mini-fertilizer factory, as it has unique characteristics of maintaining and restoring soil fertility through fixing atmospheric nitrogen in symbiotic association with Rhizobium bacteria, present in the root nodules. (Singh *et al*., 2008) [11].

The spotted pod borer causes direct damage to the plant reproductive structures such as flowers and pods, hence responsible for major yield loss. Due to lack of suitable alternative control measures, farmers continue to rely on insecticides against spotted pod borer.

(Swathi *et al*., 2018) [14]. Maruca vitrata is a major pest of black gram causing serious damage (Mia, 1998) [6]. The infestation of Maruca vitrata initiates at vegetative stage of the black gram, where it webs the tender leaves at growing tip and feed on the chlorophyll content and makes tiny holes which then shifts to the inflorescence and webs the floral parts and feed on them due to which flower buds fail to open and drop off from the inflorescence. (Manjunath *et al*., 2019) [5].

Materials and Methods

The experiment was conducted during *Kharif* 2021 at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. The experiment were set up in a Randomized Block Design (RBD) with 8 treatments duplicated three times using a suggested package of practises excluding plant protection in a plot size of (2m x 2m) at a spacing of (30x10cm), to evaluated the efficacy of selected insecticides viz.,, Triazophos 40% EC (T1), Chlorantraniliprole 18.50% SC (T2), Spinosad 45% SC (T3), Azadirachtin 0.03% EC (T4), lambda cyhalothrin 5% mEC (T5), Indoxacarb % SC (T6) Flubendiamide 39.35% SC (T7), and untreated Control (T0). The experimental field was monitored for incidence of spotted pod borer at the weekly interval to observe ETL levels of insects. Spraying was done by using knapsack sprayer. Spotted pod borer larval population were recorded by randomly picking 5 plants per plot from each treatment a day prior to insecticide application and three, seven, fourteen days after each treatments.

$$\text{Per cent reduction} = \frac{\text{Population in control-Population in treatment}}{\text{Population in control}} \times 100$$

Cost benefit ratio of treatments

Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula

$$\text{B:C Ratio} = \frac{\text{Gross returns}}{\text{Total cost incurred}}$$

Results and Discussion

As evidenced by data obtained on its incidence on plants, the efficacy of insecticides on spotted pod borer larval population of blackgram demonstrated that all the treatments were remarkably effective in suppressing the pod borer population over untreated plots.

The data on the mean (3,7 and 14 DAS) larval population of first spray revealed that all the treatments were significantly superior over control. Among all the treatments, the plot treated with T7 Flubendiamide 39.35% SC (0.863) recorded least larval population as compared to the remaining treatments. It was followed by T2 Chlorantraniliprole 18.5% SC (1.330), T4 Azadirachtin 0.03% EC(1.463), T5 Lambda cyhalothrin 5% EC(1.863), T6 Indoxacarb 14.5% SC(2.063), T1 Triazophos 40% (2.263) and T3 Spinosad 45% SC (2.510) as compared to control plot (4.110) is found to be least effective but comparatively superior over the control.

Table 1: Efficacy of selected insecticides on the population of *M. vitrata* on blackgram- (First spray)

S. No.	Treatments	Larval Population of *M. vitrata*/5 plants				
		Before spraying	3DAS	7DAS	14DAS	Mean
T1	Triazophos 40% EC	2.667	2.733	1.933	2.133	2.263
T2	Chlorantraniliprole 18.50% SC	2.333	1.733	1.133	1.333	1.330
T3	Spinosad 45% SC	2.667	2.933	2.200	2.400	2.510
T4	Azadirachtin 0.03% EC	2.333	1.933	1.133	1.333	1.463
T5	lambda cyhalothrin 5% EC	2.533	2.333	1.533	1.733	1.863
T6	Indoxycarb 14.5% SC	2.600	2.533	1.733	1.933	2.063
T7	Flubendiamide 39.35% SC	2.267	1.333	0.533	0.733	0.863
T8	Control	2.467	3.800	4.200	4.333	4.110
	F-test	NS	S	S	S	S
	S. Ed. (±)	0.597	0.067	0.115	0.134	0.193
	C.D. (P = 0.05)	0.07	0.143	0.248	0.290	0.414

The data on the mean (3, 7 and 14 DAS) larval population of second spray revealed that all the treatments were significantly superior over control. Among all the treatments, the plot treated with T7 Flubendamide 39.35% SC (0.756) recorded least larval population as compared to the remaining treatments.It was followed by T2 Chlorantraniliprole 18.5% SC (1.044), T4 Azadirachtin 0.03% EC(1.222), T5 Lambda cyhalothrin 5% EC(1.511), T6 Indoxacarb 14.5% SC(1.644),T1 Triazophos 40% (1.844) and T3 Spinosad 45% SC (2.145) as compared to control plot (4.911) is found to be least effective but comparatively superior over the control.

Table 2: Efficacy of selected insecticides on the population *M. vitrata* on blackgram-(second spray)

S. No.	Treatments	Larval Population of *M. vitrata*/5 plants				
		Before spraying	3DAS	7DAS	14DAS	Mean
T1	Triazophos 40% EC	2.133	2.067	1.533	1.933	1.844
T2	Chlorantraniliprole 18.50% SC	1.333	1.067	0.933	1.133	1.044
T3	Spinosad 45% SC	2.400	2.267	1.967	2.200	2.145
T4	Azadirachtin 0.03% EC	1.333	1.200	1.200	1.267	1.222
T5	lambda cyhalothrin 5% EC	1.733	1.667	1.333	1.533	1.511
T6	Indoxycarb 14.5% SC	1.933	1.867	1.333	1.733	1.644
T7	Flubendiamide 39.35% SC	0.733	0.733	0.867	0.667	0.756
T8	Control	4.333	4.733	4.867	5.133	4.911
	F-test	S	S	S	S	S

	S. Ed. (±)	0.134	0.057	0.24	0.374	0.4
	C.D. (P = 0.05)	0.290	0.130	0.516	0.255	0.272

The data on the mean larval population of first spray and second spray, overall mean revealed that all the treatments except untreated control are effective and at par. Among all the treatments least larval population of blackgram spotted pod borer was recorded in Flubendamide 39.35% SC (0.809). The next best treatment was Chlorantraniliprole 18.5% SC (1.187) and all other treatments are supirior than control plot (4.51) which found to be least effective.

Table 3: Efficacy of selected insecticides on the population *M. vitrata* on blackgram-(Mean)

S. No.	Treatments	Per cent reduction in larval population/5 plants		
		First spray	**Second spray**	**Mean**
T1	Triazophos 40% EC	2.263	1.844	2.053
T2	Chlorantraniliprole 18.50% SC	1.330	1.044	1.187
T3	Spinosad 45% SC	2.510	2.145	2.327
T4	Azadirachtin 0.03% EC	1.463	1.222	1.324
T5	lambda cyhalothrin 5% EC	1.863	1.511	1.687
T6	Indoxycarb 14.5% SC	2.063	1.644	1.853
T7	Flubendiamide 39.35% SC	0.863	0.756	0.809
T8	Control	4.110	4.911	4.51
	F-test	S	S	S
	S. Ed. (±)	0.193	0.4	0.296
	C.D. (P = 0.05)	0.414	0.272	0.343

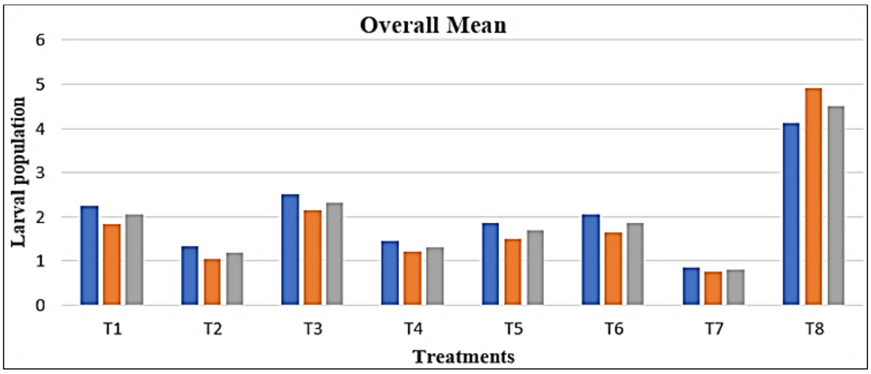

Fig 1: Graphical representation of efficacy of selected insecticides on the population *M. vitrata* on blackgram-(Mean)

The C:B ratio of various insecticide treatments were calculated which shows that maximum. Among the treatments studied, the best and most economical treatment was Flubendamide 39.35% SC (1:2.77) followed by Chlorantraniliprole 18.5% SC (1:2.44), Azadiarachtin 0.03% EC (1:2.37), Lambda cyhalothrin 5% EC (1:2.04), Indoxacarb 14.5% SC (1:1.74), Triazophos 440% EC (1:1.64), Spinosad 45% SC(1:1.12) as compared to control plot (1:1.02).

Table 4: Tabular representation of economics of cultivation

S. No.	Treatments	Yield of q/ha	Cost of yield/₹/qtl	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	C: B ratio
1.	Triazophos 40% EC	6.53	6200	40486	23518	1340	24858	1:1.64
2.	Chlorantraniliprole 18.50% SC	10.91	6200	67642	23518	4400	27918	1:2.42
3.	Spinosad 45% SC	5.01	6200	31062	23518	4400	27918	1:1.11
4.	Azadirachtin 0.03% EC	9.83	6200	60946	23518	2368	25886	1:2.35
5.	lambda cyhalothrin 5% EC	8.13	6200	50406	23518	1320	24838	1:2.02
6.	Indoxacarb 14.5% SC	7.02	6200	43524	23518	1700	25218	1:1.72
7.	Flubendiamide 39.35% SC	11.84	6200	73408	23518	3200	26718	1:2.74
8.	Control	3.83	6200	29946	23518	----	23518	1:1.27

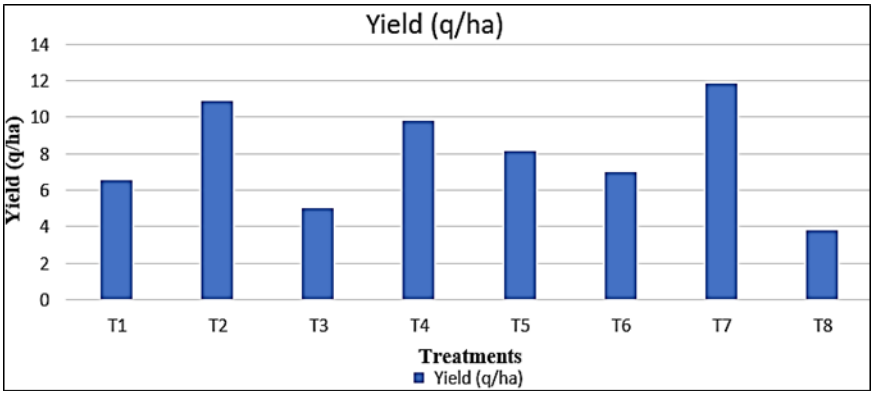

Fig 2: Graphical representation of economics of different treatments

Discussion

The data on the mean larval population of first spray and second spray, overall mean revealed that all the treatments except untreated control are effective and at par. Among all thetreatments least larval population of blackgram spotted pod borer was recorded in Flubendamide 39.35% SC (0.809) this result is similar to the findings by Selvam *et al. (*2020) [10] with result (0.81) and Swathi *et al*., (2018) [14] with the results (0.78). The next best treatment was Chlorantraniliprole 18.5% SC (1.187), these results are supported by Sreekanth *et al*. (2015) [13] with the result (1.29) and Venkataiah *et al.*, (2015) [15] with the result (1.12) and this is followed by Azadiarachtin 0.03% EC (1.324), these results are supported by Selvam. K. (2018) [9] with the results (1.54) and Haripriya *et al*. (2019) [2] with the results (4.18) and the next best treatment was Lambda cyhalothrin 5% EC (1.687), Indoxacarb 14.5% SC (1.853), Triazophos 440% EC (2.053) these results nearly similar to Mandal *et al*. (2013) [4] with the results (1.33), (1.37) and (1.33) and Spinosad 45% SC (2.327) is found to be least effective but comparatively superior over the control these results are supported by Sonune *et al*. (2010) [12] with result (2,85) and Haripriya *et al*. (2019) [2] with the results (2.56).

The yields among the different treatments were significant. All the treatments were superior over control. The highest yield was recorded in Flubendamide 39.35% SC (11.84 q/ha) followed by Chlorantraniliprole 18.5% SC (10.91q/ha), Azadiarachtin 0.03% EC (9.83q/ha), Lambda cyhalothrin 5% EC (8.13q/ha), Indoxacarb 14.5% SC (7.02), Triazophos 440% EC (6.53q/ha), Spinosad 45% SC (5.01q/ha) as compared to control plot (3.83q/ha).

Cost-benefit ratio

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Flubendamide 39.35% SC (1:2.77), these results are similarily finding by Sreekanth *et al*. (2015) [13] with result (1:2.13) and Venkataiah *et al.*, (2015) [15] with the results (1:2.06). The next best treatment is Chlorantraniliprole 18.5% SC (1:2.44), these results are similarily findings of Swathi *et al*., (2018) [14] with the results (1:2:54) and Jakhar *et al*., (2016) [3]. The best next treatment was Azadiarachtin 0.03% EC (1:2.37), these results are supported by Selvam. K (2018) [9] with results (1:2:45) and Gupta *et al*., (2009) [8] with the results (1:2.66), this is followed by the next treatment Lambda cyhalothrin 5% EC (1:2.04) and Triazophos 440% EC (1:1.64) these results are supported by Mandal *et al*., (2013) [4] with result (1;2:78) and Manjunath *et al*., (2019) [5] with result (1:1:34)and the best next treatment are Spinosad 45% SC (1:1.12) these results similarly finding by Sonune *et al*., (2010) [12] with the result (1:1;40) and Venkataiah *et al*., (2015) [15] with the results (1:1.52).

Conclusion

From the critical analysis it can be concluded that insecticides like Triazophos 40% EC, Chlorantraniliprole 18.50% SC, Spinosad 45% SC, Azadirachtin 0.03% EC, lambda cyhalothrin 5% EC, Indoxycarb 14.5% SC Flubendiamide 39.35% SC can be suitably effective against *Maruca vitrata* (Geyer) as under selected chemicals. Among the treatments studied the best and most economical treatments was Flubendamide 39.35% SC (1:2.77) followed by Chlorantraniliprole 18.5SC (1:2.44), Azadiarachtin 0.03% EC (1:2.37), Lambda cyhalothrin 5% EC (1:2.04), Triazophos 440% EC (1:1.64), Spinosad 45% SC (1:1.12).

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