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Addigam Gopal Krishna
M.Sc. Scholar, Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor, Department of Entomology, Faculty of Agriculture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author
Addigam Gopal Krishna
M.Sc. Scholar, Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Efficacy of insecticides and neem oil against spotted pod borer [*Maruca vitrata* (Geyer)], on greengram [*Vigna radiata* (L.)]

Addigam Gopal Krishna and Ashwani Kumar

Abstract
The field experiment was carried out at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. during the *Kharif* season of 2021. Two rounds of selected chemicals and neem oil were sprayed against spotted pod borer. The data indicated that treatment T_6-Chlorantraniliprole 18.5SC was the most effective treatments in reducing *M. vitrata* larval population over control followed by T_2-Emamectin Benzoate 5SG, T_7-Spinosad 45SC, T_4-Novaluron 10% EC, T_1-Flubrndamide 20%SG, T_5-Indoxacarb 14.5 SC and T_3-Neem oil 2%. Among the treatment studied, the best and most economical treatment was Emamectin Benzoate 5SG (1:3.05) followed by Chlorantraniliprole 18.5SC (1:2.95), Spinosad 45SC (1:2.62), Flubendiamide 480 SC (1:2.57), Novaluron10%EC (1:2.49), Indoxacarb 14.5%SC (1:2.31) and Neem oil 2% (1:2.24), as compared to control plot (1:1.29).

Keywords: Efficacy, greengram, insecticides, *Maruca vitrata*, spotted pod borer

Introduction
Pulses, also known as legumes, are the edible seeds of leguminous plants cultivated for food. Dried beans, lentils and peas are the most commonly known and consumed types of pulses. Pulses constitute an excellent supplement of protein in the vegetarian diet of human being and plays a significant role in correcting the wide spread malnutrition all over the world. Pulses are known as the "poor man's meat" because they are rich in nutrition and low in cost (Umbarkar *et al*., 2010) [12].

Mung bean (*Vigna radiata*) is a plant species of Fabaceae which is also known as green gram. It is sometimes confused with black gram (*Vigna mungo*) for their similar morphology, though they are two different species. The green gram is an annual vine with yellow flowers and fuzzy brown pods. There are three subgroups of *Vigna radiata*, including one cultivated (*Vigna radiata subsp. radiata*) and two wild ones (*Vigna radiata subsp. Sublobata* and *Vigna radiata subsp. glabra*). It has a height of about 15–125 cm. Mung bean has a well-developed root system. The lateral roots are many and slender, with root nodules grown. Stems are much branched, sometimes twining at the tips. Young stems are purple or green, and mature stems are grayish yellow or brown **(**Meena *et al*., 2022) [4]

Spotted pod borer, also known as legume pod borer, *Maruca vitrata* (Fabricius) causes extensive damage to green gram under field conditions. The low yield of green gram is attributed to the regular outbreaks of spotted pod borer (Singh and Srivastava, 2017). Because of its extensive host range and destructiveness, it became a persistent pest in green gram. It is known to cause an economic loss of 20 - 25%, yield loss of 2 - 84% and pod damage of 20 - 60% in green gram (Vishakanthaiah and Babu 1980; Zahid *et al.*, 2008) [14, 16] and accounting to US$ 30 million. The estimated losses in grain yield pulses of 20 to 60% due to *Maruca* damage.

Materials and Methods
The experimental trail was conducted during *Kharif* 2021 at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. The experiment was laid down in randomized block design (RBD) with three replications and eight treatments including control (water spray) are Flubendamide 480SC (T_1), Emamectin Benzoate 5SG (T_2), Neemoil 2% (T_3), Novaluron 10% EC (T_4), Indoxacarb 14.5% SC (T_5), Chlorantraniliprole 18.5% SC (T_6), Spinosad 45% SC (T_7) and untreated Control (T_0) using

variety aarti at a spacing of 30cm x 10cm. The experimental field was monitored for incidence of spotted pod borer at the weekely 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. The analysis of variance (ANOVA) technique was applied for drawing conclusion from data. The calculated values were compared the tubular values at 5% level of probability for the appropriate degree of freedom.

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

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

Gross return = Marketable Yield x Market price

Net return = Gross return – Total Yield

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

Results and Discussion

After first spray, the result presented in Table-1 revealed that the minimum number of larval population was found in Chlorantraniliprole 18.5% SC i.e, (1.60), (0.93), (1.33) larvae /5plants followed by Emamectin Benzoate 5SG i.e, (1.80), (1.00), (1.13) larvae /5 plants followed by Spinosad 45% SC, Novaluron 10% EC, Flubendiamide 20SG, Indoxacarb 14.5% SC and Neem oil 2%. The maximum larval population was found in control untreated plots with 3.20, 3.26, 3.46. The overall per cent reduction over control treatment was highest in Chlorantraniliprole 18.5% SC (62.84) followed by Emamectin Benzoate 5SG (58.09) and Spinosad 45% SC (52.69), Novaluron 10% EC (48.64), Flubendiamide 20SG (45.28), Indoxacarb 14.5% SC (39.92) and Neemoil 2% (34.67).

In second spray, the result presented in Table-2 revealed that the minimum number of larval population was found in Chlorantraniliprole 18.5% SC i.e, (0.86), (0.66), (1.06) larvae /5plants followed by Emamectin Benzoate 5SG i.e, (1.00), (0.93), (1.26) larvae /5 plants followed by Spinosad 45% SC, Novaluron 10% EC, Flubendiamide 20SG, Indoxacarb 14.5% SC and Neem oil 2%. The maximum larval population was found in control untreated plots with 3.73, 4.00, 4.13. The overall per cent reduction over control treatment was highest in Chlorantraniliprole 18.5% SC (78.04) followed by Emamectin Benzoate 5SG (71.31) and Spinosad 45% SC (67.87), Novaluron 10% EC (66.79), Flubendiamide 20SG (64.53), Indoxacarb 14.5% SC (62.65) and Neemoil 2% (61.10).

The data presented in Table-3 reveals the overall mean larval population of two sprays. The minimum number of larval population was found in Chlorantraniliprole 18.5% SC i.e, (1.078) similar fidings made by (Sreekanth *et al*., 2015) [8], followed by Emamectin Benzoate 5SG i.e, (1.189) as it was supported by (Dadas *et al*., 2018) [1], Spinosad 45% SC (1.412) as it was supported by (Meena *et al*., 2022) [4], Novaluron 10% EC (1.511) as it was supported by (Malathi and Kumar 2017) [2], Flubendiamide 20SG (1.611) as it was supported by (Muchhadiyal and Patel 2020) [5], Indoxacarb 14.5% SC(1.727) as it was supported by (Yadav and Singh 2015) [15] and Neemoil 2% (1.856) as it was supported by (Srinivasan and Sridar 2008) [10]. The maximum larval population was found in control untreated plot (3.633). The overall per cent reduction over control of first and second spray was highest in Chlorantraniliprole 18.5% SC i.e, (70.43) followed by Emamectin Benzoate 5SG i.e (62.70), Spinosad 45% SC i.e, 60.27, Novaluron 10% EC (57.71), Flubendiamide 20SG (54.90), Indoxacarb 14.5% SC (51.28) and Neemoil 2% (47.88).

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Emamectin Benzoate 5SG (1:3.05) with the similar findings Sreekanth *et al.* (2015) [8] followed by Chlorantraniliprole 18.5SC (1:2.95) with similar findings made by Dadas *et al.* (2018) [1], followed by Spinosad 45SC (1:2.62), Flubendiamide 480 SC (1:2.57) with similar findings made by Swathi *et al*. (2018) [11], Novaluron10%EC (1:2.49) with similar findings made by Vikrant *et al.* (2018) [13], Indoxacarb 14.5% SC (1:2.31) and Neem oil 2% (1:2.24). as compared to control plot **(**1:1.29).

Table 1: Efficacy of insectides and neem oil on the larval population of spotted pod borer (Maruca vitrata) of first spray

S. No	Treatments	Larval Population of *Maruca vitrata* / 5plants					
		Before Spraying	3das	7das	14das	Mean	% Reduction Over Control
T_0	Control	2.867	3.200	3.267	3.467	3.311	-
T_1	Flubendiamide 20sg	2.533	2.333	1.400	1.667	1.800	45.28
T_2	Emamectin Benzoate 5sg	2.533	1.800	1.000	1.133	1.311	58.09
T_3	Neem Oil 2%	2.933	2.733	1.667	2.067	2.156	34.67
T_4	Novaluron 10% Ec	2.667	2.200	1.333	1.533	1.689	48.64
T_5	Indoxacarb 14.5% Sc	2.800	2.533	1.533	1.867	1.978	39.92
T_6	Chlorantraniliprole 18.5% Sc	2.400	1.600	0.933	1.333	1.289	62.84
T_7	Spinosad 45% Sc	2.600	2.000	1.200	1.467	1.556	52.69
	F-Test	Ns	S	S	S	S	-
	S. Ed. (±)	0.19	0.09	0.11	0.20	0.17	-
	C.D. (P = 0.05)	____	0.193	0.234	0.421	0.356	-

* DAS: Day After Spray; NS- Non Significant; S-Significant

Table 2: Efficacy of insecticides and neem oil on the larval population spotted pod borer (*Maruca vitrata*) of second spray

S. No	Treatments	Larval Population of *Maruca vitrata* / 5plants					
		Before spraying	3DAS	7DAS	14DAS	Mean	% reduction over control
T_0	Control	3.467	3.733	4.000	4.133	3.955	-
T_1	Flubendiamide 20SG	1.667	1.467	1.333	1.467	1.422	64.53
T_2	Emamectin Benzoate 5SG	1.133	1.000	0.933	1.267	1.067	71.31
T_3	Neem oil 2%	2.067	1.667	1.400	1.600	1.556	61.10
T_4	Novaluron 10% EC	1.533	1.333	1.267	1.400	1.333	66.79
T_5	Indoxacarb 14.5% SC	1.867	1.533	1.333	1.533	1.466	62.65
T_6	Chlorantraniliprole 18.5% SC	1.333	0.867	0.667	1.067	0.867	78.04
T_7	Spinosad 45% SC	1.467	1.267	1.200	1.333	1.267	67.87
	F-test	NS	S	S	S	S	-
	S. Ed. (±)	0.20	0.15	0.13	0.13	0.16	-
	C.D. (P = 0.05)	____	0.312	0.277	0.285	0.179	-

* DAS: Day After Spray; NS- Non Significant; S-Significant

Table 3: Efficacy of insecticides and neem oil on the larval population spotted pod borer (*Maruca vitrata*) of first and second spray

S. No	Treatments	Larval population of *Maruca vitrata* / 5 plants			% reduction over control
		First spray	Second spray	Mean	
T_0	Control	3.311	3.955	3.633	-
T_1	Flubendiamide 20SG	1.800	1.422	1.611	54.90
T_2	Emamectin Benzoate 5SG	1.311	1.067	1.189	62.70
T_3	Neem oil 2%	2.156	1.556	1.856	47.88
T_4	Novaluron 10% EC	1.689	1.333	1.511	57.71
T_5	Indoxacarb 14.5% SC	1.978	1.466	1.727	51.28
T_6	Chlorantraniliprole 18.5% SC	1.289	0.867	1.078	70.43
T_7	Spinosad 45% SC	1.556	1.267	1.412	60.27
	F-test	S	S	S	-
	S. Ed. (±)	0.041	0.010	0.075	-
	C.D. (P = 0.05)	0.356	3.955	0.648	-

The data on Cost benefit ratio of the treatments are presented in tables.

Table 4: Economics of Cultivation

S. No	Treatments	Yield (q/ha)	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	C:B ratio
1	Control	5	30000	23220	0	23220	1:1.29
2	Flubendiamide 480SC	10.5	63000	23220	1220	24420	1:2.57
3	Emamectin benzoate5%SG	12.5	75000	23220	1290	24510	1:3.05
4	Neem oil2%	9.45	56700	23220	2000	25220	1:2.24
5	Novaluron 10%EC	11.20	67200	23220	3745	26965	1:2.49
6	Indoxacarb14.5%SC	10	60000	23220	2300	25520	1:2.31
7	Chlorantraniliprole 18.5%SC	13.6	81600	23220	4360	27580	1:2.95
8	Spinosad 45%SC	12	72200	23220	4300	27520	1:2.62

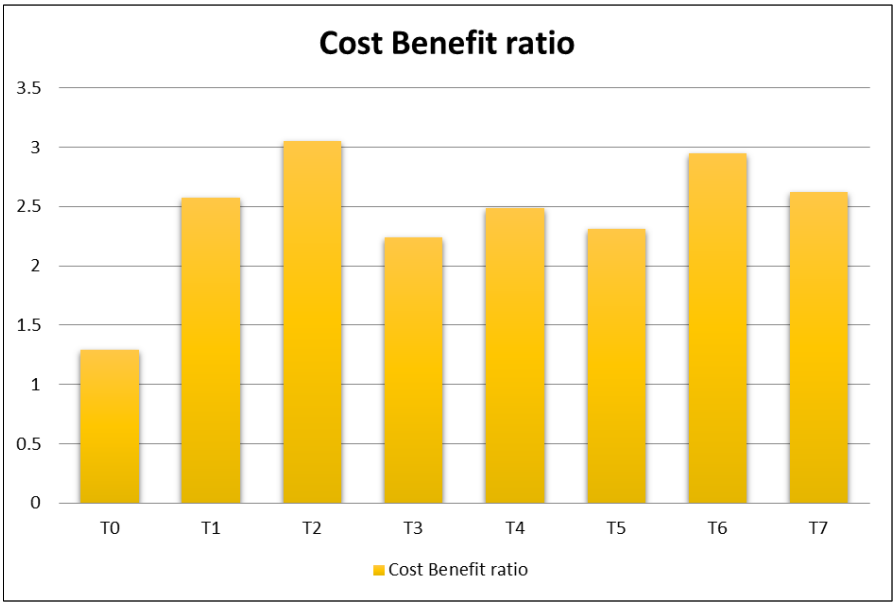

Fig 1: Cost benefit ratio of different treatments

Conclusion: From the critical analysis it can be concluded that insecticides like Chlorantraniliprole 18.5SC, Emamectin Benzoate 5SG, Spinosad 45SC, Novaluron 10% EC Flubendiamide 20SG, Spinosad 45SC can be suitably effective against *Maruca vitrata* (Geyer) as under selected chemicals. Among the treatments studied the best and most economical treatments was Emamectin Benzoate 5SG (1:3.05) followed by Chlorantraniliprole 18.5SC (1:2.95), Spinosad 45SC (1:2.62), Flubendiamide 480 SC (1:2.57), Novaluron 10%EC (1:2.49), Indoxacarb 14.5%SC (1:2.31) and Neem oil 2% (1:2.24).

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