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Bhawani Singh Meena
Department of Entomology, Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, India

Vipin Kumar
Department of Entomology, Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, India

Ram Kishor Meena
Department of Entomology, Sri Karan Narendra Agriculture University, Jobner, Rajasthan, India

BL Jakhar
Department of Entomology, Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, India

Akhtar Hussain
Department of Entomology, Sri Karan Narendra Agriculture University, Jobner, Rajasthan, India

Shakuntala
Department of Entomology, Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, India

MS Meena
Department of Entomology, Rajasthan College of Agriculture (MPUAT) Udaipur, Rajasthan, India

Pooja Sharma
Department of Entomology, Sri Karan Narendra Agriculture University, Jobner, Rajasthan, India

Corresponding Author:
Bhawani Singh Meena
Department of Entomology, Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, India

Management of pod borer, *Helicoverpa armigera* (Hubner) through newer insecticide in chickpea

Bhawani Singh Meena, Vipin Kumar, Ram Kishor Meena, BL Jakhar, Akhtar Hussain, Shakuntala, MS Meena and Pooja Sharma

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Abstract

The study was carried out to evaluate the effectiveness of six newer insecticides along with untreated control viz., chlorantarniliprole 18.5 SC, emamectin benzoate1.9 EC, indoxacarb 15.8 EC, spinosad 45 SC, flubendiamide 20 WG and quinalphos 25 EC against *Helicoverpa armigera* (Hubner) in chickpea during *Rabi* 2021-22 and 2022-23 at the Research Farm, Rajasthan Agricultural Research Institute (S.K.N. Agricultural University), Durgapura, Jaipur (Rajasthan). The pooled mean of two consecutive years (2021-22 and 2022-23) indicated that all the treatments significantly superior over control. Among the treatments, chlorantraniliprole 18.5 SC @ 0.005% was most effective with 72.49 percent reduction in *H. armigera* population, it was followed by and at par with treatment spinosad 45 SC @ 0.02% which gave 69.65 percent reduction. The treatment of quinalphos 25 EC @ 0.05% was least effective among the treatments and it gave 52.46 percent reduction. The minimum percent pod damage and maximum yield was recorded in the plants treated with chlorantarniliprole (9.15% and 19.55 q/ha, respectively) which were found significantly superior to other treatments. The maximum percent pod damage and minimum yield was evident in the treatment quinalphos (28.22% and 14.40 q/ha, respectively). Based on benefit: cost ratio of different treatments, indoxacarb 15.8 EC (1:7.55) followed by chlorantraniliprole 18.5 SC (1:7.37) were found to be most economic insecticide, because it gave the maximum benefit as compared to remaining treatments.

Keywords: *Helicoverpa armigera*, newer insecticides, benefit cost ratio

Introduction

Chickpea (*Cicer arietinum* L.), is the second most important among pulse crop in the world and is grown in India as a *Rabi* season crop and considered as 'King of Pulses' (Bhatt and Patel, 2001) [4]. Chickpea seeds are good source of protein for the vegetarians. It contains 21.5 percent protein, 64.5 percent carbohydrates and 4.5 percent fat. It is also used as feed for livestock and has a significant role in farming systems as a substitute for fallow in cereal rotations, where it contributes to the sustainability of production and reduces the need for Nitrogen fertilization by fixing atmospheric nitrogen. In India, chickpea production falls short of the demand owing to several biotic and abiotic stresses. Among the many biotic stresses, significant damage caused by insect pests resulted in low yields. The poor insect pest management strategies hampered the successful cultivation of the chickpea crop in India (Bhagwat *et al*., 1995) [3]. The crop is reported to be infested by more than 57 species of insect pests and other arthropods in India; however, the major insect pest of chickpea is: pod borer, *Helicoverpa armigera* (Hubner); leaf feeding caterpillar, *Spodoptera exigua* Hubner; black cutworm, *Agrotis ipsilon* Hufnagel; aphid, *Aphis craccivora* Koch; semilooper, *Autographa nigrisigna* Walker and pulse beetle, *Callosobruchus chinensis* Linnaeus (Ravicharan and Tayde, 2023) [16]. Amongst the insect pests, *H. armigera*, pod borer has been reported to cause maximum damage (Ojha *et al*., 2017) [14] in chickpea. A single tactic seems very hard to employ for managing any insect pest and ultimately, insecticides become the choice to be integrated with. In early times, several workers have tested the efficacy of different traditional insecticides (chlorinated hydrocarbons, organophosphates, synthetic pyrethroids and carbamates) and recommended these insecticides for the control of *H. armigera* and other pests in different crops (Kathuria and Nutan, 2005) [10]. But their indiscriminate use offered opportunity to the pest to develop resistance against most of insecticidal molecules.

Besides, residue of these insecticides has also been reported at higher concentration in edible parts of the plant as well as in the environment (Kapoor *et al*., 2000) [9]. Such old and traditional insecticides have been found ineffective to manage *H. armigera*, even at very higher doses involving higher costs and several ecological problems. Keeping these points in view, most of the workers in the present time have emphasized on the use of newer insecticides. In the present study, newer insecticidal molecules have been included for evolving an effective schedule for the management of this pest.

Materials and Methods

The experiments were conducted at the Research Farm, Rajasthan Agricultural Research Institute (S.K.N. Agricultural University), Durgapura, Jaipur (Rajasthan) for two consecutive seasons during *Rabi*, 2021-22 and 2022-23 to evaluate the efficacy of different newer insecticidal molecules in terms of suppressing the larval population of *H. armigera* infesting chickpea. The experiment was laid out in randomized block design (RBD) with seven treatments which were replicated thrice. Chickpea variety RSG- 807 was sown in the field for the experimentation and the plot size was kept 3.0 m × 3.0 m with row to row and plant to plant spacing of 30 cm × 10 cm. First spray of the insecticides was made at flowering stage when sufficient larval population of *H. armigera* appeared on the crop and thereafter, second spray was done fifteen days after first spray. Observations on the larval population of *H. armigera* were recorded from the ten randomly selected and tagged plants in each replication one day before making the treatment application and 1, 3, 7 and 10 days after spraying of the insecticides. The reduction in larvae as a result of the spray treatments was computed by comparing with the pre-treatment population and expressed as a percentage using the formula (Henderson and Tilton, 1952) [7].

$$\text{Population Reduction (\%)} = 1- \left[\frac{Ta - Cb}{Tb - Ca}\right] \times 100$$

Where,

Ta = Numbers of pod borer larvae in the treatments after application

Tb = Numbers of pod borer larvae in the treatments before application

Ca = Numbers of pod borer larvae in the control after application

Cb = Numbers of pod borer larvae in the control before application

The pod damage was recorded at harvest of the crop. The seed yield obtained per plot at harvest were recorded and converted into quintal per hectare. The data obtained were statistically analyzed.

The economics of different newer insecticides taken under study was calculated by considering the cost of application of insecticides treatments and prevailing market prices of chickpea seeds. The net profit (Rs/ha) was worked out by deducting the cost of treatments from the return of increased yield over control. The benefit cost ratio was calculated by dividing net profit with the cost of treatments including labour cost.

Results and Discussion

Effect of newer insecticides on percent reduction of larval population: The findings of the current investigation demonstrated that after insecticidal applications against pod borer *Helicoverpa armigera* were found significantly superior over control (Untreated) have been tabulated in Table no. 1 and depicted in Fig no. 1 and 2. It is evident from Table 1, among the treatments, chlorantraniliprole 18.5 SC @ 0.005% exhibited highest reduction of 71.80 and 73.17 percent in *H. rmigera* population during both the years of study. The results of present findings are in close agreement with the findings of Patel *et al.* (2016) [15], Chitralekha and Verma (2018) [5] who also recorded highest reduction of *H. armigera* population in chlorantraniliprole 18.5 SC treatment. It was followed by spinosad 45 SC @ 0.02% (69.23 and 70.07%), flubendiamide 20 WG @ 0.01% (65.52 and 66.60%) and indoxacarb 15.8 EC @ 0.01% (61.18 and 63.26%) during both the years of study. Similar results with respect to effectiveness of these insecticides were also obtained by Sreekant *et al.* (2014) [17], Dehury *et al.* (2020) [6], Khinchi and Kumawat (2020) [11], Alok *et al.* (2022) [1]. They also found Spinosad 45 SC, Flubendiamide 20 WG and Indoxacarb 15.8 EC as most promising insecticides for the management of *H. armigera* in different crops. The treatment of emamectin benzoate 1.9 EC @ 0.0015% was moderately effective with 56.20 and 58.36 percent reduction. However, Turkhade *et al.* (2015) [18] reported that the treatment of emamectin benzoate 5 SG @ 0.0015 to be most promising in reducing larval population of *H. armigera*. Among the treatments, quinalphos 25 EC @ 0.05% was least effective with 51.61 and 53.30 percent reduction. In previous study, Ojha *et al.* (2017) [14] also reported quinalphos @ 0.02% as least effective against pod borer in chickpea. In the present experiment pooled analysis of both the years (2021-22 and 2022-23) indicated that all the treatments under test followed the same trend of effectiveness. Treatment, chlorantraniliprole 18.5 SC @ 0.005% was found most effective with 72.49 percent reduction *H. armigera* larval population. It was followed by and at par with spinosad 45 SC @ 0.02% treatment which gave 69.65 percent reduction. Further, flubendiamide 20 WG @ 0.01% and indoxacarb 15.8 EC @ 0.01% treatments comprised next group of effective treatments and caused 66.06 and 62.22 percent reduction in pest population. Being moderately effective treatment, emamectin benzoate 1.9 EC @ 0.0015% brought about 57.28 percent reduction in *H. armigera* population. The treatment of quinalphos 25 EC @ 0.05% was least effective among the treatments and it gave 52.46 percent reduction.

Effect of newer insecticides on pod borer damage at harvest: The pooled mean of pod infestation of two consecutive years (2021-22 and 2022-23) at harvest ranged from 9.15-18.22 percent, *vis-a-vis*, 29.18 percent in the untreated control (Table 1). The minimum percent pod damage was recorded in the plants treated with chlorantraniliprole 18.5 SC @ 0.005% (9.15%) which were found significantly superior to other treatments. The maximum pod damage was evident in the treatment quinalphos 25 EC @ 0.05% (18.22%). The effectiveness of other newer insecticides against *H. armigera* of chickpea in the order of spinosad 45 SC @ 0.02% (10.93%) > flubendiamide (12.92%) > indoxacarb 15.8 EC @ 0.01% (15.27%) > emamectin benzoate 1.9 EC @ 0.0015%

(17.13%). The present findings are in close conformity with the findings of Meena *et al.* (2018) [13] who reported that minimum pod damage in treatment of insecticides as compared to untreated.

Seed yield of chickpea: It is evident from Table 2, the maximum seed yield of 19.55 q/ha was observed in the treatment chlorantraniliprole 18.5 SC @ 0.005%. It was followed by spinosad 45 SC @ 0.02%, flubendiamide 20 WG, indoxacarb 15.8 EC @ 0.01% and emamectin benzoate 1.9 EC @ 0.0015% viz., 19.30, 18.15, 17.50 and 15.90 q/ ha, respectively. Minimum seed yield was recorded in the plants treated with quinalphos 25 EC @ 0.05% (14.40 q/ ha) significantly superior over untreated control (11.75 q/ ha). Similarly, more or less the present findings are similar with the findings of Ravicharan and Tayde (2023) [16] who obtained the highest yield 22.76 q/ha from the treatment indoxacarb 14.5% SC followed by chlorantraniliprole 18.5% SC (20.55 q/ha), emamectin benzoate 5% SG (19.68 q/ha) and spinosad 45% SC (18.68 q/ha).

Cost benefit ratio: It is evident from Table 2, the benefit cost ratio with the greatest value was found in indoxacarb 15.8 EC @ 0.01% (1:7.55), findings were validated by Meena *et al*., (2018) [13] who obtained maximum B:C ratio in the treatment indoxacarb (8.51), followed by chlorantraniliprole 18.5 SC @ 0.005% (1: 7.37), flubendiamide 20 WG (1:6.86), emamectin benzoate 1.9 EC @ 0.0015% (1:6.21), spinosad 45 SC @ 0.02% (1:5.16). The present findings are in close conformity with the findings of Ravicharan and Tayde (2023) [16] who reported that the highest C: B ratio from the treatment indoxacarb 14.5% SC (1:4.04) followed by chlorantraniliprole 18.5% SC (1:3.52), emamectin benzoate 5% SG (and 1:3.45) and spinosad 45% SC (1:3.18). The observations were also supported by Antala *et al.* (2022) [2] and Kambrekar *et al.* (2012) [8]. According to Kumar and Kumar (2022) [12] cost benefit ratio was highest in emamectin benzoate 5% SG (1:4.5) followed by indoxacarb 14.5% SC (1:4.0) and spinosad 45% SC (1:4.0).

The minimum B:C ratio 4.79 was obtained in quinalphos 25 EC @ 0.05%.

Table 1: Management of *H. armigera* through newer insecticides in chickpea during 2021-22 and 2022-23 (Pooled)

Treatments	Formulation	Dosage	Mean Percent reduction			Percent pod damage		
			2021--22	2022-23	Pooled	2021-22	2022-23	Pooled
Chlorantarniliprole 18.5 SC	18.5 SC	0.005%	71.80 (57.92)*	73.17 (58.80)	72.49 (58.36)	9.87 (18.31)	8.44 (16.89)	9.15 (17.60)
Emamectin benzoate 1.9 EC	1.9 EC	0.005%	56.20 (48.56)	58.36 (49.81)	57.28 (49.19)	17.69 (24.87)	16.57 (24.02)	17.13 (24.45)
Indoxacarb 15.8 EC	15.8 EC	0.01%	61.18 (51.46)	63.26 (52.69)	62.22 (52.07)	15.71 (23.35)	14.82 (22.64)	15.27 (23.00)
Spinosad 45 SC	45 SC	0.05%	69.23 (56.31)	70.07 (56.83)	69.65 (56.57)	11.60 (19.91)	10.25 (18.67)	10.93 (19.29)
Flubendiamide 20 WG	20 WG	0.025%	65.52 (54.04)	66.60 (54.70)	66.06 (54.37)	13.17 (21.28)	12.67 (20.85)	12.92 (21.07)
Quinalphos 25 EC (standard check)	25 EC	0.05%	51.61 (45.92)	53.30 (46.89)	52.46 (46.41)	18.48 (25.46)	17.96 (25.07)	18.22 (25.27)
Untreated control	-	-	-	-	-	28.54 (32.29)	29.82 (33.10)	29.18 (32.69)
S Em±			1.04	1.20	0.65	0.67	0.68	0.70
CD at 5%			3.10	3.58	1.93	2.01	2.04	2.10

Figures in parenthesis are arcsin transformed values, while those outside parentheses are retransformed values.

Table 2: Economics of newer insecticides against *H. armigera* in chickpea

S. N.	Treatments	Yield (q/ha)	Increased yield over control (q/ha)	Cost of Increased yield over control	Cost of treatments (Rs./ha)	Net profit (Rs./ha)	Cost: Benefit
1	Chlorantarniliprole 18.5 SC	19.55	7.95	47700.00	5700	42000.00	7.37
2	Emamectin benzoate 1.9 EC	15.90	4.30	25800.00	3580	22220.00	6.21
3	Indoxacarb 15.8 EC	17.50	5.90	35400.00	4140	31260.00	7.55
4	Spinosad 45 SC	19.30	7.70	46200.00	7500	38700.00	5.16
5	Flubendiamide 20 WG	18.15	6.55	39300.00	5000	34300.00	6.86
6	Quinalphos 25 EC (standard check)	14.40	2.80	16800.00	2900	13900.00	4.79
7	Untreated control	11.75					

Cost of management practices

Prevailing Marketing Price of Seed- Rs. 6000 per quintal Labour charges - Rs.750 per application	Chlorantarniliprole 18.5 SC - Rs. 4200 per hectare Indoxacarb 15.8 EC - Rs. 2640 per hectare Flubendiamide 20 WG - Rs. 3500 per hectare	Emamectin benzoate 1.9 EC - Rs. 2080 per hectare Spinosad 45 SC - Rs.6000 per hectare Quinalphos 25 EC - Rs. 1400 per hectare

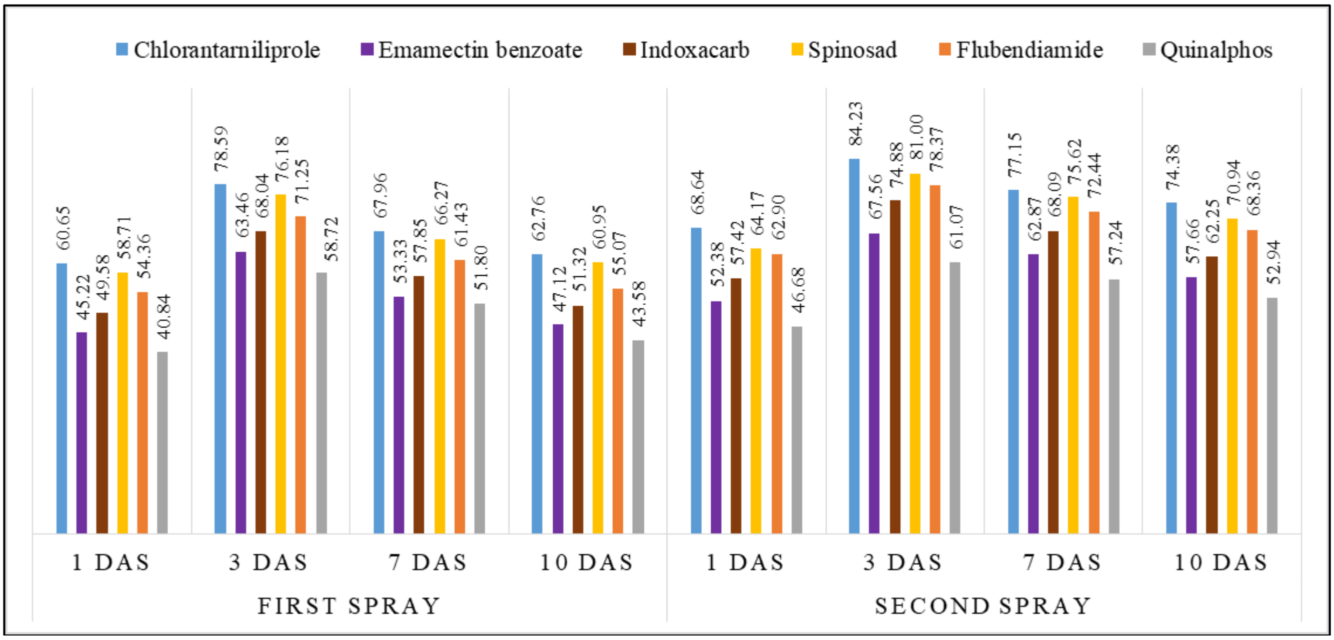

Fig 1: Percent reduction in larval population of *H. armigera* through newer insecticides in chickpea, during *Rabi*, 2021-22

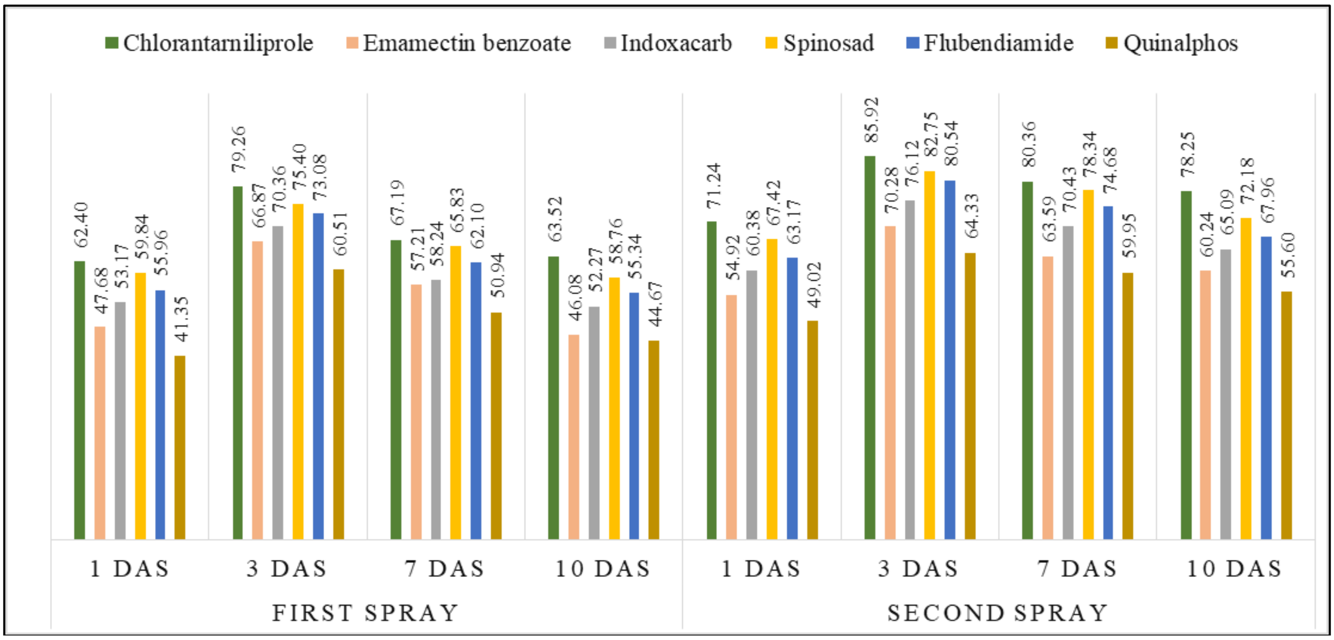

Fig 2: Percent reduction in larval population of *H. armigera* through newer insecticides in chickpea, during *Rabi* 2022-23

Conclusion

The overall efficacy of newer insecticides at different time intervals evaluated against *H. armigera* in respect to population reduction and pod damage over control revealed that chlorantraniliprole 18.5 SC @ 0.005% was found most effective followed by spinosad 45 SC @ 0.02%, flubendiamide 20 WG @ 0.01%, indoxacarb 15.8 EC @ 0.01%, emamectin benzoate 1.9 EC @ 0.0015%. The treatment of quinalphos 25 EC @ 0.05% was least effective among the treatments.

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