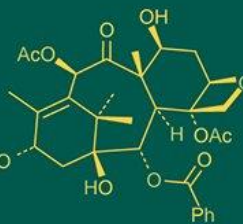
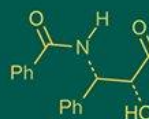


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Bioefficacy of biorational insecticides for the management of pod borer, (*Helicoverpa armigera*) on pigeonpea (*Cajanus cajan* L.)

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Abstract

The present investigation entitled “Bioefficacy of biorational insecticides for the management of pod borer, (*Helicoverpa armigera*) on pigeonpea (*Cajanus cajan* L.)” was carried out at Raj Mohini Devi College of Agriculture and Research Station, Ambikapur (C.G.) during Kharif 2024-25. The field experiment was conducted in randomized block design with seven treatments, viz., *Beauveria bassiana*, *Metarhizium anisopliae*, *Bacillus thuringiensis*, Azadirachtin (0.3% EC), *Paecilomyces lilacinus*, Emamectin benzoate (5% SG) and untreated control, each replicated thrice. Among all the treatments, Emamectin benzoate (5% SG) proved to be the most effective and recorded the lowest overall mean larval population of *H. armigera* (1.21 larvae/plant). Among the biorational insecticides, *Bacillus thuringiensis* was found to be the most effective treatment after the standard chemical check, recording an overall mean larval population of (1.84 larvae/plant), followed by Azadirachtin (1.89 larvae/plant) and *Beauveria bassiana* (1.92 larvae/plant). The untreated control registered the highest larval population (4.28 larvae/plant).

Emamectin benzoate (5% SG) also recorded the minimum pod damage (4.68%) and grain damage (10.34%), along with the highest grain yield (17.05 q/ha), net return (Rs. 62,440/ha) and incremental cost-benefit ratio (1:2.7). Among the biorational insecticides, *Bacillus thuringiensis* recorded the lowest pod damage (7.31%) and grain damage (11.27%), and produced the highest grain yield (15.77 q/ha), net return (Rs. 44,666/ha) and incremental cost-benefit ratio (1:2.0). The findings indicated that *Bacillus thuringiensis* was the most promising biorational option for the management of *H. armigera* in pigeonpea under field conditions.

Keywords: Biorational insecticides, *Helicoverpa armigera*, *Cajanus cajan*, pigeonpea, pod borer, *Bacillus thuringiensis*, *Beauveria bassiana*, *Metarhizium anisopliae*, azadirachtin, emamectin benzoate, bioefficacy, pod damage, grain damage

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is one of the major kharif pulse crops cultivated in India and is popularly referred to as red gram, tur, or arhar. It is considered to have originated in India and is extensively grown across tropical and subtropical regions due to its wide adaptability and significance in pulse-based cropping systems. The crop possesses high nutritional value, with seeds containing approximately 18 to 25 per cent protein, thereby making an important contribution to food and nutritional security (Saxena, 2008; Upadhyaya *et al.*, 2013) [9, 11]. In Chhattisgarh, pigeonpea is a major rainfed pulse crop and holds a vital position in the state's agricultural production system. During 2022–23, it was cultivated over an area of 39.87 thousand hectares, producing 27.55 thousand tonnes with an average productivity of 467 kg/ha. These figures emphasize the crop's considerable importance under the rainfed agro-climatic conditions of the state (Anonymous, 2024) [2].

The pod borer complex is regarded as one of the most serious constraints limiting pigeonpea production. More than 250 insect species have been recorded on pigeonpea; however, only a few are of major economic significance. These include the gram pod borer, *Helicoverpa armigera* (Hubner), plume moth, *Exelastis atomosa* (Walsingham), pod fly, *Melanagromyza obtusa* (Malloch) and occasionally *Maruca vitrata*, all of which together inflict considerable damage on the crop (Lal, 1998; Patil *et al.*, 1990) [6, 8].

Among these insect pests, *H. armigera* is recognized as the most destructive and constitutes a major biotic constraint in pigeonpea cultivation, causing substantial yield losses by feeding on flower buds, flowers and developing pods (Lal, 1998) [6].

Under favourable environmental conditions, these pod borers can inflict severe damage on pigeonpea, resulting in substantial yield reduction. Their management has become increasingly challenging due to the frequent and indiscriminate application of chemical insecticides, which has contributed to the development of insecticide resistance, pest resurgence, outbreaks of secondary pests and adverse effects on human health as well as the environment (Anonymous, 2021) [1].

Consequently, the continuous use of chemical insecticides is no longer regarded as a sustainable approach to pest management. Greater attention is now being directed towards environmentally safer alternatives, including biorational insecticides, microbial pesticides and botanical products, for effective pest control. In view of these considerations, the present investigation was undertaken to evaluate the bioefficacy of selected biorational insecticides against *H. armigera* in pigeonpea.

Materials and Methods

The present investigation was conducted at Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh during Kharif 2024-25 to evaluate the bioefficacy of biorational insecticides against *Helicoverpa armigera* infesting pigeonpea. The experiment was conducted in a randomized block design with three

replications and seven treatments. The pigeonpea variety CG Arhar-1 was grown in plots of 4 m × 5 m size, maintaining a spacing of 50 cm between rows and 25 cm between plants. The treatments included *Beauveria bassiana*, *Metarhizium anisopliae*, *Bacillus thuringiensis*, Azadirachtin (0.3% EC), *Paecilomyces lilacinus*, Emamectin benzoate (5% SG) and untreated control. The crop was sprayed three times, at 50 per cent flowering, pod initiation and 50 per cent pod formation stage. Spray solutions were prepared as per recommended doses and applied with a knapsack sprayer.

Observations on the larval population of *H. armigera* were recorded from randomly selected plants one day before each spray and subsequently at 3, 7 and 12 days after every spray. Pod and grain damage were assessed using 100 randomly selected pods collected from the four central rows of each experimental plot at the green pod and crop maturity stages. The percentage of pod and grain damage caused by *H. armigera* was determined based on the number of damaged pods and grains observed in each plot. Grain yield was recorded separately for each plot and subsequently expressed as quintals per hectare.

Yield increase over control was calculated by comparing the yield of each treatment with the untreated control. Economic analysis was done on the basis of market price of pigeonpea and cost of treatments. Net return and incremental cost-benefit ratio were calculated accordingly. The data on larval population and percentage damage were transformed prior to statistical analysis wherever required. The significance of treatment effects was tested at 5 per cent level of probability.

Table 1: Treatment details

Treat. No.	Name of treatments	Concentration	Dosage (g or ml/L)
T ₁	<i>Beauveria bassiana</i>	10 ⁹ CFU/ml	10 ml
T ₂	<i>Metarhizium anisopliae</i>	10 ⁷ CFU/ml	10 ml
T ₃	<i>Bacillus thuringiensis</i>	10 ¹⁰ CFU/ml	10 ml
T ₄	Azadirachtin	0.3% EC	3 ml
T ₅	<i>Paecilomyces lilacinus</i>	10 ⁷ CFU/ml	10 ml
T ₆	Emamectin benzoate	5% SG	0.5 g
T ₇	Untreated (Control)	-	-

Results and Discussion

Bioefficacy of biorational insecticides against larval population of *H. armigera* in pigeonpea

The data on the bioefficacy of different biorational insecticides against the larval population of *Helicoverpa armigera* in pigeonpea are presented in Table 2. The results revealed that the pre-treatment larval population ranged from 3.06 to 3.35 larvae per plant and the differences among treatments were non-significant, indicating a uniform distribution of the pest before the application of treatments. Following the first spray, Emamectin benzoate (5% SG) recorded the lowest mean larval population (1.40 larvae/plant). Among the biorational insecticides, *Bacillus thuringiensis* was the most effective, recording (2.12 larvae/plant), followed by *Beauveria bassiana* (2.15 larvae/plant), Azadirachtin (2.16 larvae/plant), *Metarhizium anisopliae* (2.88 larvae/plant) and *Paecilomyces lilacinus* (3.05 larvae/plant), whereas the untreated control recorded (3.77 larvae/plant). A similar response was observed after the second spray. Emamectin benzoate (5% SG) registered the lowest mean larval population (1.22 larvae/plant), while *Bacillus thuringiensis* remained the most effective biorational treatment with (1.75 larvae/plant). In comparison, the untreated control recorded (4.31

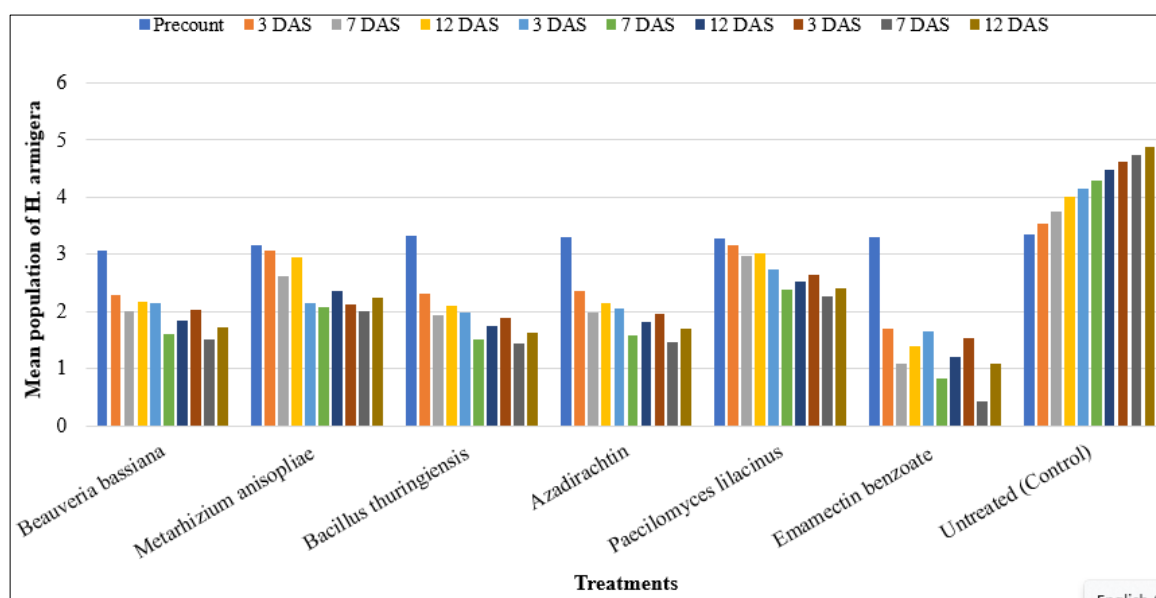
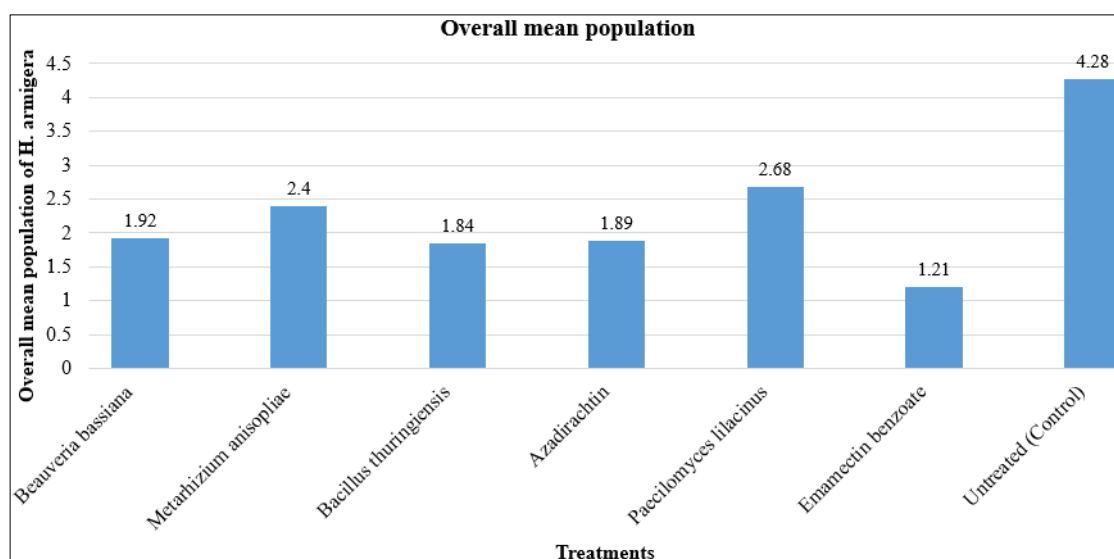
larvae/plant). After the third spray, Emamectin benzoate (5% SG) again recorded the lowest mean larval population (1.02 larvae/plant), followed by *Bacillus thuringiensis* (1.65 larvae/plant), whereas the untreated control registered (4.75 larvae/plant). Based on the overall mean larval population during the experimental period, Emamectin benzoate (5% SG) proved to be the most effective treatment (1.21 larvae/plant). Among the biorational insecticides, *Bacillus thuringiensis* was the most effective after the standard chemical check, recording (1.84 larvae/plant), followed by Azadirachtin (1.89 larvae/plant), *Beauveria bassiana* (1.92 larvae/plant), *Metarhizium anisopliae* (2.40 larvae/plant) and *Paecilomyces lilacinus* (2.68 larvae/plant), compared with 4.28 larvae/plant in the untreated control.

The present results are consistent with earlier findings. Kaur *et al.* (2018) [4] reported the lowest *H. armigera* larval population with *Bacillus thuringiensis* var. *kurstaki* (1.85 larvae/plant), followed by *Beauveria bassiana* (2.12 larvae/plant), compared with the untreated control (4.67 larvae/plant). Similarly, Meena *et al.* (2021) [7] found Emamectin benzoate (5% SG) to be the most effective treatment, followed by *Bacillus thuringiensis* and *Metarhizium anisopliae*, with the minimum larval population of 0.96 larvae/plant.

Table 2: Bioefficacy of biorational insecticides against *Helicoverpa armigera* on pigeonpea during Kharif 2024-25

Tr. No.	Treatments	Precount	Population of <i>Helicoverpa armigera</i> larvae/plant													Overall Mean
			After 1 st Spray				After 2 nd Spray				After 3 rd Spray					
			3 DAS	7 DAS	12 DAS	Mean	3 DAS	7 DAS	12 DAS	Mean	3 DAS	7 DAS	12 DAS	Mean		
T ₁	<i>Beauveria bassiana</i> (10 ⁹ CFU/ml)	3.06 (1.89)	2.28 (1.67)	2.00 (1.58)	2.17 (1.63)	2.15 (1.63)	2.14 (1.62)	1.61 (1.45)	1.84 (1.53)	1.86 (1.54)	2.04 (1.59)	1.51 (1.42)	1.72 (1.49)	1.76 (1.50)	1.92 (1.56)	
T ₂	<i>Metarhizium anisopliae</i> (10 ⁷ CFU/ml)	3.17 (1.92)	3.06 (1.89)	2.62 (1.77)	2.95 (1.86)	2.88 (1.84)	2.15 (1.63)	2.07 (1.60)	2.36 (1.69)	2.19 (1.64)	2.12 (1.62)	2.00 (1.58)	2.24 (1.66)	2.12 (1.62)	2.40 (1.70)	
T ₃	<i>Bacillus thuringiensis</i> (10 ¹⁰ CFU/ml)	3.32 (1.95)	2.32 (1.68)	1.94 (1.56)	2.10 (1.61)	2.12 (1.62)	1.99 (1.58)	1.51 (1.42)	1.75 (1.50)	1.75 (1.50)	1.89 (1.55)	1.43 (1.39)	1.63 (1.46)	1.65 (1.47)	1.84 (1.53)	
T ₄	Azadirachtin (0.3% EC)	3.31 (1.95)	2.35 (1.69)	1.98 (1.57)	2.15 (1.63)	2.16 (1.63)	2.05 (1.60)	1.57 (1.44)	1.81 (1.52)	1.81 (1.52)	1.95 (1.57)	1.47 (1.40)	1.69 (1.48)	1.70 (1.48)	1.89 (1.55)	
T ₅	<i>Paecilomyces lilacinus</i> (10 ⁷ CFU/ml)	3.28 (1.94)	3.16 (1.91)	2.98 (1.87)	3.01 (1.87)	3.05 (1.88)	2.74 (1.80)	2.39 (1.70)	2.52 (1.74)	2.55 (1.75)	2.64 (1.77)	2.27 (1.66)	2.40 (1.70)	2.44 (1.71)	2.68 (1.78)	
T ₆	Emamectin benzoate (5%SG)	3.29 (1.95)	1.71 (1.49)	1.08 (1.26)	1.40 (1.38)	1.40 (1.38)	1.64 (1.46)	0.82 (1.15)	1.21 (1.31)	1.22 (1.31)	1.54 (1.43)	0.43 (0.96)	1.09 (1.26)	1.02 (1.23)	1.21 (1.31)	
T ₇	Untreated (Control)	3.35 (1.96)	3.54 (2.01)	3.76 (2.06)	4.02 (2.13)	3.77 (2.07)	4.16 (2.16)	4.28 (2.19)	4.48 (2.23)	4.31 (2.19)	4.62 (2.26)	4.75 (2.29)	4.87 (2.32)	4.75 (2.29)	4.28 (2.19)	
	S E. ±	0.11	0.06	0.07	0.07	-	0.07	0.05	0.06	-	0.06	0.07	0.06	-	-	
	C D at 5%	NS	0.19	0.20	0.22	-	0.21	0.17	0.19	-	0.18	0.21	0.19	-	-	

Figures in parenthesis are square root transformed values, DBS = days before spray, DAS = days after spray

**Fig 1:** Bioefficacy of different biorational insecticides against *Helicoverpa armigera* on pigeonpea during Kharif 2024-25**Fig 2:** Overall mean population of *Helicoverpa armigera* after three sprays during Kharif 2024-25

Bioefficacy of various treatments against pod and grain damage due to *H. armigera* in pigeonpea

The data on pod and grain damage caused by *H. armigera* (Table 3) revealed that all the treatments significantly reduced damage compared with the untreated control. Emamectin benzoate (5% SG) recorded the lowest pod damage (4.68%) and grain damage (10.34%), whereas the untreated control registered the highest pod damage (18.65%) and grain damage (24.75%). Among the biorational insecticides, *Bacillus thuringiensis* proved to be the most effective treatment after the standard chemical check, recording the lowest pod damage (7.31%) and grain damage (11.27%). This was followed by *Beauveria bassiana*, which recorded (7.82%) pod damage and (13.49%) grain damage, Azadirachtin 0.3% EC with (8.60%) pod damage and (12.61%) grain damage, *Metarhizium anisopliae* with (8.46%) pod damage and (14.08%) grain damage and *Paecilomyces lilacinus* with (9.27%) pod damage and (15.15%) grain damage.

The present results are also supported by the findings of Kumar and Nath (2018) ^[5], who reported that Emamectin benzoate (5% SG) was highly effective in reducing larval population of *H. armigera* with minimum pod damage (8.42%), followed by *B. thuringiensis* (12.36%) and Azadirachtin 0.03% EC (15.27%), as compared to untreated control (32.48%).

Effect of biorational insecticides on grain yield and economics in pigeonpea

The grain yield and economic analysis (Table 3) revealed that all the treatments were superior to the untreated control, which recorded a grain yield of (9.20 q/ha.) Emamectin benzoate (5% SG) recorded the highest grain yield of (17.05 q/ha), maximum increase in yield over control of (7.85 q/ha), highest net return of Rs. (62,440/ha) and maximum incremental cost-benefit ratio of (1:2.7). Among the biorational insecticides, *Bacillus thuringiensis* emerged as the most effective and economical treatment after the standard chemical check by recording grain yield of (15.77 q/ha), increase in yield over control of (6.57 q/ha), net return of Rs. (44,666/ha) and ICBR of (1:2.0). It was followed by Azadirachtin (0.3% EC) with grain yield of (14.68 q/ha), yield increase of (5.48 q/ha), net return of Rs. (35,644/ha) and ICBR of (1:1.7). These findings indicated that *Bacillus thuringiensis* was the most promising biorational insecticide for the management of *H. armigera* in pigeonpea under field conditions.

The present observations are in close agreement with earlier studies. Choudhary and Singh (2017) ^[3], who revealed that Emamectin benzoate (5% SG) recorded the highest grain yield (18.42 q/ha), followed by *Bacillus thuringiensis* (16.85 q/ha) and Azadirachtin 0.3% EC (15.73 q/ha), compared to untreated control (10.24 q/ha). Similarly, Sharma and Singh (2018) ^[10], also reported that Emamectin benzoate (5% SG) as the most effective treatment, producing the highest grain yield (19.84 q/ha), while *Bacillus thuringiensis* and *Beauveria bassiana* also performed well over control.

Table 3: Incremental cost benefit ratio (ICBR), pod and grain damage of different biopesticides on pigeonpea during Kharif 2024-25

Sr. No.	Treatment	Dose ml or g/lit	Yield (q/ha)	Increase in yield over control (q/ha)	Cost	Gross return	Net return (Rs)	I.C.B.R.	Rank	Pod damage (%)	Grain damage (%)
T ₁	<i>Beauveria bassiana</i> (10 ⁹ CFU/ml)	10 ml	13.94	4.74	46800	80852	34052	1:1.7	4	7.82 (16.24)	13.49 (21.55)
T ₂	<i>Metarhizium anisopliae</i> (10 ⁷ CFU/ml)	10 gm	13.16	3.96	46800	76328	29528	1:1.6	5	8.46 (16.91)	14.08 (22.04)
T ₃	<i>Bacillus thuringiensis</i> (10 ¹⁰ CFU/ml)	10 ml	15.77	6.57	46800	91466	44666	1:2.0	2	7.31 (15.69)	11.27 (19.62)
T ₄	Azadirachtin (0.3% EC)	3 ml	14.68	5.48	49500	85144	35644	1:1.7	3	8.60 (17.05)	12.61 (20.80)
T ₅	<i>Paecilomyces lilacinus</i> (10 ⁷ CFU/ml)	10 ml	12.40	3.20	46800	71920	25120	1:1.5	6	9.27 (17.73)	15.15 (22.91)
T ₆	Emamectin benzoate (5%SG)	0.5 g	17.05	7.85	36450	98890	62440	1:2.7	1	4.68 (12.49)	10.34 (18.76)
T ₇	Untreated (Control)	---	9.20	-	36000	-	-	-	-	18.65 (25.59)	24.75 (29.83)

ICBR = Incremental Cost Benefit Ratio



Fig 3: Larvae of *Helicoverpa armigera*



Fig 4: Grain damage by *Helicoverpa armigera*



Fig 5 & 6: Pod Damage Caused by *Helicoverpa armigera*

Conclusion

Among the biorational insecticides evaluated, *Bacillus thuringiensis* emerged as the most effective treatment after the standard chemical check, Emamectin benzoate (5% SG), as it recorded the lowest pest population, minimum pod and grain damage, highest grain yield and maximum incremental cost-benefit ratio among the biopesticidal treatments. Hence, *Bacillus thuringiensis* can be considered an effective biorational option for the management of *Helicoverpa armigera* in pigeonpea.

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References

1. Anonymous. Directorate of Economics and Statistics, DAC and FW; 2021. p. 4.
2. Anonymous. Krishi Darshika: annual publication of Directorate of Extension Services, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India. 2024. p. 10.
3. Choudhary RK, Singh PS. Effect of biorational insecticides on pod borer incidence and yield of pigeonpea. *Legume Res.* 2017;40(5):923-927.
4. Kaur S, Brar AS, Singh G. Management of *Helicoverpa armigera* on pigeonpea using microbial pesticides. *Indian J Entomol.* 2018;80(2):145-150.
5. Kumar A, Nath P. Bioefficacy of biopesticides against pod borer complex in pigeonpea. *J Food Legumes.* 2018;31(2):112-116.
6. Lal SS. Insect pests in pulse crops: challenges and solutions. In: *Proceedings of the National Symposium on Management of Biotic and Abiotic Stress in Pulse Crops*; Kanpur, Uttar Pradesh, India: IFRP; 1998. p. 26-28.
7. Meena BL, Singh D, Mehta N. Comparative efficacy of eco-friendly insecticides against pod borer complex in pigeonpea. *Pharma Innov J.* 2021;10(8):345-349.
8. Patil CS, Jadhao RG, Khaire VM, Mote UN. Control of pigeonpea pod borer complex with insecticidal dust formulations. *J Maharashtra Agric Univ.* 1990;15(2):258-259.
9. Saxena KB. Genetic improvement of pigeonpea—a review. *Trop Plant Biol.* 2008;1(2):159-178.
10. Sharma RK, Singh DP. Bioefficacy of biorational insecticides against pod borer complex in pigeonpea and their impact on yield. *J Entomol Zool Stud.* 2018;6(4):1125-1129.
11. Upadhyaya HD, Reddy KN, Sharma S, Singh S, Varshney RK. Pigeonpea genetic resources and breeding for enhanced productivity. In: *Pigeonpea genetic resources and breeding*. Wallingford, UK: CAB International; 2013. p. 181-202.