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Evaluation of biorationals and insecticides against *Spodoptera exigua* (hub.) in chickpea

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Abstract
In recent years *Spodoptera exigua* (Hubner) is emerging as an important pest of chickpea, especially in South Central India where it is an economic pest of chickpea. The management of cutworm *S. exigua* on chickpea was under taken in detail under field condition. The experiment was conducted to evaluate the efficacy of different biorationals and insecticides against *S. exigua* larvae at Main Agricultural Research Station, Raichur during *Rabi*, 2016-17. There were 10 treatments in the experiment the results revealed that the mean number of larvae per meter row length of crop was in the range of (0.51 to 4.00). Least number of larvae per meter row length was recorded in spinosad (0.51) which was on par with cypermethrin 0.57, followed by lambda cyhalothrin (1.97) which was on par with *B. thuringiensis* (2.04), *M. anisopliae* (2.10), *N. rileyi* (2.64). Highest mean number of larvae per one meter row length of crop was recorded in pongamia oil (4.00) followed by malathion (3.90), *B. bassiana* (3.09). The yield data obtained after harvest of the crop indicated the maximum yield (12.02 q ha^{-1}) was recorded in spinosad followed by cypermethrin (11.53 q ha^{-1}). Among biorationals *N. rileyi* recorded highest yield (10.05 q ha^{-1}) followed by *B. thuringiensis* (9.80 q ha^{-1}).

Keywords: Spodoptera exigua, Nomuraea rileyi, Bacillus thuringiensis, Beauveria bassiana, Metarhizium anisopliae

Introduction
Chickpea (*Cicer arietinum* L.) is one of the major pulses cultivated and consumed in India. In the changing scenario, a number of insect pests which were of minor importance have attained a major status. One of such pest is *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae) is emerging as an important pest of chickpea, especially in South Central India where it is an economic pest of chickpea, larvae of which feed on the vegetative and reproductive stage causing highest foliage damage (36.56 per cent) especially in Raichur district (Nagabhushana, 2011). The young larvae of *S. exigua* initially feed gregariously on the chickpea foliage. As the larvae grow, they become solitary and continue to feed on the foliage and produce large, irregular holes on the leaves (Sharma *et al*., 2007). As a leaf feeder, the cutworm consumes much more chickpea tissues than the chickpea pod borer, *H. armigera*, but it has not been reported as a serious pest of pods. It is noticed particularly in chickpea during vegetative stage of the crop. Looking in to the severity of the pest in recent times, there is a need to manage pest at the field level, hence, an investigation of biorationals and new insecticides were used for the management of cutworm *S. exigua* on chickpea.

Material and methods
Field experiment was laid out in the randomized complete block design with three replications at Main Agricultural Research Station, Raichur during *Rabi*, 2016-17. There were ten treatments in the experiment *viz.*,T1- *Bacillus thuringiensis*, T2 - *Beauveria bassiana*, T3 - *Metarhizium anisopliae*, T4- *Nomuraea rileyi*, T5 - Pongamia oil, T6 - spinosad 45 SC, T7 - lambda cyhalothrin 2.5 EC, T8 - cypermethrin 10 EC, T9 - malathion 25% WP and T10 – Untreated control. Chickpea cultivar A1 was used for the experimentation and was sown with a spacing of 60 cm x 10 cm and plot size of 3m x 3m. Crop was raised according to package of practices except for plant protection measures. Observations on number of larvae on three randomly selected meter row length were recorded one day before to spraying and later the population was recorded at 7 and 10 days after spraying. Second spray was done after 10 days of last observation of first spray and similar observations were recorded. Data was subjected to Duncan's Multiple Range tests. Finally, yield data was recorded and the means were compared through ANOVA at 5 % level of significance.

Results and discussion

The results presented in Table 1 revealed that seven days after first application, the mean number of larvae per meter row length of crop was in the range of 0.51 to 4.00. Least number of larvae per meter row length was recorded in spinosad (0.51) which was on par with cypermethrin (0.57), followed by malathion (3.90), lambda cyhalothrin (1.97) which was on par with *B. thuringiensis* (2.04), *M. anisopliae* (2.10), *N. releyi* (2.64). Highest mean number of larvae per one meter row length of crop was recorded in pongamia oil (4.00) followed by *B. bassiana* (3.09). Ten days after first application, the mean number of larvae per one meter row length of crop was in the range of 0.14 to 2.23. Least number of larvae was recorded in spinosad (0.14) which was on par with cypermethrin (0.22) followed by malathion (0.98), lamda cyhalothrin (0.77) which was on par with *B. bassiana (*0.72), *M. anisopliae* (0.65) and *N. releyi* (0.65). Highest mean number of larvae per one meter row length of crop was recorded in pongamia oil (2.23) followed by *B. thuringiensis* (0.87).

Similarly seven days after in second spray, the mean number of larvae per meter row length of crop was in the range of 0.50 to 4.30. Least number of larvae was recorded in spinosad (0.50) which was on par with lambda cyhalothrin (0.57) followed by cypermethrin (0.87) which was on par with malathion (4.47) and *N. releyi* (2.53). Highest mean number of larvae per meter row length of crop was recorded in pongamia oil (4.32) followed by *M. anisopliae* (3.80). Ten days after second spray, the mean number of larvae per meter row length of crop was in the range of (0.14-2.88). Lowest number of larvae was recorded in spinosad (0.14), cypermethrin (0.25) and lambda cyhalothrin (0.25) and these treatments were on par with each other followed by malathion (0.77) which was on par with *N. releyi* (0.82) and *B. bassiana* (0.90). Highest larval population was recorded in pongamia oil (2.88) followed by *B. thuringiensis* (1.07) which was on par with *M. anisopliae* (1.07).

Finally the results pertaining to grain yield, the highest grain yield of (12.02 q ha^{-1}) was recorded in spinosad treatment followed by cypermethrin (11.53 q ha^{-1}), lambda cyhalothrin (10.57 q ha^{-1}), malathion (10.30 q ha^{-1}). Among biorationals maximum yield was recorded in *N. releyi* (10.05 q ha^{-1}) followed by *B. thuringiensis* (9.80 q ha^{-1}), *B. bassiana* (9.60 q ha^{-1}), *M. anisopliae* (9.52 q ha^{-1}). Lowest yield was recorded in pongamia oil (9.34 q ha^{-1}) (Table 1). Pongamia oil recorded least effective among the treatments but significant and superior over control. Hence the present results are in line with Abdul *et al.* (2003) [1] indicated spinosad as effective molecule against lepidopteran pests in chickpea. Patil and Abhilash (2014) [3] evaluated *N. rileyi* in soyabean indicated higher dosage of *N. rileyi i.e.,* 2 x10^8 as the ideal dose. In the present study *N. rileyi* at the rate of 1x10^8 also has given better results among other biopesticides. It is evident from the studies that among biorationals and insecticides evaluated against *S. exigua,* spinosad was most effective followed by cypermethrin and among biorationals, *N. rileyi* was effective followed by *B. thuringiensis*.

Conclusion

Among biorationals and insecticides evaluated against *S. exigua,* spinosad was most effective followed by cypermethrin, lambda cyhalothrin, malathion. And among biorationals *N. releyi,* was effective followed by *B. thuringiensis*.

Table 1: Field evaluation of efficacy of different biorationals and insecticides for the management of *S. exigua*

S. No.	Treatment details	Dosage	No. of larvae per meter row length					Yield (q/ha)
				First spray		Second spray		
			1 DBS	7 DAS	10 DAS	7 DAS	10 DAS	
1	*Bacillus thuringiensis*	1 ml /l	6.44 (2.63)	2.04 (1.59)^{cd}	0.87 (1.17)^{c}	1.7 (1.48)^{e}	1.07 (1.25)^{c}	9.80
2	*Beauveria bassiana*	2 ml /l	5.85 (2.52)	3.09 (1.89)^{bc}	0.72 (1.10)^{cd}	3.20 (1.92)^{cd}	0.90 (1.18)^{cd}	9.60
3	*Metarhizium anisopliae*	4 gm /l	4.72 (2.28)	2.10 (1.60)^{cd}	0.65 (1.07)^{cd}	3.80 (2.07)^{bc}	1.07 (1.25)^{c}	9.52
4	*Nomuraea rileyi*	1 gm /l	5.66 (2.48)	2.64 (1.77)^{cd}	0.65 (1.06)^{cd}	2.53 (1.73)^{d}	0.82 (1.15)^{cd}	10.05
5	Pongamia oil	20 ml /l	5.47 (2.44)	4.00 (2.12)^{b}	2.23 (1.65)^{b}	4.32 (2.19)^{b}	2.88 (1.84)^{b}	9.34
6	Spinosad 45 SC	0.12 ml /l	5.99 (2.55)	0.51 (1.00)^{f}	0.14 (0.80)^{f}	0.50 (1.00)^{h}	0.14 (0.80)^{e}	12.02
7	Lambda cyhalothrin 2.5 EC	0.5 ml /l	5.77 (2.50)	1.97 (1.56)^{cd}	0.77 (1.12)^{cd}	0.57 (1.03)^{gh}	0.25 (0.87)^{e}	10.57
8	Cypermethrin 10 EC	0.5 ml /l	5.57 (2.46)	0.57 (1.03)^{ef}	0.22 (0.85)^{ef}	0.87 (1.17)^{fg}	0.25 (0.87)^{e}	11.53
9	Malathion 25% WP	2 gm /l	5.73 (2.49)	3.90 (2.09)^{de}	0.47 (0.98)^{de}	1.20 (1.30)^{ef}	0.77 (1.12)^{d}	10.30
10	Untreated check		5.97 (2.54)	6.17 (2.58)^{a}	6.17 (2.58)^{a}	6.17 (2.58)^{a}	5.67 (2.48)^{a}	8.03
	S.EM ±			0.1	0.06	0.06	0.05	0.43
	CD (at 5%)		NS	0.29	0.19	0.19	0.14	1.28

DBS- Day before Spray, DAS- Days after Spray, Figures in parentheses are square root transformed values $\sqrt{x+0.5}$

Means followed by a common letters are not significantly different by DMRT (P=0.05)

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