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Research Note

Bioefficacy of different biopesticides against major foliage feeders on soybean [*Glycine max* (L.) Merrill]

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ABSTRACT: Field experiments were conducted to evaluate the efficacy of different biopesticides, *viz*., *Nomuraea rileyi* @ 1x10^8 conidia/lit, *Beauveria bassiana* @ 1x10^9 CFU/ml minimum @ 5 ml/lit, *Metarhizium anisopliae* @ 1x10^9 CFU/ml minimum @ 5 ml/lit, dipel @ 1 kg/ha, spinosad 45 SC @ 0.5 ml/lit, neem seed kernel extract (NSKE) @ 5% and neem oil @ 2% against foliage feeders of soybean namely, semi looper (*Chrysodeixis acuta*) and tobacco caterpillar (*Spodoptera litura*) during *Kharif*, 2016. The result revealed that all treatments were significantly superior over control. The mean larval population of *C. acuta* and *S. litura* ranged from 1.29 to 9.37 and 0.92 to 6.98 larvae per meter row length (mrl) at 3, 7 and 10 days respectively after the application of treatments. The treatments comprising Spinosad 45 SC @ 0.5 ml/lit proved highly effective in reducing the population of *C. acuta* and *S. litura* with lowest overall mean larval population of 4.71 and 3.02 larvae per mrl, respectively. Against *C. acuta* NSKE @ 5% was least effective and against *S. litura* neem oil was observed as least effective with maximum over all mean larval populations of 7.75 and 4.97, respectively.

KEY WORDS: Biopesticides, *Chrysodeixis acuta*, foliage feeders, soybean, *Spodoptera litura*

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Soybean, *Glycine max* (L.) Merill ranks first in the world for production of edible oil. India ranks third in the world in respect to the area and fifth in terms of production (Padiwal et al., 2008). It is an annual crop, fairly easy to grow, that produces more protein and oil per unit of land than almost any other crop. It is a versatile food plant that, used in its various forms, is capable of supplying most nutrients. It can substitute for meat and to some extent milk. It is a crop capable of reducing protein malnutrition. In addition, soybeans are a source of high value animal feed. The defoliators, *Spodoptera litura* and *Chrysodeixis acuta* are serious pests on soybean. The full grown caterpillars are the most voracious feeders and cause extensive damage by defoliation. The excessive and indiscriminate use of pesticide has caused several problems like development of resistance in targeted species, resurgence of secondary pest, elimination of natural enemies and wildlife, contamination of soil, water and food chain and wholesome pollution of the environment (Asokan *et al.,* 2000). Botanical pesticides are the important alternatives to minimize or replace the use of synthetic pesticides as they possess an array of properties including toxicity to the pest, repellency, anti-feedance, insect growth. Entomopathogens as biocontrol agents offer good and effective alternative to conventional insecticides. Keeping the above facts in mind this study was carried out to evaluate some commercially available eco-friendly microbial insecticides against *S. litura* and *C. acuta* in soybean so as assess their usefulness in combating these serious insect pests.

A field experiment was conducted on soybean crop during Kharif season 2016 -17 using variety JS 95-60 at village Falichadakhedi, Tehsil Mavli, District Udaipur, Rajasthan. The experiment was laid out in a randomized block design with seven treatments and three replications (Table 1). Three sprays of ecofriendly pesticides (commercial formulation) were applied on test crop on 25, 40 and 55 days after germination. *Beauveria bassiana* (Bio-Power), *Metarhizium anisopliae* (Bio-Magic) and neem oil (Nimbecidine) from M/s T Stanes & Company, *Bacillus thuringiensis* (Dipel) from M/s Sumitomo Chemicals and Spinosad (Spintor) from Bayer were used in the study. Neem seed kernel extract was pepared as per standard protocol (http://www.agritech.tnau.ac.in/org_farm/orgfarm_pestanddisease.html). The plot size was 1.8 x 2.0 m with spacing of 30 x 10 cm between rows and plants respectively

Table 1. Efficacy of microbial insecticides on green semilooper, *Chrysodeixis acuta* infesting soybean crop

Treatments	Pre-Trements	Mean of *C. acuta* larvae/mrl			
		3 DAS**	7DAS**	10 DAS**	Overall mean
T1- *Nomuraea rileyi**** @ 1×10⁸ Conidia/lit	8.76 (3.04)*	7.88 (2.89)*	4.98 (2.34)*	1.94 (1.56)*	4.93 (2.33)*
T2- *Beauveria bassiana**** 1×10⁹ CFU/ml minimum@5ml/lit	8.48 (3.00)*	7.80 (2.88)*	6.05 (2.56)*	3.49 (2.00)*	5.78 (2.51)*
T3- *Metarhizium anisopliae* *** 1×10⁹ CFU / ml minimum@5ml/lit	9.13 (3.10)*	8.60 (3.02)*	6.44 (2.63)*	3.36 (1.96)*	6.13 (2.58)*
T4- Dipel @ 1 Kg / ha	9.29 (3.13)*	8.55 (3.01)*	5.60 (2.47)*	2.43 (1.71)*	5.53 (2.45)*
T5- Spinosad 45 SC @ 0.5 ml /lit	9.18 (3.11)*	8.03 (2.92)*	4.82 (2.31)*	1.29 (1.34)*	4.71 (2.28)*
T6- Neem Seed Karnal Extracts @5%	9.37 (3.14)*	9.01 (3.08)*	7.51 (2.83)*	6.73 (2.69)*	7.75 (2.86)*
T7- Neem Oil @ 2%	8.88 (3.06)*	8.52 (3.00)*	7.06 (2.75)*	6.82 (2.71)*	7.47 (2.82)*
T8- Control (Untreated)	8.98 (3.08)*	9.60 (3.18)*	10.67 (3.34)*	10.18 (3.27)*	10.15 (3.26)*
SEM ±	0.034	0.032	0.028	0.022	0.028
CD (P = 0.05)	**0.102**	**0.098**	**0.086**	0.068	0.085

*Figures in parentheses are square root values; DAS= Days after spraying; **Mean of three sprays; NS= Non- significant; *** adding 0.2% Edible oil + 0.01% Sticker

and recommended agronomical practices were followed. Observations on larval population were recorded at 24 hours before treatment and 3rd, 7th and 10th days after treatment applications on one meter row length (mrl) at 5 random places in each plot by placing half meter scale between two rows. Data recorded on insect pest population were subjected to analyses of variance.

Green semilooper (*Chrysodeixis acuta*)

The data obtained from three sprays against larval population of *C. acuta*/mrl at 24 hrs before and 3rd, 7th and 10th days after treatments are presented in Table 1. The mean larval population *C. acuta*/mrl before treatment varied from 8.48 to 9.37. Three days after spray, *Beauveria bassiana* @ 1x10⁹ CFU/ml minimum @ 5 ml/lit recorded the least larval population (7.80 larvae/mrl) which was significantly superior over control (9.60 larvae/mrl). The application of treatments *Nomuraea rileyi* @ 1x10⁸ conidia/lit and spinosad 45 SC @ 0.5 ml/lit were found to be the next effective treatments which recorded 7.88 and 8.03 larvae per mrl, respectively. However, all the treatments were significantly superior over untreated check. At seventh day after the treatment mean larval population among different treatments were significantly reduced over control plots. Among the treatments, spinosad 45 SC @ 0.5 ml/lit was found to be the most effective as it recorded the minimum larval population (4.98 larvae/mrl) followed by *Nomuraea rileyi* (4.82 larvae/mrl), dipel (5.60 larvae/mrl), *Metarhizium anisopliae* (6.44 larvae/mrl) and neem oil (7.06 larvae/mrl). On tenth day after treatment all the treatments exhibited significantly lower population over control (10.18 larvae/mrl). Spinosad 45 SC was found to be the most effective (1.29 larvae/mrl), followed *N. rileyi* (1.94 larvae/mrl), dipel (2.43 larvae/mrl), *M. anisopliae* (3.36 larvae/mrl), *B. bassiana* (3.49 larvae/mrl), neem seed kernel extract (6.73 larvae/mrl). and neem oil (6.82 larvae/mrl). On the basis of overall mean the differences in larval population among different treatments were significant as compared to control. Among treatments, spinosad 45 SC @ 0.5 ml/lit was found to be the most effective as it recorded the lowest larval population (4.71), followed by *N. rileyi* (4.93), dipel 5.53), *B. bassiana* (5.78), *M. anisopliae* (6.13), neem oil (7.47), and neem seed kernel extract (7.75).

Tobacco caterpillar (*Spodoptera litura*)

A day before imposing the treatments, initial larval population of *S. litura* ranged from 5.55 to 6.98 larvae per mrl which were at par with each other (Table 2). At three days after spray *N. rileyi* @ 1x10⁸ conidia/lit recorded the least larval population (4.97 per mrl), which was significantly superior over the control and spinosad 45 SC @ 0.5 ml/lit was found to be the next effective treatment which recorded 5.42 larvae per mrl. However, all the treatments were significantly superior over untreated control, but *B. bassiana* @ 1x10⁹ CFU/ml recorded highest larval population of 6.42

Table 2. Efficacy of microbial insecticides on Tobacco caterpillar, *Spodoptera litura* infesting soybean crop

Treatments	Pre-Treatments	Mean of *C. acuta* larvae/mrl			
		3 DAS**	7DAS**	10 DAS**	Overall mean
T1- *Nomuraea rileyi**** @ 1×10[8] Conidia/lit	5.55 (2.46) *	4.97 (2.34) *	2.76 (1.81) *	1.68 (1.48) *	3.14 (1.91) *
T2- *Beauveria bassiana**** 1×10[9] CFU/ml minimum@5ml/lit	6.98 (2.73) *	6.42 (2.63) *	4.40 (2.21) *	2.18 (1.64) *	4.33 (2.20) *
T3- *Metarhizium anisopliae* *** 1×10[9] CFU/ml minimum@5ml/lit	5.82 (2.51) *	5.60 (2.47) *	3.90 (2.10) *	3.19 (1.92) *	4.23 (2.17) *
T4- Dipel @ 1 Kg/ha	6.69 (2.68) *	6.09 (2.57) *	3.57 (2.02) *	1.95 (1.57) *	3.87 (2.09) *
T5- Spinosad 45 SC @ 0.5 ml/lit	6.12 (2.57) *	5.42 (2.43) *	2.72 (1.79) *	0.92 (1.19) *	3.02 (1.88) *
T6- Neem Seed Karnal Extracts @5%	5.88 (2.53) *	5.64 (2.48) *	4.65 (2.27) *	4.52 (2.24) *	4.94 (2.33) *
T7- Neem Oil @ 2%	6.01 (2.55) *	5.74 (2.50) *	4.63 (2.26) *	4.56 (2.25) *	4.97 (2.34) *
T8- Control (Untreated)	6.67 (2.68) *	7.88 (2.89) *	8.88 (3.06) *	9.95 (3.23) *	8.90 (3.07) *
SEM ±	0.028	0.027	0.024	0.020	0.018
CD (*P*=0.05)	0.084	0.082	0.073	0.060	0.055

*Figures in parentheses are square root values; DAS = Days after spraying; ** Mean of three sprays; NS = Non- significant; *** adding 0.2% Edible oil + 0.01% Sticker

larvae/mrl. At 7 and 10 days after spraying spinosad 45 SC @ 0.5 ml/lit recorded the lowest larval population (2.72 and 0.92 l/mrl, respectively) over untreated control which was significantly superior over all the treatments. Untreated control recorded significantly higher population (8.88 and 9.95 larvae/mrl, respectively). On the basis of overall mean of 3 rd, 7th and 10th day after spraying all the treatments exhibited significantly low mean larval population of *S. litura* as compared to control. Among these treatments spinosad 45 SC @ 0.5 ml/lit was found to be most effective as it recorded the lowest larval population (3.01 larvae/mrl, respectively) as compared to untreated control. This was followed by *N. rileyi* (3.14), dipel (3.87), *M. anisopliae* (4.23), *B. bassiana* (4.33) and neem seed kernel extract (4.94) with significant differences between the treatments. Neem oil proved to be least effective treatment against *S. litura*.

After introduction of the soybean crop to India during 1970s, there were no major pests infesting this crop and was harvested with minimum use of chemical insecticides. During the last two decades the crop has been suffering from many pests. Among the insect pests, leaf eating caterpillars play a key role in reducing yield. Suppression of soybean pest by regular means of using pesticides has led to many health and environmental hazards and further use resulted into insecticide resistance problem which deteriorated the situation leading to outbreak of pests. Alternate crop protection methods are gaining interest in order to have sustainable management tactics against many insect pests in field crops and horticultural crops. The soybean pests, *viz*., *C. acuta* and *S. litura*, are major constraints for soybean production.

Among all the treatments, the significantly lower overall mean population of *C. acuta* was recorded in the plots treated with spinosad 45 SC and the next effective treatment was *N. rileyi*. However, all the microbial insecticide treatments were significantly superior over untreated check, whereas maximum larval population was recorded in plots treaded with NSKE5% after untreated check. Similar findings have been reported against American boll worm in cotton, castor semi-looper, tobacco caterpillar, diamond back moth and paddy stem borer (Ranga Rao *et al.*, 2007; Selvaraj and Kaushik, 2013), whereas, the efficacy of *B. bassiana* have been reported against *C. acuta* in soybean (Sharma and Ansari, 2007). Hall *et al.* (2000) reported highest mortality of soybean looper (*Photedes includens*) when applied with spinosad at 0.012 and 0.025 lb ai/ acre. Knight *et al.* (2000) reported that spinosad had good potential to control soybean looper.

The observations on *S. litura* larval population was also recorded and it is found that the most effective treatment was spinosad 45 SC against followed by *N. rileyi* and both were significantly superior over the remaining treatments. The maximum overall mean larval population was recorded in plots treated with neem oil @ 2% after untreated plots. The present findings are in conformity with several workers such as Harish (2008) who found that spinosad was effective against *S. litura*, while Jat and Ameta (2013) observed spinosad 45% SC at 200 ml/ha with 74.67 per cent mean reduction in fruit borer. Gadhiya *et al*. (2014) also found spinosad (0.018%) effective in protecting the groundnut crop from the infestation of *S. litura*.

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