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Effect of Spinetoram 11.7 SC and some Newer Chemicals against *Spodoptera litura* (F.) on Soybean

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ABSTRACT: Soybean is a wonder crop with innumerable uses in various industries as it is contributing 20% edible oil and 40% protein. However, management using chemicals is one of the mainstream steps taken in keeping defoliators below ETL. The usage of selective or newer insecticides show a reduced impact on beneficial insects. In the present situation, the experiment was conducted in farmer field in Nizamabad district in *Kharif* season during the years 2019 and 2020. The effect of spinetoram 11.7 SC and different newer insecticide molecules and were evaluated against *Spodoptera litura* and their effect on natural enemies under field conditions along with the effect on yield of crop. The insecticides *viz.*, Spinetoram 11.7 SC, Flubendiamide 480 SC, Chlorantraniliprole 18.5 SC, 5 SG, Spinosad 45 SC and Thiodicarb 75 WP were used. The observations on no. of larvae per meter row length and natural enemy population was taken. The results showed that spinetoram 11.7 SC when applied at both 0.7ml/l and also at 0.5ml/l recorded the lowest larval population 0.17 and 0.25 larvae/mrl. The highest number of natural enemy population was recorded in the treatments flubendiamide and chlorantraniliprole. The maximum net returns of Rs. 26,792.67 per hectare was obtained from spinetoram 11.7 SC @ 0.7ml/l followed by spinetoram 11.7 SC @ 0.5ml/l (Rs.21,455.33), flubendiamide 480 @ 0.6ml/l (Rs.16,491.5) respectively.

Keywords: insecticides, *Spodoptera litura,* assassin bug, spider, coccinellid, spinetoram, flubendiamide, chlorantraniliprole.

INTRODUCTION

Soybean is one of the world's major edible oilseed crop. Soybean is one of the most important oilseed crop useful for oil extraction as well as providing a dietary supplement for protein. It is a major source of edible oil (20%) and high quality protein (40%). In many countries, soybean has become an important foodstuff as corn and is hence now encouraged to produce in larger fields. Soybean originated in Asia and is the first known archives, indicated that it was a farm crop in China since the 11th century. The soybean crop cultivation is one among the noteworthy success stories in Indian agriculture. It is one of the important major oilseed cash crops of India and covers about 36% of the cultivated area in India. It is a golden crop which is useful in multiple ways. Its oil was useful as raw materials in manufacturing antibiotics, varnishes, paints, etc. Soybean meal is used as protein source for human diet and livestock feed (Bangale *et al.,* 2020). In India, soybean is grown in an area of 10.60 M ha with production of 8.50 MT and productivity of 802 kg/ha, in which Madhya Pradesh is the leading producer of soybean occupying an area of 5.01M ha with the production of 4.20 MT and productivity of 838 kg/ha (ICAR-IISR, 2017a).

The soybean crop is subjected to damage at various growth stages by different pests. Among them lepidopteran pests *viz.*, Tobacco caterpillar (*Spodoptera litura*), Bihar hairy caterpillar (*Spilosoma oblique*), Green semilooper (*Plusiaorichalcea*), Pod borer (*Helicoverpa armigera*), etc, infesting crops are likely to cause 25% yield losses by directly feeding on leaves and pods. Where, Tobacco caterpillar (*Spodoptera litura* F.) is one of the major defoliator pest seen in soybean and castor is the most preferred crop by the pest Sujatha *et al.*, (2011); Gayr and Mogalapu (2018). *Spodoptera litura* is a noctuid moth which lays eggs in masses of 400-500 eggs clusters and incubation period is 3 to 4 days. The larvae are initially gregarious and later migrate and become solitary. The mature larvae feed on the leaves, buds, flowers and pods of the plant and cause complete defoliation which cause significant yield losses (Punithavalli *et al.,* 2013). Yield losses in soybean were a direct indicative of higher larval population and higher defoliation of crop. The use of chemicals in managing *Spodoptera litura* remains as one of the main methods in preventing and managing the insect pest level below ETL within short span of time. Usually in the past broad spectrum insecticides were considered in managing defoliators such as organochlorines, carbamates, organophosphates and synthetic pyrethroids. Though the pest resistence and pesticide residues are unavoidable (Wang *et al.,* 2019). The quest for managing these pests for increasing the yield has made insecticides play a major role and their safety towards the other fauna of the agro-ecosystem i.e. non-target organisms is also equally important.

MATERIAL AND METHODS

The field experiment was laid out during *Kharif* season during the years 2019 and 2020 in a randomized block design having a plot size of 7m × 3m at a farmer's field located at Hegdoli village, Kotagirimandal, Nizamabad district, Telangana. The cultivar JS-335 was sown in the field during 24th June, 2019 and 28th June, 2020 with all the recommended crop production practices were followed except plant protection practices. Seven treatments including control were present in the Table 1.

Table 1: List of insecticide.

Treatments	Dose (ml/l or g/l)
Spinetoram 11.7 SC	0.7
Spinetoram 11.7 SC	0.5
Chlorantraniliprole 18.5 SC	0.3
Flubendiamide 39.35 SC	0.6
Spinosad 45 SC	0.4
Thiodicarb 75 WP	1.0
Control	—

The treatments were applied with help of manually operated knapsack sprayer and the entire crop season accounted for two sprayings. The observations on *Spodoptera litura* population and natural enemies populations at 3, 7 and 14 days after spraying. The population of *Spodoptera* was recorded at three random selected spots of one meter row length in each treatment leaving border rows. Larval count was made by gently shaking the plant while a white cloth was placed in between the rows. The yield obtained was recorded and the populations of *Spodoptera,* natural enemies and yield were statistically analysed (Mishra and Gupta, 2017).

RESULTS AND DISCUSSION

The results of pooled 2019 and 2020 are presented in Table 2 and 3. The larval population in all the treatments was uniform at one day before imposition of treatments as indicated by the non-significant differences among the various treatments. At fourteen days after spraying, the least larval population was noticed in spinetoram 11.7 SC @ 0.7ml/l which was at par with spinetoram 11.7 SC @0.5ml/l (0.17 and 0.25 larvae/mrl). The next best treatment was flubendiamide 480 SC @ 0.6 ml/l (0.33 larvae/mrl) and spinosad 45 SC @ 0.4ml/l (0.40 larvae/mrl) which were on par with each other and the first insecticide differed significantly with all other treatments. Significantly higher larval population was noticed in thiodicarb 75 WP @ 1g/l (0.53 larvae/mrl) was at par with chlorantraniliprole 18.5 SC @ 0.3ml/l (0.70 larvae/mrl) but superior over untreated check (4.44 larvae/mrl). At the end of spray, the per cent protection over control was maximum in spinetoram 11.7 SC @ 0.7ml/l (78.94%) followed by spinetoram 11.7 SC @ 0.5ml/l (77.63%), flubendiamide 480 SC @ 0.6 ml/l (75.26%), spinosad 45 SC @ 0.4 ml/l (73.15%) and thiodicarb 75 WP @ 0.2 ml/l (70%). The lowest protection against *Spodoptera litura* was recorded by chlorantraniliprole 18.5 SC @ 0.3 ml/l (63.42%) (Table 2).

Table 2: Effect of insecticides on *Spodoptera litura* population on soybean during 2019 and 2020.

Treatments	1dbs	14das	14das	Mean	% protection
Spinetoram 11.7 SC @0.7ml/l	3.36 (1.96)	0.53 (1.02)	0.17 (0.82)	0.80 (1.07)	78.94%
Spinetoram 11.7 SC @ 0.5ml/l	3.14 (1.91)	0.67 (1.08)	0.25 (0.86)	0.85 (1.11)	77.63%
Chlorantraniliprole 18.5 SC @0.3ml/l	3.23 (1.93)	1.39 (1.37)	0.70 (1.09)	1.39 (1.35)	63.42%
Flubendiamide 39.35 SC @0.6ml/l	3.05 (1.88)	0.79 (1.14)	0.33 (0.91)	0.94 (1.16)	75.26%
Spinosad 45 SC @0.4ml/l	3.05 (1.88)	0.86 (1.17)	0.40 (0.95)	1.02 (1.20)	73.15%
Thiodicarb 75 WP @ 1g/l	2.95 (1.86)	0.97 (1.21)	0.53 (1.01)	1.14 (1.25)	70%
Control	3.24 (1.93)	3.98 (2.12)	4.44 (2.22)	3.80 (2.07)	—
SEM	**0.021**	**0.033**	**0.026**	**0.065**	—
CD @5%	**NS**	**0.102**	**0.082**	**0.187**	—

Figures in parenthesis were square root transformed ( ); NS – Non-significant; dbs – days before spraying; das- days after spraying

Natural enemies: At fourteen days after spraying, the assassin bug population ranged from 0.91 to 0.05 bug/plant among the treatments apart from control (2.59 bug/plant). The highest population was recorded in flubendiamide 480SC @ 0.6ml/l with 0.91 bug/plant which was also statistically at par with spinetoram 11.7 SC @ 0.5ml/l, chlorantraniliprole 18.5 SC @ 0.3ml/l, spinetoram 11.7 SC @0.7ml/l and spinosad 45 SC @0.4ml/l (0.70, 0.54. 0.11 and 0.10 bug/plant). The lowest population was recorded in thiodicarb 75 WP @ 1g/l (0.05 bug/plant). At fourteen days after spraying, the spider population ranged from 1.25 to 0.09 spider/plant among the treatments apart from control (2.59 spider/plant). The highest population recorded in treatments, chlorantraniliprole 18.5 SC @ 0.3ml/l with 1.25 spider/plant which was statistically at par with spinetoram 11.7 SC @ 0.5ml/l, flubendiamide 480 SC @ 0.6ml/l, spinetoram 11.7 SC @ 0.7ml/l, spinosad 45 SC @ 0.4ml/l with 1.12, 1.09, 0.69 and 0.65 spider/plant. The lowest population was recorded in thiodicarb 75 WP 1g/l (0.09 spider/plant) .At fourteen days after spraying, the coccinellid population ranged from 1.87 to 0.48 beetles/plant among the treatments apart from control (3.33 beetle/plant). The highest population was recorded in chlorantraniliprole 18.5 SC @ 0.3ml/l with 1.87 beetle/plant which was statistically at par with flubendiamide 480 SC @ 0.6ml/l, spinetoram 11.7 SC @ 0.5ml/l and spinetoram 11.7 SC @ 0.7ml/l with 1.57, 1.51 and 1.27 beetle/plant. The lowest population was recorded in thiodicarb 75 WP 1g/l (0.48 beetle/plant) which is also at par with spinosad 45 SC @0.4ml/l with 0.62 beetle/plant (Table 3).

Table 3: Effect of insecticides on natural enemies on soybean during 2019 and 2020.

Treatments	1DBS			14das			14das		
	Assassin bug	Spider	Coccinellid (*M. sexmaculata*)	Predatory bug	Spider	Coccinellid (*M. sexmaculata*)	Predatory bug	Spider	Coccinellid (*M. sexmaculata*)
Spinetoram 11.7 SC @0.7ml/l	2.15 (1.62)	1.67 (1.47)	3.60 (2.00)	0.33 (0.90)	0.97 (1.21)	2.57 (1.75)	0.11 (0.78)	0.69 (1.07)	1.27 (1.33)
Spinetoram 11.7 SC @ 0.5ml/l	2.19 (1.63)	1.99 (1.56)	3.71 (2.03)	1.29 (1.32)	1.51 (1.41)	3.32 (1.93)	0.70 (1.09)	1.12 (1.24)	1.51 (1.40)
Chlorantraniliprole 18.5 SC @0.3ml/l	1.83 (1.50)	1.69 (1.46)	4.11 (2.14)	1.20 (1.27)	1.44 (1.39)	3.77 (2.06)	0.54 (1.01)	1.25 (1.31)	1.87 (1.53)
Flubendiamide 39.35 SC @0.6ml/l	2.19 (1.60)	1.72 (1.47)	3.82 (2.07)	1.35 (1.29)	1.51 (1.41)	3.30 (1.94)	0.91 (1.15)	1.09 (1.26)	1.57 (1.43)
Spinosad 45 SC @0.4ml/l	2.61 (1.76)	1.88 (1.51)	3.98 (2.11)	0.39 (0.94)	1.02 (1.23)	1.87 (1.51)	0.10 (0.77)	0.65 (1.06)	0.62 (1.03)
Thiodicarb 75 WP @ 1g/l	2.49 (1.70)	1.54 (1.42)	3.93 (2.10)	0.20 (0.83)	0.98 (1.21)	1.16 (1.29)	0.05 (0.74)	0.09 (0.76)	0.48 (0.99)
Control	2.83 (1.78)	1.84 (1.52)	4.05 (2.13)	3.46 (1.94)	2.25 (1.66)	4.65 (2.27)	3.82 (2.05)	2.59 (1.74)	3.33 (1.94)
SEM	**0.102**	**0.058**	**0.056**	**0.126**	**0.050**	**0.131**	**0.104**	**0.116**	**0.132**
CD @5%	**NS**	**NS**	**NS**	**0.392**	**0.154**	**0.408**	**0.323**	**0.331**	**0.410**

Figures in parenthesis were square root transformed ( ); NS – Non-significant, dbs – days before spraying; das- days after spraying

Among the different treatments, spinetoram 11.7 SC @ 0.7ml/l registered maximum seed yield 17.38 q/ha); the next in order were spinetoram 11.7 SC @ 0.5 ml/l (15.53 q/ha), flubendiamide 480 SC @ 0.6 ml/l (15.32 q/ha), spinosad 45 SC @ 0.4 ml/l (13.83 q/ha), thiodicarb 75 WP @ 1 g/l (12.60 q/ha) The first insecticide differed significantly from rest of the treatments. The untreated control recorded least seed yield (9.40 q/ha) which was significantly inferior to all other treatments. In case of percent increased yield spinetoram 11.7 SC @ 0.7ml/l recorded 84.97 per cent increase in yield over untreated check followed by spinetoram 11.7 SC @ 0.3ml/l and flubendiamide 480 SC @ 0.6 ml/l with 65.30 and 63.01 per cent increase in yield over control. The lowest yield was recorded in chlorantraniliprole 18.5 SC @ 0.3 ml/l (11.80 q/ha) and untreated control (9.40 q/ha) (Table 4).

The maximum net returns of Rs.26,792.67 per hectare was obtained from spinetoram 11.7 SC @ 0.7ml/l followed by spinetoram 11.7 SC @ 0.5ml/l (Rs.21,455.33), flubendiamide 480 @ 0.6ml/l (Rs.16,491.5), spinosad 45 SC @ 0.4ml/l (Rs.12,462), thiodicarb 75WP @ 1g/l (Rs.12,231.30). The lowest net returns were obtained by chlorantraniliprole 18.5 SC @ 0.3ml/l (Rs.9,912) (Table 5). With regard to the economics of the insecticidal treatments, from spinetoram11.7 SC @ 0.7ml/l recorded the highest cost benefit ratio of 1.75 followed by from spinetoram 11.7 SC @ 0.5ml/l (1.62), flubendiamide 480 SC @0.6ml/l (1.43) were the next best treatments. The lowest was recorded in and chlorantraniliprole 18.5 SC @ 0.3ml/l (1.31) (Table 5).

Table 4: Seed yield.

Treatments	Yield (q/ha)	% increase over control
Spinetoram 11.7 SC @0.7ml/l	17.38 (4.23)	84.97
Spinetoram 11.7 SC @ 0.5ml/l	15.53 (4.00)	65.30
Chlorantraniliprole 18.5 SC @0.3ml/l	11.80 (3.51)	25.55
Flubendiamide 39.35 SC @0.6ml/l	15.32 (3.98)	63.01
Spinosad 45 SC @0.4ml/l	13.83 (3.79)	47.21
Thiodicarb 75 WP @ 1g/l	12.60 (3.62)	34.06
Control	9.40 (3.14)	0.00
SEM	**0.036**	—
CD @5%	**0.112**	—

Figures in parenthesis were square root transformed ( )

Table 5: Cost economics on soybean for 2019 and 2020.

Treatments	Seed yield (kg/ha)	Cost of cultivation	Gross returns	Net returns	B:c ratio
Spinetoram 11.7 SC @0.7ml/l	1738	35,735.33	62,528	26,792.67	1.75
Spinetoram 11.7 SC @ 0.5ml/l	1553	34,392.67	55,848	21,455.33	1.62
Chlorantraniliprole 18.5 SC @0.3ml/l	1179.5	32,626	42,538.5	9,912.5	1.31
Flubendiamide 39.35 SC @0.6ml/l	1531.5	38,578	55,069.5	16,491.5	1.43
Spinosad 45 SC @0.4ml/l	1383	37,276	49,738	12,462	1.33
Thiodicarb 75 WP @ 1g/l	1259.5	33,137.2	45,368.5	12,231.3	1.37
Control	939.5	31,036	33,848.5	2,812.5	1.09

Field View

Living and dead larvae found in field

Natural enemies found in field

Damaged and healthy pods

These results are also in agreement with findings of Muthukrishnan *et al.,* (2013); Natikar *et al.,* (2016ab); Mishra and Gupta (2017); Pramod Sasvihalli *et al.,* (2017); Nayaka *et al.,* (2018); Bokan *et al.,* (2020) who reported that spinetoram, flubendiamide and chlorantraniliprole reduced larval population of *Spodoptera litura* as well as conserved natural enemies along with imparting high returns.

FUTURE SCOPE

In the current scenario of pest management strategies, the development of resistance to the insecticides has become the biggest challenge. Therefore, the need for implementing the usage of newer insecticide molecules for effective control is the need of the hour. As, newer molecules differ with their mode of action could be a promising option to handle the situation. The new molecule spinetoram 11.7 SC was found to be most toxic and effective in managing the pest, alongside of this flubendiamide 39.35 SC and chlorantraniliprole 18.5 SC were found to be conserving natural enemy populations. The susceptibility of *Spodoptera litura* to these chemicals on various crops has not been found. Thereby, time to time monitoring of the susceptibility status of these newer molecules at field level need to be examined regularly. As, farmers depend upon newer insecticides than conventional management options under the current farming scenario

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Conflict of Interest. None.

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