Int.J.Curr.Microbiol.App.Sci (2020) *9*(12): 1697-1708

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 12 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.912.202

Bio-efficacy of Different Insecticides against *Spodoptera litura* on Groundnut

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A B S T R A C T

Keywords

Bio-efficacy, Different insecticides, *Spodoptera litura*

Article Info

Accepted:
12 November 2020
Available Online:
10 December 2020

The present field experiment were conducted to evaluate "Bio-efficacy of different insecticides against *Spodoptera litura* on groundnut" under field condition during *Kharif* season of 2019 at research farm of Oilseed Research Station, Latur, Maharashtra, India. The observations on total number of *Spodoptera litura* were recorded on top, middle and bottom leaves of five randomly selected plants from each treatment at one day before and 3, 7, and 14 days after first and second application of insecticides. The treatments of different insecticides *viz.*, Chlorantranilliprole 0.0185 per cent, Indoxacarb 0.01 per cent, Emamectin benzoate 0.002 per cent, Cypermethrin 0.002 per cent, Profenophos 0.1 per cent and Quinalphos 0.005 per cent were evaluated against *Spodoptera litura* revealed that among all the insecticides chlorantranilliprole 0.0185 per cent was found most effective for managing gram pod borer larvae population followed by indoxacarb 0.01 per cent, emamectin benzoate 0.002 per cent, cypermethrin 0.002 per cent, profenophos 0.1 per cent and quinalphos 0.005 per cent. Significantly higher seed yield (3286 kg/ha) of groundnut was recorded in treatment chlorantranilliprole 0.0185 per cent however, it was found at par with treatment Indoxacarb 0.01 per cent (3133 kg/ha). The highest ICBR (1:5.02) was recorded with treatment chlorantranilliprole 0.0185 per cent which was followed by Indoxacarb 0.01 per cent (1:4.91).

Introduction

Groundnut (*Arachis hypogaea* L.), is an important oilseed and ancillary food crop of the world belongs to genus *Arachis* tribe Aechynomenae, family Fabaceae, is a tetra foliate legume crop with yellow sessile flowers and subterranean pods. It is native of South America. It is a valuable cash crop for millions of small scale farmers in the semi-arid tropics and is the principle oilseed crop in India. The groundnut seeds are rich source of edible oil (48 to 50 per cent), protein (26 to 28 per cent) and also a valuable source of dietary fiber, minerals and vitamins namely B, E and K (Smith, 2002) [33]. Among the total fatty acid in groundnut oil Oleic acid and linoleic acid accounts for 75 to 80 per cent of the total fatty acid in groundnut oil (Mercer *et al.*, 1990) [23]. It is also known as 'Indian Almond' and eaten as roasted or boiled. After the oil extraction groundnut cake is a high protein animal feed and haulm provides quality fodder. A variety of value products like peanut butter, chikki, milk, burfi, bhujia and biscuits are made from groundnut. The groundnut shell used in industries as fuel, filler in fertilizers and in extraction of mustard facilitates better recovery and low energy consumption.

World's statistics revealed that India has the largest groundnut growing area in the world and is the second largest producer after china. Gujarat, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka and Maharashtra are the major groundnut growing states of India and together account for about 90% of the national area under groundnut. In India, groundnut crop is cultivated in *Kharif, Rabi* and summer seasons grown in an area of about 5.06 m ha with the production of 8.05 mt and productivity of 1583 kg/ha. In Maharashtra, the area under groundnut cultivation was 1.95 lakh hectare with production of 2.66 lakh metric tons and productivity comprises 883 kg per hectare (Anonymous, 2018) [5].

The biggest threat to groundnut cultivation is the vulnerable wide spread attack by more than 115 insects have been reported to occur on groundnut in India and few are quite destructive and reduce the yield considerably. The crop annually incurs losses amounting to Rs. 238 crores due to insect-pests and diseases (Dutta *et al*., 2020) [13]. Insect pests of groundnut causes damage in both field and storage conditions. Of these, *Spodoptera litura*, *Aproaerema modicella*, white grub, thrips, aphid, jassids, gram caterpillar, red hairy caterpillar and termites are found to be economically important. Possible yield losses due to *Aproaerema modicella* are estimated 49.56 per cent, Jassids 40 per cent, aphid 16-40 per cent, thrips 17-40 per cent, red hairy caterpillar 26-75 per cent. Tobacco caterpillar, *Spodoptera litura* is one of the important pest which is polyphagous and occur regularly in the field. *Helicoverpa armigera* and *Spodoptera litura* causes about 26 to 100 % yield loss under field conditions (Dhir*et al*., 1992) [11]. *Helicoverpa armigera* and *Spodoptera litura* are reported to cause damage on more than 180 crops (Islam *et al*., 2007) [19]. Hairy caterpillar are widely distributed in Asia and Africa and it is polyphagous insect pest of groundnut, the larvae of hairy caterpillar, feed on groundnut leaves, buds and flowers (Rangarao and Rao, 2013) [29]. Amongst which *Aproaerema modicella* Deventer, *Amrasca biguttula biguttula*, *Spodoptera litura* Fabricus, *Helicoverpa armigera* Hubner, *Aphis craccivora* Koch, *Scirtothrips dorsalis* H. are considered as important destructive pests on groundnut (Amin and Mohammad, 1980) [4].

Spodoptera litura larvae feed gregariously scraping the chlorophyll soon disperse. Later stages feed voraciously on the foliage at night, hiding usually in the soil around the base of the plants during the day

Materials and Methods

The studies on "Bio-efficacy of different insecticides against *Spodoptera litura* on groundnut" were conducted during *Kharif* season 2019 at Oilseed Research Station, Latur, Maharashtra, India. The experiment was conducted in a randomized block design (RBD) with seven treatments including untreated control with three replications. Groundnut crop was sown on 31 July, 2019 in a gross plot of 4.2m x 5 m maintaining net plot of 3.6 m x 4.8m. The row to row distance of 30 cm and plant to plant distance of 10 cm was maintained. The dose of fertilizer at the rate of 20 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare was given at the time of sowing. The crop was grown under protective irrigation. The treatments of different insecticides *viz*., Chlorantranilliprole 0.0185 per cent, Indoxacarb 0.01 per cent, Emamectin benzoate 0.002 per cent, Cypermethrin 0.002 per cent, Profenophos 0.1 per cent and Quinalphos 0.005 per cent were applied on appearance of lepidopteran pests and subsequent spray were given at 15 days interval using manually operated knapsack sprayer. The observations on total number of *Spodoptera litura* larvae was recorded per five plant from each on top, middle and bottom leaves of five randomly selected plants from each treatment at one day before treatment and 3, 7, and 14 days after first and second application of insecticides.

Results and Discussion

The bio-efficacy data regarding *Spodoptera litura* during *Kharif* 2019 on groundnut.

Spodoptera litura

First spray

The effect of different insecticides on population of *Spodoptera litura* on groundnut after first spray are presented in Table 1 and depicted in Fig. 1. The results revealed that all the insecticides were found significantly superior over untreated control in reducing larval population of *Spodoptera litura* at 3, 7, and 14 days after first spray application.

At three day after first spray, significantly minimum larval population of *Spodoptera litura* (1.07 larvae/five plant) was recorded from the plots treated with treatment T2 i.e. Chlorantranilliprole 18.5 SC @ 0.0185 per cent. The next effective treatment was treatment T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (3.13 *Spodoptera litura* larvae /five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @ 0.002 per cent (4.67 *Spodoptera litura* larvae/five plant) in reducing *Spodoptera litura* larvae population. The subsequent order of effectiveness was treatment T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (5.67 *Spodoptera litura* larvae/five plant) and treatment T5 i.e. Profenophos 50 EC @ 0.1 per cent (6.33 *Spodoptera litura* larvae/five plant). These three treatments were found statistically at par with each other. The next best treatment observed was treatment T1 i.e. Quinalphos 25 EC @ 0.05 per cent which recorded 7.00 *Spodoptera litura* larvae/five plant. Significantly highest spodoptera population (9.67 *Spodoptera litura* larvae/five plant) was observed in treatment T7 i.e. untreated control.

At seven days after first spray the treatment T2 i.e. Chlorantraniliprole 18.5 SC 0.0185 per cent observed significantly effective in minimizing *Spodoptera litura* larvae population (2.40 larvae/five plant). The next effective treatment was T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (5.60 *Spodoptera litura* larvae/five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @ 0.002 per cent (7.00 *Spodoptera litura* larvae/five plant) in reducing *Spodoptera litura* larvae population. Both these T4 and T6 treatments were found statistically at par with each other. The subsequent order of effectiveness was treatment T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (8.33 *Spodoptera litura* larvae/five plant). The next effective treatment was T5 i.e. Profenophos 50 EC @ 0.1 per cent (9.00 *Spodoptera litura* larvae/five plant). These three treatments i.e. T6, T3 and T5 were statistically at par with each other. The subsequent order of effectiveness was treatment T1 i.e. Quinalphos 25 EC @ 0.05 per cent (10.67 *Spodoptera litura* larvae/five plant) and both these T5 and T1 were found statistically at par with each other. While the highest population of 14.33 *Spodoptera litura* larvae/five plant was recorded in treatment T7 i.e. untreated control.

Table.1 Effect of different insecticides on the population of *Spodoptera litura* on groundnut (After first spray)

Tr. No.	Treatment	Concentration used (%)	Mean population of *Spodoptera litura* larvae per five plant			
			1 day before Spraying	Days after spraying		
				3	7	14
T1	Quinalphos 25 EC	0.005	16.27 (4.09)*	7.00 (2.73)	10.67 (3.31)	**11.67 (3.46)**
T2	Chlorantranilliprole 18.5 SC	0.0185	11.20 (3.42)	1.07 (1.25)	2.40 (1.70)	**2.67 (1.77)**
T3	Cypermethrin 10 EC	0.002	14.13 (3.81)	5.67 (2.48)	8.33 (2.97)	**9.33 (3.13)**
T4	Indoxicarb 15.8 SC	0.02	13.80 (3.76)	3.13 (1.91)	5.60 (2.47)	**6.13 (2.57)**
T5	Profenophos 50 EC	0.1	15.40 (3.98)	6.33 (2.61)	9.00 (3.08)	**9.47 (3.16)**
T6	Emamectin benzoate 5 WDG	0.002	13.67 (3.76)	4.67 (2.27)	7.00 (2.73)	**7.00 (2.74)**
T7	Untreated Control	-	13.60 (3.72)	9.67 (3.18)	14.33 (3.84)	**14.67 (3.88)**
	S.E. ±		0.246	0.117	0.154	**0.173**
	C.D. at 5%		NS	0.356	0.466	**0.526**
	C.V. (%)		**11.22**	**8.66**	**9.27**	**10.15**

*Figures in parentheses are square root(x + 0.5) transformed values. NS: Non significant

Table.2 Effect of different insecticides on the larval population of *Spodoptera litura* on groundnut (After second spray)

Tr. No.	Treatment	Concentration used (%)	Mean population of *Spodoptera litura* larvae per five plant			
			1 day before Spraying	Days after spraying		
				3	7	14
T1	Quinalphos 25 EC	0.005	13.53 (3.73)*	10.33 (3.29)	11.33 (3.43)	**11.67 (3.47)**
T2	Chlorantranilliprole 18.5 SC	0.0185	13.20 (3.70)	1.13 (1.28)	1.60 (1.44)	**2.93 (1.85)**
T3	Cypermethrin 10 EC	0.002	15.67 (4.02)	5.33 (2.41)	7.67 (2.85)	**8.67 (3.02)**
T4	Indoxicarb 15.8 SC	0.02	13.87 (3.78)	3.27 (1.93)	3.73 (2.05)	**5.33 (2.41)**
T5	Profenophos 50 EC	0.1	13.40 (3.69)	5.93 (2.53)	8.27 (2.95)	**10.00 (3.23)**
T6	Emamectin benzoate 5 WDG	0.002	13.33 (3.71)	3.93 (2.10)	5.67 (2.46)	**7.67 (2.84)**
T7	Untreated Control	-	13.96 (3.79)	12.00 (3.52)	13.00 (3.67)	**15.00 (3.93)**
	S.E. ±		0.231	0.141	0.167	**0.156**
	C.D. at 5%		NS	0.427	0.506	**0.473**
	C.V. (%)		**10.59**	**10.01**	**10.73**	**9.107**

*Figures in parentheses are square root ($\sqrt{x + 0.5}$) transformed values. NS: Non significant

Fig.1 Effect of different insecticides on the larval population of *Spodoptera litura* (After first spray)

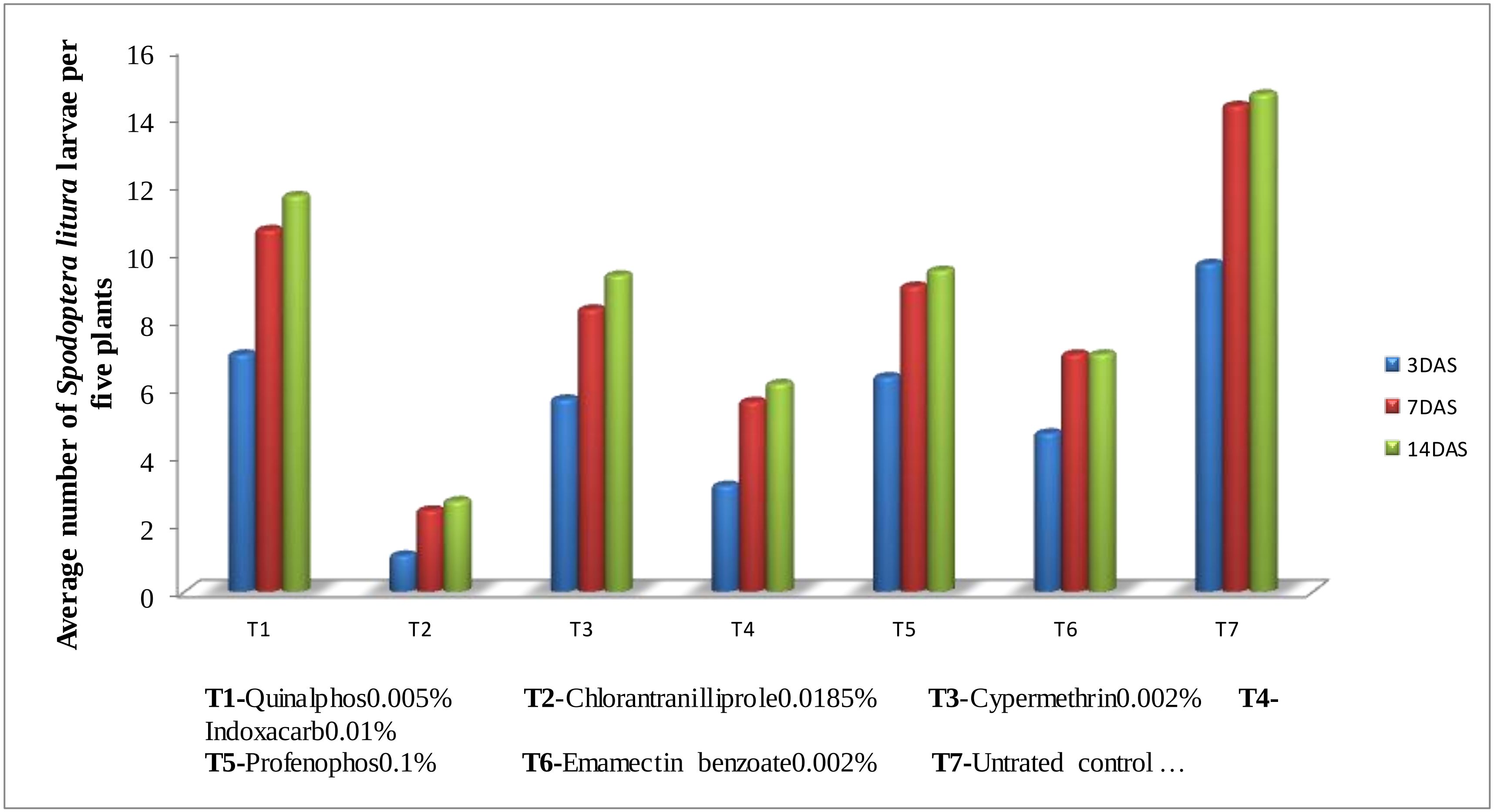
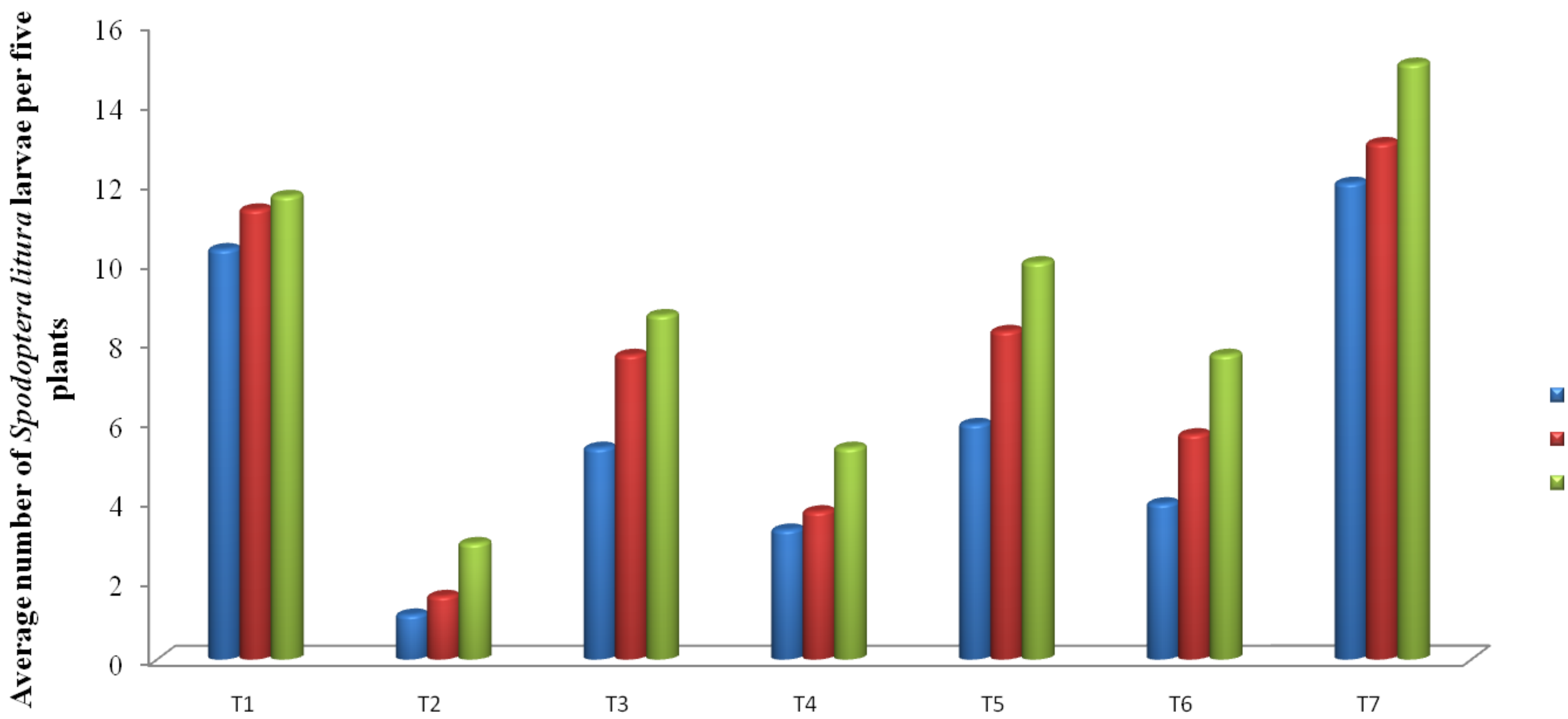


Fig.2 Effect of different insecticides on the larval population of *Spodoptera litura* (After second spray)



T1-Quinalphos0.005% **T2**-Chlorantranilliprole0.0185% **T3**-Cypermethrin0.002% **T4**-Indoxacarb0.01%
T5-Profenophos0.1% **T6**-Emamectin benzoate0.002% **T7**-Untrated control

At fourteen days after first spray lowest larval population of *Spodoptera litura* (2.67 *Spodoptera litura* larvae/five plant) was recorded in the plots treated with treatment T2 i.e. Chlorantraniliprole 18.5 SC @ 0.0185 per cent observed significantly effective in minimizing *Spodoptera litura* larvae population.

The next effective treatment were treatment T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (6.13 *Spodoptera litura* larvae/five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @ 0.002 per cent (7.00 *Spodoptera litura* larvae/five plant) in reducing *Spodoptera litura* larvae population. Both these treatments were found statistically at par with each other.

The next effective treatment was T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (9.33 *Spodoptera litura* larvae/five plant) then T5 treatment i.e. Profenophos 50 EC @ 0.1 per cent (9.47 *Spodoptera litura* larvae/five plant). These three treatments were found statistically at par with each other. The next effective treatment was T1 i.e. Quinalphos 25 EC @ 0.05 per cent (11.67 *Spodoptera litura* larvae/five plant). These T3, T5 and T1 were at par with each other. The highest larval population of *Spodoptera litura* (14.67 larvae/five plant) was recorded in treatments T7 i.e. untreated control.

Thus, after first spray it can be concluded that the *Spodoptera litura* larvae population was decreased for only initial three days after first spray and thereafter the population slowly increased. Also, the plots treated with chlorantraniliprole 18.5 SC @ 0.0185 per cent recorded significantly lowest population of *Spodoptera litura* larvae on groundnut to the extent of 1.07, 2.40 and 2.67 larvae/plant respectively at 3,7 and 14 days after spraying and found effective over rest of the treatments.

Second spray

The results in respect of effect of different insecticides on population of *Spodoptera litura* larvae after second spray are presented in Table 2 and Fig. 2. The data revealed that similar trend was observed after second spray also and all the insecticides under investigation were observed to be significantly superior over untreated control in reducing the population of *Spodoptera litura* on groundnut at 3, 7 and 14 days after second spray.

At three day after second spray, significantly minimum population of *Spodoptera litura* larvae (1.13 *Spodoptera litura* larvae/five plant) was recorded from the plots treated with treatment T2 i.e. Chlorantranilliprole 18.5 SC @ 0.0185 per cent. The next effective treatment was treatment T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (3.27 *Spodoptera litura* larvae/five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @ 0.002 per cent (3.93 *Spodoptera litura* larvae/five plant) in reducing *Spodoptera litura* larvae population. Both these treatments were found statistically at par with each other. The subsequent order of effectiveness was treatment T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (5.33 *Spodoptera litura* larvae/five plant) and treatment T5 i.e. Profenophos 50 EC @ 0.1 per cent (5.93 *Spodoptera litura* larvae/five plant). These three treatments were found statistically at par with each other. The next best treatment observed was treatment T1 i.e. Quinalphos 25 EC @ 0.05 per cent which recorded 10.33 *Spodoptera litura* larvae/five plant. Significantly highest *Spodoptera litura* larvae population (12.00 *Spodoptera litura* larvae/five plant) was observed in treatment T7 i.e. untreated control.

At seven days after first spray more or less same trend was observed and the treatment T2 i.e. Chlorantraniliprole 18.5 SC 0.0185 per cent observed significantly effective in minimizing *Spodoptera litura* larvae larvae population (1.60 larvae/five plant). The next effective treatment was T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (3.73 *Spodoptera litura* larvae/five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @0.002 per cent (5.67 *Spodoptera litura* larvae/five plant) in reducing *Spodoptera litura* larvae population. Both these T4 and T6 treatments were found statistically at par with each other. The subsequent order of effectiveness was treatment T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (7.67 *Spodoptera litura* larvae/five plant). The next effective treatment was T5 i.e. Profenophos 50 EC @ 0.1 per cent (8.27 *Spodoptera litura* larvae/five plant). These three treatments were found statistically at par with each other. The subsequent order of effectiveness was treatment T1 i.e. Quinalphos 25 EC @ 0.05 per cent (11.33 *Spodoptera litura* larvae/five plant). While the highest population of 13.00 *Spodoptera litura* larvae/five plant was recorded in treatment T7 i.e. untreated control.

At fourteen days after first spray, significantly lowest population of *Spodoptera litura* larvae (2.93 *Spodoptera litura* larvae/five plant) was recorded in the plots treated with treatment T2 i.e. Chlorantraniliprole 18.5 SC @ 0.0185 per cent observed significantly effective in minimum *Spodoptera litura* larvae population. The next effective treatment were treatment T4 i.e. Indoxacarb 15.8 SC @ 0.01 per cent (5.33 *Spodoptera litura* larvae/five plant) which was followed by treatment T6 i.e. Emamectin benzoate 5 WDG @ 0.002 per cent (7.67 *Spodoptera litura* larvae/five plant) in reducing larval population. Both these treatments were found statistically at par with each other. The next effective treatment was T3 i.e. Cypermethrin 10 EC @ 0.02 per cent (8.67 *Spodoptera litura* larvae/five plant) then T5 treatment i.e. Profenophos 50 EC @ 0.1 per cent (10.00 *Spodoptera litura*/five plant). These three treatments were found statistically at par with each other. The next effective treatment was T1 i.e. Quinalphos 25 EC @ 0.05 per cent (11.67 *Spodoptera litura* larvae/five plant). These treatments T3, T5 and T1 were at par with each other. The highest population of *Spodoptera litura* larvae (15.00 *Spodoptera litura* larvae/five plant) was recorded in treatments T7 i.e. untreated control.

Thus, overall it was observed that the insecticidal treatments suppress the *Spodoptera litura* larvae population for initial period only. The population increased slowly after three days onwards of the spray. Also, among the insecticides tested chlorantranilliprole 18.5 SC @ 0.0185 per cent was found most effective as it recorded significantly lowest population of *Spodoptera litura* larvae on groundnut to the extent of 1.13, 1.60 and 2.93 larvae per plant at 3, 7 and 14 days after spraying, respectively over rest of the insecticides.

Earlier, the effectiveness of chlorantranilliprole against *Spodoptera litura* on groundnut was reported by Gadhiya *et al.*, (2014) [15].The effectiveness of chlorantranilliprole as foliar spray against defoliators on castor by Duraimurugan and Laxminarayana (2014) [12]. Among four insecticides they concluded chlorantranilliprole @ 30 g a.i. per ha were very effective in suppressing the larval population of semilooper and tobacco caterpillar (*Spodoptera litura*). Gadhiya *et al.*, (2014) [15] reported chlorantranilliprole and emamectin benzoate most effective and chlorantranilliprole followed by indoxacarb to control *Spodoptera litura* infesting groundnut. Kumar *et al.*, (2015) [21] monitored bio-efficacy of nine insecticides against *Spodoptera litura* on groundnut and reported chlorantranilliprole found most effective. Muzammil*et al*., (2017) [27] on sunflower against defoliators. Chopade *et al*., (2018) [9] studied newer insecticides against major insect pests of sesamum and reported chlorantranilliprole were most effective against capsule borer.

The next effective treatment were indoxacarb Harish *et al*., (2009) [18] reported emamectin benzoate superior to chloropyriphos against lepidopteran defoliator in soyabean. Mutkule *et al*., (2009) [26] evaluated spinosad and emamectin benzoate found best in suppression of larval population against *Spodoptera litura* on groundnut. Emamectin benzoate + novaluron reduce larval population of *Spodoptera litura* on groundnut reported by Satynararayana *et al.,* (2010) [30]. Bhandane *et al.,* (2016) [7] reported emamectin benzoate and cypermethrin more effective against *Spodoptera litura* on castor. But the present study investigated that chlorantranilliprole most effective followed by indoxacarb and emamectin benzoate.

The present study concluded that among the seven treatments, all the insecticide treatments were more effective than control in reducing the *Spodoptera litura* larvae chlorantranilliprole 0.0185 per cent was found extremely effective for control of larval population of *Spodoptera litura* on groundnut.

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How to cite this article:

Waykule, P.K., D.S. Mutkule, A.S. Jadhav, A.P. Dhormare and Bankar, D.R. 2020. Bio-efficacy of Different Insecticides against *Spodoptera litura* on Groundnut. *Int.J.Curr.Microbiol.App.Sci.* 9(12): 1697-1708. doi: https://doi.org/10.20546/ijcmas.2020.912.202