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BIOEFFICACY OF THIAMETHOXAM 12.6% + LAMBDA CYHALOHTHRIN 9.5% ZC AGAINST LEPIDOPTERAN INSECT PESTS IN BLACK GRAM

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ABSTRACT

The experiment on the Bioefficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 125, 150, 175 and 350 ml/ha along with Thiamethoxam 25%@ 100 gm/ha, Lambda cyhalohthrin 5% EC@ 500 ml/ha, Thiodicarb 75% WP@ 750 gm/ha and Quinalphos 25% EC@ 1500 ml/ha against pests in Blackgram was conducted in Randomized Block Design with three replications at Agronomy farm, R.C.A., Udaipur during *Kharif*, 2017 and 2018. Blackgram variety PU-31 was sown during both cropping seasons. It was evaluated that Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 175 ml/ha followed by Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 150 ml/ha was most effective to control insect pest i.e. *Maruca* spp., *Helicoverpa* and *Spodoptera* in blackgram with highest yield production compare to other treatments. The other treatments also found significantly effective in reducing the larval population in Black gram.

Key words: Black gram, bioefficacy, insect pest, thiamethoxam, lambda cyhalohthrin

INTRODUCTION

Pulses play an important role in Indian Agriculture. India is one of the largest pulses producing country in the World. Black gram (*Vigna Mungo* L. Hepper) is also an important pulse crop in India. Black gram is commonly known as "Urd bean". Black gram is also grown as a cover crop as well as catch crop due to short duration. The total production of black gram in India is 3.36 million tons (Anonymous, 2018-19); whereas, in Rajasthan total area and production under black gram was 7.50 lakh hectares and 7.41 lakh tons with the productivity of 988 kg/ha (Anonymous[1], 2018-19). Black gram has many important insect pests that cause serious damage and reduction in yield among them foliage feeder and pod borers like *Maruca* spp., *Helicoverpa* and *Spodoptera* are major importent insect pest of black gram. The annual yield loss due to the insect pests has been estimated at about 30 per cent in urd bean. The long-term use of single insecticides resulted in insecticide resistance and biomagnifications of insecticides and forcing the farmers to use higher dose and more application frequency. Thereby increasing the cost. Pesticide mixtures may enhance the suppression of arthropod pest population due to either synergistic interaction or potentiation between or among pesticides that are mixed together. It has been proposed that pesticide mixtures may delay the onset of resistance developing in arthropod pest populations (Mallet, 1989). Considering all these facts, the present study was undertaken with the objective to evaluate the Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC for the management of Maruca spp., Helicoverpa and Spodoptera in black gram ecosystem

MATERIALS AND METHODS

The experiment on the Bioefficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 125, 150, 175 and 350 ml/ha along with Thiamethoxam 25%@ 100 gm/ha, Lambda cyhalohthrin 5% EC@ 500 ml/ha, Thiodicarb 75% WP@ 750 gm/ha and Quinalphos 25% EC@ 1500 ml/ha against pests in Blackgram was conducted in Randomized Block Design with three replications at Agronomy farm, R.C.A., Udaipur during *Kharif*, 2017 and 2018. Blackgram variety PU-31 was sown on 5 August and 3 July, 2017 & 2018 respectively. Sowing was done in plots each measuring 22.5 sq m at row to row and plant to plant spacing of 45 cm x 10 cm. There were nine treatments replicated three times. Each treatment was applied two times initiating first spray as soon as a pest's infestation started and subsequent second spray was given at 15 days interval.

$$\text{Percent corrected mortality} = 100\ [1 - \frac{T_a \times C_b}{T_b \times C_a}\ ]$$

T_a = Number of pests after treatment,

T_b= Number of pests before treatment

C_a= Number of pests in control after treatment

C_b= Number of pests in control before treatment

The yield of Black gram for each treatment at each picking was recorded and yield per hectare was calculated for each treatment separately.

RESULTS AND DISCUSSION

The different doses of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC, & Thiamethoxam 25% WG, Lambda cyhalohthrin 5% EC, Thiodicarb 75% WP and Quinalphos 25% EC were evaluated against pests of black gram *i.e. Maruca* spp., *Helicoverpa* and *Spodoptera* under field condition at Agronomy farm, Rajasthan college of Agriculture (Udaipur) during the year *Kharif*, 2017 and 2018.

(i) *Maruca* spp.

The data recorded on mean reduction in the population of *maruca* spp. at 1, 3, 5, 7 and 10 days after first and second sprays have been presented in Table 1 and 2. The data reveals that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of *maruca* spp was recorded in case of two spray of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 175 ml/ha which resulted 69.20, 78.86, 80.90, 80.63, 77.16; 73.55, 81.70, 82.23, 83.55, 79.44 and 64.82, 70.92, 78.25, 81.69, 78.90; 70.24, 78.28, 84.58, 84.14, 74.37 per cent reduction in mean population of *Maruca* spp at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif*, 2017 and 2018 respectively. Spray of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 150 ml/ha was found at par to above treatment which caused 63.40, 69.52, 76.84, 80.27, 77.23; 68.86, 76.91, 83.09, 82.74, 72.93 and 67.25, 76.90, 78.98, 78.68, 75.25; 71.65, 79.55, 80.27, 81.58, 77.57 per cent reduction in mean population of *maruca* spp at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018 respectively. It was followed by Lambda cyhalohthrin 5% EC@ 500 ml/ha, Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC@125 ml/ha, Quinalphos 25% EC@ 1500 ml/ha and Thiodicarb 75% WP@ 750 gm/ha at at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018, respectively and Spray of Thiamethoxam 25% WG@ 100 gm/ha was found least effective among all treatments which resulted 38.05, 58.45, 55.60, 65.63, 47.04; 53.94,64.20, 67.85, 68.97, 57.14 and 43.92, 48.50, 56.59, 60.76, 48.94; 47.53, 53.41, 59.33, 62.14, 53.53 per cent reduction in *Maruca* spp population at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018, respectively. These results also found similar to Swamy *et al.* (2010) reported that Thiodicarb 75WP provided good protection and registered significantly less incidence of *Maruca* larvae and pod damage over control. Mandal *et al.* (2013) and Sonune *et al.* (2010) also evaluated that lambda cyhalothrin was significantly effective to reducing spotted pod borer in black gram.

(ii) *Helicoverpa*

The data recorded on mean reduction in the population of *helicoverpa* at 1, 3, 5, 7 and 10 days after first and second sprays have been presented in Table 3 and 4. The data reveals that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of *Helicoverpa* was recorded in case of two sprays of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 175 ml/ha which resulted 68.66, 78.32, 80.36, 80.09, 76.62; 73.01, 81.14, 81.69, 83.01, 78.90 and 64.28, 70.38, 77.70, 81.14, 78.35; 69.70, 77.74, 84.03, 83.59, 73.82 per cent reduction in mean population of *Helicoverpa* at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif*, 2017 and 2018 respectively. Spray of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC @ 150 ml/ha was found at par to above treatment which caused 67.25, 76.90, 78.98, 78.68, 75.25; 71.65, 79.55, 80.27, 81.58, 77.57 and , 62.86, 68.98, 76.30, 79.72, 76.68; 68.32, 76.37, 82.55, 82.20, 72.39 per cent reduction in mean population of *Helicoverpa* at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018 respectively. It was followed by Lambda cyhalohthrin 5% EC@ 500 ml/ha, Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC@125 ml/ha, Quinalphos 25% EC@ 1500 ml/ha and Thiodicarb 75% WP@ 750 gm/ha at at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018, respectively and minimum mean reduction in population of *Helicoverpa* was recorded in spray of Thiamethoxam 25% WG@ 100 gm/ha which resulted 47.51, 57.90, 55.06, 65.09, 46.50; 53.40, 63.66, 67.31, 68.43, 56.60 and 43.38, 47.96, 56.05, 60.22, 48.40; 46.99, 52.87, 58.79, 61.60, 52.98 per cent reduction in mean population of *Helicoverpa* at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018 respectively. The present findings are in the line of results obtained by Thangavel *et al*, (2014) who recorded that three rounds of application of Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% @ 150 ml/ha at ten days interval was most effective treatment with the lowest mean population of *Helicoverpa armigera* and fruit damage. Ghosh *et al*., (2010) found that quinalphos and lambda cyhalothrin were effective against *H. armigera* on tomato. Balikai *et*

Table 1. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Maruca spp.* on blackgram during *Kharif*, 2017

	Treatments	Dose (g/ml ha^{-1})	Mean reduction (%) in *Maruca spp.* population, days after spray											
			Istspray						IIndspray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	1.97	-	-	-	-	-		-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	2.00	49.80 (58.34)	55.15 (67.34)	57.28 (70.78)	57.98 (71.89)	49.31 (57.49)	1.63	54.15 (65.70)	58.62 (72.89)	57.84 (71.67)	59.35 (74.02)	56.52 (69.57)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.08	55.42 (67.79)	61.64 (77.44)	63.09 (79.52)	62.88 (79.22)	60.53 (75.79)	1.75	58.17 (72.19)	63.50 (80.09)	64.02 (80.81)	64.98 (82.12)	62.11 (78.12)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	1.68	56.29 (69.20)	62.63 (78.86)	64.09 (80.90)	63.89 (80.63)	61.45 (77.16)	1.88	59.05 (73.55)	64.67 (81.70)	65.07 (82.23)	66.08 (83.55)	63.04 (79.44)
T5	Thiamethoxam 25% WG	100	2.04	43.88 (38.05)	49.86 (58.45)	48.22 (55.60)	54.11 (65.63)	43.30 (47.04)	1.86	47.26 (53.94)	53.25 (64.20)	55.46 (67.85)	56.15 (68.97)	49.11 (57.14)
T6	Lambda cyhalohthrin 5% EC	500	2.12	53.92 (65.32)	59.91 (74.87)	61.05 (76.05)	61.61 (77.39)	57.15 (70.58)	1.82	56.86 (70.11)	62.01 (77.97)	62.99 (79.38)	64.11 (80.94)	61.61 (77.40)
T7	Thiodicarb 75% WP	750	2.16	44.90 (49.82)	51.07 (60.52)	50.33 (59.25)	55.27 (67.54)	44.13 (46.02)	1.95	48.86 (56.71)	54.21 (65.80)	56.16 (68.99)	56.31 (69.23)	50.40 (59.36)
T8	Quinalphos 25% EC	1500	1.78	48.38 (55.88)	53.97 (65.40)	56.11 (68.91)	56.19 (69.03)	50.84 (60.12)	1.77	53.50 (64.62)	57.07 (70.45)	56.89 (70.16)	57.18 (70.62)	55.10 (67.27)
	SEm±		0.197	1.083	0.875	0.702	0.897	0.750	0.105	0.749	1.224	0.740	0.991	1.044
	C.D. at 5%		0.597	3.337	2.695	2.163	2.764	2.312	0.318	2.309	3.772	2.282	3.054	3.218

Figures in parenthesis are angular per cent value

PTP = Pre treatment population.

Table 2. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Maruca spp.* on blackgram during *Kharif*, 2018

	Treatments	Dose (g/ml ha-^{1})	Mean reduction (%) in *Maruca spp.* population, days after spray											
			Istspray						IIndspray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	2.12	-	-	-	-	-	1.77	-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	2.08	48.59 (56.25)	48.67 (56.38)	56.12 (68.93)	56.22 (69.08)	55.09 (67.25)	1.63	49.35 (57.57)	55.46 (67.85)	58.42 (72.57)	59.85 (74.77)	52.45 (62.85)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.17	52.77 (63.40)	56.49 (69.52)	61.24 (76.84)	63.63 (80.27)	61.50 (77.23)	1.75	56.08 (68.86)	61.28 (76.91)	65.72 (83.09)	65.45 (82.74)	58.65 (72.93)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	1.85	53.62 (64.82)	57.37 (70.92)	62.20 (78.25)	64.66 (81.69)	62.66 (78.90)	1.88	56.94 (70.24)	62.22 (78.28)	66.87 (84.58)	66.53 (84.14)	59.58 (74.37)
T5	Thiamethoxam 25% WG	100	2.14	41.51 (43.92)	44.14 (48.50)	48.79 (56.59)	51.22 (60.76)	44.39 (48.94)	1.86	43.58 (47.53)	46.96 (53.41)	50.38 (59.33)	52.03 (62.14)	47.02 (53.53)
T6	Lambda cyhalohthrin 5% EC	500	2.19	50.98 (60.37)	53.16 (64.05)	58.97 (73.42)	61.53 (77.28)	58.03 (71.97)	1.82	53.93 (65.34)	58.91 (73.34)	64.91 (82.02)	64.09 (80.91)	57.55 (71.21)
T7	Thiodicarb 75% WP	750	2.16	41.59 (44.06)	45.26 (50.46)	48.92 (56.82)	51.99 (62.07)	46.02 (51.78)	1.95	45.48 (50.84)	48.12 (55.44)	51.64 (61.49)	55.59 (68.06)	47.38 (54.15)
T8	Quinalphos 25% EC	1500	2.00	47.60 (54.53)	47.89 (55.04)	54.16 (65.71)	55.13 (67.31)	54.72 (66.64)	1.87	48.60 (56.27)	54.29 (65.93)	57.60 (71.29)	59.08 (73.59)	51.03 (60.44)
	SEm±		0.110	0.933	0.793	0.859	1.691	1.264	0.115	0.996	1.386	1.133	1.246	1.076
	C.D. at 5%		0.332	2.875	2.443	2.646	5.210	3.894	0.349	3.069	4.271	3.492	3.838	3.316

Figures in parenthesis are angular per cent value

PTP = Pre treatment population.

Table 3. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Helicoverpa* on blackgram during *Kharif*, 2017

	Treatments	Dose (g/ml ha-^{1})	Mean reduction (%) in *Helicoverpa* population, days after spray											
			Ist spray						IInd spray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	2.37	-	-	-	-	-	2.34	-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	2.31	49.49 (57.80)	54.82 (66.80)	56.94 (70.23)	57.64 (71.35)	48.99 (56.95)	2.23	53.82 (65.16)	58.27 (72.34)	57.50 (71.13)	59.00 (73.48)	56.19 (69.03)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.34	55.09 (67.25)	61.27 (76.90)	62.71 (78.98)	62.50 (78.68)	60.16 (75.25)	2.06	57.83 (71.65)	63.11 (79.55)	63.63 (80.27)	64.58 (81.58)	61.73 (77.57)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	2.34	55.96 (68.66)	62.25 (78.32)	63.70 (80.36)	63.50 (80.09)	61.09 (76.62)	2.27	58.70 (73.01)	64.26 (81.14)	64.67 (81.69)	65.66 (83.01)	62.66 (78.90)
T5	Thiamethoxam 25% WG	100	2.20	43.57 (47.51)	49.55 (57.90)	47.91 (55.06)	53.78 (65.09)	42.99 (46.50)	2.11	46.95 (53.40)	52.93 (63.66)	55.13 (67.31)	55.82 (68.43)	48.79 (56.60)
T6	Lambda cyhalohthrin 5% EC	500	2.13	53.60 (64.78)	59.55 (74.32)	60.68 (76.03)	61.24 (76.85)	56.81 (70.04)	2.00	56.52 (69.57)	61.64 (77.43)	62.61 (78.84)	63.72 (80.40)	61.24 (76.86)
T7	Thiodicarb 75% WP	750	2.08	44.59 (49.28)	50.76 (59.98)	50.01 (58.71)	54.94 (67.00)	43.83 (47.95)	1.91	48.55 (56.17)	53.88 (65.26)	55.83 (68.45)	55.98 (68.69)	50.08 (58.82)
T8	Quinalphos 25% EC	1500	2.08	48.07 (55.34)	53.65 (64.86)	55.78 (68.37)	55.85 (68.49)	50.52 (59.58)	2.31	53.18 (64.08)	56.73 (69.91)	56.55 (69.62)	56.84 (70.08)	54.77 (66.73)
	SEm±		0.101	1.071	0.864	0.693	0.885	0.741	0.094	0.740	1.206	0.730	0.977	1.030
	C.D. at 5%		0.307	3.299	2.662	2.134	2.727	2.282	0.284	2.280	3.717	2.249	3.010	3.173

Figures in parenthesis are angular per cent value

PTP = Pre treatment population.

Table 4. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Helicoverpa* on blackgram during *Kharif*, 2018

	Treatments	Dose (g/ml ha-^{1})	Mean reduction (%) in *Helicoverpa* population, days after spray											
			Istspray						IIndspray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	2.05	-	-	-	-	-	2.23	-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	2.15	48.28 (55.71)	48.36 (55.84)	55.79 (68.39)	55.88 (68.54)	54.76 (66.71)	2.00	49.04 (57.03)	55.12 (67.30)	58.07 (72.03)	59.49 (74.23)	52.13 (62.31)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.20	52.45 (62.86)	56.15 (68.98)	60.87 (76.30)	63.24 (79.72)	61.13 (76.68)	1.76	55.75 (68.32)	60.91 (76.37)	65.31 (82.55)	65.04 (82.20)	58.30 (72.39)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	2.25	53.29 (64.28)	57.03 (70.38)	61.82 (77.70)	64.26 (81.14)	62.27 (78.35)	2.04	56.60 (69.70)	61.85 (77.74)	66.45 (84.03)	66.10 (83.59)	59.23 (73.82)
T5	Thiamethoxam 25% WG	100	2.04	41.19 (43.38)	43.83 (47.96)	48.48 (56.05)	50.90 (60.22)	44.08 (48.40)	1.74	43.27 (46.99)	46.64 (52.87)	50.06 (58.79)	51.71 (61.60)	46.71 (52.98)
T6	Lambda cyhalohthrin 5% EC	500	1.95	50.67 (59.83)	52.84 (63.51)	58.62 (72.88)	61.16 (76.73)	57.69 (71.43)	1.70	53.61 (64.80)	58.56 (72.79)	64.51 (81.48)	63.70 (80.37)	57.21 (70.67)
T7	Thiodicarb 75% WP	750	2.08	41.28 (43.52)	44.95 (49.92)	48.61 (56.28)	51.67 (61.53)	45.71 (51.24)	1.82	45.17 (50.30)	47.81 (54.90)	51.33 (60.95)	55.26 (67.52)	47.07 (53.61)
T8	Quinalphos 25% EC	1500	1.90	47.29 (53.99)	47.58 (54.50)	53.83 (65.17)	54.80 (66.76)	54.39 (66.10)	2.05	48.29 (55.43)	53.96 (65.390	57.26 (70.75)	58.72 (73.05)	50.71 (59.90)
	SEm±		0.150	0.923	0.783	0.847	1.666	1.244	0.203	0.984	1.368	1.117	1.226	1.064
	C.D. at 5%		0.456	2.843	2.414	2.609	5.132	3.833	0.615	3.032	4.215	3.441	3.777	3.278

Figures in parenthesis are angular per cent value

PTP = Pre treatment population.

Table 5. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Spodoptera* on blackgram during *Kharif*, 2017

	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in *Spodoptera* population, days after spray											
			Istspray						IIndspray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	2.32	-	-	-	-	-	2.18	-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	2.19	50.02 (58.72)	55.38 (67.72)	57.52 (71.16)	58.23 (72.28)	49.53 (57.87)	2.00	54.38 (66.08)	58.87 (73.27)	58.09 (72.05)	59.60 (74.40)	56.76 (69.95)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.27	55.66 (68.18)	61.90 (77.82)	63.36 (79.90)	63.15 (79.60)	60.78 (76.17)	2.11	58.42 (72.57)	63.77 (80.47)	64.30 (81.19)	65.27 (82.50)	62.38 (78.50)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	2.31	56.53 (69.58)	62.90 (79.24)	64.37 (81.29)	64.17 (81.01)	61.71 (77.55)	2.22	59.30 (73.93)	64.96 (82.08)	65.36 (82.61)	66.37 (83.94)	63.31 (79.82)
T5	Thiamethoxam 25% WG	100	2.02	44.10 (48.43)	50.08 (58.83)	48.44 (55.98)	54.34 (66.01)	43.52 (47.42)	2.09	47.48 (54.32)	53.48 (64.59)	55.69 (68.23)	56.39 (69.36)	49.33 (57.53)
T6	Lambda cyhalohthrin 5% EC	500	2.08	54.15 (65.70)	60.16 (75.25)	61.30 (76.95)	61.87 (77.77)	57.39 (70.96)	1.92	57.10 (70.49)	62.27 (78.35)	63.26 (79.76)	64.39 (81.32)	61.88 (77.78)
T7	Thiodicarb 75% WP	750	2.19	45.11 (50.20)	51.30 (60.90)	50.55 (59.63)	55.50 (67.92)	44.35 (48.87)	2.01	49.08 (57.09)	54.44 (66.18)	56.40 (69.37)	56.55 (69.61)	50.62 (59.75)
T8	Quinalphos 25% EC	1500	2.04	48.60 (56.26)	54.20 (65.78)	56.35 (69.29)	56.42 (69.42)	51.06 (60.50)	1.97	53.73 (65.00)	57.31 (70.83)	57.13 (70.54)	57.42 (71.00)	55.33 (67.65)
	SEm±		0.117	1.092	0.882	0.709	0.905	0.757	0.114	0.756	1.237	0.748	1.002	1.055
	C.D. at 5%		0.356	3.365	2.719	2.183	2.790	2.334	0.344	2.330	3.811	2.305	3.086	3.250

Figures in parenthesis are angular per cent value
PTP = Pre treatment population.

Table 6. Efficacy of Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC against *Spodoptera* on blackgram during *Kharif*, 2018

	Treatment	Dose (g/ml ha-^{1})	Mean reduction (%) in *Spodoptera* population, days after spray											
			Istspray						IIndspray					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
T1	CHECK	-	2.21	-	-	-	-	-	2.05	-	-	-	-	-
T2	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	125	1.97	47.82 (54.91)	48.11 (55.42)	54.39 (66.09)	55.36 (67.69)	54.95 (67.02)	1.92	48.82 (56.65)	54.52 (66.31)	57.84 (71.67)	59.33 (73.98)	51.25 (60.82)
T3	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	150	2.01	51.21 (60.75)	53.39 (64.43)	59.21 (73.80)	61.80 (77.67)	58.27 (72.35)	1.98	54.16 (65.72)	59.16 (73.72)	65.20 (82.40)	64.37 (81.30)	57.79 (71.59)
T4	Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC	175	2.20	53.00 (63.78)	56.73 (69.90)	61.50 (77.23)	63.90 (80.65)	61.76 (77.61)	2.27	56.32 (69.25)	61.54 (77.30)	66.01 (83.47)	65.75 (83.13)	58.90 (73.31)
T5	Thiamethoxam 25% WG	100	2.18	53.85 (65.20)	57.61 (71.30)	62.47 (78.63)	64.95 (82.07)	62.93 (79.29)	2.09	57.18 (70.62)	62.49 (78.66)	67.18 (84.96)	66.83 (84.52)	59.83 (74.75)
T6	Lambda cyhalohthrin 5% EC	500	1.93	48.81 (56.63)	48.89 (56.76)	56.36 (69.31)	56.45 (69.46)	55.33 (67.63)	1.85	49.57 (57.95)	55.69 (68.23)	58.66 (72.95)	60.10 (75.15)	52.67 (63.23)
T7	Thiodicarb 75% WP	750	1.93	41.72 (44.30)	44.36 (48.88)	49.01 (56.97)	51.44 (61.15)	44.61 (49.32)	1.99	43.80 (47.91)	47.17 (53.79)	50.60 (59.71)	52.25 (62.52)	47.24 (53.91)
T8	Quinalphos 25% EC	1500	1.93	41.81 (44.44)	45.48 (50.84)	49.14 (57.20)	52.21 (62.45)	46.24 (52.16)	2.06	45.70 (51.22)	48.34 (55.82)	51.87 (61.87)	55.82 (68.44)	47.60 (54.53)
	SEm±		0.128	0.941	0.800	0.867	1.709	1.278	0.078	1.005	1.399	1.145	1.260	1.085
	C.D. at 5%		0.387	2.898	2.464	2.673	5.266	3.939	0.236	3.096	4.312	3.529	3.883	3.343

Figures in parenthesis are angular per cent value PTP = Pre treatment population.

al, (2001) also found that two sprays with quinalphos 0.05 % gave effective control of pod borer, *Helicoverpa armigera* (Hub.). Thiodicarb 75% WP also recorded significantly effective to reducing the larval population of *Helicoverpa* in checkpea (Suneel and Sarada, 2015). Babar *et al.*, (2012) recorded that thiodicarb caused more than 70% egg mortality in the laboratory experiment and found most effective as ovicide against *Helicoverpa armigera*.

iii. ***Spodoptera***

The data presented in Table 5 and 6 reveal that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of *Spodoptera* was recorded in case of fist spray (2017) of 12.6% + Lambda cyhalohthrin 9.5% ZC @ 175 ml/ha which resulted 69.58, 79.24, 81.29, 81.01, 77.55, and 2nd spray, (2017) 73.93, 82.08, 82.61, 83.94, 79.82 whereas 63.78, 69.90, 77.23, 80.65, 77.61 (1st spray,2018) and in 2nd spray, 2018 resulted 69.25, 77.30, 83.47, 83.13, 73.31 per cent reduction in *Spodoptera* population at 1, 3, 5, 7 and 10 days after spray. It was followed by Lambda cyhalohthrin 5% EC@ 500 ml/ha, Thiamethoxam 12.6% + Lambda cyhalohthrin 9.5% ZC@125 ml/ha, Quinalphos 25% EC@ 1500 ml/ha and Thiodicarb 75% WP@ 750 gm/ha at at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018, respectively. Spray of Thiamethoxam 25% WG@ 100 gm/ha was found least effective among all treatments which resulted in 48.43, 58.83, 55.98, 66.01, 47.42; 54.32, 64.59, 68.23, 69.36, 57.53 and 65.20, 71.30, 78.63, 82.07, 79.29; 70.62, 78.66, 84.96, 84.52, 74.75 per cent reduction in *Spodoptera* population at 1, 3, 5, 7 and 10 days after first and second spray during *Kharif,* 2017 and 2018, respectively. The results are in agreements with the results of Chand (2012) who found that Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% successfully controlled the populations of *Spodoptera litura* in soyabean crop. Justin *et al.* (2015) found that Quinalphos 25 EC and Thiodicarb 75 WP were significantly effective against *Helicoverpa* and *Spodoptera* larvae.

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