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Bio-efficacy of bas 306 02 I 240 SC against major insect pests of chilli during *rabi* season 2016-17 to 2017-18

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Abstract
An experiment was conducted to observe the "Bio-efficacy of BAS 306 02 I 240 SC against major insect pests of chilli during Rabi Season 2016-17 and 2017-18" at Horticulture farm, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur. During the bio efficacy trial among the insecticidal treatments, T3 @ 240g a.i. /ha BAS 306 02 I 240 SC were showed significantly superior mortality over untreated control in effectively control the major insect pests population of chilli. All the tested doses of insecticides, there was no phytotoxicity symptoms were recorded in chilli crop. Among all the insecticidal treatment minimum coccinellids beetle population was observed in (T4) BAS 306 02 I 240 SC @ 288 g a.i. /ha (0.17 coccinellids beetle per plant), followed by (T3) BAS 306 02 I 240 SC @ 240 g a.i./ha (0.26 coccinellids beetle per plant),(T2) BAS 306 02 I 240 SC @ 192 g a.i. / ha (0.24 coccinellids beetle per plant), and were found statistically at par. There was maximum coccinellids beetle population (0.36 coccinellids beetle per plant) in untreated control (T7). On the basis of pooled data 2016-17 and 2017-18 the highest average yield of 106.11 q/ha was recorded in the T3 plot treated with BAS 306 02 I 240 SC @ 240 g a.i./ha followed by T4-BAS 306 02 I 240 SC @ 288 g a.i./ha (106.11 q/ha) as compared to the control (78.00 q/ha).

Keywords: Chilli, mites, whitefly, thrips, fruit borer, coccinellids, yield.

Introduction
Chilli is one of the most important commercial crops grown in India and it is produce almost throughout the country. Chilli (*Capsicum annuum* L.) belongs to the family Solanaceous is an important spice cum vegetable crop generally used as a part of human dietary. The plant is an herbaceous, annual have a basal or terminal gathering of leaves. Chilli (*C. annum* L.) popularly known as 'mirch' in Hindi (Mondal, 2012). The different factors are responsible for the low productivity and production of chilli includes unfavourable climate, low quality seeds, insect, mite pests and diseases. The insects and mites are of prime importance which altogether significantly affects both the quality and production of chilli. About 51 insect and 2 mite species, belonging to 27 families and 9 orders were infesting to chilli. Among these-whitefly, *Bemisia tabaci Genn., thrips, Scirtothrips dorsalis Hood, jassid, Amrasca biguttula biguttula* (Ishida), aphid *Aphis gossypii* Glover, fruit borer *Helicoverpa armigra* (Hubner) and mites, *Polyphagotarsonemus latus* Banks are important pests contributing 60 to 75% yield loss in chilli crop. In order to preventing the infestation of the insect pests and to produce a quality crop production, it is essential to manage the pest population at proper time with suitable and appropriate measures (Chavan *et al.* 2017) [3]. among all the sucking pests attacking chilli thrips, *Scirtothrips dorsalis* Hood and whitefly, *Bemisia tabaci* (Gennadius) are dominant pests (Berke and Sheih, 2000). The estimated loss due to sucking pests was up to 30 to 50 per cent (Varadharajan 1994) [27]. Insecticide application is one of the management options that can substantially reduce yield losses caused by sucking insects. Bio-efficacy of newer pesticides needs to be studied for formulating effective and economical management strategies of insect pests. Therefore, the present investigation was conducted to evaluate the bio-efficacy of certain newer insecticides against sucking insect pests infesting chilli. (Sangle, *et al.* 2017) [22].

Materials and Methods
The field experiment was conducted at the Experimental Farm of Department of Entomology, College of Agriculture, IGKV, Raipur. In the two consequent years *i.e.* 2016-2017 and 2017-2018. Six treatments including an untreated control were laid out in Randomized Block Design

(RBD) with three replications. The healthy Popular variety f_1 hybrid seedlings of about 30 days old having uniform size were used for transplanting on hills marked at 60 X 65 cm in each plot having the size of 3 x 4 m^2. All the agronomic practices as per recommendations were timely followed. Observations were taken on number of pest population from 10 randomly selected plants in each plot before spraying and 1, 3, 5, 7 & 10 days after each spray. The percent reductions in pest populations were calculated. Effect of BAS 306 02 I 240 SC on major natural enemies were observed in the experimental plot at each observation interval (population of different natural enemies). The cumulative data were statistically analyzed after appropriate transformation (Gomez and Gomez, 1984).

Treatment Details

Tr. No.	Treatment	Dose/ha		
		a. i. (g)	Formulation (ml)	Water volume (L)
T_1	BAS 306 02 I 240 SC	144	600	500
T_2	BAS 306 02 I 240 SC	192	800	500
T_3	BAS 306 02 I 240 SC	240	1000	500
T_4	BAS 306 02 I 240 SC	288	1200	500
T_5	Emamectin Benzoate 5% SG	10	200	500
T_6	Acetamiprid 20% SP	100	100	500
T_7	Untreated control			

Results and Discussion

Table 1: Bio-efficacy of BAS 306 02 I 240 SC against thrips on chilli during *Rabi* pooled data 2016-17 and 2017-18.

Treatment	Insecticide	Dose	Pre treatment	Average no. of Thrips/ 3 leaves / 5 plant										Overall mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144 g a.i./ha	4.64 (2.27)	1.64 (1.6)	1.12 (1.44)	2.33 (1.81)	4.53 (2.33)	5.27 (2.49)	3.54 (2.11)	3.02 (1.98)	2.45 (1.84)	4.55 (2.33)	5.26 (2.49)	3.96
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	3.83 (2.05)	1.22 (1.45)	0.63 (1.26)	2.25 (1.79)	2.95 (1.97)	4.55 (2.34)	3.07 (2.01)	1.77 (1.64)	2.38 (1.82)	2.99 (1.98)	4.59 (2.35)	2.98
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	3.97 (2.09)	1.04 (1.4)	0.76 (1.3)	2.15 (1.75)	3.36 (2.05)	3.47 (2.10)	2.76 (1.92)	2.14 (1.74)	1.67 (1.62)	3.35 (2.05)	3.47 (2.1)	2.70
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	4.44 (2.27)	2.91 (1.94)	2.25 (1.76)	3.54 (2.11)	4.66 (2.36)	5.14 (2.46)	3.36 (2.07)	2.88 (1.94)	2.87 (1.96)	4.65 (2.35)	5.17 (2.46)	2.18
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	6.96 (2.79)	5.26 (2.46)	4.48 (2.36)	4.27 (2.29)	5.36 (2.54)	6.13 (2.67)	4.39 (2.29)	5.16 (2.47)	4.59 (2.36)	5.36 (2.53)	6.17 (2.67)	5.38
T6	Acetamiprid 20% SP	100 g a.i./ha	5.81 (2.53)	3.46 (2.03)	2.80 (1.90)	3.3 (2.05)	4.96 (2.44)	5.71 (2.58)	3.96 (2.20)	4.09 (2.23)	3.52 (2.10)	4.97 (2.43)	5.71 (2.58)	4.53
T7	Untreated control	-	6.70 (2.91)	5.26 (3.01)	4.58 (3.22)	4.84 (3.27)	5.62 (3.08)	6.87 (3.27)	5.74 (3.56)	5.76 (3.27)	6.98 (3.31)	6.59 (3.08)	7.86 (3.27)	6.54
SEm±			0.28	0.13	0.11	0.11	0.10	0.09	0.12	0.07	0.07	0.10	0.09	---
CD at 5%			NS	0.39	0.36	0.32	0.30	0.29	0.38	0.24	0.23	0.31	0.29	

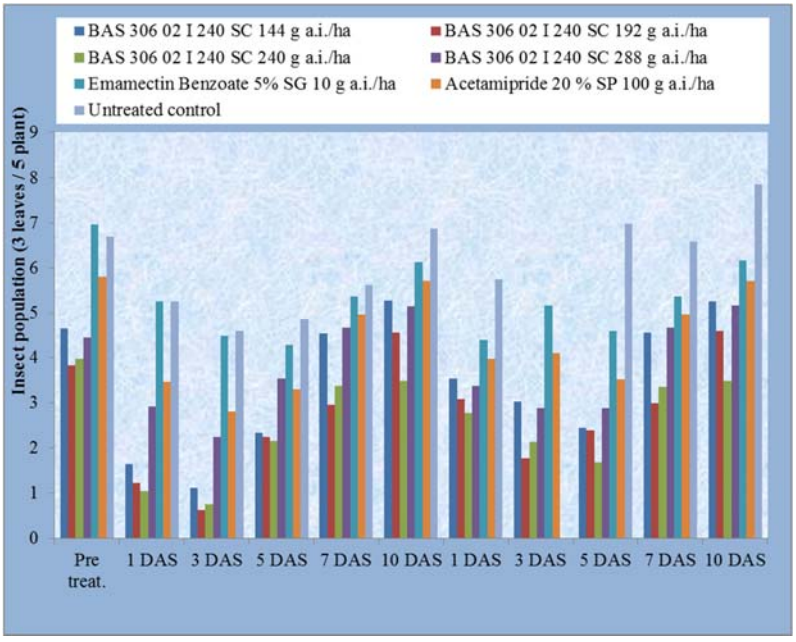

Fig 1: Days after 1st and 2nd spraying

Table 2: Bio-efficacy of BAS 306 02 I 240 SC against whitefly on chilli during *rabi* pooled data 2016-17and 2017-18.

Treatment	Insecticide	Dose	Pre treatment	Average no. of Whitefly / 3 leaves / 5 plant										Overall mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144g a.i./ha	3.64 (1.93)	0.98 (1.39)	0.88 (1.35)	1.17 (1.46)	0.97 (1.4)	1.55 (1.58)	1.09 (1.42)	0.87 (1.34)	0.84 (1.33)	1.08 (1.43)	1.66 (1.62)	1.77
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	3.82 (2.04)	0.81 (1.32)	0.68 (1.29)	1.05 (1.41)	0.78 (1.32)	1.05 (1.41)	0.88 (1.34)	0.85 (1.34)	0.67 (1.27)	0.64 (1.26)	0.85 (1.32)	1.49
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	4.25 (2.15)	0.88 (1.34)	0.78 (1.32)	0.75 (1.31)	0.97 (1.39)	0.88 (1.35)	0.97 (1.37)	0.75 (1.3)	0.43 (1.17)	0.55 (1.23)	0.79 (1.34)	1.14
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	3.78 (2.06)	1.18 (1.47)	0.97 (1.39)	1.49 (1.57)	1.3 (1.50)	1.66 (1.62)	2.19 (1.77)	1.84 (1.67)	1.68 (1.62)	1.36 (1.51)	1.88 (1.68)	1.08
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	4.78 (2.28)	1.77 (1.63)	1.58 (1.58)	1.56 (1.59)	1.69 (1.62)	1.76 (1.65)	2.27 (1.79)	1.93 (1.69)	1.87 (1.68)	1.49 (1.57)	1.83 (1.67)	2.04
T6	Acetamiprid 20% SP	100 g a.i./ha	4.21 (2.11)	1.38 (1.51)	1.23 (1.47)	1.37 (1.53)	1.33 (1.51)	1.66 (1.62)	1.68 (1.61)	1.40 (1.52)	1.36 (1.51)	1.29 (1.50)	1.75 (1.65)	1.72
T7	Untreated control	-	3.59 (2.42)	4.66 (2.35)	4.73 (2.36)	4.87 (2.39)	5.06 (2.43)	5.38 (2.51)	4.84 (2.31)	5.14 (2.39)	5.06 (2.38)	4.47 (2.29)	4.67 (2.33)	3.82
SEm+			0.28	0.11	0.10	0.09	0.08	0.07	0.13	0.12	0.12	0.10	0.10	----
CD at 5%			NS	0.33	0.32	0.30	0.27	0.22	0.43	0.38	0.38	0.33	0.33	

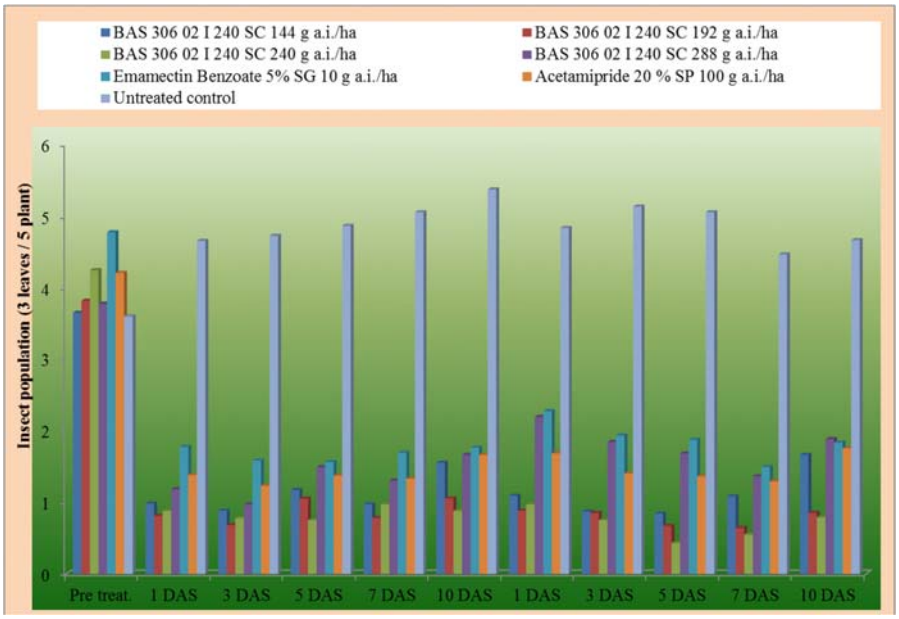

Fig 2: Days after 1st and 2nd spraying

Table 3: Bio-efficacy of BAS 306 02 I 240 SC against fruit borer on chilli during *rabi* pooled data 2016-17and 2017-18.

Treatment	Insecticide	Dose	Pre treatment	I Spray					II Spray					Over all mean
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144 g a.i./ha	1.59 (1.44)	1.52 (1.42)	1.32 (1.35)	1.48 (1.41)	1.49 (1.41)	1.52 (1.42)	1.60 (1.45)	1.32 (1.35)	0.96 (1.21)	1.16 (1.29)	1.20 (1.30)	1.38
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	1.65 (1.46)	1.37 (1.37)	1.00 (1.22)	1.31 (1.34)	1.45 (1.40)	1.33 (1.35)	1.58m (1.44)	1.08 (1.25)	0.61 (1.05)	0.89 (1.18)	1.04 (1.23)	1.10
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	1.35 (1.36)	1.33 (1.35)	0.93 (1.2)	1.12 (1.27)	1.29 (1.31)	1.32 (1.3)	1.24 (1.32)	0.99 (1.22)	0.73 (1.11)	0.97 (1.21)	1.08 (1.25)	0.73
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	1.40 (1.38)	1.35 (1.36)	1.00 (1.22)	1.19 (1.29)	0.70 (1.08)	1.32 (1.31)	1.23 (1.31)	1.03 (1.23)	0.81 (1.14)	1.09 (1.26)	1.15 (1.27)	0.34
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	1.37 (1.35)	0.73 (1.11)	0.00 (0.71)	0.00 (0.71)	0.30 (0.87)	0.53 (0.94)	0.43 (0.96)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.38 (0.94)	1.21
T6	Acetamipride 20% SP	100 g a.i./ha	1.41 (1.37)	0.87 (1.17)	0.13 (0.79)	0.00 (0.71)	0.33 (0.89)	1.18 (1.29)	0.36 (0.92)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.46 (0.94)	1.14
T7	Untreated control		1.56 (1.43)	1.55 (1.42)	1.35 (1.36)	1.51 (1.42)	1.56 (1.43)	1.60 (1.45)	1.56 (1.44)	1.39 (1.37)	1.16 (1.29)	1.35 (1.36)	1.46 (1.42)	2.46
SEm+			1.51	1.64	1.67	1.79	1.86	1.94	1.79	1.93	1.83	1.89	1.90	------
CD at 5%			1.42	1.46	1.47	1.51	1.64	1.69	1.51	1.56	1.53	1.54	1.68	

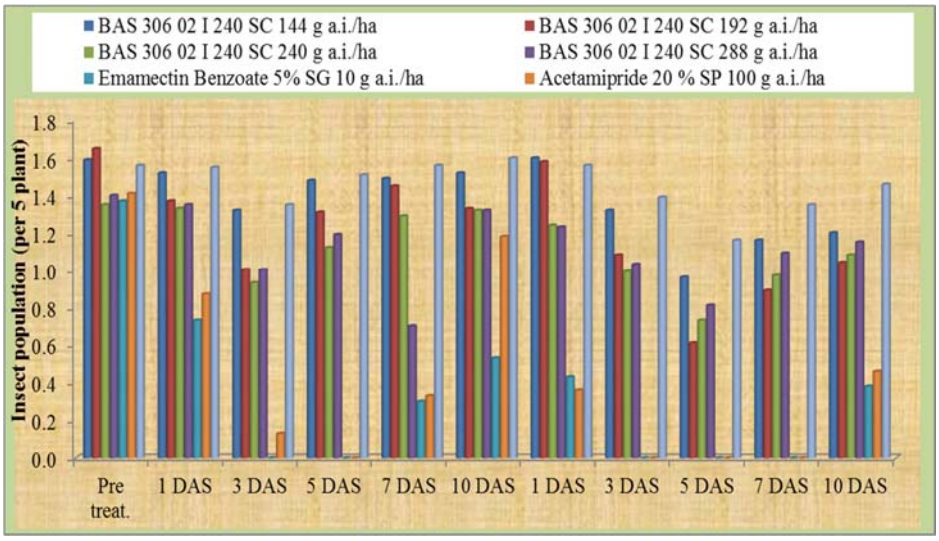

Fig 3: Days after 1st and 2nd spraying

Table 4: Bio-efficacy of BAS 306 02 I 240 SC against aphid on chilli during *Rabi* pooled data 2016-17 and 2017-18.

Treatment	Insecticide	Dose	Pre treatment	Average no. of aphid / 3 leaves / 5 plant										Overall mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144g a.i./ha	9.36 (3.14)	4.29 (2.19)	5.02 (2.35)	5.58 (2.47)	6.17 (2.58)	8.04 (2.92)	3.74 (2.06)	3.78 (2.07)	4.47 (2.23)	4.97 (2.34)	5.25 (2.40)	5.52
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	9.20 (3.11)	3.04 (1.88)	3.26 (1.94)	3.55 (2.01)	3.76 (2.06)	4.50 (2.24)	2.60 (1.76)	3.31 (1.95)	3.60 (2.02)	3.79 (2.07)	3.93 (2.10)	4.05
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	9.62 (3.18)	5.69 (2.49)	6.05 (2.56)	6.41 (2.63)	6.72 (2.69)	6.95 (2.73)	4.88 (2.32)	5.11 (2.37)	5.06 (2.36)	5.21 (2.39)	5.36 (2.42)	6.10
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	9.75 (3.20)	0.39 (0.94)	0.95 (1.20)	1.32 (1.35)	1.84 (1.53)	2.02 (1.59)	0.63 (1.06)	0.69m (1.09)	0.86 (1.17)	1.02 (1.23)	1.09 (1.26)	1.87
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	9.74 (3.20)	1.02 (1.23)	1.19 (1.30)	1.94 (1.56)	2.62 (1.77)	3.42 (1.98)	1.10 (1.26)	1.55 (1.43)	1.76 (1.50)	1.97 (1.57)	2.38 (1.70)	2.61
T6	Acetamipride 20% SP	100 g a.i./ha	9.26 (3.12)	3.80 (2.07)	4.18 (2.16)	4.88 (2.32)	5.34 (2.42)	6.09 (2.57)	2.92 (1.85)	3.60 (2.02)	4.25 (2.18)	4.60 (2.26)	5.12 (2.37)	4.91
T7	Untreated control		9.89 (3.22)	10.00 (3.24)	10.40 (3.30)	10.21 (3.27)	10.26 (3.28)	10.32 (3.29)	9.87 (3.22)	9.56 (3.17)	9.45 (3.15)	9.25 (3.12)	8.85 (3.06)	9.82
SEm+			NS	0.14	0.14	0.16	0.16	0.16	0.13	0.13	0.14	0.15	0.14	
CD at 5%			NS	0.41	0.42	0.48	0.47	0.48	0.38	0.39	0.41	0.44	0.42	

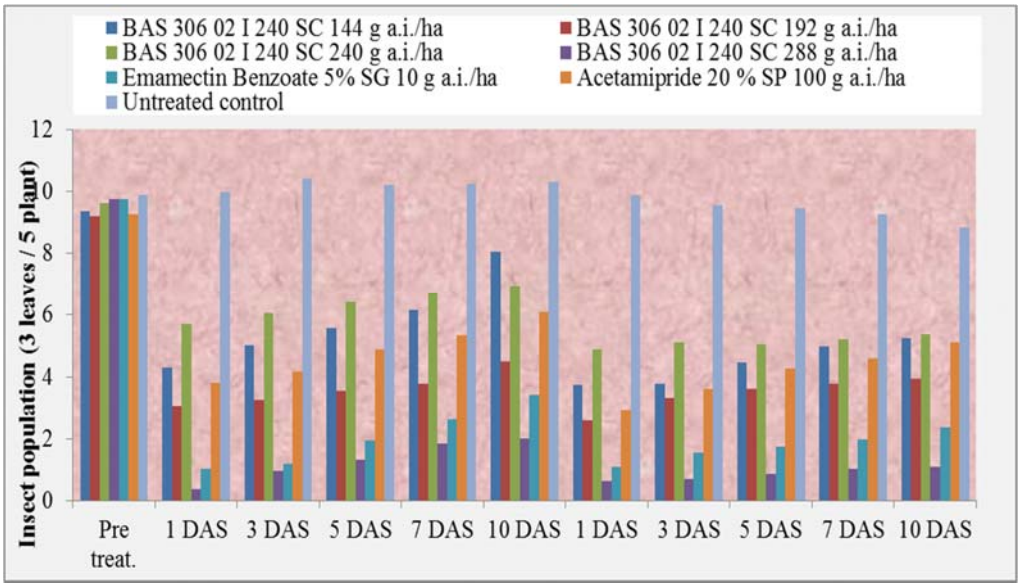

Fig 4: Days after 1st and 2nd spraying

Table 5: Bio-efficacy of BAS 306 02 I 240 SC against mites on chilli during *rabi* pooled data 2016-17 and 2017-18.

Treatment No.	Treatment	Dose	Pre treatment	I Spray					II Spray					Overall mean
			1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144 g a.i./ha	0.34 (1.16)	0.17 (1.08)	0.20 (1.10)	0.24 (1.11)	0.26 (1.13)	0.27 (1.12)	0.16 (1.08)	0.19 (1.09)	0.21 (1.10)	0.27 (1.12)	0.26 (1.11)	0.20
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	0.26 (1.12)	0.19 (1.09)	0.16 (1.07)	0.30 (1.14)	0.26 (1.12)	0.32 (1.15)	0.22 (1.11)	0.17 (1.08)	0.25 (1.11)	0.24 (1.11)	0.25 (1.11)	0.24
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	0.24 (1.11)	0.11 (1.05)	0.15 (1.07)	0.25 (1.11)	0.27 (1.12)	0.33 (1.15)	0.22 (1.10)	0.16 (1.07)	0.26 (1.12)	0.27 (1.12)	0.32 (1.14)	0.26
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	0.26 (1.12)	0.15 (1.07)	0.13 (1.06)	0.22 (1.11)	0.25 (1.11)	0.22 (1.10)	0.14 (1.07)	0.13 (1.06)	0.16 (1.06)	0.22 (1.11)	0.32 (1.14)	0.17
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	0.15 (1.07)	0.12 (1.06)	0.16 (1.07)	0.17 (1.08)	0.22 (1.10)	0.26 (1.12)	0.15 (1.07)	0.12 (1.06)	0.2 (1.11)	0.25 (1.12)	0.28 (1.12)	0.21
T6	Acetamipride 20% SP	100 g a.i./ha	0.18 (1.09)	0.10 (1.04)	0.15 (1.07)	0.14 (1.06)	0.20 (1.08)	0.25 (1.11)	0.14 (1.07)	0.15 (1.07)	0.22 (1.10)	0.25 (1.11)	0.27 (1.12)	0.22
T_7	Untreated control		0.34 (1.16)	0.30 (1.11)	0.26 (1.08)	0.29 (1.11)	0.34 (1.15)	0.36 (1.16)	0.41 (1.18)	0.41 (1.19)	0.43 (1.20)	0.45 (1.20)	0.44 (1.19)	0.36
SEm+			0.02	0.020	0.023	0.023	0.022	0.023	0.023	0.024	0.025	0.026	0.024	
CD at 5%			NS	0.06	0.09	0.10	0.10	0.08	0.12	0.12	0.06	0.13	0.05	

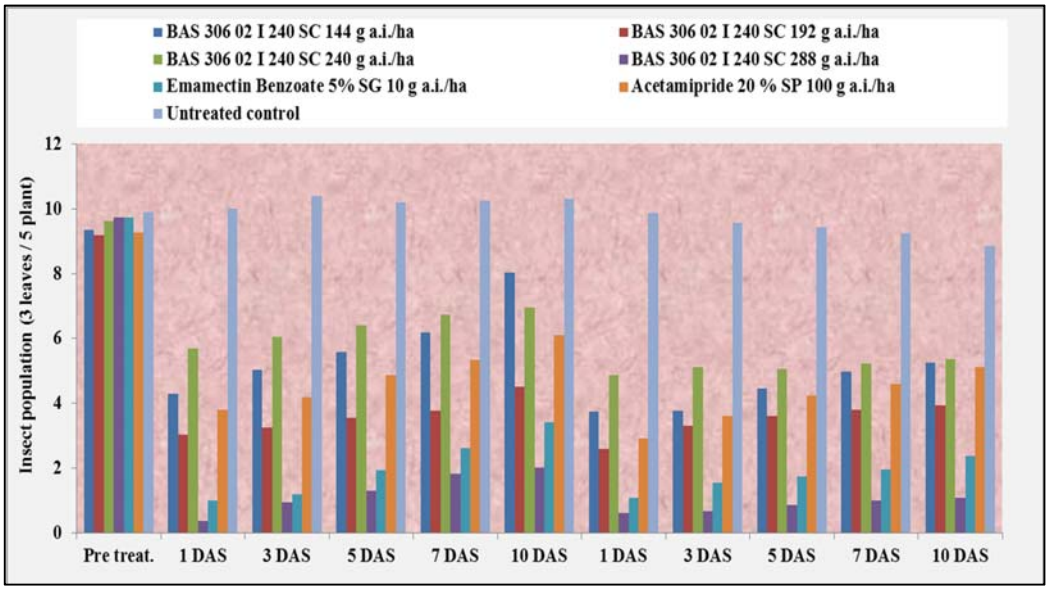

Fig 5: Days after 1st and 2nd spraying

Table 6: Bio-efficacy of BAS 450 01 I 300 SC against Coccinellids on chilli during pooled data *rabi* 2016-17 and 2017-18.

Treatment No.	Treatment	Dose	Pre treatment	I Spray					II Spray					Over all mean
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	BAS 306 02 I 240 SC	144g a.i./ha	1.11 (1.26)	1.00 (1.22)	0.60 (1.02)	0.62 (1.06)	0.54 (1.03)	0.60 (1.05)	0.25 (0.86)	0.62 (1.06)	0.65 (1.07)	0.88 (1.17)	0.46 (1.02)	0.69
T_2	BAS 306 02 I 240 SC	192 g a.i./ha	1.12 (1.26)	1.02 (1.23)	0.52 (0.99)	0.42 (0.97)	0.51 (0.1)	0.63 (1.06)	0.34 (0.92)	0.83 (1.16)	0.63 (1.07)	0.83 (1.15)	0.74 (1.12)	0.66
T_3	BAS 306 02 I 240 SC	240 g a.i./ha	0.89 (1.17)	0.75 (1.11)	0.57 (1.02)	0.42 (0.97)	0.43 (0.97)	0.45n (0.97)	0.255 (0.86)	0.615 (0.60)	0.71 (1.1)	0.80 (1.13)	0.62 (1.03)	0.68
T_4	BAS 306 02 I 240 SC	288 g a.i./ha	0.87 (1.16)	0.76 (1.13)	0.55 (102)	0.66 (1.07)	0.63 (1.06)	0.66 (1.07)	0.43 (0.96)	0.56 (1.03)	0.80 (1.14)	0.85 (1.16)	0.67 (1.05)	0.59
T_5	Emamectin Benzoate 5% SG	10 g a.i./ha	1.26 (1.33)	0.69 (1.10)	1.25 (1.31)	1.00 (1.22)	1.06 (1.22)	0.95 (1.2)	0.95 (1.2)	0.74 (1.10)	1.15 (1.28)	0.82 (1.14)	0.73 (1.11)	0.86
T6	Acetamipride 20% SP	100 g a.i./ha	1.13 (1.28)	0.90 (1.18)	0.93 (1.17)	0.80 (1.14)	0.81 (1.13)	0.78 (1.13)	0.60 (1.03)	0.69 (1.08)	0.90 (0.11)	0.85 (0.02)	0.60 (0.05)	0.80
T7	Untreated control		1.00 (1.22)	1.34 (1.36)	0.85 (1.15)	0.97 (1.22)	0.90 (1.18)	0.95 (1.19)	0.52 (1.01)	1.06 (1.25)	1.05 (1.22)	0.96 (1.21)	0.86 (1.15)	0.95
SEm+			0.026	0.025	0.026	0.025	0.024	0.026	0.023	0.024	0.026	0.024	0.026	
CD at 5%			NS	NS	0.06	0.09	0.06	NS	0.08	0.12	0.12	0.06	0.07	

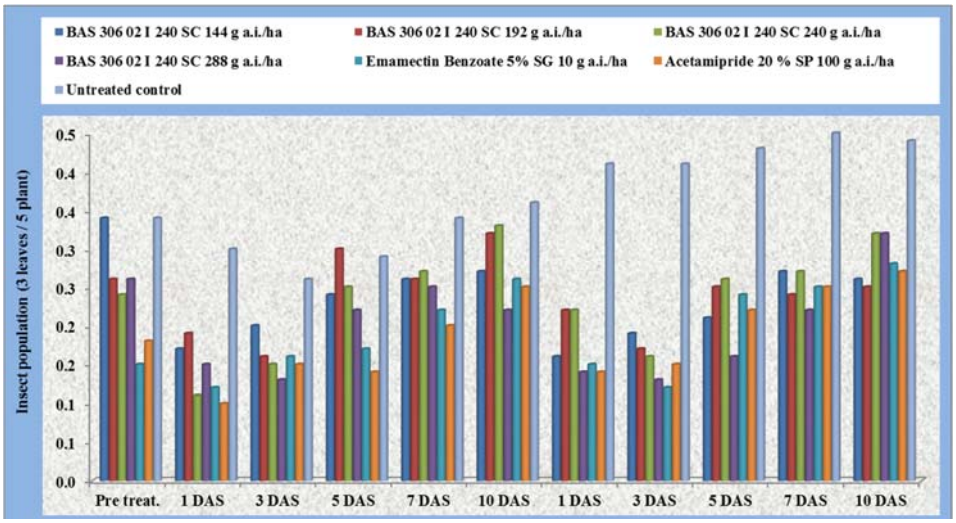

Fig 6: Days after 1st and 2nd spraying

Table 7: Bio-efficacy of BAS 306 02 I 240 SC against Staphylinid on chilli during *rabi* pooled data 2016-17 and 2017-18.

S. No.	Name ff treatment	Dose	Green Chilli Yield (q/ha)
T1	BAS 306 02 I 240 SC	144g a.i./ha	97.89
T2	BAS 306 02 I 240 SC	192 g a.i./ha	101.52
T3	BAS 306 02 I 240 SC	240 g a.i./ha	103.77
T4	BAS 306 02 I 240 SC	288 g a.i./ha	106.11
T5	Emamectin Benzoate 5% SG	70 g a.i./ha	96.08
T6	Acetamiprid 20% SP	100 g a.i./ha	94.27
T7	Control	Untreated	78.00

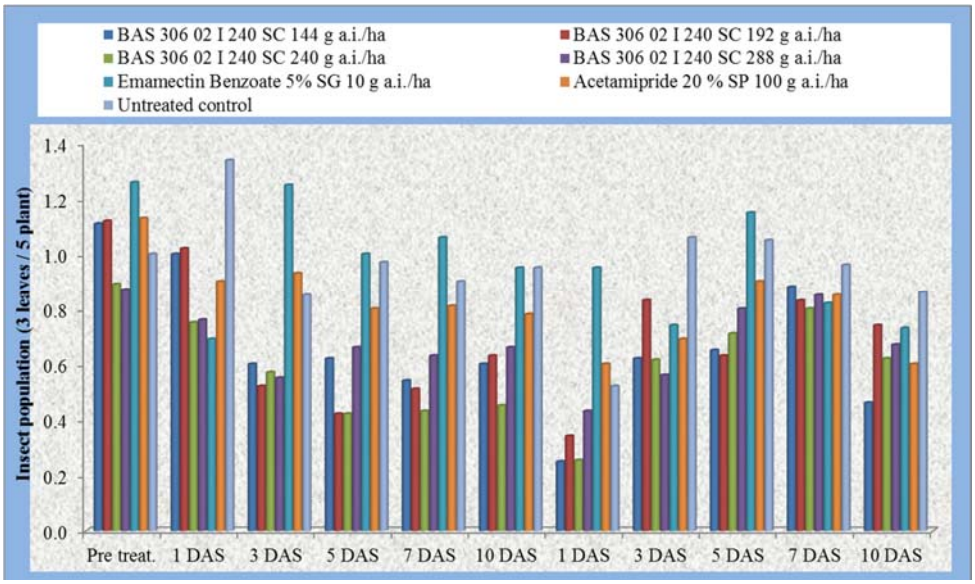

Fig 7: Days after 1st and 2nd spraying

Table 8: Pooled mean yield data of chilli to application of different insecticides against different insect pest of chilli crops during 2016-17 & 2017-18.

S. No.	Name of treatment	Dose	Green Chilli Yield(q/ha)
T1	BAS 306 02 I 240 SC	144g a.i./ha	97.89
T2	BAS 306 02 I 240 SC	192 g a.i./ha	101.52
T3	BAS 306 02 I 240 SC	240 g a.i./ha	103.77
T4	BAS 306 02 I 240 SC	288 g a.i./ha	106.11
T5	Emamectin Benzoate 5% SG	70 g a.i./ha	96.08
T6	Acetamiprid 20 % SP	100 g a.i./ha	94.27
T7	Control	Untreated	78.00

Results and Discussion

Bio-efficacies of newer insecticides against major insect pests of chilli.

The present study was conducted to evaluate the bio-efficacy of newer insecticides against chilli insect pests which were applied major insect pests *i.e* thrips (Scirtothrips dorsalis), aphid (*Aphis gossypii*), mite (P*oly phagotarsonemus latus*), and whitefly (*Bemisia tabaci*) in chilli crop. An experiment with six insecticides *viz*. BAS 306 02 I SC @ 144 g a.i. /ha, BAS 306 02 I 240 SC @ 192 g. a. i./ha, BAS 306 02 I 240 SC @ 240 g. a.i./ha, BAS 306 02 I 240 SC@ 288 g a.i. /ha, emamectin benzoate 5% SG @ 10 g a.i. /ha, and Acetamipride 20% SP @ 100 g a.i./ha. Was laid out in randomized block design with three replication along with an untreated check for comparison.

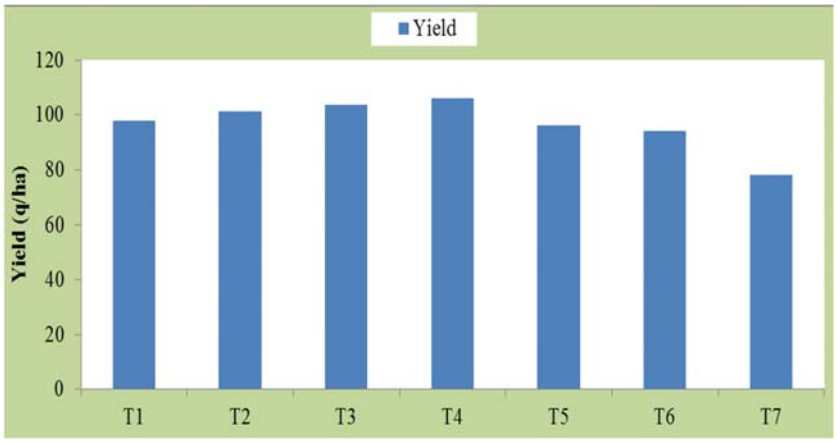

Fig 8: Treatments

Thrips, *Scirtothrips dorsalis* (Hood)

Data from Table 1. On thrips, *Scirtothrips dorsalis* Hood population recorded before spray revealed non – significant different among different treatment which indicated uniform distribution of in all the experimental plots in both years.

The bio-efficacy of overall mean data of different insect pests on 2016-17 and 2017-18 revealed that in pretreatment observation the minimum thrips population was observed in (T4) BAS 306 02 I 240 SC @ 288 g a.i./ ha (2.18 thrips/ plant), followed by (T3) BAS 306 02 I 240 SC @ 240 g a.i./ha (2.70/plant), (T2) BAS 306 02 I 240 SC @ 192 g a.i./ha (2.98/ plant) and (T1) BAS 306 02 I 240 SC @ 144 g a.i./ha (3.96/ plant). There was maximum thrips population (6.54/plant) in untreated control (T7).

The present results are in conformity with the findings of Dhanalakshmi and Mallapur (2008) [4]. who reported that Spinosad 45 SC @ 0.1 ml/l was most effective against thrips found on par with acetamiprid 20 SP @ 0.2 g/l. Shivanna *et al*. (2011) [25]. Revealed that Spinosad 45 SC and standard check acetamiprid 20 SP were found effective against sucking insect pest *viz*., whitefly and thrips in cotton. Mahalingappa *et al*. 2008 [11]. The results indicated that fipronil 0.01 and Triazophos 0.08 per cent were most effective against thrips in chillies, which were followed by profenophos 0.10, ethion 0.10 and cypermethrin 0.0012 per cent. Chlorpyriphos 0.0012 per cent was least effective against thrips. Reddy and Sreehari 2009 [17]. The results revealed that the Fipronil 80 WG @ 50 g a.i/ha recorded lowest number of thrips and is on par with Fipronil 80 WG @ 40 g a.i/ha, Regent 5% SC @ 40 g a.i/ha and Acephate 75% sp @ 468.75 g a.i/ha, whereas Confidor 200 SL and fipronil 80 WG @ 30 g a.i/ha were found least effective against thrips. Studies conducted by Kaur and Singh (2013) [8]. Revealed that Acephate and imidacloprid proved significantly superior in reducing the incidence of thrips in capsicum support the present findings. Maity *et al*. (2015) [12]. Support the present finding who reported that fipronil was the most effective insecticides against chilli thrips. Eelier, Patil, *et al*. 2017 [15]. reported that among different treatments, dimethoate 30 EC and sulphur 80 WDG were found effective against chilli sucking pests like thrips (1.71 1.85/3 leaves), mites (1.40 & 1.50/3 leaves) and aphids (1.54 & 1.59/3 leaves) by recording least population over control. However, bifenthrin 10 EC and fenazaquin 10 EC recorded higher population and found ineffective against thrips, mites and aphids. Yadav *et al*. 2017 [28]. Found that acetamiprid 0.005% caused maximum per cent reduction in thrips and whitefly population of the both sprays. While, in case of jassid imidacloprid 17.8 SL was registered with maximum per cent reduction in the both sprays. Sagle, *et al*. 2017 [22]. Observed that imidacloprid 17.8 SL @ 0.005% (5.12 thrips/3 leaves and 0.96 whiteflies/leaf), acetamiprid 20 SP 0.004% (0.58 whiteflies/leaf) and Triazophos 40 EC @ 0.04% (1.09 whiteflies/leaf) found most effective. RG Samota, *et al*. 2017 [19]. Observed that acetamiprid (82.62%) was found to be the most effective, followed by thiamethoxam (80.79%), imidacloprid (77.90%), fipronil (76.38%) and standard check (71.92%), former three treatments were statistically at par with each other in their efficacy.

Whitefly, Bemisia tabaci (Gennadius)

Data pertaining to the whitefly population on chilli 1 day before and 1st, 3rd, 5th, 7th, and 10th days after 1st and 2nd spray is presented in Table2 and graphically represented in fig 02.Pooled average in respect of efficacy of testing insecticide molecules against chilli whiteflies are presented in Table 02 and graphically represented in Fig 02 The recount of whiteflies before initiation of the spray treatment was in the range of 1.08 to 3.82 whiteflies/three leaves. Entire treated plot had statistically highly significant lower population as compared to control. Treatment (T4) BAS 306 02 I 240 SC @ 288 g a.i./ha had minimum whitefly population (1.08 whitefly/plant) followed by (T3) BAS 306 02 I 240 SC @ 240 g a.i./ ha (1.14 whitefly/plant) were found statistically at par, The maximum whitefly population (3.82 whitefly/plant) noticed in (T7) untreated control. Thus, the results obtained in the present investigation are conformity with the findings of earlier research workers Razaq *et al*. (2005) [16]. found that population of whitefly was below ETL in plots treated with acetamiprid (3.38/leaf) and diafenthiuron (2.69/leaf) seven day after application and diafenthiuron, acetamiprid, imidacloprid and thiamethoxam proved to be the most effective in reducing whiteflies population. Afzal *et al*. (2014) [1]. Showed that diafenthiuron, acetamiprid and thiamethoxam were most effective insecticides against whitefly up to seven days after application. While, diafenthiuron gave maximum mortality during first spray (89.52 and 85.80%) and second spray (91.67 and 87.51%) after 72 hrs of application. Anjali Harne 2014 [7]. observed among treatments. Lowest whitefly population per 10 cm twig was recorded in treatment Fipronil 5 SC @ 0.350 l/ha (1.92, whiteflies /sample), followed by Dimethoate 30 EC@ 0.580 l/ha (1.98), Triazophos 40 EC @ 1.050 l/ha (2.03), Triazophos 40 EC @ 0.7 l/ha (2.03), Fipronil 5 SC @ 0.525 l/ha (2.05), Imidacloprid 17.8 SL @ 0.058 l/ha (2.07), Dimethoate 30 EC @ 0.875 l/ha (2.08) and Imidacloprid 17.8 SL @ 0.09 l/ha (2.20), that were at par. Highest whitefly population per 10 cm twig was recorded in untreated control

(2.63). Earlier Yadav *et al.* 2017 [28]. found that acetamiprid 0.005% caused maximum per cent reduction in thrips and whitefly population of the both sprays. While, in case of jassid imidacloprid 17.8 SL was registered with maximum per cent reduction in the both sprays. Chavan *et al.* 2017 [3]. reported that among all the treatments, Fipronil 200 SC 250 mL/ha, was found to be the best treatment followed by Fipronil 200 SC 200 mL/ha, Fipronil 200 SC 150 mL/ha, Lamda cyhalothrin 5EC 300 mL/ha, Fipronil 5 SC 1000 mL/ha, Imidacloprid 200SL 250 mL/ha, Lamda cyhalothrin 4.9% CS 15 g a.i./ha and Indoxacarb 14.5% SC60 g a.i/ha were found most effective against different pest complex of chilli. Sangle, *et al.* 2017 [22]. Observed that imidacloprid 17.8 SL @ 0.005% (5.12 thrips/3 leaves and 0.96 whiteflies/leaf), acetamiprid 20 SP 0.004% (0.58 whiteflies/leaf) and Triazophos 40 EC @ 0.04% (1.09 whiteflies/leaf) found most effective.

Aphid, *aphis gossypii* (Glovers)

Observations on aphid incidence were recorded from five randomly selected plant of each treatment replication. Aphid population was recorded prior and post application of insecticidal treatment on the basis of nymph and adult of aphid by visual counting. The pre-treatment population of aphids was uniform during 2016 -17and 2017-18.

Pooled average in respect of efficacy of testing insecticide molecules against chilli whiteflies are presented in Table. and graphically represented in Fig. The precount of whiteflies before initiation of the spray treatment was in the range of 1.08 to 3.82 whiteflies/three leaves. Entire treated plot had statistically highly significant lower population as compared to control. Treatment (T4) BAS 306 02 I 240 SC @ 288 g a.i./ha had minimum whitefly population (1.08 whitefly/plant) followed by (T3) BAS 306 02 I 240 SC @ 240 g a.i./ ha (1.14 whitefly/plant) were found statistically at par, The maximum whitefly population (3.82 whitefly/plant) noticed in (T7) untreated control.

The present results are in conformity with the findings of Kumar *et al.* (2010)**.** Bio efficacy of seven insecticides with different concentration viz., Endosulfan (0.07%), Monocrotophos (0.05%), Malathion (0.05%), Dimethoate (0.04%), Phosalone (0.04%), Cypermethrin (0.01%) and Neem oil (3.5%) was evaluated against aphid, *Aphis gossypii* (Glover) on chilli, Meitei morok *Capsicum annum* L. Among the insecticides, the best result was obtained with Malathion (0.05%) and Phosalone (0.04%), but Neem oil (3.5%) was found least effective in reducing *Aphis gossypii* population.

Mites

The population of mites was uniform in all the experimental treatment plots, since the average population of mites was statistically non – significant. The average mites population was 1.52 to 2.52 (mites/three leaves) justifying that there was need to protect the crop from mites infestation

The bio-efficacy of overall mean pooled data of different insect pests on 2016-17 and 2017-18. All insecticidal treatment were still statistically better than control. Among all the insecticidal treatment minimum mites population was observed in (T4) BAS 306 02 I 240 SC @ 288 g a.i./ha (2.10 mites/plant), followed by (T3) BAS 306 02 I 240 SC @ 240 g a.i./ha (2.75 mites/plant), and (T2) BAS 306 02 I 240 SC @ 192 g a.i. / ha (2.86 mites/plant), were found statistically at par. There was maximum mites population (3.40/plant) in untreated control (T7). The entire treated plot had statistically highly significant lower population as compared to control.

The present results are in conformity with the findings of Pathipati *et al.* (2012) [14]. reported that maximum mortality of mites was observed with fenpyroximate 25 EC at the rate of 500 ml/ha (98.6%) followed by abamectin 1.9 EC at the rate of 125 ml/ha a.i. /ha (95.66%) and propagate 50 EC at the rate of 1000 ml/ha (88.99%). Reddy *et al.* (2013) [18]. reported that new acaricides (spiromesifen, hexythiazox and fenpyroximate) are most effective against two spotted mite, Tetranychus urticae Koch in ridge gourd field.

Varghese and Mathew (2013) [26]. reported that spiromesifen 45 SC at 100 g a.i./ha and propagate 57 EC at 570 g a.i./ha were found to be effective in reducing chilli mite population. Kavya *et al*., (2015) [9]. Revealed that new acaricides like propagate (0.78 mites/leaf) and spiromesifen (1.05 mites/leaf) reduced the overall mite population more significantly than other acaricides. Eelier, Patil, *et al.* 2017 [15]. reported that among different treatments, dimethoate 30 EC and sulphur 80 WDG were found effective against chilli sucking pests like thrips (1.71 1.85/3 leaves), mites (1.40 & 1.50/3 leaves) and aphids (1.54 & 1.59/3 leaves) by recording least population over control. However, bifenthrin 10 EC and fenazaquin 10 EC recorded higher population and found ineffective against thrips, mites and aphids. Chavan *et al*. 2017 [3]. reported that among all the treatments, Fipronil 200 SC 250 mL/ha, was found to be the best treatment followed by Fipronil 200 SC 200 mL/ha, Fipronil 200 SC 150 mL/ha, Lamda cyhalothrin 5EC 300 mL/ha, Fipronil 5 SC 1000mL/ha, Imidacloprid 200SL 250 mL/ha, Lamda cyhalothrin 4.9% CS 15 g a.i./ha and Indoxacarb 14.5% SC60 g a.i/ha were found most effective against different pest complex of chilli.

Fruit borer

Fruit damage on the basis of number of larvae/plant was recorded during the harvesting period of chilli fruits from the experimental crop. The data on number of larvae/plant reflected the level of larval infestation of *Helicoverpa armigera* on chilli crop. Hence, the data obtained on number of larvae/plant was used for comparing the efficacy of spray treatments.

The bio-efficacy of overall mean pooled data of different insect pests on chilli 2016-17 and 2017-18. Among all the insecticidal treatment the minimum fruit borer larvae population (T_3) BAS 306 02 I 240 SC @ 240 g a.i./ha (0.73 larvae/plant) and (T_2) BAS 306 02 I 240 SC @ 192 g a.i./ha (1.10 larvae/plant) were found statistically at par, followed by (T_1) BAS 306 02 I 240 SC @ 144 g a.i. /ha (1.38 larvae plant) and (T_6) Acetamiprid 20% SC @ 100 g a.i./ha (1.14 larvae /plant. The maximum fruit borer population (T_7) was recorded untreated control.

Thus the results obtained in the present investigation are in conformity the findings of earlier workers. Shah *et al.* (2013) [23]. reported the minimum larvae per plant of *Helicoverpa armigera* (0.40 and 0.46) was recorded in emamectin benzoate and neem seed extract and maximum number of larvae per plant was recorded (1.00) in control plot. Roopa and Kumar (2014) **[20]**. studied the bio – efficacy of new insecticide molecules against capsicum fruit borer, *Helicoverpa armigera* (Hubner). The results indicated that among different chemical spinosad 45 SC @ 0.01% emerged as the best treatment which recorded highest per cent reduction of 76.53 with a highest yield of 30050 kg/ha. Eelier, Patil, *et al*. 2017 [15]. reported that novaluron 10 EC and thiodicarb 75 SP were effective against fruit borers like *Helicoverpa* (0.70 & 0.73/plant) and *Spodoptera* (0.56 & 0.80/plant). Chavan *et al*. 2017 [3]. reported that among all the treatments, Fipronil 200 SC 250 mL/ha, was found to be the best treatment followed by Fipronil 200 SC 200 mL/ha, Fipronil 200 SC 150 mL/ha, Lamda cyhalothrin 5EC 300 mL/ha, Fipronil 5 SC 1000mL/ha, Imidacloprid 200SL 250 mL/ha, Lamda cyhalothrin 4.9% CS 15 g a.i./ha and Indoxacarb 14.5% SC60 g a.i/ha were found most effective against different pest compelex of chilli. Guru PN and Patil CS 2018 [15] The results indicated that among various treatments, flubendiamide 240+ thiacloprid 240 @ 120 g a.i./ha was found superior treatment with least larval population of *Helicoverpa armigera* (0.13 larvae per plant), *Spodoptera* spp. (0.33 larvae per meter row length) and least fruit damage (1.73%).

Effect of insecticides on the natural enemies of insect pest on chilli.

Coccinellids

During the course of study chilli crop mainly infested by thrips, aphid, mite, whitefly, and fruit borer. The natural enemies were observed on the same plant at the time of recording insect pests population at weekly pest population at weekly intervals. The detailed descriptions of natural enemies are given below:

The bio-efficacy of overall mean pooled data of different insect pests on 2016-17 and 2017-18. All insecticidal treatment were still statistically better than control. Among all the insecticidal treatment minimum coccinellids beetle population was observed in (T4) BAS 306 02 I 240 SC @ 288 g a.i./ha (0.17 coccinellids beetle per plant), followed by(T3) BAS 306 02 I 240 SC @ 240 g a.i./ha (0.26

coccinellids beetle per plant),(T2) BAS 306 02 I 240 SC @ 192 g a.i. / ha (0.24 coccinellids beetle per plant), and were found statistically at par. There was maximum coccinellids beetle population (0.36 coccinellids beetle per plant) in untreated control (T7). The entire treated plot had statistically highly significant lower population as compared to control. The present findings are almost similar to those of Singh *et al.* (2013) who reported the coccinellids appeared more or less after occurrence of aphid with 0.33 coccinellids/leaf. The population gradually increased and peaked with 2.51 coccinellids/leaf. More or less similar findings were obtained by Chintkuntlawar *et al*. (2015) who reported that the natural enemy's ladybird beetle grub and adults were the predators, which devour nymph and adult stages of soft bodied insect species viz., whitefly, aphids, jassids etc. First appearance of ladybird beetle reproductive stage of the crop.

Staphylinid beetle

The data related to effect of different insecticides on Staphylinid beetle after spraying was presented in Table …. and graphically depicted in fig…. respectively.

The bio-efficacy of overall mean pooled data of different insect pests on 2016-17 and 2017-18. All insecticidal treatment were still statistically better than control. Among all the insecticidal treatment minimum Staphylinid beetle population was observed in (T4) BAS 306 02 I 240 SC @ 288 g a.i./ha (0.59 Staphylinid beetle per plant), followed by(T2) BAS 306 02 I 240 SC @ 192 g a.i. / ha (0.66 Staphylinid beetle per plant), (T3) BAS 306 02 I 240 SC @ 240 g a.i./ha (0.68 Staphylinid beetle per plant), and were found statistically at par. There was maximum Staphylinid beetle population (0.95 Staphylinid beetle per plant) in untreated control (T7). The entire treated plot had statistically highly significant lower population as compared to control.

Mean yield data of chilli to application of different insecticides against different insect pest of chilli crops during 2016-17and 2017-18.

The data on yield of chilli fruits is presented in Table … and graphically in Fig… It was seen from the data that the entire average marketable fruit yield among different treatments ranged.

The data of two years (2016 – 17 and 2017 – 18) mean total healthy chilli green fruit yield of all the treatment was significantly higher over untreated control Yield of green fruit of chilli ranged between 78.00 to 106.11 q/ha. Maximum yield was recorded from treatment T4 BAS 306 02 I 240 SC @ 288 g a.i./ha (106.11 q/ha.) followed by T3 BAS 306 02 I 240 SC @ 240 g a.i./ha (103.77 q/ ha). The lowest total yield recorded from untreated control (T7) (78.00 q/ ha).

Above findings are in close agreement with earlier researchers, Ghosh *et al*. (2009) who recorded highest mean consequential yield increase over control in thiamethoxam followed by acetamiprid, fipronil and clothianidin. Shitole (2013) [13]. reported that significantly maximum yield (15278 kg/ha) of green chilli with 229.34% increased over control was recorded from the crop treated with spinosad 0.009 percent. Varghese *et al*. (2013) [26]. Reported that spinosad 0.015 per cent was found most effective in increasing yield of chilli.

Earlier, Patil, *et al.* 2017 [15]. reported that pooled data on yield indicated that significantly higher green chilli yield obtained in Sulphur 80 WDG @ 3g/l (2755 kg/ha) followed by dimethoate 30 EC (2598 kg/ha), phosphamidon 85 WSC (2431 kg/ha) and acephate 75 WP (2314 kg/ha). On contrary, significantly lower yield was noticed in fenazaquin 10 EC (1675 kg/ha) and bifenthrin 10 EC (1726 kg/ha). Sangle, *et al.* 2017 [22]. observed that highest green chilli fruit yield (110.25 q/ha) was harvested from crop treated with imidacloprid followed by thiamethoxam (106.55 q/ha), triazophos (103.79 q/ha) and acetamiprid (102.91 q/ha). Wale S.D., *et al*. 2018 [21]. reported that of yield of green chillies, Betacyfluthrin 90 + Imidacloprid 210 OD @ (27.9 + 65.1), (21.6 + 50.4), and Pyriproxyfen 5 + Fenpropathrin 15 EC @ (37.5 + 112.5) g a.i./ha and yield Betacyfluthrin 90 + Imidacloprid 210 OD @ (15.3 + 35.7) g a.i./ha were found effective in descending manner than rest of the treatments and recorded (80.00 q/ha), (77.10 q/ha), (76.73 q/ha) and (76.17 q/ha), respectively.

Conclusion

On the basis of two years data, during 2016-17 & 2017-18 indicated that, the effect of all tested doses of BAS 306 02 I 240 SC effectively control the population of against major insect pests of Chilli. It was also observed that treatment T_3 @ 240g a.i./ha BAS 306 02 I 240 SC effectively control the population of against major insect pests of chilli and increase yield was found 28.48 q/ha over the untreated control and standard check and also observed all dosages levels tested for bio efficacy has no influence/effect on the natural enemy under field condition.

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