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Bioefficacy of some bio-pesticides against major pests of chilli

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Abstract
A field experiment was conducted with seven bio pesticides, Derisom, Anosom, Margosom, Spinosad, *Verticillium lecanii, Beauveria bassiana* and *B.t. varkurstaki* along with a chemical check, Imidacloprid to find out their bio-efficacy against major pests of Chilli specially chilli aphid (*Aphis gossypii*) Glover, chilli thrips (*Scirtothrips dorsalis* Hood), yellow mite (*Polyphagotarsonemus latus* Banks) and fruit borer (*Helicoverpa armigera* Hub.). Results shows that Imidacloprid was most effective against aphid with 76.65% reduction of population over control followed by Derisom(68.38%), Margosom(64.98%) and *V.lecanii* (63.49%). Highest percentage reduction of thrips over control was found in Imidacloprid treated plots (73.40%) followed by Margosom (62.52%) and *V. lecanii* (59.92%). Highest percentage reduction of yellow mite over control was found in Derisom treated plots (61.52%) followed by *V. lecanii* (55.27%).

Keywords: Chilli, bio-efficacy, bio-pesticides, aphid, thrips, yellow mite

1. Introduction
Chilli (*Capsicum annum* L.) is an important vegetable and condiment crop grown throughout the India. India is the largest consumer and exporter of chilli in the world with a production of 13,76,000 tons from an area of 792,000 ha and productivity is about 1.74 tons per ha (R. Geetha and Dr. K. Selvarani, 2017) [1]. Andhra Pradesh is the largest producer of chilli in India, contributing to about 44% of the total production and West Bengal contributes about 7.26% (R. Geetha and Dr.K. Selvarani, 2017) [2].

The export of chilli and chilli products from India have been steadily increasing. But a number of factors are responsible for low yield that include adverse climate, poor quality seeds, diseases, insect and mites significantly affects both the quality and production of chilli. One of the major limiting factors in chilli production in India is pest problem. In chilli more than 55 species of pests were recorded. The major insect pests are capable of reducing the yield up to 77-79% in which thrips and mites alone cause 34.14% and fruit borer accounts for 42.86% yield loss of chilli (Ahmed *et al*., 1987) [3]. Major insect pests of chilli are sap sucking pests, *viz.*, thrips (*Scirtothrips dorsalis* Hood), aphids (*Aphis gossypii* Glover) and mites (*Polyphagotarsonemus latus* Banks). Surveys conducted by AVRDC in Asia revealed that chilli is known to be infested by several insect and non-insect pests of which the tarsonemid mite, *Polyphagotarsonemus latus* Banks and thrips, *Scirtothrips dorsalis* Hood are the most destructive and are considered as major pests (Berke and Sheih, 2000) [4]. Farmers use a lot of chemical pesticides repeatedly to get rid of these pest problems which leads to increase in deposition of toxic residues in the body, destruction of ecological balance by killing the beneficial insects and natural enemies, development of resistance to insecticides leading to unsuccessful crop protection, resurgence and outbreak of the major insect pests and secondary pests etc. But, the new age science always advice to manage the pest population without disrupting the eco-system or natural balance.

In order to overcome these problems and keeping in view, the importance of chilli crop, the present studies were undertaken to validate and test the efficacy of different biologically originated pesticides and bio agents against major pests of chilli.

2. Materials and Methods
1. Treatments imposed
Nine treatments i.e, Derisom (Karanjin 2%EC) @2ml/lt, Anosom (Annonin 1% EC)@2ml/lt, Margosom (Azadirachtin 0.15% EC)@2ml/lt, Lipel (*Bacillus thuringiensis var.* kurstaki)

@2gm/lt,Biosar(*Verticillium lecanii*) @5gm/lt, Biocere (*Beauveria bassiana*) @5gm/lt, Imidacloprid(17.8%SL) @0.3ml/lt, Tracer(Spinosad 45% SC)@1ml/lt and a untreated plot.

2. Experimental layout

There were 3 replications of each treatment. Total 27 plots of 3m x 2m size were sown with "Bullet" variety of chilli in a spacing of 50 cm x 50 cm. The experiment was laid out in Randomized block design. All the recommended agronomic practices i.e, fertilizer application, interculture operation, proper irrigation and weeding operations were practiced thoroughly.

3. Methods of recording observation

With the build up of sufficient pest population, the pesticides were sprayed three times at 15 days interval i.e. 1st on 15th January, 2nd on 1st February and the 3rd one is on 16thFebruary, 2018. Pest count was taken from randomly selected five leaves from randomly selected five plants in each plot. In case of mites, the leaves thus collected from the field were put in a zip lock poly-propelene bag and brought to the laboratory for observation of no. of yellow mites under stereo-zoom binocular microscope (Olympus SZ-40). For aphid and thrips population nymph and adults were counted with the help of a hand lens. First observation was taken before the day of spraying and subsequent observations were taken at 3rd, 7th and 10thdays after spraying. The yield data was also recorded during each plucking and also at the final harvest. Yield of green chilli from different plucking's were recorded from each treatment plot and computed as q/ha.

4. Statistical analysis

The critical difference (CD) at 5% level of significance was worked out from the data of chilli thrips, aphids and yellow mite before treatment (PT) and after treatment of three consecutive sprays and the mean population were calculated and the data were analyzed in RBD and as well as percentage of reduction over control were calculated.

5. Results and Discussion

Though fruit borer (*Helicoverpa armigera*) is a major pest of chilli resulting about 42.86% yield loss (Ahmed *et al.*,1987), it did not cause any significant damage during the experiment as no such population fruit borer was found. Therefore, efficacy of above insecticides had been studied against aphid, thrips and yellow mite infesting chilli. These insecticides had been tested on the basis of mean pest population and their percent reduction over control. Besides, the yield was also recorded to find out the influence of these insecticides on the yield of chilli.

5.1 Efficacy of insecticides against Aphid

It can be seen from (Table-1) that the pretreatment count of aphid before 1st spray varied between 1.40-1.74 aphid per leaf. After first spray highest percentage reduction of aphid population over control was also recorded in Imidacloprid treated plots (64.80%) followed by Derisom (60.97%). During second spray, aphid population ranged between 3.38 - 5.20 aphid/leaf. After second spray, Imidacloprid recorded minimum population of aphid (1.84aphid/ leaf) followed by Derisom (2.72 aphid/ leaf). After 3rd spray, highest percentage reduction of aphid population over control was also recorded in Imidacloprid treated plots (88.75%) followed by Margosom (79.74%).

After all three consecutive sprays it was revealed that (Table-2) Imidacloprid provided best control with lowest mean population of aphid (1.45 aphid/leaf) followed by Derisom (2.21 aphid/leaf), Margosom (2.32 aphid/ leaf) and *V. lecanii* (2.43 aphid/ leaf). Highest percentage reduction of aphid population over control was recorded in Imidacloprid treated plots (76.65%) (Fig.1). This finding is similar to that of A.Ghosal, M. L. Chatterjee and A. Bhattacharyya (2013) [5] and N.K. Joshi and V.K. Sharma (2009) [6]. The next best results were given by Derisom (68.38%), Margosom (64.98) and *V. lecanii* (63.49%). Study of Anitha *et al.* (2008) [7] about the effectivity of neem oil and *V. lecanii* against chilli aphid and the investigation of K.Kafle (2015) [8] about the effectivity of derisom against mustard aphid, *Lipaphis erysimi*, is in close proximity with the present findings.

5.2 Efficacy of pesticides against chilli thrips

At early stage of the crop there was no incidence of thrips, therefore, no observation of thrips was recorded during first spray. This may be due to lower temperature prevailing at that time (daily average min. temp. of 8.09 ^{0}C and daily average max. temp. of 23.34 ^{0}C). Thrips population has negative correlation with the temperature as found by M.M. Hossain *et.al*. (2015) [9]. Incidence of thrips was noticed before second spray but there was no significant difference among the treatments. The thrips population was observed during the 4th week of February. During second spray (Table-3) pre-treatment count of thrips varied from 1.49 thrips/leaf to 1.73 thrips/leaf. After second spray, Imidacloprid recorded lowest population with 0.85thrips /leaf followed by Margosom (1.20 thrips/leaf) and *V. lecanii* (1.24 thrips/leaf). During 3rd spray thrips population varied from 3.53 thrips /leaf to 5.02 thrips/ leaf with significant difference among the treatments. After third spray lowest mean population of thrips (1.65 thrips/ leaf) was observed in Imidacloprid treated plots followed by Margosom (2.32 aphid/leaf), *V. lecanii* (2.57 thrips/leaf).

After all three spraying (Table-4) (Fig.2), it was revealed that highest percentage reduction was found in Imidacloprid treated plots (73.40%) followed by Margosom (62.52%) and *V. lecanii* (59.92%). Study of Saini *et al.* (2016) [10], supports the present findings about Imidacloprid, Margosom and *V. lecanii* but opposes the present findings in case of *Beauveria bassiana*. But the findings of Rakesh Kumar Meena and Anoorag R. Tyde (2017) [11] and R.G Samota, B.L Jat and Mamta Devi Choudhury (2017) [12], about the less effectivity of *Beauveria bassiana* against chilli thrips support the present findings.

5.3 Efficacy of pesticides against yellow mite

At early stage of the crop, there was no incidence of mites, therefore, no observation of mites was recorded during first spray.This may be due to lower temperature prevailing at that time (daily average min. temp. of 8.09 ^{0}C and daily average max. temp. of 23.34 ^{0}C). Incidence of mites was noticed at 7 days after second spray but there was significant difference among the treatments. After second spray (Table-5), Derisom recorded lowest population with 1.27 mites /leaf followed by *V. lecanii* (1.45 mites/leaf). Before third spray significant difference of mite population was seen among the treatments. After third spray lowest mean population of mites (3.05 mites/leaf) was observed in Derisom treated plots followed by *V. lecanii* (3.62 mites/leaf).

After all three spraying (Table-6) (Fig.3), it was revealed that

highest percentage reduction was also found in Derisom treated plots (61.52%) followed by *V. lecanii* (55.27%). *B. bassiana* resulted in 22.58% reduction over control which is in close proximity with the findings of K.Murugasrideviet *al.*(2018) [13] with 39.80% cumulative mean population reduction.

5.4 Effect on yield

The result revealed that there was significant variation of yield among the treatments ranging from 34.56 q/ha to 57.51 q/ha (Table-7) (Fig.4). Highest fruit yield of chilli (57.51 q/ha) was recorded in Derisom treated plots followed by *V. lecanii* (55.80 q/ha), Imidacloprid (54.56 q/ha) and Margosom (52.18 q/ha) respectively. Derisom showed highest percentage increase of yield over control with 66.40% increase. Whereas, the yield obtained from untreated control plots was 34.56 q/ha (Table-7).

Table 1: Effects of three consecutive sprays of bio pesticides on incidence of aphids in Chilli at Jaguli farm, BCKV.

Treatments	Dose (ml/L) Or (gm/L)	PCB 1st spray	MP at diff. DAS (no./leaf))			Mean popln of 1st spray	% ROC	PCB 2nd spray	MP at diff. DAS (no./leaf)			Mean popln of 2nd spray	% ROC	PCB 3rd spray	MP at diff. DAS (no./leaf))			Mean popln of 3rd spray	% ROC
			3DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS		
Derisome @2%EC	2 ml/lit	1.53 (1.42)	0.77 (1.12)	1.4 (1.37)	1.94 (1.56)	1.37	52.26	3.62 (2.02)	1.70 (1.48)	2.69 (1.78)	4.28 (2.18)	2.89	62.94	6.66 (2.67)	3.36 (1.96)	2.66 (1.77)	2.13 (1.62)	2.72	79.74
Anosom @1%EC	2 ml/lit	1.45 (1.39)	1.25 (1.32)	2.22 (1.65)	2.89 (1.84)	2.12	26.13	4.96 (2.33)	4.81 (2.30)	5.73 (2.49)	7.13 (2.76)	5.89	24.48	8.93 (3.07)	8.52 (3.00)	9.68 (3.21)	11.22 (3.42)	9.80	27.02
Margosom @0.15% EC	2 ml/lit	1.45 (1.39)	0.58 (1.04)	1.10 (1.26)	1.66 (1.47)	1.12	60.97	3.50 (2.00)	1.64 (1.46)	2.76 (1.80)	3.78 (2.07)	2.72	65.12	6.84 (2.70)	3.50 (2.00)	2.8 (1.81)	2.13 (1.62)	2.81	79.07
Lipel (*B.t.*)	2 ml/lit	1.48 (1.40)	1.98 (1.57)	2.44 (1.71)	3.4 (1.88)	2.48	13.58	4.53 (2.24)	5.10 (2.36)	5.82 (2.51)	7.46 (2.82)	6.13	21.41	9.14 (3.10)	9.30 (3.13)	10.73 (3.35)	12.01 (3.53)	10.68	20.47
Biosar *(V. lecanii)*	5gm/lit	1.74 (1.49)	0.92 (1.19)	1.42 (1.38)	1.96 (1.56)	1.43	50.17	4.12 (2.14)	1.86 (1.53)	2.76 (1.80)	4.28 (2.18)	2.96	62.05	6.30 (2.60)	3.52 (2.00)	2.89 (1.84)	2.37 (1.69)	2.92	78.25
Biocere *(B.bassiana)*	5gm/lit	1.68 (1.47)	1.4 (1.37)	1.89 (1.54)	2.6 (1.76)	1.96	31.70	4.46 (2.22)	5.10 (2.36)	5.62 (2.47)	6.76 (2.69)	5.83	25.25	7.88 (2.89)	9.26 (3.12)	10.42 (3.30)	11.49 (3.46)	10.39	22.63
Novaluron @10% EC	1.8ml/lit	1.61 (1.45)	0.48 (0.98)	0.96 (1.20)	1.6 (1.44)	1.01	64.80	3.38 (1.97)	0.77 (1.12)	1.53 (1.42)	3.21 (1.92)	1.84	76.41	6.81 (2.70)	2.14 (1.62)	1.41 (1.38)	0.97 (1.21)	1.51	88.75
Spinosad	1ml/lit	1.4 (1.37)	1.30 (1.34)	2.17 (1.63)	3.04 (1.88)	2.17	24.39	4.81 (2.24)	5.77 (2.50)	6.85 (2.71)	8.06 (2.92)	6.89	11.66	8.69 (3.03)	9.89 (3.22)	11 (3.39)	12.24 (3.56)	11.04	17.79
Untreated		1.44 (1.39)	2.18 (1.63)	2.89 (1.84)	3.54 (2.01)	2.87	*	5.2 (2.38)	6.54 (2.65)	7.68 (2.86)	9.2 (3.11)	7.80	*	9.46 (3.15)	11.38 (3.44)	13.54 (3.74)	15.37 (3.98)	13.43	*
SE.m ±		0.043	0.029	0.023	0.018	*	*	0.023	0.026	0.024	0.024	*	*	0.028	0.025	0.018	0.019	*	*
CD at 5%		NS	0.088	0.069	0.054	*	*	0.032	0.036	0.034	0.072	*	*	0.085	0.076	0.054	0.057	*	*

PCB= Pretreatment count before, ROC= Reduction over control, Popln= Population, DAS= Days after spray, MP= Mean population Figures in the parenthesis are the square root transformed value, NS= Non significant

Table 2: Overall performance of the pesticides against aphid population after three consecutive spray.

Treatment	Dose (ml/L or gm/L)	No. of aphid after each spray			Mean of three spray	% reduction over control at different spray			Overall ROC after all spray
		1ST	2ND	3RD		1ST	2ND	3RD	
Margosom@0.15%EC	2 ml/lit	1.37	2.89	2.72	2.32	52.26	62.94	79.74	64.98
Anosom @1%EC	2 ml/lit	2.12	5.89	9.80	5.93	26.13	24.48	27.02	25.87
Derisom @2% EC	2 ml/lit	1.12	2.72	2.81	2.21	60.97	65.12	79.07	68.38
Lipel (B.t.)	2gm/lit	2.48	6.13	10.68	6.43	13.58	21.41	20.47	18.48
Biosar (*V. lecanii*)	5gm/lit	1.43	2.96	2.92	2.43	50.17	62.05	78.25	63.49
Biocere (*B. bassiana*)	5gm/lit	1.96	5.83	10.39	6.06	31.70	25.25	22.63	26.52
Imidacloprid 17.8% SL	0.3ml/lit	1.01	1.84	1.51	1.45	64.80	76.41	88.75	76.65
Tracer @45% SC	1 ml/lit	2.17	6.89	11.04	6.70	24.39	11.66	17.79	17.94
Untreated		2.87	7.80	13.43	8.03				

ROC= Reduction over control

Table 3: Effects of three consecutive sprays of those biopesticides on incidence of thrips in Chilli at Jaguli farm, BCKV.

Treatments	Dose (ml/L) Or (gm/L)	PCB 1st spray	MP at diff. DAS (no./leaf))			Mean popln of 1st spray	% ROC	PCB 2nd spray	MP at diff. DAS (no./leaf)			Mean popln of 2nd spray	% ROC	PCB 3rd spray	MP at diff. DAS (no./leaf))			Mean popln of 3rd spray	% ROC
			3DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS		
Derisome @2%EC	2 ml/lit	*	*	*	*	*	*	1.49 (1.41)	0.73 (1.11)	1.22 (1.31)	2.25 (1.65)	1.40	55.12	3.54 (2.01)	1.72 (1.48)	2.46 (1.72)	3.60 (2.02)	2.59	59.27
Anosom @1%EC	2 ml/lit	*	*	*	*	*	*	1.44 (1.39)	1.41 (1.38)	2.14 (1.62)	3.62 (2.03)	2.39	23.39	4.73 (2.28)	4.60 (2.25)	5.10 (2.36)	5.50 (2.44)	5.06	20.44
Margosom @0.15% EC	2 ml/lit	*	*	*	*	*	*	1.57 (1.43)	0.58 (1.04)	1.04 (1.24)	1.97 (1.57)	1.20	61.53	4.41 (2.21)	1.78 (1.51)	2.20 (1.64)	3.00 (1.87)	2.32	63.52
Lipel (*B.t.*)	2 ml/lit	*	*	*	*	*	*	1.54 (1.49)	1.74 (1.69)	2.37 (1.90)	3.14 (0.70)	2.42	22.43	4.30 (2.19)	4.24 (2.17)	4.85 (2.31)	5.54 (2.45)	4.88	23.27
Biosar	5gm/lit	*	*	*	*	*	*	1.69	0.56	0.86	2.29	1.24	60.25	4.32	1.88	2.45	3.40	2.57	59.59

(*V. lecanii*)								(1.48)	(1.02)	(1.16)	(1.67)			(2.19)	(1.54)	(1.71)	(1.97)		
Biocere (*B.bassiana)*	5gm/lit	*	*	*	*	*	*	1.41 (1.38)	1.64 (1.46)	2.18 (1.63)	2.92 (1.84)	2.24	28.20	4.62 (2.26)	4.28 (2.18)	4.40 (2.21)	5.10 (2.36)	4.59	27.83
Novaluron @10% EC	1.8ml/lit	*	*	*	*	*	*	1.49 (1.41)	0.38 (0.94)	0.66 (1.08)	1.52 (1.42)	0.85	72.75	3.53 (2.00)	0.81 (1.14)	1.26 (1.32)	2.88 (1.83)	1.65	74.05
Spinosad	1ml/lit	*	*	*	*	*	*	1.53 (1.42)	1.30 (1.34)	1.80 (1.51)	2.35 (1.68)	1.81	41.98	4.38 (2.20)	2.32 (1.67)	3.90 (2.09)	5.05 (2.35)	3.75	41.03
Untreated		*	*	*	*	*	*	1.73 (1.49)	1.92 (1.64)	3.12 (1.88)	4.33 (2.19)	3.12	*	5.02 (2.35)	5.70 (2.48)	6.20 (2.58)	7.20 (2.77)	6.36	*
SE.m ±		*	*	*	*	*	*	0.023	0.014	0.017	0.015	*	*	0.019	0.014	0.014	0.014	*	*
CD at 5%		*	*	*	*	*	*	NS	0.043	0.050	0.045	*	*	0.058	0.043	0.041	0.041	*	*

PCB= Pretreatment count before, ROC= Reduction over control, Popl^{n}= Population, DAS= Days after spray, MP= Mean population Figures in the parenthesis are the square root transformed value, NS= Non significant

Table 4: Overall performance of the insecticides against thrips population

Treatment	Dose (ml/L or gm/L)	No. of thrips after each spray			Mean of three spray	% reduction over control at different spray			Overall ROC after all spray
		1ST	2ND	3RD		1ST	2ND	3RD	
Derisom @2% EC	2 ml/lit	*	1.40	2.59	1.99	*	55.12	59.27	57.19
Anosom @1%EC	2 ml/lit	*	2.39	5.06	3.72	*	23.39	20.44	21.91
Margosom @0.15%EC	2 ml/lit	*	1.20	2.32	1.76	*	61.53	63.52	62.52
Lipel (B.t.)	2gm/lit	*	2.42	4.88	3.65	*	22.43	23.27	22.85
Biosar (*V. lecanii*)	5gm/lit	*	1.24	2.57	1.90	*	60.25	59.59	59.92
Biocere (*B. bassiana*)	5gm/lit	*	2.24	4.59	3.41	*	28.20	27.83	28.01
Imidacloprid 17.8% SL	0.3 ml/lit	*	0.85	1.65	1.25	*	72.75	74.05	73.40
Tracer @45% SC	1 ml/lit	*	1.81	3.75	2.78	*	41.98	41.03	41.50
Untreated		*	3.12	6.36	4.74	*			

ROC= Reduction over control

Table 5: Effects of three consecutive sprays of those biopesticides on incidence of mites in Chilli at Jaguli farm, BCKV.

Treatments	Dose (ml/L) Or (gm/L)	PCB 1st spray	MP at diff. DAS (no./leaf))			Mean popl^{n} of 1st spray	% ROC	PCB 2nd spray	MP at diff. DAS (no./leaf)			Mean popl^{n} of 2nd spray	% ROC	PCB 3rd spray	MP at diff. DAS (no./leaf))			Mean popl^{n} of 3rd spray	% ROC
			3DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS				3 DAS	7 DAS	10 DAS		
Derisome @2%EC	2 ml/lit	*	*	*	*	*	*	*	*	1.05 (1.24)	1.50 (1.14)	1.27	58.36	3.10 (1.89)	1.41 (1.38)	2.77 (1.80)	4.98 (2.34)	3.05	64.69
Anosom @1%EC	2 ml/lit	*	*	*	*	*	*	*	*	2.01 (1.58)	2.50 (1.73)	2.25	26.22	4.72 (2.28)	4.80 (2.30)	5.77 (2.50)	7.49 (2.82)	6.02	30.32
Margosom @0.15% EC	2 ml/lit	*	*	*	*	*	*	*	*	1.98 (1.57)	2.40 (1.70)	2.19	28.19	4.62 (2.26)	4.57 (2.25)	5.26 (2.40)	7.57 (2.84)	5.80	32.87
Lipel (*B.t.*)	2 ml/lit	*	*	*	*	*	*	*	*	2.01 (1.58)	2.40 (1.70)	2.20	27.86	4.30 (2.19)	4.8 (2.30)	5.64 (2.47)	8.32 (2.96)	6.80	21.29
Biosar (*V. lecanii*)	5gm/lit	*	*	*	*	*	*	*	*	1.10 (1.26)	1.80 (1.51)	1.45	52.45	3.41 (1.97)	1.70 (1.48)	3.06 (1.88)	6.09 (2.56)	3.62	58.10
Biocere (*B.bassiana*)	5gm/lit	*	*	*	*	*	*	*	*	2.02 (1.58)	2.45 (1.17)	2.23	26.88	5.42 (2.43)	6.02 (2.55)	6.88 (2.71)	8.28 (2.96)	7.06	18.28
Novaluron @10% EC	1.8ml/lit	*	*	*	*	*	*	*	*	1.95 (1.56)	2.50 (1.73)	2.22	27.21	4.94 (2.33)	5.74 (2.49)	6.44 (2.63)	7.98 (2.91)	6.72	22.22
Spinosad	1ml/lit	*	*	*	*	*	*	*	*	1.94 (1.56)	2.48 (1.72)	2.21	27.54	5.36 (2.42)	6.26 (2.59)	6.97 (2.73)	7.74 (2.87)	6.98	19.21
Untreated		*	*	*	*	*	*	*	*	2.80 (1.81)	3.30 (1.94)	3.05	*	5.84 (2.51)	7.29 (2.79)	8.70 (3.03)	9.94 (3.23)	8.64	*
SE.m ±		*	*	*	*	*	*	*	*	0.06	0.06	*	*	0.017	0.021	0.025	0.020	*	*
CD at 5%		*	*	*	*	*	*	*	*	0.018	0.018	*	*	0.052	0.065	0.077	0.062	*	*

PCB= Pretreatment count before, ROC= Reduction over control, Popl^{n}= Population, DAS= Days after spray, MP= Mean population Figures in the parenthesis are the square root transformed value, NS= Non significant

Table 6: Effects of the pesticides against yellow mite population.

Treatment	Dose (ml/L or gm/L)	No. of yellow mite after each spray			Mean of three spray	% reduction over control at different spray			Overall ROC after all spray
		1ST	2ND	3RD		1ST	2ND	3RD	
Derisom @2% EC	2 ml/lit	*	1.27	3.05	2.16	*	58.36	64.69	61.52
Anosom @1%EC	2 ml/lit	*	2.25	6.02	4.13	*	26.22	30.32	28.27
Margosom @0.15%EC	2 ml/lit	*	2.19	5.80	3.99	*	28.19	32.87	30.53
Lipel (B.t.)	2gm/lit	*	2.20	6.80	4.50	*	27.86	21.29	24.57
Biosar (*V. lecanii*)	5gm/lit	*	1.45	3.62	2.53	*	52.45	58.10	55.27
Biocere (*B. bassiana*)	5gm/lit	*	2.23	7.06	4.64	*	26.88	18.28	22.58

Imidacloprid 17.8% SL	0.3ml/lit	*	2.22	6.72	4.47	*	27.21	22.22	24.71
Tracer @45% SC	1 ml/lit	*	2.21	6.98	4.59	*	27.54	19.21	23.37
Untreated		*	3.05	8.64	5.84				

ROC= Reduction over control

Table 7: Effects of the pesticides on incidence of major pests in Chilli and their effect on yield.

Treatment	Dose (ml/L or gm/L)	Mean scoring of chilli aphid/leaf	Mean scoring of chillithrips/leaf	Mean scoring of chilli mite/leaf	Yield (q/ha)	% increase of yield over control
Derisom @2% EC	2 ml/lit	2.32 (1.67)	1.99 (1.57)	2.16 (1.61)	57.51	66.40
Anosom @1%EC	2 ml/lit	5.93 (2.53)	3.72 (2.05)	4.13 (2.15)	39.40	14.00
Margosom @0.15%EC	2 ml/lit	2.21 (1.64)	1.76 (1.50)	3.99 (2.11)	52.18	50.98
Lipel (B.t.)	2gm/lit	6.43 (2.63)	3.65 (2.03)	4.50 (2.23)	41.38	19.73
Biosar (*V. lecanii*)	5gm/lit	2.43 (1.71)	1.90 (1.54)	2.53 (1.74)	55.80	61.45
Biocere (*B. bassiana*)	5gm/lit	6.06 (2.56)	3.41 (1.97)	4.64 (2.26)	40.03	15.82
Imidacloprid 17.8% SL	0.3 ml/lit	1.45 (1.39)	1.25 (1.32)	4.47 (2.22)	54.56	57.87
Tracer @45% SC	1 ml/lit	6.70 (2.68)	2.78 (1.81)	4.59 (2.25)	43.62	26.21
Untreated		8.03 (2.92)	4.74 (2.28)	5.84 (2.51)	34.56	*
CD at 5%		0.60	0.24	0.34	0.126	*

Figures in the parenthesis are square root transformed values, NS = Non significant

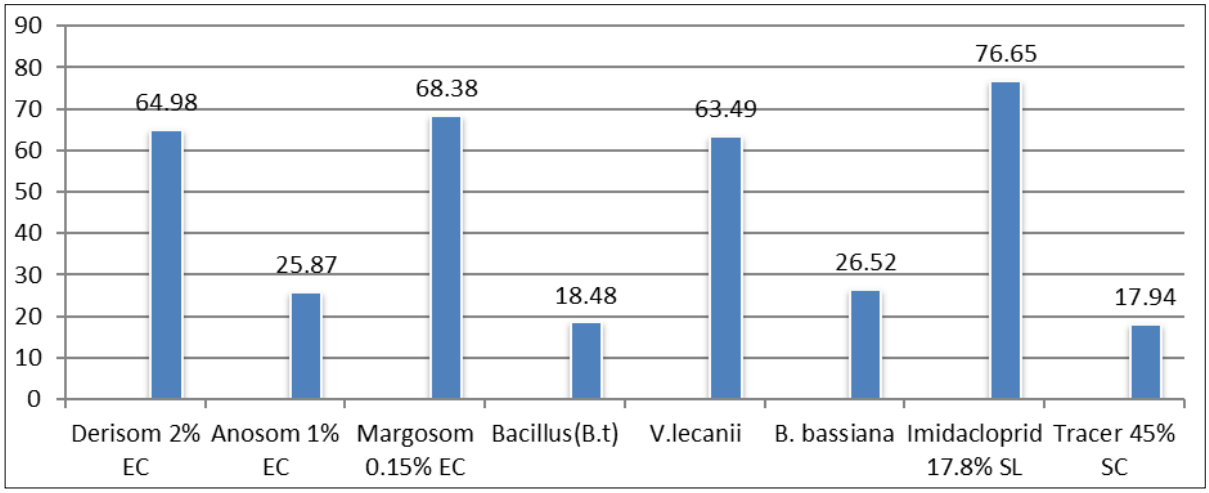

Fig 1: Overall percentage reduction of aphid population over control (X axis denotes percentage ROC of aphid population and Y axis denotes different treatments).

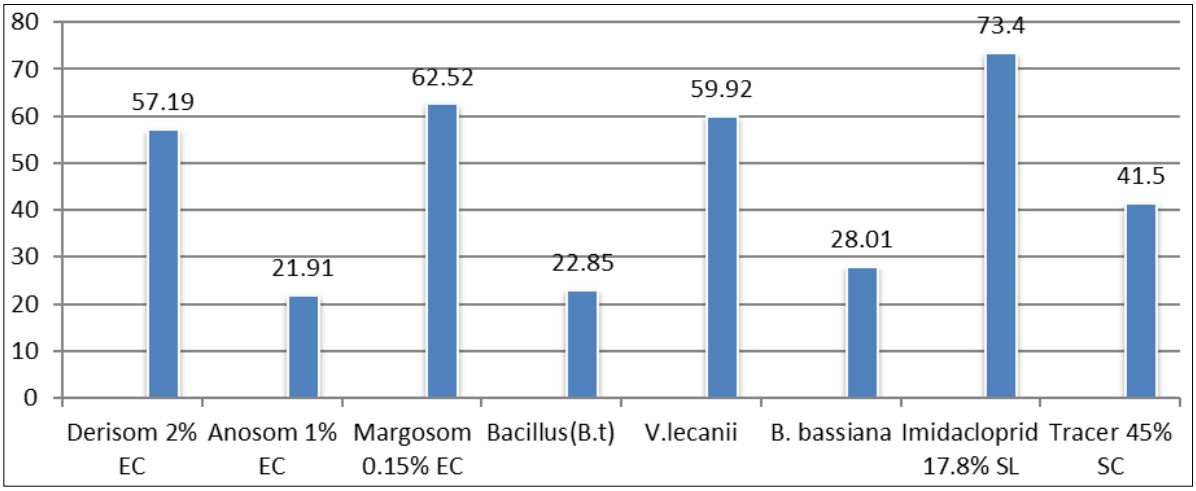

Fig 2: Overall percentage reduction of thrips population over control (X axis denotes percentage ROC of thrips population and Y axis denotes different treatments).

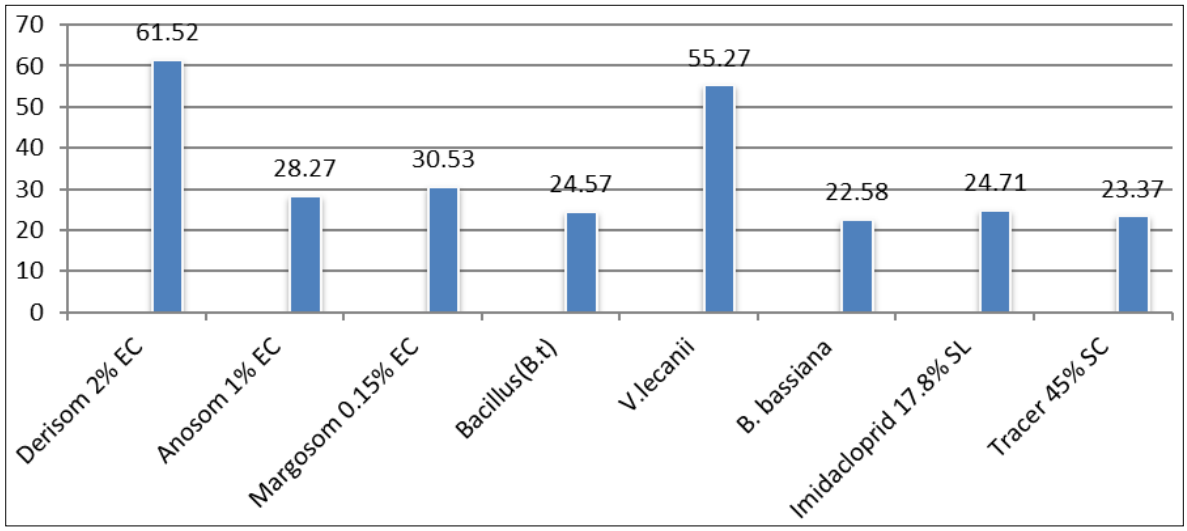

Fig 3: Overall percentage reduction of yellow mite population over control (X axis denotes percentage ROC of yellow mite population and Y axis denotes different treatments).

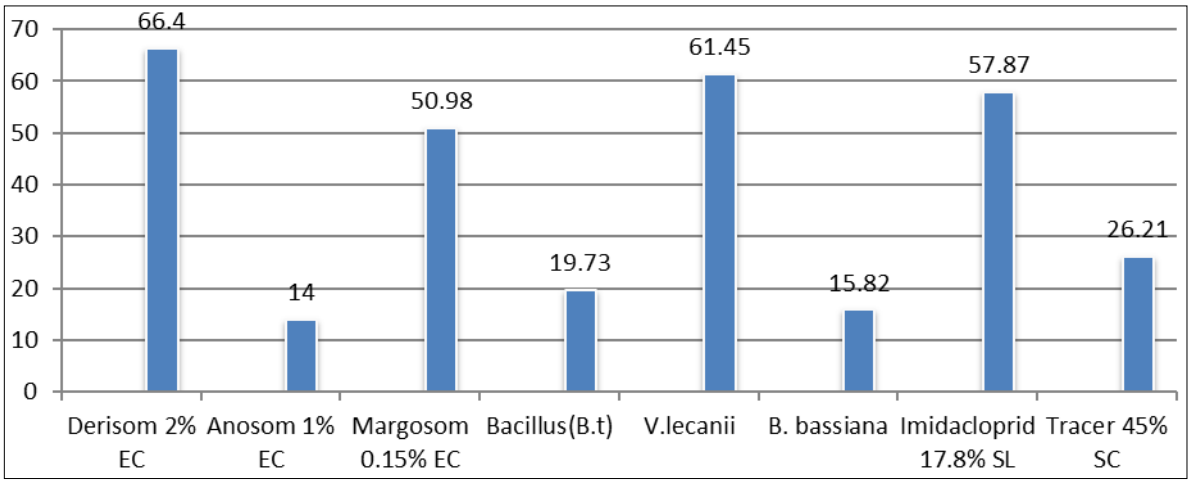

Fig 4: Effects on yield (X axis denotes percentage ROC of yellow mite population and Y axis denotes different treatments).

6. Conclusion

The overall findings from the present investigation in the field condition revealed that the insecticides like Derisom, Margosom and *V. lecanii* performed very well in reducing the sucking pest population and increasing the yield of chilli in comparison with the chemical check Imidacloprid. Imidacloprid was best against aphid followed by Derisom, Margosom and *V. lecanii*. For controlling thrips, Imidacloprid was best followed by Margosom, *V. lecanii* and Derisom. Against mites, Derisom provided best result with by *V. lecanii*.

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