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Evaluation of insecticides and acaricides against yellow mite and thrips infesting chilli (*Capsicum annum* L.)

A. SAMANTA, K. SEN AND I. BASU

Department of Agricultural Entomology, Faculty of Agriculture
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal

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ABSTRACT

Field experiment was conducted at District Seed Farm (AB Block) of BCKV, Kalyani, Nadia, West Bengal during Mid January to May, 2013 to evaluate the efficacy of different acaricidal and insecticidal molecules against thrips and yellow mite infestation on chilli. Among the treatments, spiromesifen 24SC @ 120 g a.i. ha^{-1}, fenpyroximate 5 SC @ 25 g a.i. ha^{-1} and diafenthiuron 50 WP @ 375 g a.i. ha^{-1} were observed to be very much effective against yellow mite. Whereas, chlorfenapyr 10 SC @ 75 g a.i. ha^{-1}, diafenthiuron 50 WP @ 375 g a.i. ha^{-1} and spiromesifen 24 SC @ 120 g a.i. ha^{-1} were adjudged as the effective insecticides against thrips. None of the chemicals was found harmful against predatory coccinelids and spiders. Highest fruit yield was obtained with diafenthiuron 50 WP @ 375 g a.i. ha^{-1} (17.64 q ha^{-1}) followed by spiromesifen 24 SC @ 120 g a.i. ha^{-1} (16.05 q ha^{-1}). Thus, spiromesifen 24 SC, chlorfenapyr 10 SC, fenpyroximate 5 SC and difenthiuron 50 WP may be recommended to control yellow mite and thrips infestation in chilli.

***Keywords*:** Acaricide, bioefficacy, chilli, insecticide, thrips, yellow mite

Chilli (*Capsicum annuam* L.) is an important commercial spice crop across the globe and in India, green chilli occupies an area of 292 thousand hectares with annual production of 2955 thousand metric tonnes during 2015-16 (http://www.agricoop.nic.in). Although, the crop has got great export potential besides huge domestic requirement, a number of limiting factors have been attributed for low productivity (Reddy *et al*., 2011). Chilli is widely grown in states among them occurrence of viral diseases as well as ravages caused by insect pets are significant ones (Gundannavar *et al*., 2007). Chilli is known to be affected by 57 insect and non-insect pests of which the Tarsonemid mite, *Polyphagotarsonemus latus* (Banks) (Acari:Tarsonemidae) and thrips, *Scirtothrips dorsalis* Hood are most destructive sucking pests and are considered as major pests (Reddy and Puttaswamy, 1984; Berke *et al*., 2000).They have got some bio-ecological advantages than the other pests, due to having very small in size, high bioticpotential, lack of effective natural enemies, capacity to adopt newer environment quickly andquick resistance development against toxicants (Venkateshalu *et al*., 2009). In India, chillisuffers a typical malady which is a characteristic leaf curl syndrome called "Murda" (Kulkarni *et al*., 2011). Chilli thrips and mites affected leaves curl "upward" and "down ward" resulting in a typical damage known as 'leaf curl syndrome' [15]. Economic yield loss may be 11-75 per cent quantitatively and 60-80 per cent qualitatively in the event of serious infestation [6].They cause ahavoc economic loss each year especially in thesouthern districts of West Bengal and have become a threat to the chilli growers (Sarkar *et al.,* 2008).To overcome these menace farmers are generally tend to apply 5 to 6 round of chemical sprays which are not only highly toxic in nature but also harmful as they leave their toxic residues in the soil as well as in the fruit where fresh green chillies are consumed more frequently. This tendency increases the number of chemical sprays over the years and ultimately, increasing the cost of cultivation making chilli cultivation non-profitable and risky. Besides these ill effects, indiscriminate use of pesticides causes resistance against many chemicals as well as pestresurgence and secondary pest outbreak. Keeping above aspects in mind, the present investigation was aimed to study the efficacy of some new acaro-insecticides with solo application at different dosages against two obnoxious sucking pests as well as their effect on naturally occurring predators (coccinellids and spiders) in chilli eco-system.

MATERIALS AND METHODS

The present experiment was conducted at the District Seed Farm (A-B Block) of BCKV located at Kalyani, Nadia, West Bengal during Mid January to May, 2013. The experiment was laid out in Randomized Block Design (RBD) with fifteen treatments including untreated control and three replications. Chilli cultivar "Bullet" (*Capsicum annum*var. *annum* L.) was used for the study which is a very common cultivar used by the farmers of West Bengal. Seedlings were raised in nursery beds and

Email: koushik579@gmail.com

40 days old seedlings were transplanted in the plot size of 3 × 3m at a distance of 50 cm between plants and 50 cm between rows on raised beds in the main field on 10th January, 2013. Each plot was represented by 5 rows accommodating 25 plants. Recommended agronomic package of practices were adopted for raising the crop. Soon after infestation of yellow mite and thrips the insecticidal spray was initiated with different chemicals viz., fenpyroximate 5 SC @ 15 and 25 g *a.i.* ha^{-1}, pyriproxifen 10 EC @ 50 and 75 *a.i.* ha^{-1}, propargite 57 EC @ 427.50 and 712.50 g *a.i.* ha^{-1}, dicofol 18.5 EC @ 231.25 and 277.50 g *a.i.* ha^{-1}, spiromesifen 24 SC @ 90 and 120 g *a.i.* ha^{-1}, chlorfenapyr 10 SC @ 50 and 75 g *a.i.* ha^{-1} and diafenthiuron 50 WP @ 300 and 375 g *a.i.* ha^{-1}. The spray volume was 500 litres ha^{-1}. All the three sprays were advocated at an interval of 15 days. Spraying was done with a high volume knapsack sprayer. A buffer area of one meter width was left around each experimental plot to safeguard against the possible drift and contamination during spraying operations.

Population of mites and thrips was recorded from the undersurface and upper surface of leaves respectively. Pest counts were made from three leaves one each from the upper, middle and lower position of five randomly selected plants $plot^{-1}$ (Satpathy, 1973). Thus 15 observations were made each time from each plot. The leaves collected from the fields were put in a zip lock polypropylene bag and brought to the laboratory for observation under stereo-zoom binocular microscope (Olympus SZ-40). Pre- and post treatment counts of mites and thrips were taken at 1 day before and 1 day, 3 days, 7 days after first, second and third sprayings. Population of natural enemies namely spider and coccinelid predators (*Coccinella septempunctata*, *Coccinella transversalis*, *Cheilomenes sexmaculata*, *Micraspis discolor*) were also recorded for the study. Fruit yield from each plot was recorded. Data were compiled and analyzed statistically by using software SPSS 20.0. The percent reduction or increase in mite and thrips population was assessed following the formula cited by Henderson and Tilton (1955).

Percent reduction = $[1 - (T_a \times C_b)/ (T_b \times C_a)] \times 100$

Where,

T_a = Population in treated plots after treatment

T_b = Population in treated plots before treatment

C_a = Population in control plots after treatment

C_b = Population in control plots before treatment

Afterwards the data were subjected to analysis of variance (ANOVA) after making suitable transformation wherever necessary.

RESULTS AND DISCUSSION

The effect of different acaro-insecticidal sprayings against yellow mite and thrips infesting chilli has been presented in the table 1 and 2. The number of yellow mite and thrips per leaf in the pre-treatment count prior to first spray was found non-significant whereas, prior to second and third sprays it was found significant. The percent reduction or increase of yellow mite and thrips recorded during different days after treatment was superior to untreated control. It was evident that mean percent reduction of yellow mite and thrips population after all the sprays was significant in comparison to the untreated control (Table 1, 2). Among the treatments, spiromesifen 24 SC @ 120 g *a.i.* ha^{-1}, diafenthiuron @ 375 g *a.i.* ha^{-1} and spiromesifen 24 SC @ 90 g *a.i.* ha^{-1} were very promising in suppression of population of yellow mite after first spray by 97.93, 95.68 and 94.55 per cent respectively. After second and third round of spray, spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} brought down 95.17 and 98.18 per cent reduction of yellow mite population, respectively. Fenpyroximate 5 EC @ 25 g *a.i.* ha^{-1} was found next to spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} in reducing yellow mite population. The overall mean percent reduction of yellow mite population revealed that spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} was the best treatment (97.09%) followed by fenpyroximate 5 EC @ 25 g *a.i.* ha^{-1} (94.52%) and diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1} (93.97%). Dicofol 18.5 EC @ 231.25 g *a.i.* ha^{-1} (60.00%) was found least effective against yellow mite in comparison to other chemicals tested.

In case of thrips, chlorfenapyr 10 SC @ 75 g *a.i.* ha^{-1} (92.97%, 91.74% and 90.75%), diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1} (88.85%, 91.70% and 86.82%) and spiromesifen 24SC @ 120 g *a.i.* ha^{-1} (87.26%, 84.08% and 83.80%) were found effective in mean percent reduction of thrips population after first, second and third spray, respectively.The overall mean percent reduction of thrips population indicated that chlorfenapyr 10 SC @ 75 g *a.i.* ha^{-1} was the best treatment (91.82%) followed by diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1} (89.12%) and spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} (85.05%). The least effective treatment against thrips was recorded with fenpyroximate 5 SC @ 15 and 25 g *a.i.* ha^{-1} (18.32% and 23.75%). The success of these

Table 1: Efficacy of different treatments against chilli yellow mite, *P. latus*

Treatment	Pre-treatment count (mite leaf^{-1})$^{\#}$			Percent reduction of mite population (days after each spray)$^{\#\#}$												Overall mean reduction (%)
				1st spray				2nd spray				3rd spray				
	1st spray	2nd spray	3rd spray	1 DAS	3 DAS	7 DAS	Mean	1 DAS	3 DAS	7 DAS	Mean	1 DAS	3 DAS	7 DAS	Mean	
Fenpyroximate	6.72	5.84	4.67	93.43	90.62	82.82	88.95	96.10	89.21	83.69	89.67	97.40	91.08	88.32	92.27	90.30
5 SC @15 g *a.i.* ha^{-1}	(2.69)	(2.52)	(2.27)	(78.25)	(72.72)	(66.0)	(72.32)	(81.35)	(71.93)	(66.79)	(73.36)	(84.78)	(73.21)	(70.79)	(76.26)	(73.98)
Fenpyroximate 5 SC	6.61	5.74	4.74	97.77	93.02	87.44	92.74	98.77	94.53	88.75	94.02	99.04	96.74	94.61	96.80	94.52
@ 25 g *a.i.* ha^{-1}	(2.67)	(2.50)	(2.29)	(83.54)	(75.33)	(69.78)	(76.22)	(86.57)	(79.29)	(71.34)	(79.07)	(87.04)	(81.99)	(77.44)	(82.16)	(79.15)
Pyriproxifen 10 EC	6.57	5.74	4.58	80.36	77.89	65.42	74.56	80.78	77.58	72.60	76.99	88.27	79.74	70.95	79.66	77.07
@ 50 g *a.i.* ha^{-1}	(2.66)	(2.50)	(2.25)	(64.59)	(62.69)	(54.42)	(60.56)	(64.96)	(62.54)	(58.83)	(62.11)	(70.55)	(63.93)	(57.77)	(64.08)	(62.25)
Pyriproxifen 10 EC	6.81	5.81	4.54	89.58	84.54	72.49	82.20	90.20	87.02	82.08	86.44	94.92	87.98	80.45	87.78	85.47
@ 75 g *a.i.* ha^{-1}	(2.70)	(2.51)	(2.24)	(71.91)	(67.36)	(58.77)	(66.01)	(72.29)	(69.65)	(65.70)	(69.21)	(78.05)	(70.41)	(64.13)	(70.86)	(68.69)
Propargite 57 EC	6.70	5.78	4.64	88.37	78.07	54.70	73.71	84.81	73.44	49.47	69.24	85.02	79.53	50.75	71.77	71.57
@ 427.5 g *a.i.* ha^{-1}	(2.68)	(2.51)	(2.27)	(70.58)	(62.59)	(48.00)	(60.39)	(67.90)	(59.41)	(44.95)	(57.42)	(67.82)	(64.00)	(45.72)	(59.18)	(59.00)
Propargite 57 EC	6.61	5.79	4.57	95.20	83.54	69.96	82.90	91.67	73.70	66.76	77.38	87.67	85.87	69.58	81.04	80.44
@ 712.5 g *a.i.* ha^{-1}	(2.67)	(2.51)	(2.25)	(78.23)	(66.59)	(57.13)	(67.32)	(73.84)	(59.65)	(55.12)	(62.87)	(69.95)	(68.45)	(56.98)	(65.13)	(65.11)
Dicofol 18.5 EC	6.82	5.68	4.49	78.45	67.21	48.22	64.62	78.86	61.72	24.40	54.99	86.80	56.08	38.22	60.37	60.00
@ 231.25 g *a.i.* ha^{-1}	(2.71)	(2.49)	(2.23)	(62.87)	(55.40)	(44.24)	(54.17)	(63.12)	(52.16)	(29.89)	(48.39)	(69.52)	(48.86)	(38.33)	(52.24)	(51.60)
Dicofol 18.5 EC	6.83	5.69	4.24	88.53	75.48	72.43	78.82	88.47	71.19	62.77	74.14	90.49	75.73	65.41	77.21	76.72
@ 277.50 g *a.i.* ha^{-1}	(2.71)	(2.49)	(2.18)	(70.71)	(60.73)	(58.75)	(63.40)	(71.02)	(57.98)	(52.74)	(60.58)	(72.69)	(61.13)	(54.37)	(62.73)	(62.24)
Spiromesifen 24 SC	6.49	5.85	4.35	98.86	95.43	89.37	94.55	96.94	88.67	86.23	90.61	95.38	92.67	93.43	93.83	93.00
@ 90 g *a.i.* ha^{-1}	(2.64)	(2.52)	(2.20)	(86.72)	(78.50)	(71.75)	(78.99)	(84.29)	(71.12)	(68.73)	(74.71)	(80.48)	(74.86)	(76.66)	(77.33)	(77.01)
Spiromesifen 24 SC	6.72	5.89	4.46	100.00	98.67	95.13	97.93	100.00	96.05	89.45	95.17	100.00	98.53	96.00	98.18	97.09
@ 120 g *a.i.* ha^{-1}	(2.69)	(2.53)	(2.23)	(90.0)	(86.41)	(78.07)	(84.83)	(90.00)	(81.14)	(72.13)	(81.09)	(90.00)	(85.05)	(79.36)	(84.80)	(83.57)
Chlorfenapyr 10 SC	6.44	5.61	4.44	92.54	75.31	63.12	76.99	89.86	78.53	51.29	73.23	90.41	67.17	56.54	71.38	73.86
@ 50 g *a.i.* ha^{-1}	(2.63)	(2.47)	(2.22)	(74.93)	(60.71)	(52.94)	(62.86)	(72.12)	(62.81)	(46.03)	(60.32)	(72.54)	(55.86)	(49.11)	(59.17)	(60.78)
Chlorfenapyr 10 SC	6.61	5.66	4.56	98.53	78.02	72.69	83.08	94.70	81.96	64.46	80.38	92.17	76.07	76.55	81.60	81.69
@ 75 g *a.i.* ha^{-1}	(2.67)	(2.48)	(2.25)	(86.21)	(62.81)	(58.97)	(69.33)	(79.63)	(65.43)	(54.06)	(66.37)	(74.62)	(61.25)	(61.40)	(65.76)	(67.15)
Diafenthiuron 50 WP	6.53	5.62	4.35	98.81	93.42	86.94	93.06	91.87	84.74	82.85	86.49	97.61	83.19	77.41	86.07	88.54
@ 300 g *a.i.* ha^{-1}	(2.65)	(2.47)	(2.20)	(86.64)	(76.04)	(69.27)	(77.32)	(80.34)	(67.48)	(66.11)	(71.31)	(85.01)	(66.49)	(62.06)	(71.19)	(73.27)
Diafenthiuron 50 WP	6.48	5.62	4.58	100.00	97.15	89.90	95.68	98.63	92.45	86.82	92.64	100.00	94.56	86.22	93.59	93.97
@ 375 g *a.i.* ha^{-1}	(2.64)	(2.47)	(2.25)	(90.0)	(82.64)	(71.99)	(74.88)	(86.35)	(74.87)	(69.39)	(76.87)	(90.00)	(77.42)	(68.70)	(78.71)	(75.79)
Untreated Control	6.71	7.68	8.05	0	0	0	0	0	0	0	0	0	0	0	0	0
	(2.69)	(2.86)	(2.92)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)
SEm (±)	**0.02**	**0.02**	**0.02**	**2.14**	**2.00**	**1.73**	**2.67**	**2.95**	**2.42**	**2.06**	**2.68**	**2.20**	**2.69**	**1.88**	**2.68**	**1.18**
LSD (0.05)	**NS**	**0.06**	**0.06**	**6.21**	**5.80**	**5.01**	**7.73**	**8.53**	**7.01**	**5.97**	**7.77**	**6.39**	**7.79**	**5.44**	**7.77**	**3.41**

*Note: NS – Non significant; [#]Values in parentheses are (x+0.5) square root transformed and [##]angular transformed; *Significant at 0.05 level; DAS- Days after spray*

Table 2: Efficacy of different treatments against chilli thrips, *S. dorsalis*

Treatment	Pre-treatment count(thrips/leaf)#			Percent reduction in thrips population (days after each spray) ##												Overall mean % reduction ##
				1st spray				2nd spray				3rd spray				
	1st spray	2nd spray	3rd spray	1 DAS	3 DAS	7 DAS	Mean	1 DAS	3 DAS	7 DAS	Mean	1 DAS	3 DAS	7 DAS	Mean	
Fenpyroximate 5 SC	4.59	4.44	3.74	49.71	39.14	4.58	31.14	27.07	12.80	+4.98	11.63	25.99	2.53	+5.23	7.63	18.32
@15 g *a.i.* ha^{-1}	(2.26)	(2.22)	(2.06)	(45.10)	(39.00)	(11.89)	(32.00)	(31.65)	(21.34)	(0.00)	(17.66)	(30.18)	(10.07)	(0.00)	(13.42)	(21.99)
Fenpyroximate 5 SC	4.81	4.35	4.12	62.64	54.19	11.01	42.61	31.97	14.08	8.69	18.24	35.83	4.32	4.71	14.96	23.75
@ 25 g *a.i.* ha^{-1}	(2.30)	(2.20)	(2.15)	(52.63)	(47.70)	(19.65)	(39.99)	(34.70)	(22.42)	(17.65)	(24.92)	(36.78)	(12.76)	(13.14)	(20.89)	(25.24)
Pyriproxifen 10 EC	4.60	4.41	3.81	78.24	78.30	49.93	68.82	83.03	70.09	48.01	67.04	90.13	68.92	49.15	69.40	68.42
@ 50 g *a.i.* ha^{-1}	(2.26)	(2.21)	(2.08)	(63.17)	(62.86)	(45.27)	(57.10)	(66.06)	(57.18)	(44.14)	(55.79)	(72.31)	(56.47)	(44.80)	(57.86)	(56.92)
Pyriproxifen 10 EC	4.71	4.25	3.89	91.17	83.56	73.24	82.66	90.61	84.43	68.84	81.30	94.13	84.19	55.57	77.96	80.64
@ 75 g *a.i.* ha^{-1}	(2.28)	(2.18)	(2.09)	(76.13)	(66.58)	(59.41)	(67.37)	(72.83)	(67.26)	(56.39)	(65.49)	(76.78)	(67.16)	(48.49)	(64.14)	(65.64)
Propargite 57 EC	4.64	4.35	3.97	57.43	43.98	8.00	36.47	62.77	52.84	19.38	45.00	49.11	18.52	+10.42	19.12	33.53
@ 427.5 g *a.i.* ha^{-1}	(2.27)	(2.20)	(2.11)	(49.58)	(41.82)	(14.81)	(35.40)	(52.72)	(46.92)	(26.40)	(42.01)	(44.79)	(25.72)	(0.00)	(23.50)	(33.89)
Propargite 57 EC	4.67	4.31	3.90	66.94	52.31	24.04	47.76	69.79	67.60	28.28	55.22	59.02	28.90	+5.54	27.42	43.47
@ 712.5 g *a.i.* ha^{-1}	(2.27)	(2.19)	(2.10)	(55.30)	(46.62)	(29.38)	(43.77)	(57.08)	(55.62)	(32.44)	(48.38)	(50.58)	(32.80)	(0.00)	(27.79)	(40.01)
Dicofol 18.5 EC	4.70	4.37	3.99	70.15	42.24	6.43	39.61	69.60	25.96	+14.48	27.03	77.28	+4.43	+17.19	18.55	28.40
@ 231.25 g *a.i.* ha^{-1}	(2.28)	(2.21)	(2.12)	(57.23)	(39.91)	(14.94)	(37.36)	(57.08)	(30.91)	(0.00)	(29.33)	(61.92)	(0.00)	(0.00)	(20.64)	(29.15)
Dicofol 18.5 EC	4.69	4.37	3.87	80.06	50.95	22.91	51.31	79.75	41.60	+4.20	39.05	85.59	+1.77	+7.45	25.46	38.61
@ 277.50 g *a.i.* ha^{-1}	(2.28)	(2.21)	(2.09)	(64.01)	(46.26)	(28.85)	(46.37)	(63.87)	(40.45)	(0.00)	(34.77)	(68.25)	(0.00)	(0.00)	(22.75)	(34.64)
Spiromesifen 24 SC	4.70	4.35	3.72	89.22	82.64	63.93	78.59	89.20	70.02	51.86	70.36	87.42	66.05	52.57	68.68	72.54
@ 90 g *a.i.* ha^{-1}	(2.28)	(2.20)	(2.05)	(72.00)	(65.86)	(53.45)	(63.77)	(71.50)	(57.12)	(46.36)	(58.33)	(69.83)	(54.71)	(46.77)	(57.10)	(59.72)
Spiromesifen 24 SC	4.61	4.21	3.94	97.48	91.05	73.24	87.26	96.65	77.34	78.24	84.08	98.67	81.45	71.29	83.80	85.05
@ 120 g *a.i.* ha^{-1}	(2.26)	(2.17)	(2.11)	(84.87)	(73.74)	(59.27)	(72.63)	(81.83)	(61.94)	(62.61)	(68.79)	(86.42)	(65.12)	(57.96)	(69.83)	(70.39)
Chlorfenapyr 10 SC	4.66	4.37	3.79	92.68	83.80	64.56	80.34	90.11	77.11	69.45	78.89	96.45	86.55	51.75	78.25	79.16
@ 50 g *a.i.* ha^{-1}	(2.27)	(2.21)	(2.07)	(77.41)	(67.01)	(53.80)	(66.07)	(72.98)	(61.79)	(56.90)	(63.89)	(81.65)	(69.06)	(46.29)	(65.67)	(65.19)
Chlorfenapyr 10 SC	4.75	4.26	3.85	97.99	96.93	83.99	92.97	99.02	94.92	81.26	91.74	98.23	92.78	81.24	90.75	91.82
@ 75 g *a.i.* ha^{-1}	(2.29)	(2.18)	(2.09)	(85.47)	(82.33)	(67.02)	(78.27)	(87.01)	(77.70)	(65.11)	(76.61)	(85.77)	(75.32)	(64.93)	(75.34)	(76.65)
Diafenthiuron 50 WP	4.67	4.30	3.71	93.32	79.29	73.54	82.05	93.14	79.76	70.84	81.25	91.90	76.16	55.44	74.50	79.26
@ 300 g *a.i.* ha^{-1}	(2.27)	(2.19)	(2.05)	(75.65)	(63.32)	(59.58)	(66.18)	(75.63)	(63.66)	(57.68)	(65.66)	(74.03)	(61.18)	(48.42)	(61.21)	(64.32)
Diafenthiuron 50 WP	4.68	4.36	3.73	95.95	86.72	83.88	88.85	98.40	91.61	85.08	91.70	98.75	87.36	74.35	86.82	89.12
@ 375 g *a.i.* ha^{-1}	(2.27)	(2.20)	(2.05)	(80.99)	(69.32)	(66.88)	(72.40)	(86.02)	(74.29)	(67.81)	(76.04)	(86.53)	(69.87)	(59.91)	(72.10)	(73.48)
Untreated Control	4.78	5.15	6.29	0	0	0	0	0	0	0	0	0	0	0	0	0
	(2.30)	(2.38)	(2.61)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)	(4.05)
SEm (±)	**0.02**	**0.02**	**0.04**	**3.13**	**1.92**	**3.15**	**3.55**	**2.24**	**1.03**	**1.37**	**4.97**	**2.97**	**1.37**	**0.53**	**6.41**	**2.99**
LSD (0.05)	**NS**	**0.07**	**0.12**	**9.07**	**5.56**	**9.14**	**10.30**	**6.49**	**2.98**	**3.98**	**14.38**	**8.60**	**3.98**	**1.53**	**18.58**	**8.67**

*Note: NS – Non significant; #Values in parentheses are (x+0.5) square root transformed and ##angular transformed; *Significant at 0.05 level; DAS- Days after spray*

Table 3: Effect different treatments on natural enemies in chilli

Treatment	Natural enemy population plant^{-1} on 7th day after each spray (mean of three sprays)			
	Coccinellids		Spiders	
	Pre-treatment count (no. plant^{-1})	Post-treatment count (no. plant^{-1})	Pre-treatment count (no. plant^{-1})	Post-treatment count (no. plant^{-1})
Fenpyroximate 5 SC @15 g *a.i.* ha^{-1}	3.17(1.92)	3.29(1.95)	1.71(1.49)	1.74(1.50)
Fenpyroximate 5 SC @ 25 g *a.i.* ha^{-1}	3.39(1.97)	3.43(1.98)	1.67(1.47)	1.79(1.51)
Pyriproxifen 10 EC @ 50 g *a.i.* ha^{-1}	3.14(1.91)	3.41(1.98)	1.67(1.47)	2.01(1.58)
Pyriproxifen 10 EC @ 75 g *a.i.* ha^{-1}	3.30(1.95)	3.53(2.01)	1.60(1.45)	1.78(1.51)
Propargite 57 EC @ 427.5 g *a.i.* ha^{-1}	3.15(1.91)	3.46(1.99)	1.81(1.52)	1.94(1.56)
Propargite 57 EC @ 712.5 g *a.i.* ha^{-1}	3.21(1.93)	3.44(1.99)	1.89(1.55)	1.92(1.56)
Dicofol 18.5 EC@ 231.25 g *a.i.* ha^{-1}	3.34(1.96)	3.29(1.95)	1.85(1.53)	1.90(1.55)
Dicofol 18.5 EC @ 277.50 g *a.i.* ha^{-1}	3.23(1.93)	3.37(1.97)	1.78(1.51)	1.93(1.56)
Spiromesifen 24 SC@ 90 g *a.i.* ha^{-1}	3.21(1.93)	3.48(1.99)	1.92(1.56)	1.92(1.55)
Spiromesifen 24 SC@ 120 g *a.i.* ha^{-1}	3.35(1.96)	3.41(1.98)	1.84(1.53)	1.95(1.56)
Chlorfenapyr 10 SC @ 50 g *a.i.* ha^{-1}	3.38(1.97)	3.47(1.99)	1.77(1.50)	1.97(1.57)
Chlorfenapyr 10 SC @ 75 g *a.i.* ha^{-1}	3.18(1.92)	3.53(2.01)	1.82(1.52)	1.96(1.57)
Diafenthiuron 50 WP @ 300 g *a.i.* ha^{-1}	3.35(1.96)	3.54(2.01)	1.84(1.53)	1.98(1.58)
Diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1}	3.34(1.96)	3.53(2.01)	1.82(1.52)	1.82(1.52)
Untreated Control	3.35(1.96)	3.46(1.99)	1.80(1.52)	2.04(1.59)
SEm (±)	**0.02**	**0.02**	**0.04**	**0.03**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**

Note: NS – Not significant; Figures in parentheses are (x+0.5) square root transformed value

Table 4: Yield of green chilli in different treatments

Treatment	Yield (q ha^{-1})	% increase in yield over control
Fenpyroximate 5 SC @15 g *a.i.* ha^{-1}	10.25	47.80
Fenpyroximate 5 SC @ 25 g *a.i.* ha^{-1}	11.67	54.16
Pyriproxifen 10 EC @ 50 g *a.i.* ha^{-1}	11.56	53.72
Pyriproxifen 10 EC @ 75 g *a.i.* ha^{-1}	13.08	59.10
Propargite 57 EC @ 427.5 g *a.i.* ha^{-1}	9.21	41.84
Propargite 57 EC @ 712.5 g *a.i.* ha^{-1}	10.24	47.75
Dicofol 18.5 EC@ 231.25 g *a.i.* ha^{-1}	7.24	26.10
Dicofol 18.5 EC @ 277.50 g *a.i.* ha^{-1}	8.42	36.46
Spiromesifen 24 SC@ 90 g *a.i.* ha^{-1}	14.26	62.48
Spiromesifen 24 SC@ 120 g *a.i.* ha^{-1}	16.05	67.25
Chlorfenapyr 10 SC @ 50 g *a.i.* ha^{-1}	12.65	57.71
Chlorfenapyr 10 SC @ 75 g *a.i.* ha^{-1}	14.48	63.05
Diafenthiuron 50 WP @ 300 g *a.i.* ha^{-1}	15.88	66.54
Diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1}	17.64	69.67
Untreated Control	5.35	-
SEm (±)	**0.09**	
LSD (0.05)	**0.42***	-

*Note: Figures in parentheses are angular transformed values; *Significant at 0.05 level* new pesticides might be due to their unique mode of action as they are more tissue specific and activated inside the target cells of insects providing selective toxicity to insects and safety to natural enemies (Varghese and Mathew, 2013).The present findings are in conformity of the results obtained by Kavitha *et al*. (2006) who reported that efficacy of spiromesifen 24 SC in managing population of *Polyphagotarsonemus latus* Banks was better than dicofol. Similar to our findings, Nagaraj *et al*. (2007) also reported that lowest population of yellow mite (*P. latus*) and lowest leaf curl index were recorded in the plots treated with spiromesifen 240 SC. Varghese and Mathew (2013) found that spiromesifen 45 SC at 100 g *a.i.* ha^{-1} and propargite 57 EC at 570 g *a.i.* ha^{-1} were found to be effective in reducing chilli mite population. While Smitha and Giraddi (2006) reported that fenpyroximate 5 EC was most effective in controlling yellow mite (*P. latus*). Similar results were also obtained by Sarkar *et al*. (2013) and Seal *et al*. (2006) who reported that chlorfenapyr 10 SC was the best insecticides against chilli thrips. However, Zainab *et al*. (2016) reported that pyridaben 20% WP closely followed by fenpyroximate 5% EC were found most effective in the reduction of chilli thrips population which are in contrary to the present findings.

The population of both the predators maintained typical uniform distribution which apprehends the negative impact of test chemicals against natural enemies (Table- 3). The statement can be further be substantiated with mean population of coccinellids and spiders provided in the table-3. It reveals from the study that the softness of pesticide chemistry against the naturally occurring predators (coccinellids and spiders). The findings are supported by Varghese and Mathew (2013) who stated that newer insecticides and acaricides were effective in reducing the sucking pests of chilli viz. mites and thrips, without significantly affecting the natural enemies in the chilli ecosystem.

The yield of green chilli in different treatment has been presented in table 4. It is evident from the table that among the treatments, diafenthiuron 50 WP at higher dosage (375 g *a.i.* ha^{-1}) gave the highest yield (17.64 q ha^{-1}) of green chilli followed by spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} (16.05 q ha^{-1}). The minimum yield was recorded in dicofol 18.5 EC @ 231.25 g *a.i.* ha^{-1} treated plots (7.24 q ha^{-1}). Yield recorded in different treated plots were found superior over control (5.35 q ha^{-1}).Considering the percent increase of yield over control it appears that diafenthiuron 50 WP @ 375 g *a.i.* ha^{-1} and spiromesifen 24 SC @ 120 g *a.i.* ha^{-1} provided more than 65 per cent increment in yield (67.25% to 69.67% increase). Diccofol 18.5 EC was very much unimpressive providing 26.10 and 36.46 per cent increase in yield over control. The present findings are in conformity with the findings of Chakrabarti and Sarkar (2014), Patel *et al*. (2006) and Gundannavar *et al*. (2007).

It may be concluded from the above discussion that the newer molecules can effectively utilized in the IPM programme due to their novel mode of action against target pests, selective toxicity and safety to natural enemies with less harmful to the crop environment.

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