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Hemant Swami
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Udaipur, Rajasthan, India

Lekha
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Udaipur, Rajasthan, India

Virender Singh
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Udaipur, Rajasthan, India

Deepak Jain
KVK, Badgaon, Udaipur, Rajasthan, India

Kuldeep Kumar
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Udaipur, Rajasthan, India

Correspondence
Hemant Swami
Department of Entomology, Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT), Udaipur, Rajasthan, India

Bio efficacy of pyriproxyfen 10% EC against whitefly, *Bemisia tabaci* and Aphids, *Aphis gossipii* infesting chilli crop

Hemant Swami, Lekha, Virender Singh, Deepak Jain and Kuldeep Kumar

Abstract
A field experiment was conducted to evaluate insecticide Pyriproxyfen 10% EC 75 g a.i @ 750, 1000, 1250 ml for controlling whitefly, *Bemisia tabaci* and aphid infesting chilli crop with other treatments i.e., Imidacloprid 17.8% SL and Fenpropathrin 30% EC including untreated control at Horticulture Farm, Rajasthan college of agriculture, Udaipur during *Kharif* 2016 and 2017, subsequently. All among the treatments, Pyriproxyfen 10% EC @ 1250 ml/ha followed by Imidacloprid 17.8% SL 50 g a.i. @ 250 ml/ha found the most effective to reduce the whitefly, *Bemisia tabaci* and aphids *Aphis gossipii* population in chilli crop during both years, *Kharif* 2016 and 2017. The chilli fruit yield among different treatments ranged from 141.80 to 146.00 and 142.30 and 146.80 q/ha against 122.0 and 122.40 q/ha in untreated control during *Kharif*, 2016 and 2017, respectively. The highest marketable yield of chilli146.0 and 146.40 q/ha was recorded in case of spray of Pyriproxyfen 10% EC 125 g.a.i @ 1250 ml during *Kharif*, 2016 and 2017, respectively. It was found at par to spray of Pyriproxyfen 10% EC 100 g.a.i @ 1000 ml which yielded 144.0 and 144.70 q/ha during *Kharif*, 2016 and 2017, respectively. It was followed by Imidacloprid 17.8%SL 50 g.a.i. @ 250 ml and Pyriproxyfen 10% EC 75 g.a.i @ 750 ml which recorded 143.80 and 143.40and 144.20 and 143.70q/ha during *Kharif*, 2016 and 2017, respectively. Fenpropathrin 30% EC 100 g.a.i @ 340 ml was also found superior to untreated control which yielded 141.80and 142.30 q/ha during *Kharif*, 2016 and 2017, respectively.

Keywords: *Bemisia tabaci*, chilli, pyriproxyfen and sucking pests

1. Introduction
Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae is an important spice cum vegetable crop commonly used in Indian dietary. It is grown throughout the year as a cash crop and used in green and red ripe dried stage for their pungency, colour and other ingredients in all culinary preparations of rich and poor alike to impart taste, flavor and colour. Nutritionally, it is a rich source of vitamin A, B and C. Capsaicin an alkaloid responsible for pungency in chilli has medicinal properties and it prevents heart attack by dilating the blood vessels (Gill, 1989) [1]. India is the largest consumer and exporter of chilli in the world with It is being cultivated in 173 lakh hectare area with the production of 1992.0 lakh metric tons and productivity of 11.5 metric tons per ha (Anonymous 2016) [2]. In India, it is intensively cultivated in Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Rajasthan and in hilly areas of Uttar Pradesh (Ratnakumari *et al*., 2001) [3]. In Rajasthan, it is cultivated in an area of 12.21 thousand hectares with an annual production of 17.71 million tons (Anonymous, 2013) [4]. The major chilli growing districts of Rajasthan include Jodhpur, Swai Madhopur, Pali, Jalore, Bhilwara, Jaipur, Ajmer, Tonk, Udaipur and Bharatpur. Nearly 35 species of insect pests occur on chilli which includes thrips, aphid, whitefly, fruit borer, cutworm, plant bug, mite and other minor pests. Among all the sucking pests attacking chilli whitefly, *Bemisia tabaci* (Gennadius) and thrips, *Scirtothrips dorsalis* Hood are dominant pests. The estimated loss due to sucking pests was up to 30 to 50 per cent (Varadharajan *et al* 1994) [5]. Insecticide application is one of the management options that can substantially reduce yield losses caused by sucking insects. Bioefficacy 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 bioefficacy of certain newer insecticides against sucking insect pests infesting chilli.

2. Materials and Methods

The present experiment on the bioefficacy of pyriproxyfen 10% EC against whiteflies, aphids, was conducted in Randomized Block Design with three replications at Horticulture farm, R.C.A., Udaipur during *Kharif*, 2016 and 2017. Chilli variety (Gopika) was transplanted on 17thAugust 2016 and 5th April 2017, respectively. Sowing was done in plots each measuring 3.80 x 3.15 m^2 at row to row and plant to plant spacing of 60 X 60 cm^2. There were six treatments replicated three times. Each treatment was applied two times initiating first spray as soon as a pest's infestation starts and subsequent second spray was given at 14 days interval. The Pyriproxyfen 10% EC 75 g.a.i @ 750, 1000, 1250 ml and other treatments i.e., Imidacloprid 17.8%SL 50 g.a.i. @ 250 ml, Fenpropathrin 30% EC 100 g.a.i @ 340 ml were applied against sucking pests of chilli *i.e.* Whitefly *Bemisia tabaci* (Genn.) and aphids, *Aphis gossipii*, under field condition at Horticulture farm, Rajasthan college of Agriculture (Udaipur) during the year *Kharif*, 2016 and 2017. The observation on the population of whiteflies and aphids was recorded on top, middle and lower per plant (3 leaves / plant) on five randomly selected and tagged plants. The observation was recorded one day before and at 3, 7, 10 and 14 days after each spray and mean reduction in population was calculated at 3, 7, 10 and 14 days after each sprays.

The percent corrected mortality of the pests was calculated from the formula given by Henderson and Tilton (1955) [6]:

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

T_a = Number of insects after treatment,
T_b= Number of insects before treatment
C_a= Number of insects in control after treatment
C_b= Number of insects in control before treatment

The analysis of variance was computed after subjecting the data in to angular transformation.

3. Result and discussion

3.1 Whitefly

The data recorded on mean reduction in the population of whitefly at 3, 7, 10 and 14 days after first and second sprays are presented in Table 1 and 2. The data revealed that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of whitefly was recorded in case of two spray of Pyriproxyfen 10% EC @ 1250 ml/ha which resulted 75.79, 73.80, 70.25, 69.16; 80.01, 78.68, 75.43 and 73.03; 77.52, 75.76, 72.25, 70.18; 81.04, 79.75, 76.48 and 74.58 per cent reduction in mean population of whitefly at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017respectively.

Spray of Imidacloprid 17.8% SL at 250 ml/ha was found at par to above treatment which caused 73.31, 72.87, 69.22, 67.83; 79.01, 77.07, 74.48 and 72.54; 75.64, 73.87, 71.23, 69.80; 79.05 78.11 75.53and 73.69 per cent reduction in mean population of whitefly at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017respectively. It was followed by Pyriproxyfen 10% EC @ 1000 ml/ha which resulted 64.78, 62.15, 60.92, 58.63; 70.79, 69.18, 67.78 and 65.64; 65.72, 63.97, 61.90; 59.60, 71.84, 70.14, 68.83 and 66.70 per cent reduction in whitefly population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively and followed by Fenpropathrin 30% EC @ 340 ml/ha which caused 62.59, 60.89, 57.80, 55.90; 65.58, 63.79, 60.81 and 55.23; 64.21, 62.85, 55.71, 53.80; 66.61, 64.84, 61.86 and 56.26 per cent reduction in whitefly population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively. Pyriproxyfen 10% EC @ 750 ml/ha which resulted 59.61, 58.74, 55.49, 52.26; 65.01, 64.52, 61.23 and 57.13; 60.68, 58.91, 56.47, 53.29; 66.15, 65.58, 62.87 and 58.59 per cent reduction in whitefly population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively. These results were supported by Choudhari *et al* (2015) [7] who observed that the plots treated with imidacloprid, acetamiprid and clothianidin exhibited significantly lesser number of whitefly over rest of the insecticides. Similarly Abbas and Farhan (2014) [8] reported that pyriproxyfen was effective against cotton whitefly *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae). Sangle *et al* (2017) [9] found that among all the evaluated different insecticides, imidacloprid 17.8 SL @ 0.005% recorded lowest whitefly population in chilli crop.

3.2 Aphid

The data recorded on mean reduction in the population of aphid at 3, 7, 10 and 14 days after first and second sprays are presented in Table 5 and 6. The data revealed that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of aphid was recorded in case of two spray of Pyriproxyfen 10% EC @ 1250 ml/ha which resulted 73.83, 72.41, 67.78, 65.93; 78.56, 75.78, 75.42 and 73.12; 73.37, 71.99, 68.98, 66.76; 78.98, 78.23, 74.1 and 71.79 per cent reduction in mean population of aphid at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively.

Spray of Imidacloprid 17.8%SL at 250 ml/ha was found at par to above treatment which caused 71.52, 70.05, 66.81, 64.92; 78.32, 74.50, 72.19 and 68.42; 72.73, 71.29, 66.95, 64.19; 78.02, 77.2, 74.79 and 69.19per cent reduction in mean population of aphid at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017 respectively. It was followed by Pyriproxyfen 10% EC @ 1000 ml/ha which resulted 70.51, 67.22, 62.64, 61.55; 71.65, 69.31, 68.70 and 66.22; 69.79, 68.17, 63.34, 60.31; 71.36, 70.36, 67.18 and 64.09per cent reduction in aphid population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively and followed by Fenpropathrin 30% EC @ 340 ml/ha which caused 63.14, 61.26, 57.02, 54.60; 70.45, 67.84, 64.77 and 62.69; 61.53, 59.10, 56.72,54.64; 68.28, 67.14, 63.40 and 61.54 per cent reduction in aphid population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively. Pyriproxyfen 10% EC @ 750 ml/ha which resulted 55.56, 53.71, 51.52, 48.90; 66.57, 63.66, 63.44 and 61.56; 54.95, 52.58, 50.87,49.78; 64.27, 63.00, 60.93 and 58.89 per cent reduction in aphid population at 3, 7, 10 and 14 days after first and second spray during *Kharif*, 2016 and 2017, respectively. The present results are in conformity with the findings of Wale *et al* (2018) [10] who found that the dose of Imidacloprid 17.8% w/w SL @ 65.2 g a.i./ha was found effective for control of aphids, jassids and thrips. Patel (2013) [11] found that Pyriproxifen + fenpropethrin 500 ml/ha was most effective to reducing aphid and other insect pests population brinjal, *Solanum melongena* (Linn.).

3.3 Chilli fruit yield

The data presented in Table-5 revealed that all the treatments yielded significantly higher marketable yield over untreated control. The chilli fruit yield among different treatments ranged from 141.80 to 146.00 and 142.30 and 146.80 q/ha against 122.0 and 122.40 q/ha in untreated control during *Kharif*, 2016 and 2017, respectively. The highest marketable yield of chilli146.0 and 146.40 q/ha was recorded in case of spray of Pyriproxyfen 10% EC 125 g.a.i @ 1250 ml during *Kharif*, 2016 and 2017, respectively. It was found at par to spray of Pyriproxyfen 10% EC 100 g.a.i @ 1000 ml which yielded 144.0 and 144.70 q/ha during *Kharif*, 2016 and 2017, respectively. It was followed by Imidacloprid 17.8%SL 50 g.a.i. @ 250 ml and Pyriproxyfen 10% EC 75 g.a.i @ 750 ml which recorded 143.80 and 143.40and 144.20 and 143.70q/ha during *Kharif*, 2016 and 2017, respectively. Fenpropathrin 30% EC 100 g.a.i @ 340 mlwas also found superior to untreated control which yielded 141.80and 142.30 q/ha during *Kharif*, 2016 and 2017, respectively. Whereas, Patil *et al*. (2002) [12], Singh *et al*. (2004) [13] and Kumar *et al*. (2014) [15] who reported highest yield of chilli in the treatment of imidacloprid.

Table 1: Efficacy of Pyriproxyfen 10% EC against whitefly on chilli during *Kharif*, 2016.

S. No.	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in whitefly population, days after spray							
			Istspray				IIndspray			
			PTP	3 day	7 day	10 day	14 day	3 day	7 day	10 day	14 day
1	Pyriproxyfen 10% EC	750	1.58	59.61 (50.54)	58.74 (50.03	55.49 (48.15)	52.26 (46.30)	65.01 (53.74)	64.52 (53.44)	61.23 (51.49)	57.13 (49.10)
2	Pyriproxyfen 10% EC	1000	1.64	64.78 (53.59)	62.15 (52.03	60.92 (51.31)	58.63 (49.97)	70.79 (57.28)	69.18 (56.28)	67.78 (55.41)	65.64 (54.12)
3	Pyriproxyfen 10% EC	1250	1.32	75.79 (60.53)	73.80 (59.21	70.25 (56.95)	69.16 (56.27)	80.01 (63.44)	78.68 (62.50)	75.43 (60.28)	73.03 (58.71)
4	Imidacloprid 17.8%SL	250	1.55	73.31 (58.90)	72.87 (58.61	69.22 (56.30)	67.83 (55.45)	79.01 (62.73)	77.07 (61.39)	74.48 (59.66)	72.54 (58.39)
5	Fenpropathrin 30% EC	340	1.54	62.59 (52.29)	60.89 (51.29	57.80 (49.49)	55.90 (48.39)	65.58 (54.08)	63.79 (53.00)	60.81 (51.24)	55.23 (48.00)
6	Untreated control	-	1.64	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SEm±			0.698	0.936	1.075	0.545	0.650	0.809	0.597	0.776
	C.D. at 5%			2.152	2.883	3.312	1.680	2.002	2.493	1.839	2.391

PTP = Pretreatment population.
Figures in parenthesis are angular arcsine value

Table 2: Efficacy of Pyriproxyfen 10% EC against whitefly on chilli during *Kharif*, 2017.

S. No.	Treatment	Dose(g/ml ha^{-1})	Mean reduction (%) in whitefly population, days after spray							
			Istspray				IIndspray			
			PTP	3 day	7 day	10 day	14 day	3 day	7 day	10 day	14 day
1	Pyriproxyfen 10% EC	750	1.72	60.68 (51.17)	58.91 (50.13)	56.47 (48.72)	53.29 (46.89)	66.15 (54.42)	65.58 (54.08)	62.87 (52.46)	58.59 (49.95)
2	Pyriproxyfen 10% EC	1000	1.78	65.72 (54.16)	63.97 (53.11)	61.90 (51.88)	59.60 (50.54)	71.84 (57.95)	70.14 (56.88)	68.83 (56.06)	66.70 (54.75)
3	Pyriproxyfen 10% EC	1250	1.54	77.52 (61.70)	75.76 (60.50)	72.25 (58.21)	70.18 (56.90)	81.04 (64.19)	79.75 (63.25)	76.48 (60.99)	74.58 (59.72)
4	Imidacloprid 17.8%SL	250	1.60	75.64 (60.42)	73.87 (59.26)	71.23 (57.56)	69.80 (56.67)	79.05 (62.76)	78.11 (62.10)	75.53 (60.35)	73.69 (59.14)
5	Fenpropathrin 30% EC	340	1.62	64.21 (53.26)	62.85 (52.45)	55.71 (48.28)	53.80 (47.18)	66.61 (54.70)	64.84 (53.63)	61.86 (51.86)	56.26 (48.60)
6	Untreated control	-		0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SEm±			0.725	0.970	1.097	1.097	0.662	0.828	0.614	0.800
	C.D. at 5%			2.233	2.990	3.381	3.381	2.039	2.552	1.893	2.464

PTP = Pretreatment population.
Figures in parenthesis are angular arcsine value

Table 3: Efficacy of Pyriproxyfen 10% EC against aphid on chilli during *Kharif*, 2016

S. No.	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in aphid population, days after spray							
			Istspray				IIndspray			
			PTP	3 day	7 day	10 day	14 day	3 day	7 day	10 day	14 day
1.	Pyriproxyfen 10% EC	750	1.33	55.56 (48.19)	53.71 (47.13)	51.52 (45.87)	48.90 (44.37)	66.57 (54.68)	63.66 (52.93)	63.44 (52.80)	61.56 (51.68)
2.	Pyriproxyfen 10% EC	1000	1.64	70.51 (57.13)	67.22 (55.07)	62.64 (52.32)	61.55 (51.68)	71.65 (57.83)	69.31 (56.36)	68.70 (55.98)	66.22 (54.47)
3.	Pyriproxyfen 10% EC	1250	1.52	73.83 (59.24)	72.41 (58.32)	67.78 (55.41)	65.93 (54.29)	78.56 (62.42)	75.78 (60.52)	75.42 (60.28)	73.12 (58.77)
4.	Imidacloprid 17.8%SL	250	1.40	71.52 (57.75)	70.05 (56.82)	66.81 (54.82)	64.92 (53.68)	78.32 (62.25)	74.50 (59.67)	72.19 (58.18)	68.42 (55.81)
5.	Fenpropathrin 30% EC	340	1.33	63.14	61.26	57.02	54.60	70.45	67.84	64.77	62.69

				(52.87)	(51.51)	(49.04)	(47.64)	(57.07)	(55.45)	(53.59)	(52.35)
6.	Untreated control	-	1.43	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SEm±			0.708	0.905	1.030	0.520	0.655	0.820	0.595	0.812
	C.D. at 5%			2.181	2.789	3.173	1.604	2.020	2.528	1.835	2.503

PTP = Pretreatment population.
Figures in parenthesis are angular arcsine value

Table 4: Efficacy of Pyriproxyfen 10% EC against aphid on chilli during *Kharif*, 2017.

S. No.	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in aphid population, days after spray							
			Istspray				IIndspray			
			PTP	3 day	7 day	10 day	14 day	3 day	7 day	10 day	14 day
1	Pyriproxyfen 10% EC	750	1.40	54.95 (47.84)	52.58 (46.48)	50.87 (45.50)	49.78 (44.87)	64.27 (53.29)	63.00 (52.54)	60.93 (51.31)	58.89 (50.12)
2	Pyriproxyfen 10% EC	1000	1.30	69.79 (56.66)	68.17 (55.65)	63.34 (52.74)	60.31 (50.95)	71.36 (57.64)	70.36 (57.02)	67.18 (55.05)	64.09 (53.19)
3	Pyriproxyfen 10% EC	1250	1.45	73.37 (58.93)	71.99 (58.05)	68.98 (56.15)	66.76 (54.79)	78.98 (62.71)	78.23 (62.19)	74.10 (59.41)	71.79 (57.92)
4	Imidacloprid 17.8%SL	250	1.35	72.73 (58.52)	71.29 (57.60)	66.95 (54.91)	64.19 (53.24)	78.02 (62.04)	77.20 (61.48)	74.79 (59.86)	69.19 (56.28)
5	Fenpropathrin 30% EC	340	1.38	61.53 (51.67)	59.10 (50.24)	56.72 (48.86)	54.64 (47.66)	68.28 (55.72)	67.14 (55.02)	63.40 (52.77)	61.54 (51.67)
6	Untreated control	-	1.33	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SEm±			0.698	0.885	0.862	0.525	0.645	0.860	0.597	0.781
	C.D. at 5%			2.151	2.727	2.656	1.617	1.987	2.649	1.838	2.406

PTP = Pretreatment population.
Figures in parenthesis are angular arcsine value

Table 5: Effect of Pyriproxyfen 10% EC on fruit yield of chilli (*Kharif*, 2016 and 2017).

S. No.	Treatment	Dose (g/ml ha^{-1})	2016 q/ha	2017 q/ha
1	Pyriproxyfen 10% EC	750	143.40	143.70
2	Pyriproxyfen 10% EC	1000	144.00	144.70
3	Pyriproxyfen 10% EC	1250	146.00	146.40
4	Imidacloprid 17.8%SL	250	143.80	144.20
5	Fenpropathrin 30% EC	340	141.80	142.30
6	Untreated control	-	122.00	122.40

4. Conclusion

Field experiments on the bio-efficacy of Pyriproxyfen 10% EC @ 750, 1000 and 1250 ml, Imidacloprid 17.8% SL 50 g.a.i. @ 250 ml, Fenpropathrin 30% EC 100 g.a.i @ 340 ml against whiteflies, aphids, jassids and thrips was conducted at Rajasthan College of Agriculture, Udaipur during *Kharif*, 2016 and 2017. The data revealed that two spray of Pyriproxyfen 10% EC 125 g.a.i @ 1250 mlat 14 days interval caused highest reduction in the population of whiteflies, aphids, jassids and thrips and also recorded the highest marketable yield of chilli. Pyriproxyfen 10% EC 100 g.a.i @ 1000 ml was found at par to above treatment in terms of mean reduction in the population of whiteflies and aphids, and also the marketable yield of chilli.

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