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Efficacy of new insecticide chemistry tolfenpyrad 15% EC against insect pests of cucumber (*Cucumis sativus* L.)

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Abstract
Field trials were carried out to evaluate the bio efficacy of tolfenpyrad 15% EC against insect pests of Cucumber (*Cucumis sativus* L.). The experiment was grounded with seven treatments with three doses of Tolfenpyrad 15% EC @ 100.5, 124.5 and 150 g a.i. /ha along with standard insecticides *viz.*, Imidacloprid 17.8% SL @ 22.5 g a.i. /ha, Fipronil 5% SC @ 40 g a.i. /ha, and Chlorpyriphos 20% EC @ 200 g a.i./ha were used for comparison. Overall, the field trials revealed that, tolfenpyrad 15 EC @ 150 g a.i/ha provided cross-spectrum and superior in managing the leafhoppers, thrips and red pumpkin beetles with highest yield in highest dosage of tolfenpyrad 15% EC @ 150 g a.i./ha and it was at par with its next lowest dosage treatments of tolfenpyrad 15% EC @ 124.5 g a.i./ha and 100.50 g a.i./ha which recorded 5.85 t/ha and 5.21 t/ha in the year 2015-16 and similar trend during 2016-17 with highest yield of 5.75 t/ha was noticed in the highest dosage of tolfenpyrad 15% EC @ 150 g a.i./ha followed by next dosage treatments. Whereas the standard insecticides, Fipronil 5% SC @ @ 40 g a.i. /ha was found next most effective in the mean reduction of sucking pests in both the years.

Keywords: Bio efficacy, new insecticide, sucking pests, cucumber

Introduction
Among the vegetables, Cucumber (*Cucumis sativus* L.) is widely cultivated plant in the gourd family. The cucumber is originally from South Asia, but now grown on most continents. Cucumber is grown in an area of 74, 000 hectares with the production of 1142, 000 metric tons (Anon., 2017) [1]. Nutritively 100 g of edible portion of cucumber contains 96.3 g moisture, 2.5 g carbohydrates, 0.4 g protein, 0.1 g fat, 0.3 g minerals, 10 mg calcium, 0.4 g fibre and traces of vitamin C and iron. The protected vegetable cultivation technology can be utilized for year round production of high value quality vegetable crops, with high yield. Increasing photosynthetic efficiency and reduction in Transpiratory loss are added advantages of protected cultivation Protected cultivation of crops provides protection from adverse environmental conditions (Sood *et al*., 2015) [10]. In India, about twenty insect and mite species have been recorded to be associated with the crop (Sood *et al*., 2006) [9]. Chewing and sucking type of insect pest attacks to vegetables especially to cucurbits (Foster, 2008) [3]. The major pests of cucumber are red pumpkin beetle, flea beetle, aphids, leafhoppers, thrips, whiteflies and fruit flies. Management of sucking pests is one of the important aspects so as to reduce the transmission of diseases and to sustain the produce. Farmers mostly rely on chemical pesticides for controlling pest population. In the past, several chemical insecticides have been proved effective in controlling the pests. However, development of resistance to conventional insecticides against the pest is a serious threat to India. In this regard the bio efficacy of selected insecticides on insect pests infesting cucumber was carried out.

Materials and Methods
Experimental layout
The experiment on the bio efficacy of tolfenpyrad (15% EC) against jassids, thrips and red pumpkin beetles was conducted in Randomized Block Design with three replications at M.A.R.S., Raichur during Rabi, 2016 and 2017 seasons. Cucumber hybrid DWD-Green was sown in the plots each measuring 5.0 x 5.0 Sq. m. at row to row and plant to plant spacing of 90cm x 20cm, respectively.

Treatment details

There were eight treatments replicated three times. The test chemical, tolfenpyrad (15% EC) was tested at three doses *viz.* 100.50, 124.50 and 150 g a.i. /ha. Different doses of tolfenpyrad was tested in comparison with standard check treatment *viz.* Imidacloprid 17.8% SL @ 22.5 g a.i. /ha, Fipronil 5% SC @ 40 g a.i. /ha and Chlorpyriphos 20% EC @ 250 g a.i. /ha along with untreated check.

Observations

Observation on the insect pest population was recorded at a day before spray and one, three, seven, ten and fifteen days after treatment imposition. Each treatment was applied two times initiating first spray as soon as the pest population crossed the ETL level and subsequent second spray was given at 20 days after first treatment imposition.

Statistical analysis

Recorded observations were computed and tabulated which were further converted by square root for the larval count and RBD analysis was done with the XL-Stat statistical tool.

Results and Discussion

Thrips

One day before first spray, the thrips population in different treatments ranged from 12.27 to 12.41 per three leaves and it was statistically non-significant. A day after spray in the year 2015-16 the lowest population of thrips was observed in the highest dosage treatment of tolfenpyrad 15% EC @ 150 g a.i./ha which recorded 9.31 per three leaves followed by this was its next lower dosage treatment of tolfenpyrad 15% EC @ 124.5 g a.i./ha (9.39 thrips/3 leaves). The treatment tolfenpyrad 15% EC @ 100.5 g a.i./ha recorded the thrips population of 9.62 per three leaves which was on par with fipronil 5%SC @ 40 g a.i./ha (9.57 thrips/3 leaves). At three days after spray PII 405 @ 150 g a.i./ha recorded the lowest population of 6.33 thrips/3 leaves and was superior which was followed by tolfenpyrad 15% EC @ 124.5 g a.i./ha which recorded the population of 6.41 thrips per three leaves and were on par with each other. Similar trend was observed at seven, ten and fifteen days after spray (Table 1).

In the year 2016-17 a day after spray the lowest population of thrips was observed in the highest dosage treatment of tolfenpyrad 15% EC @ 150 g a.i./ha which recorded 9.86 per three leaves followed by this was its next lower dosage treatment of tolfenpyrad 15% EC @ 124.5 g a.i./ha (9.94 thrips/3 leaves). The treatment tolfenpyrad (PII 405) 15% EC @ 100.5 g a.i./ha recorded the thrips population of 10.17 per three leaves which was on par with fipronil 5%SC @ 40 g a.i./ha (10.12 thrips/3 leaves). At fifteen days after spray highest thrips population was observed in the untreated control with 13.49 thrips per three leaves. The trend remained same even after second spray wherein the tolfenpyrad 15% EC @ 150 g a.i./ha was found to be superior in reducing the thrips population followed by the treatments tolfenpyrad 15% EC @ 124.5 g a.i./ha and tolfenpyrad 15% EC @ 100.5 g a.i./ha were on par with each other (Table 2).

Table 1: Bio efficacy of tolfenpyrad 15% EC against thrips in cucumber, *Rabi* 2015-16

S. No.	Treatments	Dosage (g.a.i/ha)	No. of thrips per leaf											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	12.27	9.62 (3.23)	6.64 (2.73)	4.65 (2.31)	1.88 (1.57)	3.84 (2.11)	11.38	9.04 (3.12)	5.98 (2.58)	3.94 (2.13)	1.72 (1.50)	2.75 (1.82)
2	Tolfenpyrad 15% EC	124.5	12.36	9.39 (3.14)	6.41 (2.63)	4.42 (2.22)	1.65 (1.47)	3.61 (2.03)	11.29	8.81 (3.05)	5.75 (2.50)	3.71 (2.05)	1.49 (1.41)	2.52 (1.74)
3	Tolfenpyrad 15% EC	150	12.41	9.31 (3.13)	6.33 (2.61)	4.34 (2.20)	1.57 (1.44)	3.53 (2.01)	11.40	8.73 (3.04)	5.67 (2.48)	3.63 (2.03)	1.41 (1.37)	2.44 (1.70)
4	Imidacloprid 17.8% SL	22.5	12.41	9.83 (3.21)	6.89 (2.72)	4.98 (2.34)	3.55 (2.01)	4.05 (2.13)	11.47	9.25 (3.12)	6.23 (2.59)	4.27 (2.18)	3.39 (1.97)	2.96 (1.86)
5	Fipronil 5% SC	40	12.35	9.57 (3.19)	6.61 (2.70)	4.67 (2.29)	1.93 (1.59)	3.81 (2.12)	11.30	8.99 (3.10)	5.95 (2.56)	3.96 (2.13)	1.77 (1.54)	2.72 (1.80)
6	Chlorpyriphos 20%EC	250	12.33	11.19 (3.42)	11.31 (3.44)	11.28 (3.43)	10.18 (3.27)	10.79 (3.36)	11.35	10.61 (3.33)	10.65 (3.34)	10.57 (3.33)	10.02 (3.24)	9.70 (3.18)
7	Untreated control	--	12.28	12.42 (3.59)	12.55 (3.61)	12.47 (3.60)	11.81 (3.51)	11.96 (3.53)	11.32	11.43 (3.45)	11.56 (3.47)	11.29 (3.43)	11.35 (3.45)	10.88 (3.39)
S. Em±			0.41	0.03	0.01	0.02	0.03	0.02	0.25	0.02	0.03	0.03	0.02	0.02
CD @0.5			NS	0.08	0.04	0.06	0.07	0.06	NS	0.04	0.06	0.07	0.06	0.05

DBS: Day before spray
DAS: Day after spray
*Figures in parentheses are square root transformed values

Table 2: Bio efficacy of tolfenpyrad 15% EC against thrips in cucumber, *Rabi* 2016-17

S. No.	Treatments	Dosage (g.a.i/ha)	No. of thrips per leaf											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	13.80	10.17 (3.27)	7.03 (2.74)	5.16 (2.38)	2.13 (1.62)	3.57 (2.02)	12.35	9.45 (3.15)	6.31 (2.61)	4.18 (2.16)	1.91 (1.55)	3.08 (1.89)
2	Tolfenpyrad 15% EC	124.5	13.75	9.94 (3.23)	6.80 (2.70)	4.93 (2.33)	1.90 (1.55)	3.34 (1.96)	12.44	9.22 (3.12)	6.08 (2.57)	3.95 (2.11)	1.68 (1.48)	2.85 (1.83)
3	Tolfenpyrad 15% EC	150	13.80	9.86 (3.22)	6.72 (2.69)	4.85 (2.31)	1.82 (1.52)	3.26 (1.94)	12.37	9.14 (3.10)	6.00 (2.55)	3.87 (2.09)	1.60 (1.45)	2.77 (1.81)
4	Imidacloprid 17.8% SL	22.5	13.66	10.38 (3.30)	7.28 (2.79)	5.49 (2.45)	3.80 (2.07)	3.78 (2.07)	12.26	9.66 (3.19)	6.56 (2.66)	4.51 (2.24)	3.58 (2.02)	3.29 (1.95)

5	Fipronil 5% SC	40	13.74	10.12 (3.26)	7.00 (2.74)	5.18 (2.38)	2.18 (1.64)	3.54 (2.01)	12.27	9.40 (3.15)	6.28 (2.60)	4.20 (2.17)	1.96 (1.57)	3.05 (1.88)
6	Chlorpyriphos 20%EC	250	13.72	11.74 (3.50)	11.70 (3.49)	11.79 (3.51)	10.43 (3.31)	10.52 (3.32)	12.32	11.02 (3.39)	10.98 (3.39)	10.81 (3.36)	10.21 (3.27)	10.03 (3.24)
7	Untreated control	--	13.67	13.83 (3.79)	14.05 (3.81)	13.93 (3.80)	14.07 (3.82)	13.49 (3.74)	12.29	12.44 (3.60)	12.58 (3.62)	12.73 (3.64)	12.67 (3.63)	13.04 (3.68)
S. Em±			0.58	0.02	0.02	0.02	0.02	0.03	0.39	0.02	0.04	0.02	0.03	0.02
CD @0.5			NS	0.07	0.05	0.07	0.06	0.07	NS	0.05	0.08	0.08	0.06	0.06

DBS: Day before spray
DAS: Day after spray
*Figures in parentheses are square root transformed values

Red pumpkin beetles

During the first year (2015-16) the highest dosage treatment of tolfenpyrad 15% EC @ 150 g a.i./ha which recorded 3.87 per plant followed by this was its next lower dosage treatment of tolfenpyrad 15% EC @ 124.5 g a.i./ha (3.8794 beetles/plant) were on par with each other. The treatment tolfenpyrad 15% EC @ 100.5 g a.i./ha recorded the beetle population of 4.13 per plant which was on par with chlorpyriphos 20%EC @ 250 g a.i./ha (4.18 beetles/plant). The treatments imidacloprid 17.8% SL @ 22.5 g a.i./ha and fipronil 5% SC @ 40 g a.i./ha recorded the beetles population of 4.95 and 5.02 per plant respectively and were on par with each other. At three days after spray tolfenpyrad 15% EC @ 150 g a.i./ha recorded the lowest population of 2.98 beetles/plant and was superior which was followed by tolfenpyrad (PII 405) 15% EC @ 124.5 g a.i./ha which recorded the population of 3.05 beetles and were on par with each other. At seven, ten and fifteen days after spray similar trend was noticed wherein lowest population was observed in tolfenpyrad 15% EC @ 150 g a.i./ha (Table 3).

A day after spray during the year 2016-17, the lowest population of beetles was observed in the highest dosage treatment of tolfenpyrad 15% EC @ 150 g a.i./ha which recorded 3.58 per plant followed by this was its next lower dosage treatment of tolfenpyrad (PII 405) 15% EC @ 124.5 g a.i./ha (3.65 beetles/plant) were on par with each other. The treatment tolfenpyrad 15% EC @ 100.5 g a.i./ha recorded the beetle population of 3.84 per plant which was on par with chlorpyriphos 20% EC @ 250 g a.i./ha (3.89 beetles/plant). The treatments imidacloprid 17.8% SL @ 22.5 g a.i./ha and fipronil 5% SC @ 40 g a.i./ha recorded the beetles population of 4.66 and 4.73 per plant respectively and were on par with each other. At seven days after spray similar trend was noticed wherein lowest population was observed in tolfenpyrad 15% EC @ 150 g a.i./ha followed by its next lower dosage treatment tolfenpyrad 15% EC @ 124.5 g a.i./ha. At fifteen days after spray population of beetles increased in all the treatments and the highest population was observed in the untreated control with 4.83 beetles per plant. The trend remained same even after second spray wherein the tolfenpyrad 15% EC @ 150 g a.i./ha was found to be superior in reducing the beetle population followed by the treatments tolfenpyrad 15% EC @ 124.5 g a.i./ha (Table 4).

Table 3: Bio efficacy of tolfenpyrad 15% EC against red pumpkin beetles in cucumber, *Rabi* 2015-16

S. No.	Treatments	Dosage (G.A.I/ha)	No. of beetles/plant											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	5.28	4.13 (2.15)	3.24 (1.94)	2.48 (1.75)	2.15 (1.64)	3.04 (1.90)	5.97	4.36 (2.22)	3.39 (1.99)	2.76 (1.83)	2.26 (1.69)	3.21 (1.97)
2	Tolfenpyrad 15% EC	124.5	5.33	3.94 (2.11)	3.05 (1.88)	2.29 (1.67)	1.96 (1.57)	2.85 (1.83)	6.02	4.17 (2.16)	3.20 (1.92)	2.57 (1.75)	2.07 (1.60)	3.02 (1.88)
3	Tolfenpyrad 15% EC	150	5.41	3.87 (2.09)	2.98 (1.87)	2.22 (1.65)	1.89 (1.55)	2.78 (1.81)	6.10	4.10 (2.14)	3.13 (1.91)	2.50 (1.73)	2.00 (1.58)	2.95 (1.86)
4	Imidacloprid 17.8% SL	22.5	5.45	4.95 (2.33)	5.13 (2.37)	5.39 (2.43)	5.51 (2.45)	5.92 (2.53)	6.14	5.18 (2.38)	5.28 (2.40)	5.67 (2.48)	5.62 (2.47)	6.09 (2.57)
5	Fipronil 5% SC	40	5.29	5.02 (2.35)	5.21 (2.39)	5.43 (2.44)	5.49 (2.45)	5.98 (2.55)	5.98	5.25 (2.40)	5.36 (2.42)	5.71 (2.49)	5.60 (2.47)	6.15 (2.59)
6	Chlorpyriphos 20%EC	250	5.36	4.18 (2.19)	3.28 (1.97)	2.53 (1.77)	2.22 (1.68)	3.11 (1.92)	5.96	4.41 (2.25)	3.43 (1.99)	2.81 (1.85)	2.33 (1.70)	3.28 (1.99)
7	Untreated control	--	5.27	5.41 (2.43)	5.59 (2.47)	5.76 (2.50)	5.99 (2.55)	6.39 (2.62)	6.05	6.19 (2.59)	6.28 (2.60)	6.41 (2.63)	6.08 (2.57)	6.22 (2.59)
S.Em±			0.33	0.01	0.02	0.02	0.03	0.02	0.19	0.03	0.02	0.01	0.02	0.02
CD @0.5			NS	0.03	0.05	0.05	0.07	0.05	NS	0.07	0.05	0.03	0.07	0.06

DBS: Day before spray DAS: Day after spray
*Figures in parentheses are square root transformed values

Table 4: Bio efficacy of tolfenpyrad 15% EC against red pumpkin beetles in cucumber, *Rabi* 2016-1

S. No.	Treatments	Dosage (G.A.I/ha)	No. of beetles/plant											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	4.87	3.84 (2.08)	3.06 (1.89)	2.34 (1.69)	1.67 (1.47)	2.47 (1.72)	5.39	4.02 (2.13)	3.06 (1.89)	2.47 (1.72)	1.71 (1.49)	2.35 (1.69)
2	Tolfenpyrad 15% EC	124.5	4.92	3.65 (2.04)	2.87 (1.84)	2.15 (1.63)	1.48 (1.41)	2.28 (1.67)	5.44	3.83 (2.08)	2.87 (1.84)	2.28 (1.67)	1.52 (1.42)	2.16 (1.63)

3	Tolfenpyrad 15% EC	150	4.86	3.58 (2.02)	2.80 (1.82)	2.08 (1.61)	1.41 (1.38)	2.21 (1.65)	5.52	3.76 (2.06)	2.80 (1.82)	2.21 (1.65)	1.45 (1.40)	2.09 (1.61)
4	Imidacloprid 17.8% SL	22.5	4.95	4.66 (2.27)	4.95 (2.33)	5.25 (2.40)	5.03 (2.35)	5.35 (2.42)	5.47	4.84 (2.31)	4.95 (2.33)	5.38 (2.42)	5.07 (2.36)	5.23 (2.39)
5	Fipronil 5% SC	40	4.88	4.73 (2.29)	5.03 (2.35)	5.29 (2.41)	5.01 (2.35)	5.41 (2.43)	5.40	4.91 (2.33)	5.03 (2.35)	5.42 (2.43)	5.05 (2.36)	5.29 (2.41)
6	Chlorpyriphos 20% EC	250	5.04	3.89 (2.10)	3.10 (1.90)	2.39 (1.70)	1.74 (1.50)	2.54 (1.74)	5.38	4.07 (2.14)	3.10 (1.90)	2.52 (1.74)	1.78 (1.51)	2.42 (1.71)
7	Untreated control	--	5.00	5.09 (2.36)	4.96 (2.34)	5.11 (2.37)	5.04 (2.35)	4.83 (2.31)	5.56	5.71 (2.49)	5.82 (2.51)	5.66 (2.48)	5.49 (2.45)	5.3 (2.41)
S. Em±			0.61	0.02	0.03	0.02	0.02	0.02	0.29	0.04	0.03	0.01	0.03	0.02
CD @0.5			NS	0.04	0.06	0.04	0.06	0.06	NS	0.08	0.06	0.03	0.06	0.06

Leafhoppers

Highest dosage treatment of tolfenpyrad 15% EC @ 150 g a.i./ha which recorded 5.29 per three leaves followed by this was its next lower dosage treatment of tolfenpyrad 15% EC @ 124.5 g a.i./ha (5.33 leafhoppers/3 leaves) and were on par with each other. The treatment tolfenpyrad (PII 405) 15% EC @ 100.5 g a.i./ha recorded the leafhopper population of 5.71 per three leaves which was on par with fipronil 5%SC @ 40 g a.i./ha (5.68 leafhoppers/3 leaves). At three days after spray tolfenpyrad 15% EC @ 150 g a.i./ha recorded the lowest population of 2.31 leafhoppers/3 leaves and was superior which was followed by tolfenpyrad 15% EC @ 124.5 g a.i./ha which recorded 2.35 leafhopper per three leaves respectively and were on par with each other. At seven days after spray similar trend was noticed wherein lowest population was observed in tolfenpyrad 15% EC @ 150 g a.i./ha followed by its next lower dosage treatment tolfenpyrad 15% EC @ 124.5 g a.i./ha and 100.5 g a.i./ha. At fifteen days after spray population highest leafhoppers population was observed in the untreated control with 7.58 leafhoppers per three leaves. The trend remained same even after second spray wherein the tolfenpyrad 15% EC @ 150 g a.i./ha was found to be superior in reducing the leafhoppers population in the year 2015-16 (Table 5).

During the year 2016-17, at three days after spray tolfenpyrad 15% EC @ 150 g a.i./ha recorded the lowest population of 2.44 leafhoppers/3 leaves and was superior which was followed by tolfenpyrad 15% EC @ 124.5 g a.i./ha which recorded 2.48 leafhopper per three leaves respectively and were on par with each other. Lower dosage treatment of tolfenpyrad (PII 405) 15% EC @ 100.5 g a.i. /ha (2.86 leafhoppers/3 leaves) was on par with fipronil 5% SC @ 40 g a.i./ha (2.90 leafhoppers/3 leaves). At seven days after spray similar trend was noticed wherein lowest population was observed in tolfenpyrad 15% EC @ 150 g a.i./ha followed by its next lower dosage treatment tolfenpyrad 15% EC @ 124.5 g a.i./ha and 100.5 g a.i./ha. The trend remained same even after second spray wherein the tolfenpyrad 15% EC @ 150 g a.i./ha was found to be superior in reducing the leafhoppers population (Table 6).

Table 5: Bio efficacy of tolfenpyrad 15% EC against leafhoppers in cucumber, *Rabi* 2015-16

S. No.	Treatments	Dosage (g.a.i/ha)	No. of leaf hoppers per leaf											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	7.86	5.71 (2.49)	2.73 (1.80)	1.64 (1.46)	1.27 (1.33)	3.23 (1.93)	8.45	6.00 (2.55)	2.91 (1.85)	1.87 (1.54)	1.45 (1.40)	2.94 (1.85)
2	Tolfenpyrad 15% EC	124.5	7.92	5.33 (2.41)	2.35 (1.69)	1.26 (1.33)	0.89 (1.18)	2.85 (1.53)	8.58	5.62 (2.47)	2.53 (1.74)	1.49 (1.41)	1.07 (1.25)	2.56 (1.75)
3	Tolfenpyrad 15% EC	150	7.76	5.29 (2.40)	2.31 (1.68)	1.22 (1.31)	0.85 (1.16)	2.81 (1.81)	8.43	5.58 (2.45)	2.49 (1.72)	1.45 (1.40)	1.03 (1.23)	2.52 (1.73)
4	Imidacloprid 17.8% SL	22.5	7.85	5.77 (2.53)	3.09 (1.92)	4.98 (2.37)	3.63 (2.06)	4.25 (2.21)	8.51	6.06 (2.59)	3.27 (1.97)	5.21 (2.42)	3.81 (2.11)	3.96 (2.16)
5	Fipronil 5% SC	40	7.79	5.68 (2.47)	2.77 (1.81)	4.67 (2.27)	1.38 (1.37)	3.26 (1.94)	8.48	5.97 (2.54)	2.95 (1.86)	4.90 (2.32)	1.56 (1.44)	2.97 (1.86)
6	Chlorpyriphos 20%EC	250	7.92	7.56 (2.84)	7.29 (2.79)	7.32 (2.80)	7.08 (2.75)	7.29 (2.79)	8.59	7.85 (2.89)	7.47 (2.82)	7.55 (2.84)	7.26 (2.79)	7.00 (2.74)
7	Untreated control	--	7.82	7.58 (2.85)	7.72 (2.89)	7.83 (2.90)	7.38 (2.81)	7.58 (2.85)	8.52	8.62 (3.04)	8.55 (3.02)	8.71 (3.05)	8.66 (3.03)	8.09 (2.93)
S. Em±			0.28	0.03	0.04	0.02	0.05	0.03	0.37	0.02	0.03	0.04	0.05	0.02
CD @0.5			NS	0.07	0.10	0.05	0.12	0.10	NS	0.06	0.10	0.13	0.13	0.07

DBS: Day before spray

DAS: Day after spray

*Figures in parentheses are square root transformed values

Table 6: Bio efficacy of tolfenpyrad 15% EC against leafhoppers in cucumber, *Rabi* 2016-17

S. No.	Treatments	Dosage (g.a.i/ha)	No. of leaf hoppers per leaf											
			First Spray						Second Spray					
			1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	1 DBS	1 DAS	3 DAS	7 DAS	10 DAS	15 DAS
1	Tolfenpyrad 15% EC	100.5	8.82	5.87 (2.52)	2.86 (1.82)	1.52 (1.42)	1.09 (1.26)	1.68 (1.48)	9.41	6.16 (2.58)	3.04 (1.88)	1.75 (1.50)	1.63 (1.46)	2.29 (1.67)
2	Tolfenpyrad 15% EC	124.5	8.72	5.49 2.45)	2.48 (1.73)	1.14 (1.28)	0.71 (1.10)	1.30 (1.34)	8.72	5.78 (2.51)	2.66 (1.78)	1.37 (1.37)	1.25 (1.32)	1.91 (1.55)
3	Tolfenpyrad 15% EC	150	8.83	5.45	2.44	1.10	0.67	1.26	8.88	5.74	2.62	1.33	1.21	1.87

				(2.44)	(1.71)	(1.26)	(1.08)	(1.33)		(2.50)	(1.77)	(1.35)	(1.31)	(1.54)
4	Imidacloprid 17.8% SL	22.5	8.81	5.93 (2.54)	3.22 (1.93)	4.86 (2.32)	3.45 (1.99)	2.70 (1.79)	9.47	6.22 (2.59)	3.40 (1.97)	5.09 (2.36)	3.99 (2.12)	3.31 (1.95)
5	Fipronil 5% SC	40	8.75	5.84 (2.52)	2.90 (1.84)	4.55 (2.25)	1.20 (1.30)	1.71 (1.49)	9.44	6.13 (2.57)	3.08 (1.89)	4.78 (2.30)	1.74 (1.50)	2.32 (1.68)
6	Chlorpyriphos 20%EC	250	8.87	7.72 (2.87)	7.42 (2.81)	7.20 (2.77)	6.90 (2.72)	5.74 (2.50)	9.54	8.01 (2.920	7.60 (2.85)	7.43 (2.82)	7.44 (2.82)	6.35 (2.62)
7	Untreated control	--	8.78	8.91 (3.07)	9.05 (3.09)	8.76 (3.04)	8.63 (3.02)	8.56 (3.01)	9.48	8.91 (3.07)	9.05 (3.09)	8.76 (3.04)	8.92 (3.07)	9.05 (3.09)
S. Em±			0.56	0.04	0.02	0.02	0.04	0.03	0.85	0.03	0.02	0.05	0.05	0.03
CD @0.5			NS	0.11	0.09	0.05	0.13	0.11	NS	0.07	0.08	0.12	0.14	0.08

DBS: Day before spray
DAS: Day after spray
*Figures in parentheses are square root transformed values

Yield

During the year 2015-16, highest yield of 5.91 t/ha was noticed in the highest dosage of tolfenpyrad 15% EC @ 150 g a.i./ha and it was at par with its next lowest dosage treatments of tolfenpyrad 15% EC @ 124.5 g a.i./ha and 100.50 g a.i./ha which recorded 5.85 t/ha and 5.21 t/ha respectively. The fipronil 50% SC @ 40 g a.i./ha, chlorpyriphos 20% EC @ 250 g a.i./ha and imidacloprid 17.8% SL @ 22.5 g a.i./ha recorded yield of 5.09, 4.00 and 4.52 t/ha. Similarly, highest yield of 5.75 t/ha was noticed in the highest dosage of tolfenpyrad 15% EC @ 150 g a.i./ha and it was at par with its next lowest dosage treatments of tolfenpyrad 15% EC @ 124.5 g a.i./ha and 100.50 g a.i./ha which recorded 5.69 t/ha and 5.45 t/ha respectively in 2016-17 season (Table 7).

According to Ramesh Babu and Virendra Singh (2014) [8], tolfenpyrad @ 150 and 125 g a.i/ha found highly effective against hopper complex of mango. Field test with different doses ranging from 125 to 150g a.i./ha, the Tolfenpyrad effectively controlled sucking pest complex in okra and cotton, thrips and capsule borers of chilli and onion thrips (Mandal, 2013) [6]. Similar findings were also recorded by Walunj *et al.* (2016) [12]. Similarly, Lekha *et al.* (2018) [5] reported that tolfenpyrad 15 EC @ 150 g a.i/ha provided cross-spectrum control of insect pests as it registered highest mean reduction of whitefly (91.82%), jassids (86.80%), thrips (86.47%) and aphids (91.54%). Application of tolfenpyrad 15% EC at 150 g a.i./ha showed significantly least survival of thrips on 5, 7 and 10 days after spray, resulting in least fruit damage (Walunj *et al.*, 2016) [12].

Similarly, Kalyan *et al* (2013) [4] studied the bioefficacy of tolfenpyrad 15% EC against sucking pests of cotton. They observed that the doses of tolfenpyrad 15% EC at 125 and 150g a.i./ha were significantly superior to imidacloprid 17.8 SL and thiomethoxam 25 WG in suppressing the population of sucking pests in cotton. [8] Saini *et al.* (2010) [9] observed that tolfenpyrad at all the three doses was significantly superior to imidacloprid 17.8 SL and thiomethoxam 25 WG in suppressing the population of jassids on cotton. Maximum reduction in aphid population after third, seventh and fourteenth days after sprays ranged from 24.45 to 97.14% in tolfenpyrad @ 150 and 125 g. a.i/ha (Bajpai *et al*., 2013) [2]. Tolfenpyrad15 EC at 125 and 150g a.i./ ha were highly effective in controlling the aphids and thrips in cumin (Patel *et al.*, 2013) [6]. The lowest shoot infestation was recorded from the application of tolfenpyrad (15% EC) @ 150 g a.i. /ha which resulted in 16.62, 15.00 and17.62, 17.62, per cent at seven days after first and second spray Lekha *et al.* (2018) [5].

Table 7: Bio efficacy of tolfenpyrad 15% EC on yield in cucumber

S. No.	Treatments	Dosage (G.A.I/ha)	Yield (t/ha)	
			2015-16	2016-17
1	Tolfenpyrad 15% EC	100.5	5.21	5.45
2	Tolfenpyrad 15% EC	124.5	5.85	5.69
3	Tolfenpyrad 15% EC	150	5.91	5.75
4	Imidacloprid 17.8% SL	22.5	4.52	4.36
5	Fipronil 5% SC	40	5.09	4.93
6	Chlorpyriphos 20%EC	250	4.00	3.84
7	Untreated control	--	3.13	2.98
S. Em±			0.21	0.16
CD @0.5			0.62	0.52

Conclusion

It is evident from the above results that tolfenpyrad @ 150g a.i./ha was found most effective against sucking pests and it was significantly superior over rest of the treatments and lower dosage treatments of tolfenpyrad were at par with Fipronil 5% SC.

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