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Arundhati Sasmal
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

S Das
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

PK Sarangi
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

S Panda
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

D Khulbe
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

P Samant
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
Arundhati Sasmal
RRTTS (Coastal Zone), OUAT, Bhubaneswar, Odisha, India

Field evaluation of insecticides against thrips (*Scirtothrips dorsalis* Hood) in chilli

Arundhati Sasmal, S Das, PK Sarangi, S Panda, D Khulbe and P Samant

Abstract
The field experiments were conducted at Regional Research and Technology Transfer Station (RRTTS), Coastal Zone, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar to evaluate some insecticides with different modes of action against thrips (*Scirtothrips dorsalis* Hood) during *Rabi*, 2016-17, 2017-18 and 2018-19 in chilli variety 'Utkal Ava'. The seeds were treated with imidacloprid 600FS @5ml/kg in all the treatments except untreated control plot. Acetamiprid 20%SP @10g a.i./ha, spinosad 45%SC @73g a.i./ha, fenpyroximate 5%EC @30g a.i./ha, emamectin benzoate 5%SG @10g a.i./ha, fipronil 80%WG @ 50g a.i./ha, spiromesifen 22.9%SC @ 96g a.i./ha, acephate 75%SP @500g a.i./ha and dimethoate 30%EC @300g a.i./ha were applied as foliar spray at 30 and 45 days after transplanting in the treatment modules T_1 to T_8 respectively. The untreated check treatment (T_9) was devoid of chemical insecticide spray. The pooled mean population of thrips derived from three experimental seasons indicated that fipronil 80%WG @ 50g a.i./ha and spiromesifen 22.9%SC @ 96g a.i./ha were at par in effectiveness against chilli thrips where 1.01 and 1.07 thrips/leaf were recorded respectively. Spiromesifen 22.9%SC @ 96g a.i./ha was found to be very much safe to predators such as spiders throughout the three experimental seasons (1.60 spiders/plant). Highest green chilli yield (92.1q /ha) was obtained from spiromesifen 22.9%SC @ 96g a.i./ha treated plot which contributed net income (Rs171600/ha) and benefit cost ratio (2.64). Fipronil 80%WG treated plot recorded second highest yield (87.9 q/ha) with net income of Rs159613/ha and B:C ratio (2.53).

Keywords: Chilli, fipronil 80%WG, spiders, spiromesifen 22.9%SC, thrips

1. Introduction
In India chilli (*Capsicum annum* L.) is used in green and dried stage as it provides colour, pungency in all culinary preparation. Thrips (*Scirtothrips dorsalis* Hood) is the major sucking insect pest causing considerable yield loss in chilli. Thrips is a major sucking insect pest responsible for low productivity [3]. Severe infestation of thrips alone can cause 50% yield loss [2]. Nymphs and adult thrips are found along the mid vein or along the borders of damaged leaf tissues. They suck the sap from the foliage and lacerate the leaf tissue, which result in upward curling of leaves, flowers drop and scaring on the leaves. For management of thrips chemical insecticides are applied as foliar spray. The present experiment was carried out to evaluate the effect of some insecticides with different mode of action against chilli thrips.

2. Materials and Methods
The evaluation of eight insecticides with different modes of action against chilli thrips was conducted during *Rabi*, 2016-17, 2017-18 and 2018-19 at Regional Research and Technology Transfer Station (RRTTS), Coastal Zone, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar. Randomized Block Design was adopted to conduct the experiment where nine number of treatments were replicated thrice. The chilli variety 'Utkal Ava' was grown for the experiment. Chilli seeds were treated with imidacloprid 600FS @5ml/kg in all the treatments except untreated control plot. Acetamiprid 20%SP @10g a.i./ha, spinosad 45%SC @73g a.i./ha, fenpyroximate 5%EC @30g a.i./ha, emamectin benzoate 5%SG @10g a.i./ha, fipronil 80%WG @ 50g a.i./ha, spiromesifen 22.9%SC @ 96g a.i./ha, acephate 75%SP @500g a.i./ha and dimethoate 30%EC @300g a.i./ha were applied as foliar spray at 30 and 45 days after transplanting in the treatment modules T_1 to T_8 as shown in table 1. The untreated control plot (T_9) was not applied with any insecticide.
Observations on population of thrips was noted in different treatment plots. Five plants were randomly selected in different treatment plots in each replication. Number of thrips (nymphs and adults) were counted in top, middle and bottom leaves of each plant with the help of

magnifying hand lens. Average number of thrips per leaf was calculated in each treatment plot. Observations were recorded at 5, 10 and 15 days after each spray. Population count of beneficial insects were recorded to evaluate the safety of chemicals used in different treatments towards natural enemies. Data on spider population were noted. Five plants were randomly selected from each treatment plot of each replication. Total number of spiders was counted in each plant at 5, 10 and 15 days after each spray in each treatment plot. The mean population of thrips/leaf and spiders/plant of all the observations were calculated in each experimental season.

Marketable green chilli yield from each treatment plot at each harvesting date were recorded and the total yield was derived. It was converted to quintal per hectare.

Gross income of each treatment was calculated by multiplying yield and the selling price of chilli. Cost of cultivation was calculated for each treatment considering all production cost including cost of treatment chemicals. Net income was obtained by deducting cost of cultivation of the treatment from gross income of that treatment. Benefit cost was calculated by dividing gross income by cost of cultivation of each treatment.

All the data collected were analyzed statistically by OPSTAT, a free Online Agriculture Data Analysis Tool created by O.P. Sheoran, Computer Programmer at CCS HAU, Hisar, India [8]. The results derived from that has been discussed below.

3. Results and Discussion

3.1 Population of thrips

3.1.1 Thrips population during *Rabi*, 2016-17

Experimental results of *Rabi*, 2016-17 shows that the treatment received spraying of

fipronil 80%WG @ 50g a.i./ha at 30 and 45 days after transplanting recorded lowest thrips (1.08 thrips/leaf) which is statistically at par with the treatment received spraying of spiromesifen 22.9%SC @ 96g a.i./ha (1.12 thrips/leaf). Spinosad 45%SC @73g a.i./ha treated plots also harbored lower thrips population (1.48thrips/leaf) which was the second lowest population among the treatments. Acetamiprid 20%SP @10g a.i./ha, acephate 75%SP @500g a.i./ha and dimethoate 30%EC @300g a.i./ha were proved to be equally effective against chilli thrips where 1.77, 1.85 and 2.00 thrips/leaf were observed respectively compared to 3.51 thrips/leaf in the untreated control plot (Table 1).

3.1.2 Thrips population during *Rabi*, 2017-18

During *Rabi*, 2017-18 the treatment received spraying of fipronil 80%WG @ 50g a.i./ha at 30 and 45 days after transplanting proved its supremacy among the tested chemicals and recorded 0.79 thrips/leaf as compared to 4.00 thrips/leaf in untreated plot. Spinosad 45%SC and spiromesifen 22.9%SC @ 96g a.i./ha were equally effective and performed as the second-best as the treated plots recorded 1.01 and1.03 thrips/leaf respectively. Acetamiprid 20%SP @10g a.i./ha and acephate 75%SP @500g a.i./ha were statistically at par and the treated plots had 1.56 and 1.66 thrips/leaf (Table 1).

3.1.3 Thrips population during *Rabi*, 2018-19

Lowest thrips population was found in spiromesifen 22.9%SC @ 96g a.i./ha treatment (1.06 thrips/leaf) and was at par with fipronil 80%WG @ 50g a.i./ha (1.17thrips/leaf). Spinosad 45%SC sprayed plot had recorded 1.30 thrips/leaf which can be treated as second best chemical. Acetamiprid 20%SP @10g a.i./ha, dimethoate 30%EC @300g a.i./ha and acephate 75%SP @500g a.i./ha were proved to be equally effective against chilli thrips where 1.85, 1.87 and 1.91thrips/leaf were observed respectively compared to 4.17thrips/leaf found in the untreated control plot (Table 1).

3.1.4 Pooled mean thrips population

The pooled mean of three season data reflects that the two chemicals fipronil 80%WG @ 50g a.i./ha and spiromesifen 22.9%SC @ 96g a.i./ha were equally effective in chilli thrips management where 1.01 and 1.07 thrips/leaf were recorded. Spinosad 45%SC was proved as second-best chemical (1.26thrips/leaf). Acetamiprid 20%SP @10g a.i./ha and acephate 75%SP @500g a.i./ha were statistically at par where 1.73 and 1.81 thrips/leaf were recorded (Table 1).

Figure-1 reflects that spraying of fipronil 80%WG caused highest percentage reduction in thrips/leaf over control (74%) followed by spiromesifen 22.9%SC (73%).

The present findings are similar with the opinion of Reddy *et al*. (2009) [4] that fipronil 80WG @50g a.i./ha was effective against thrips in chilli. Sanghamitra *et al*. (2018) [7] opined that fipronil 200SCw/v @50g a.i./ha was found most effective in reducing thrips. Effectiveness of spiromesifen against chilli thrips was concluded by Varghese *et al*. (2013) [9] which corroborates the present results.

3.2 Effect of insecticides on spider population

3.2.1 Spider population during *Rabi*, 2016-17

Table 2 shows that the chemical spiromesifen 22.9%SC@ 96g a.i./ha sprayed at 30 and 45 days after transplanting was safe to spiders as the treated plot harbored 2.34 spiders/plant compared to 2.70 spiders/plant in untreated control plot. Emamectin benzoate 5%SG @10g a.i./ha was also found to be relatively safer (2.07 spiders/plant) followed by fenpyroximate 5%EC @30g a.i./ha (1.81 spiders/plant).

3.2.2 Spider population during *Rabi*, 2017-18

During second season the same trend has been observed as the treatment constituting spiromesifen 22.9%SC @ 96g a.i./ha had highest population of spiders (1.20spiders/plant) which is at par with the untreated control plot where 1.22 spiders/plant was recorded. Spinosad 45%SC @73g a.i./ha was also relatively safer among the chemicals as the treatment had 0.97 spiders/plant. Emamectin benzoate 5%SG @10g a.i./ha and Acephate 75%SP @500g a.i./ha were equally safe as the treatments recorded 0.88 and 0.86 spiders/plant respectively (Table 2).

3.2.3 Spider population during *Rabi*, 2018-19

(Table 2) shows that the data recorded in spiromesifen 22.9%SC treated plots recorded the highest population of predators (1.26 spiders/plant) among the treated chemicals which statistically equal with that of untreated control plot (1.32 spiders/plant). In spinosad 45%SC @73g a.i./ha treated plots the spider population was second highest (1.07 spiders/plant).

3.2.4 Pooled mean spider population

The pooled mean population data of three seasons clearly indicates the safety of the spraying of spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting over the other treated chemicals with 1.60 spiders/plant compared to 1.75 spiders/plant in untreated control plot. Emamectin benzoate 5%SG @10g a.i./ha was the next best chemical

which is safer to predators (1.25 spiders/plant). Spinosad 45%SC and fenpyroximate 5%EC were equally safe where 1.13 spiders/plant was observed (Table 2).

Lowest percent reduction (9%) in spider/plant over untreated control was recorded in spiromesifen 22.9%SC treated plants (Figure 2).

The safety of spiromesifen 24SC @120g a.i./ha towards spiders was reported by Samanta *et al*. (2017) [6]. Roy *et al*. (2017) [5] also gave similar opinion that spiromesifen 22.9SC was safer to predatory fauna in his experiment.

3.3 Marketable green chilli yield

3.3.1 Green chilli yield *Rabi,* 2016-17

Highest green chilli yield (92.6q/ha) was obtained in the treatment sprayed with spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting which is at par with spinosad 45%SC @73g a.i./ha (89.5q/ha) and fipronil 80%WG @ 50g a.i./ha (88.4q/ha). The untreated control plot had 63.8q/ha yield (Table 3).

3.3.2 Green chilli yield *Rabi,* 2017-18

In the second season spinosad 45%SC @73g a.i./ha treated plot yielded highest chilli yield (92.4q/ha) statistically at par with spiromesifen 22.9%SC @ 96g a.i./ha (91.5q/ha), fipronil 80%WG @ 50g a.i./ha (87.2q/ha) and emamectin benzoate 5%SG @10g a.i./ha (86.3q/ha) compared to 60.2q/ha yield in control plot (Table 3).

3.3.3 Green chilli yield during *Rabi,* 2018-19

During third year the treatment received spraying of spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting was significantly superior to other treatments in yield achievement (92.1q/ha). Second highest yield was obtained from the treatment where, fipronil 80%WG @ 50g a.i./ha was applied. Spinosad 45%SC, emamectin benzoate 5%SG and fenpyroximate 5%EC were statistically equal with respect to green chilli yield. The untreated control plot produced 59.1q green chilli per hectare (Table 3).

3.3.4 Pooled mean green chilli yield

Pooled mean yield data indicates the prominent superiority of the treatment sprayed with spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting achieved 92.1q/ha green chilli. The treatments sprayed with spinosad 45%SC and @73g a.i./ha and fipronil 80%WG @ 50g a.i./ha produced 88.8 and 87.9 q/ha yield which are at par (Table 3).

Highest percent improvement in green chilli yield over control (51%) was achieved in spiromesifen 22.9%SC treated plot (Figure 3).

The yield achievement of spiromesifen 22.9%SC proved in the present experiment is supported by Baladhiya *et al*. (2018) [1] from Anand Agricultural University, Gujrat.

3.4 Economics of different treatments evaluated

Table 3 indicates that highest net income (Rs171600/-) and B:C ratio 2.64 was obtained from the treatment sprayed with spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting. This is followed by spinosad 45%SC @73g a.i./ha with net income (Rs159972/-) and B:C ratio (2.50). The treatment constituting fipronil 80%WG @ 50g a.i./ha had net income of Rs 159613/- and B:C ratio (2.53).

Table 1: Population of thrips in different treatments

Treatments No	Treatment detail	Number of Thrips/leaf			
		Rabi, 2016-17	*Rabi,* 2017-18	*Rabi,* 2018-19	Mean
T_1	ST+ Acetamiprid 20%SP @10g a.i./ha at 30 and 45DAT	1.77 (1.66)	1.56 (1.60)	1.85 (1.69)	1.73 (1.65)
T_2	ST+ Spinosad 45%SC @73g a.i./ha at 30 and 45 DAT	1.48 (1.57)	1.01 (1.42)	1.30 (1.52)	1.26 (1.50)
T_3	ST+ Fenpyroximate 5%EC @30g a.i./ha at 30 and 45DAT	2.75 (1.94)	2.90 (1.98)	2.83 (1.96)	2.83 (1.96)
T_4	ST+ Emamectin benzoate 5%SG @10g a.i./ha at 30 and 45DAT	2.80 (1.95)	2.95 (1.99)	2.67 (1.92)	2.81 (1.95)
T_5	ST+ Fipronil 80%WG @ 50g a.i./ha at 30 and 45DAT	1.08 (1.44)	0.79 (1.34)	1.17 (1.47)	1.01 (1.42)
T_6	ST+ Spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45DAT	1.12 (1.46)	1.03 (1.43)	1.06 (1.44)	1.07 (1.44)
T_7	ST+ Acephate 75%SP @500g a.i./ha at 30 and 45DAT	1.85 (1.69)	1.66 (1.63)	1.91 (1.71)	1.81 (1.68)
T_8	ST+ Dimethoate 30%EC @300g a.i./ha at 30 and 45DAT	2.00 (1.73)	1.85 (1.69)	1.87 (1.69)	1.91 (1.71)
T_9	Untreated Control	3.51 (2.12)	4.00 (2.24)	4.17 (2.27)	3.89 (2.21)
	SE (m) ±	0.022	0.020	0.016	0.016
	C.D. (0.05)	0.07	0.06	0.05	0.05

Value in parentheses are the square root transformed value.

ST: Seed treatment with imidacloprid 600FS @5ml/kg

Table 2: Population of spiders in different treatments

Treatments No	Treatment detail	Number of spiders/plants			
		***Rabi*, 2016-17**	***Rabi*, 2017-18**	***Rabi*, 2018-19**	**Mean**
T_1	ST+ Acetamiprid 20%SP @10g a.i./ha at 30 and 45DAT	1.00 (1.41)	0.59 (1.26)	0.66 (1.29)	0.75 (1.32)
T_2	ST+ Spinosad 45%SC @73g a.i./ha at 30 and 45 DAT	1.35 (1.53)	0.97 (1.40)	1.07 (1.44)	1.13 (1.46)
T_3	ST+ Fenpyroximate 5%EC @30g a.i./ha at 30 and 45DAT	1.81 (1.67)	0.70 (1.30)	0.88 (1.37)	1.13 (1.46)
T_4	ST+ Emamectin benzoate 5%SG @10g a.i./ha at 30 and 45DAT	2.07 (1.75)	0.88 (1.37)	0.80 (1.34)	1.25 (1.50)
T_5	ST+ Fipronil 80%WG @ 50g a.i./ha at 30 and 45DAT	1.52 (1.58)	0.74 (1.32)	0.86 (1.36)	1.04 (1.43)
T_6	ST+ Spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45DAT	2.34 (1.82)	1.20 (1.48)	1.26 (1.50)	1.60 (1.61)
T_7	ST+ Acephate 75%SP @500g a.i./ha at 30 and 45DAT	0.37 (1.16)	0.86 (1.36)	0.82 (1.35)	0.68 (1.30)
T_8	ST+ Dimethoate 30%EC @300g a.i./ha at 30 and 45DAT	0.25 (1.11)	0.40 (1.18)	0.42 (1.19)	0.36 (1.17)
T_9	Untreated Control	2.70 (1.92)	1.22 (1.49)	1.32 (1.52)	1.75 (1.66)
	SE (m) ±	0.029	0.022	0.021	0.018
	C.D. (0.05)	0.09	0.07	0.06	0.05

Value in parentheses are the square root transformed value.
ST: Seed treatment with imidacloprid 600FS @5ml/kg

Table 3: Green chilli yield and economics in different treatments.

Treatments	Treatment detail	Green chilli yield (q/ha)				Gross income	Cost of cultivation	Net income	B:C Ratio
		Rabi, 2016-17	**Rabi, 2017-18**	**Rabi, 2018-19**	**Mean**	**(Rs/ha)**	**(Rs/ha)**	**(Rs/ha)**	
T_1	ST+ Acetamiprid 20%SP @10g a.i./ha at 30 and 45DAT	76.4	80.6	74.1	77.0	231000	100750	130250	2.29
T_2	ST+ Spinosad 45%SC @73g a.i./ha at 30 and 45 DAT	89.5	92.4	84.6	88.8	266400	106428	159972	2.50
T_3	ST+ Fenpyroximate 5%EC @30g a.i./ha at 30 and 45DAT	77.2	78.6	83.9	79.9	239700	101430	138270	2.36
T_4	ST+ Emamectin benzoate 5%SG @10g a.i./ha at 30 and 45DAT	85.0	86.3	84.6	85.3	255900	102850	153050	2.49
T_5	ST+ Fipronil 80%WG @ 50g a.i./ha at 30 and 45DAT	88.4	87.2	88.4	87.9	263700	104087	159613	2.53
T_6	ST+ Spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45DAT	92.6	91.5	92.1	92.1	276300	104700	171600	2.64
T_7	ST+ Acephate 75%SP @500g a.i./ha at 30 and 45DAT	73.1	75.7	81.5	76.8	230400	100600	129800	2.29
T_8	ST+ Dimethoate 30%EC @300g a.i./ha at 30 and 45DAT	70.5	72.6	77.1	73.4	220200	101200	119000	2.18
T_9	Untreated Control	63.8	60.2	59.1	61.0	183000	100000	83000	1.83
	SE (m) ±	1.26	1.48	0.96	0.98				
	C.D. (0.05)	3.8	4.5	2.9	3.0				

ST: Seed treatment with imidacloprid 600FS @5ml/kg
Selling price of green chilli- Rs 3000/q

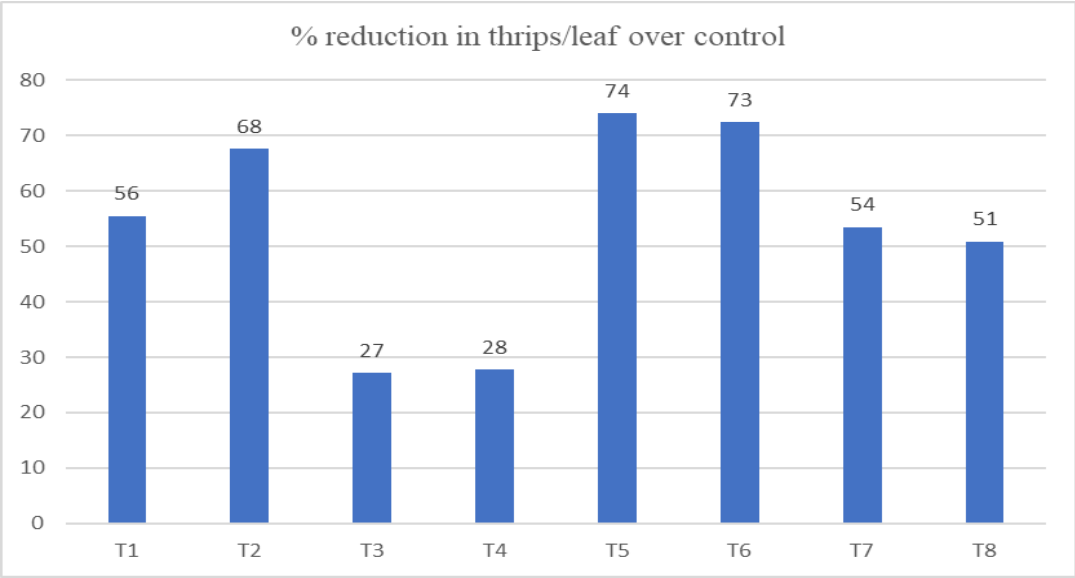

Fig 1: Percentage reduction in thrips over untreated control

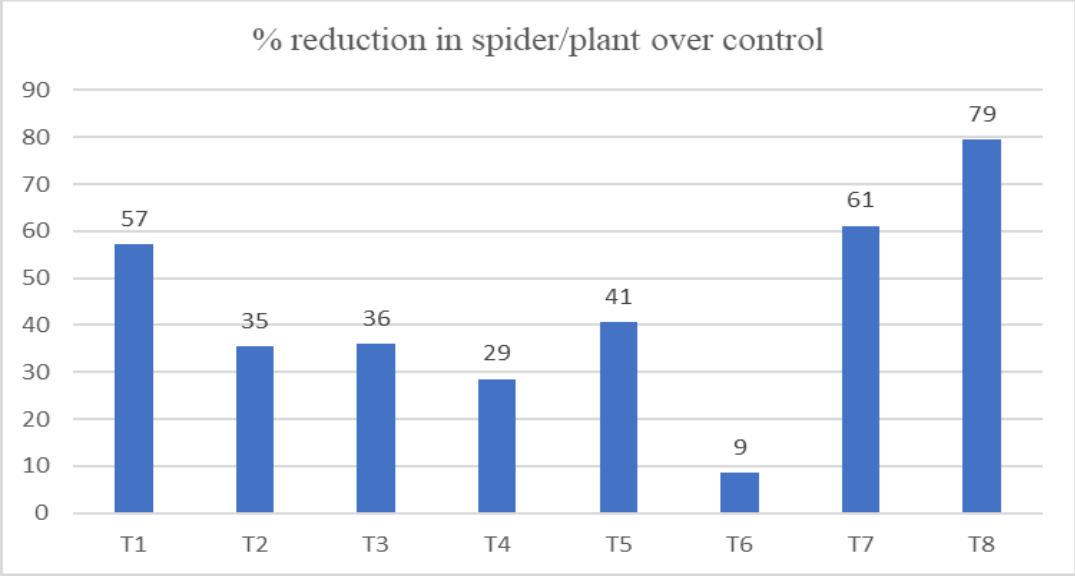

Fig 2: Percentage reduction in spider over untreated control

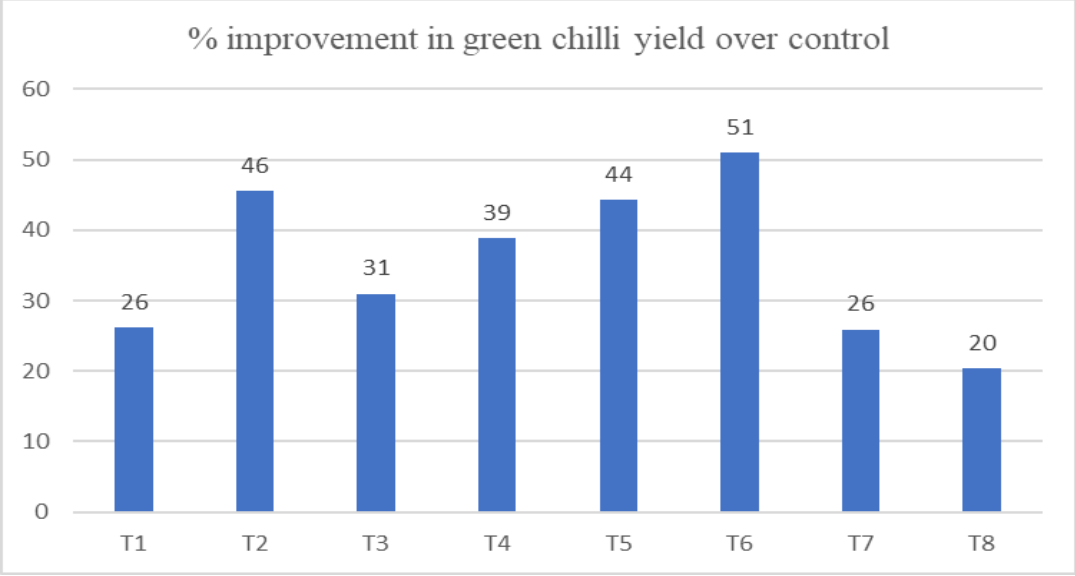

Fig 3: Percentage improvement in green chilli yield over untreated control**.**

4. Conclusion

The pooled mean thrips population of three experimental seasons indicates that fipronil 80%WG @ 50g a.i./ha and spiromesifen 22.9%SC @ 96g a.i./ha were statistically at par in effectiveness against chilli thrips where 1.01 and 1.07 thrips/leaf were recorded. However, spiromesifen 22.9%SC @ 96g a.i./ha was found to be very much safer to predatory spiders as it recorded 1.60 spiders/plant compared to 1.75 spiders/plant in untreated control plot. Pooled mean yield data showed the prominent superiority of the treatment sprayed with spiromesifen 22.9%SC @ 96g a.i./ha at 30 and 45 days after transplanting where 92.1q/ha green chilli yield was obtained resulting highest net income (Rs171600/-) and B:C ratio 2.64.

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