Crossref

IJBSM November 2022, 13(11):1130-1140 Print ISSN 0976-3988 Online ISSN 0976-4038 Article AR3112a

Research Article Stress Management

DOI: HTTPS://DOI.ORG/10.23910/1.2022.3112a

Bioefficacy of Some Newer Generation Insecticides Against Chilli Thrips, *Scirtothrips dorsalis* Hood

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ABSTRACT

An experiment was conducted in the *pre-kharif* season during the months of January–June of the years 2018 and 2019 at farmer's field at Benuria, Birbhum, in the lateritic zone of West Bengal, India. 'Tejaswini', a promising popular variety, was taken for the study. Four-week old plants were transplanted and plot size was 5.0×5.0 m^2, in a Randomized Block Design with thirteen treatments, including control with three replications in both the seasons. Three consecutive sprayings were done at 30, 50 and 70 days after planting. The lowest population of thrips was observed in Broflanilid 20% SC @ 25 g a.i. ha^{-1} and it was statistically superior over Dinotefuran 20% SG @ 30 g a.i. ha^{-1}, Profenofos 50% EC @ 500 g a.i. ha^{-1} and Azadirachtin 3% @ 15 g a.i. ha^{-1}.While, non-significant differences in insect populations were recorded among Spinosad 45% SC @ 73 g a.i. ha^{-1}, Fipronil 5% SC @ 50 g a.i. ha^{-1}, Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1}, Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1}, Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1}, Thiamethoxam 25% WG @ 25 g a.i. ha^{-1}, λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} and Difenthiuron 50% WP @ 300 g a.i. ha^{-1}, respectively. The newer molecule, Broflanilid 20% SC @ 25 g a.i. ha^{-1} was found most efficacious against the chilli thrips among the treatments, and this molecule can be recommended to effectively manage the chilli thrips.

KEYWORDS: Chilli, thrips, bioefficacy, IBCR

***Citation* (VANCOUVER):** Mandal and Mondal, Bioefficacy of Some Newer Generation Insecticides Against Chilli Thrips, *Scirtothrips dorsalis* Hood. *International Journal of Bio-resource and Stress Management,* 2022; 13(11), 1130-1140. HTTPS://DOI.ORG/10.23910/1.2022.3112a.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 30th May 2022 RECEIVED in revised form on 20th October 2022 ACCEPTED in final form on 04th November 2022 PUBLISHED on 15th November 2022

1. INTRODUCTION

The solanaceous crop, chilli (*Capsicum annuum* L.) is an economically important vegetable cum spice crop grown in almost all parts of the tropical and subtropical regions of the world (Siri et al., 2020). The crop is grown for its fruit, which is valued for its color, flavor, spice, and vegetable nutrition, which is provided in its various products (Kumar et al., 2006). Capsaicin, an active component of chilli, is responsible for the burning sensation and is used for medicinal purposes, having analgesic properties (Bosland et al., 2012). Red chillies are rich source of iron, potassium, magnesium, vitamin C, vitamin B6 and contain a small amount of beta-carotene (Idrees et al., 2020). India is the world leader in green chilli production, followed by China and Pakistan. In India, chilli was grown on an area of 418 lakh ha with an annual production of 45.05 million tonnes and an average productivity of 11 mt ha^{-1} in the years 2021–2022 (Department of Agriculture & Farmers Welfare. 2022). In West Bengal, 61,400 tons of chilies were produced from 52,453 ha (Ashoka et al., 2013), while 2.5 mt was produced in Birbhum district (Paul et al., 2013). The cultivation of chilli has become capital-intensive due to many constraints, of which the losses caused by insect pests and mites are significant (Anon, 1987). The insect pests that are comprised of more than 39 genera and 51 species cause significant damage to the crop (Hosamani et al., 2005, Maity et al., 2015, Vanisree et al., 2017). Among various pests of chilli, *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera) is considered the most destructive one that causes upward leaf curling, scarring in the peduncle of chilli fruit, distortion of leaves, discoloration of buds and flowers (Chintkuntlawar et al., 2013). This thysanopteran *S. dorsalis* are colour, costal ridges on abdomen, antennae, ocelli and setae on fore wing. Body colour is pale yellow with dark brown costal ridges on abdominal segments 3-7. Both first and second instar nymph and adult causes damage to the crop. (Kaur and Lahiri, 2022). Thrips has dynamic in nature, and succession of the pest occur with the nature of the agro-ecosystem (Bhede et al., 2008, Meena et al., 2017). The yield losses due to infestation of thrips alone can reach up to 75% or more in the Indian sub-continent (Sarkar et al., 2015).

Chemical insecticides play an important role in combating the pest menace (Nandihalli 2006; Sathua, 2017) and the farmers have a habit of using excessive and often indiscriminate use of insecticides, which not only pushes up the cost of production but also invites the problem of insecticidal resistance (Varghese et al., 2013). Recently, the presence of pesticide residues in spices in general and chillies in particular has been a major non-tariff barrier against the export of chillies to developed countries (Nandihalli, 1979, Dhotre et al., 2001; and Joia et al., 1974). The presence of many conventional insecticides such as ethion, chlorpyriphos, cypermethrin and quinalphos have seriously affected the export of chillies (Kumari. B., 2010). It, therefore, is imperative to resort to newer molecules of insecticides with short residuals and different modes of action for the management of the pest with little disturbance to the agro-ecosystem (Yeung et al., 2017, Bhutia et al., 2018). Hence, an attempt has been made to find out the efficacy of different newer chemistry of insecticides against *S. dorsalis* along with cost economics studies in chilli.

2. MATERIALS AND METHODS

The field experiment was conducted during pre-kharif season of 2018 and 2019, at Binuria village, Sriniketan, West Bengal, India. The village is situated at 23.66°N latitude, 87.66°E longitude and at an average altitude of 58.90 m above mean sea level (Anonymous, 2020). 'Tejaswini', a promising popular variety grown across the state of West Bengal was used as test variety which comes with a moderate size dark green fruits with high pungency. The plants were grown in the nursery bed with a length, width and height of 7.0 m, 1 m and 15 cm, respectively. Four weeks old plants were transplanted in different treatments with 60×45 cm^2 spacing. The plot size was taken 5.0×5.0 m^2, in a Randomized Block Design with thirteen treatments including control with three replications in both the season. Three consecutive spraying was done at 30, 50 and 70 days after planting. Thrips infested plants were observed minutely and damage symptom was recorded digitally. To study the population density of thrips, five plants were selected randomly from each plot and tagged. Three leaves each from upper and middle canopies of each sampled plants were collected and observed minutely with the help of a magnifying glass (10x) for the presence of insect at one day before each spraying as pre-treatment count as well as 1, 3, 7, 10 and 14 days after spraying. These bioassay data were subjected to analysis of variance after making necessary transformation (Gomez and Gomez, 1984) for comparison of treatment means. Reduction of insect population in different treatments over control was used as an indicator of insecticidal efficacy which was worked out as per the modified formula of Abbott (1925) proposed by Fleming and Retnakaran (1985).

1-(Post-treatment population in treatment/ Pre-treatment population in treatment)×(Pre-treatment population in untreated control/ Post-treatment population in untreated control)×100 1

First harvesting was done at 85 days after transplanting (DAT) and successive plucking was made at an interval of

5 days. The fruit yield was converted to the unit as quintal per hectare. To compare the yield performance in different treatments, analysis of variance was also carried out in randomized block design. The per cent increase of yield in treatment over control was calculated as proposed by Vanisreeet al. (2013).

Percent increase of yield in treatment over control =

{(Yield in treatment – Yield in control)/ Yield in control} ×100 ………………..(2)

Analysis of incremental benefit-cost ratios (IBCR) was carried out to find out the cost-effective treatment. The analysis was done by estimating different cost of cultivation and return from the fruit yield in each treatment after converting them to one hectare of land and the ratio was calculated using following formula:

IBCR = Net gain in treatment/ Total cost in treatment ....(3)

Where, Net gain in treatment = Realization over control – Total cost in treatment

Realization over control = Total gain in treatment – (Total gain in control- Total cost in control)

3. RESULTS AND DISCUSSION

The results revealed that thrips populations in different treatments were recorded at par before taking any control measure. Besides, in every treatment, the pre-treatment count of the mean insect population was higher than the post-treatment count. After the insecticidal application, thrips populations decreased significantly in all the treated plots. However, a gradual decline of the thrips population was recorded at 14 days after the second application (64 days after transplanting) due to frequent rainfall and the ageing of chilli plants. The lowest population of thrips (0.65 thrips leaf^{-1}) was observed in Broflanilid 20% SC @ 25 g a.i. ha^{-1}after first application, and it was statistically superior over Azadirachtin 0.03% @ 15 g a.i. ha^{-1}. (2.90 thrips leaf^{-1}) at different days after spraying. Thrips population in different treatments was followed as Spinosad 45 % SC @ 73 g a.i. ha^{-1} (0.68 thrips leaf^{-1}), Fipronil 5% SC @ 50 g a.i. ha^{-1} (0.83 thrips leaf^{-1}), Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (0.90), Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (0.98 thrips leaf^{-1}), Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} (1.54 thrips leaf^{-1}), Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (1.56 thrips leaf^{-1}), λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} (1.62 thrips leaf^{-1}), Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (1.69 thrips leaf^{-1}), Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (2.40 thrips leaf^{-1}) and Profenofos 50% EC @ 500 g a.i. ha^{-1} (2.71 thrips leaf^{-1}), respectively. Whereas, maximum thrips population was observed in untreated control plot (8.03 thrips leaf^{-1}). Percent protection offered by different treatments was in order of Broflanilid 20% SC @ 25 g a.i. ha^{-1} (90.01%) > Spinosad 45 % SC @ 73 g a.i. ha^{-1} (89.56%) > Fipronil 5% SC @ 50 g a.i. ha^{-1} (87.47) > Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (86.47) > Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (84.95) > Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} (76.75%) > Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (76.08%)>λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} (75.67%) > Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (74.29) > Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (63.47%) > Profenofos 50% EC @ 500 g a.i. ha^{-1} (58.71) > Azadirachtin 3% @ 15 g a.i. ha^{-1}. (55.81%), respectively (Table 1).

Before second application, all the treatments were on per with each other excluding control (9.42 thrips leaf^{-1}). After insecticide application, thrips population was drastically decreased in all the treated plots. Again, Broflanilid 20% SC @ 25 g a.i. ha^{-1} (0.28 thrips leaf^{-1}) exhibited better control but was statistically on per with Spinosad 45 % SC @ 73 g a.i. ha^{-1} (0.29 thrips leaf^{-1}), Fipronil 5% SC @ 50 g a.i. ha^{-1} (0.33 thrips leaf^{-1}), Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (0.40), Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (0.49 thrips leaf^{-1}), Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} (0.97 thrips/leaf), Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (0.92 thrips/leaf), λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} (0.94 thrips/leaf) and Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (1.05 thrips leaf^{-1}). While, the treatment Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (1.83 thrips leaf^{-1}) found lesser efficacious against the thrips and the treatment was followed by Profenofos 50% EC @ 500 g a.i. ha^{-1} (2.18 thrips leaf^{-1}) and Azadirachtin 3% @ 15 g a.i. ha^{-1} (2.18 thrips leaf^{-1}). The gradual decrease of thrips populations in different treatments were recorded at 14 days after spraying. The percent protection offered by the different treatments was in order of Broflanilid 20% SC @ 25g a.i. ha^{-1} (75.87%) > Spinosad 45 % SC @ 73 g a.i. ha^{-1} (75.62%) > Fipronil 5% SC @ 50 g a.i. ha^{-1} (72.95) > Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (68.73) > Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (67.68) > Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} (67.22%) > Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (67.02%) > λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} (66.56%) > Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (63.03) > Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (37.58%) > Profenofos 50% EC @ 500 g a.i. ha^{-1} (33.30) > Azadirachtin 3% @ 15 g a.i..ha^{-1} (27.01%), respectively (Table 2).

The thrips population during the third spray was lower than that of the first and second sprays, and a very low population was observed 14 days after spraying in all the experimental plots. The treatments Broflanilid 20% SC (0.17 thrips leaf^{-1}) again proved the best performer, followed by Spinosad 45% SC (0.18 thrips leaf^{-1}) with a maximum reduction over control of 74.52% and 73.18%, respectively (Table 3).

Table 4 revealed that the pre-treatment count of thrips population during the second season was on per in all

Table 1: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during *pre-kharif* 2018 (1st Spray)

Treatment no.	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_1	4.13 (2.00)^{a}	1.59 (1.42)^{ab}	1.54 (1.42)^{bc}	1.44 (1.39)^{bc}	1.37 (1.33)^{bc}	1.74 (1.49)^{bc}	1.54	76.75
T_2	4.07 (2.09)^{a}	0.76 (1.09)^{b}	0.71 (1.10)^{bc}	0.60 (1.02)^{c}	0.50 (0.98)^{c}	0.83 (1.12)^{c}	0.68	89.56
T_3	4.13 (2.11)^{a}	0.95 (1.15)^{b}	0.89 (1.18)^{bc}	0.76 (1.09)^{bc}	0.53(1.00)^{bc}	1.01 (1.21)^{bc}	0.83	87.47
T_4	4.15 (2.15)^{a}	1.67 (1.42)^{ab}	1.62 (1.44)^{bc}	1.52 (1.41)^{bc}	1.45 (1.38)^{bc}	1.84 (1.52)^{bc}	1.62	75.67
T_5	4.08 (2.01)^{a}	1.62 (1.41)^{ab}	1.57 (1.39)^{bc}	1.47 (1.35)^{bc}	1.40 (1.33)^{bc}	1.77 (1.50)^{bc}	1.56	76.08
T_6	4.08 (2.13)^{a}	1.13 (1.25)^{b}	1.08 (1.22)^{bc}	0.93 (1.14)^{bc}	0.57 (1.01)^{bc}	1.21 (1.28)^{bc}	0.98	84.95
T_7	4.09 (2.13)^{a}	2.46 (1.71)^{ab}	2.42 (1.70)^{bc}	2.40 (1.70)^{bc}	2.37 (1.69)^{bc}	2.32 (1.68)^{bc}	2.40	63.47
T_8	4.11 (2.13)^{a}	1.74 (1.46)^{ab}	1.69 (1.45)^{bc}	1.59 (1.42)^{bc}	1.52 (1.41)^{bc}	1.92 (1.55)^{bc}	1.69	74.29
T_9	4.09 (1.95)^{a}	0.73 (1.08)^{b}	0.68 (1.07)^{c}	0.57 (1.01)^{c}	0.49 (0.98)^{c}	0.80 (1.10)^{c}	0.65	90.01
T_{10}	4.13 (2.15)^{a}	1.02 (1.21)^{b}	0.97 (1.19)^{bc}	0.84 (1.12)^{bc}	0.56 (1.00)^{bc}	1.08 (1.26)^{bc}	0.90	86.47
T_{11}	4.10 (2.14)^{a}	2.75 (1.80)^{ab}	2.67 (1.78)^{abc}	2.63 (1.77)^{bc}	2.67 (1.78)^{bc}	2.84 (1.82)^{bc}	2.71	58.71
T_{12}	4.09 (2.08)^{a}	2.93 (1.85)^{ab}	2.85 (1.83)^{ab}	2.81 (1.82)^{b}	2.85 (1.83)^{b}	3.04 (1.88)^{b}	2.90	55.81
T_{13}	4.15 (2.12)^{a}	4.72 (2.28)^{a}	5.86 (2.51)^{a}	6.84 (2.70)^{a}	7.83 (2.87)^{a}	8.03 (2.90)^{a}	6.65	0.00
SEm±	0.338	0.176	0.142	0.150	0.138	0.142		
CD (p=0.05)	NS	0.518	0.418	0.439	0.407	0.417		

T_1: Imidacloprid 17.80% SL @ 25 g a.i. ha^{-1}; T_2: Spinosad 45 % SC @ 73 g a.i. ha^{-1}; T_3: Fipronil 5% SC @ 50 g a.i. ha^{-1}; T_4: Lamdacyhalothrin 5% EC @ 15 g a.i. ha^{-1}; T_5: Thiamethoxam 25% WG @ 25 g a.i. ha^{-1}; T_6: Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1}; T_7: Dinotefuran 20% SG @ 30 g a.i. ha^{-1}; T_8: Difenthiuron 50% WP @ 300 g a.i. ha^{-1}; T_9: Broflanilid 20% SC @ 25 g a.i. ha^{-1}; T_{10}: Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1}; T_{11}: Profenofos 50% EC @ 500 g a.i. ha^{-1}; T_{12}: Azadirachtin 3% @ 15 g a.i. ha^{-1}; T_3: Control; Data presented in parentheses indicate $\sqrt{(x+0.5)}$ transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at $p \leq 0.05$.

the treatments. Insecticidal intervention resulted in a significant reduction of thrips population over the control plot at 5.52 thrips leaf^{-1}. The lowest thrips population was recorded in the treatment Broflanilid 20% SC, and it was statistically superior over Azadirachtin 3% @ 15 g a.i. ha^{-1} and Profenofos 50% EC @ 500 g a.i. ha^{-1}. The post mean of the populations on different dates after the second spray revealed that they followed the same trend as the 1st spray. The treatment Broflanilid 20% SC proved better than the other treatments but was on par with Spinosad 45% SC. As the thripsinfestation was more at early stage, the pest population was found at a lower level during the third spray. However, after insecticidal application, the lowest mean population was recorded in Broflanilid 20% SC, which was superior to Azadirachtin 3% @ 15 g a.i. ha^{-1} and Profenofos 50% EC @ 500 g a.i. ha^{-1} and Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (Table 5 and 6).

A similar trend was evident in the combined data from the two seasons: the lowest thrips population was observed in the treatment of Broflanilid 20% SC, and it was statistically comparable to Spinosad 45% SC @ 73 g a.i. ha-1, Fipronil 5% SC @ 50 g a.i. ha-1, Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1}, and Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1}. However, with Broflanilid 20% SC, the other treatments were shown to be statistically insignificant (Table 7).

Earlier, Patil et al. (2018) reported that fipronil 5% SC @ 50 g a.i. ha^{-1} gave maximum protection against the thips, while Sathua et al. (2017) recorded maximum control of the thrips population by the application of imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1}. In another experiment, Prasad and Ahmed (2009) recorded the best results in the treatment of Spinosad 45 % SC applied @ 73 g a.i. ha^{-1} . Yousaf et al. (2019) reported that imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} recorded maximum control of thrips. Misra and Sahu (2018) reported that Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} was recorded as the maximum control of chilli thrips. However, Sriyanka Lahiri and Yambisa (2021) reported that Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} recorded maximum control of chilli thrips.

3.1. Fruit yield of chilli and economics of different treatments:

Fruit yields corresponding to different treatments were statistically analyzed and presented in Table 8. All the treatments produced a significantly higher yields than the

Table 2: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during *pre-kharif* 2018 (2nd Spray)

Treatment no.	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_1	2.89 (1.82)^{b}	1.29 (1.30)^{bcd}	0.97 (1.19)^{bc}	0.92 (1.17)^{bc}	0.86 (1.15)^{bc}	0.43 (0.96)^{b}	0.89	67.22
T_2	1.27 (1.33)^{b}	0.38 (0.93)^{cd}	0.35 (0.91)^{c}	0.30 (0.89)^{c}	0.27 (0.87)^{c}	0.15 (0.80)^{b}	0.29	75.62
T_3	1.29 (1.34)^{b}	0.43 (0.95)^{cd}	0.39 (0.93)^{c}	0.36 (0.92)^{c}	0.30 (0.88)^{c}	0.16 (0.81)^{b}	0.33	72.95
T_4	2.99 (1.83)b	1.40 (1.32)^{bcd}	1.00 (1.19)^{bc}	0.95 (1.17)^{bc}	0.89 (1.15)^{bc}	0.45 (0.96)^{b}	0.94	66.56
T_5	2.92 (1.83)^{b}	1.37 (1.32)^{bcd}	0.98 (1.20)^{bc}	0.93 (1.18)^{bc}	0.87 (1.15)^{bc}	0.44 (0.96)^{b}	0.91	67.02
T_6	2.36 (1.65)^{b}	1.56 (1.32)^{bcd}	0.72 (1.07)^{c}	0.63 (1.04)^{c}	0.45 (0.96)^{c}	0.23 (0.85)^{b}	0.72	67.68
T_7	3.12 (1.89)^{b}	2.10 (1.61)^{bcd}	2.07 (1.60)^{b}	2.02 (1.58)^{b}	1.96 (1.56)^{b}	0.98 (1.21)^{b}	1.83	37.58
T_8	3.01 (1.86)^{b}	1.23 (1.27)^{bcd}	1.20 (1.26)^{bc}	1.15 (1.24)^{bc}	1.09 (1.21)^{bc}	0.55 (1.00)^{b}	1.05	63.03
T_9	1.22 (1.31)^{b}	0.37 (0.92)^{d}	0.34 (0.91)^{c}	0.29 (0.88)^{c}	0.26 (0.87)^{c}	0.12 (0.78)^{b}	0.28	75.87
T_{10}	1.37 (1.36)^{b}	0.52 (0.99)^{cd}	0.48 (0.97)^{c}	0.43 (0.95)^{c}	0.39 (0.93)^{c}	0.19 (0.83)^{b}	0.40	68.73
T_{11}	3.15 (1.91)^{b}	2.26 (1.66)^{bc}	2.21 (1.64)^{b}	2.16 (1.62)^{b}	2.18 (1.63)^{b}	1.05 (1.22)^{b}	1.98	33.30
T_{12}	3.18 (1.92)^{b}	2.50 (1.73)^{b}	2.45 (1.71)^{b}	2.40 (1.70)^{b}	2.42 (1.70)^{b}	1.17 (1.26)^{b}	2.18	27.01
T_{13}	10.02 (3.23)^{a}	10.14 (3.23)^{a}	10.23 (3.24)^{a}	10.50 (3.30)^{a}	10.93 (3.37)^{a}	5.28 (2.37)^{a}	9.42	0.00
SEm±	0.151	0.142	0.118	0.113	0.114	0.125		
CD (p=0.05)	0.442	0.417	0.346	0.331	0.334	0.366		

Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at p≤0.05.

Table 3: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during *pre-kharif* 2018 (3rd Spray)

Treatment no.	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_1	1.10 (1.26)^{b}	0.45 (0.97)^{cd}	0.43 (0.96)^{bcd}	0.22 (0.84)^{b}	0.21 (0.84)^{b}	0.17 (0.82)^{b}	0.30	60.34
T_2	0.97 (1.21)^{b}	0.33 (0.88)^{d}	0.27 (0.85)^{d}	0.11 (0.77)^{b}	0.10 (0.77)^{b}	0.09 (0.76)^{b}	0.18	73.18
T_3	1.03 (1.23)^{b}	0.37 (0.93)^{d}	0.28 (0.86)^{d}	0.12 (0.78)^{b}	0.11 (0.78)^{b}	0.09 (0.77)^{b}	0.20	72.29
T_4	1.17 (1.29)^{b}	0.53 (1.01)^{bcd}	0.51 (1.00)^{bcd}	0.32 (0.90)^{b}	0.31 (0.89)^{b}	0.18 (0.82)^{b}	0.37	53.75
T_5	1.13 (1.27)^{b}	0.49 (0.99)^{cd}	0.47 (0.98)^{bcd}	0.23 (0.85)^{b}	0.22 (0.85)^{b}	0.17 (0.82)^{b}	0.32	59.14
T_6	1.08 (1.25)^{b}	0.41 (0.95)^{cd}	0.37 (0.93)^{cd}	0.13 (0.79)^{b}	0.16 (0.81)^{b}	0.13 (0.79)^{b}	0.24	67.61
T_7	1.82 (1.52)^{b}	1.02 (1.23)^{bcd}	1.00 (1.23)^{bcd}	0.47 (0.98)^{b}	0.46 (0.98)^{b}	0.32 (0.90)^{b}	0.65	47.32
T_8	1.25 (1.30)^{b}	0.66 (1.08)^{bcd}	0.64 (1.07)^{bcd}	0.33 (0.91)^{b}	0.32 (0.90)^{b}	0.27 (0.87)^{b}	0.44	48.09
T_9	0.96 (1.20)^{b}	0.31 (0.87)^{d}	0.25 (0.84)^{d}	0.10 (0.77)^{b}	0.09 (0.77)^{b}	0.08 (0.76)^{b}	0.17	74.52
T_{10}	1.09 (1.25)^{b}	0.40 (0.94)^{d}	0.32 (0.90)^{cd}	0.17 (0.81)^{b}	0.15 (0.80)^{b}	0.13 (0.79)^{b}	0.23	68.90
T_{11}	2.04 (1.59)^{b}	1.38 (1.37)^{bc}	1.36 (1.36)^{bc}	0.48 (0.99)^{b}	0.50 (1.00)^{b}	0.34 (0.91)^{b}	0.81	41.89
T_{12}	2.14 (1.60)^{b}	1.55 (1.43)^{b}	1.53 (1.42)^{b}	0.54 (1.02)^{b}	0.56 (1.03)^{b}	0.38 (0.94)^{b}	0.91	37.78
T_{13}	6.23 (2.58)^{a}	6.91 (2.71)^{a}	7.08 (2.73)^{a}	2.52 (1.70)^{a}	2.59 (1.74)^{a}	2.21 (1.59)^{a}	4.26	0.00
SEm±	0.119	0.082	0.094	0.077	0.065	0.082		
CD (p=0.05)	0.348	0.242	0.275	0.227	0.192	0.241		

Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at p≤0.05.

Table 4: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during 2nd Season and 1st Spray (*pre-kharif* Season: 2019; January to Jun)

Treatment no.	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_1	4.14 (2.14)^{a}	1.52 (1.41)^{bc}	0.80 (1.13)^{bcd}	0.72 (1.10)^{bcd}	0.70 (1.09)^{bcd}	1.00 (1.22)^{bc}	0.95	82.75
T_2	4.13 (2.14)^{a}	0.83 (1.15)^{c}	0.45 (0.97)^{d}	0.37 (0.93)^{d}	0.35 (0.92)^{d}	0.63 (1.06)^{c}	0.53	90.39
T_3	4.14 (2.14)^{a}	0.88 (1.17)^{c}	0.46 (0.98)^{cd}	0.38 (0.94)^{d}	0.36 (0.93)^{d}	0.65 (1.07)^{c}	0.55	90.00
T_4	4.15 (2.15)^{a}	1.68 (1.46)^{bc}	0.87 (1.16)^{bcd}	0.79 (1.13)^{bcd}	0.77 (1.12)^{bcd}	1.07 (1.25)^{bc}	1.04	81.20
T_5	4.17 (2.16)^{a}	1.54 (1.42)^{bc}	0.81 (1.14)^{bcd}	0.73 (1.10)^{bcd}	0.71 (1.09)^{bcd}	1.01 (1.23)^{bc}	0.96	82.61
T_6	4.15 (2.15)^{a}	1.05 (1.24)^{bc}	0.55 (1.03)^{bcd}	0.42 (0.96)^{cd}	0.41 (0.95)^{cd}	0.75 (1.12)^{c}	0.64	88.44
T_7	4.20 (2.12)^{a}	2.23 (1.65)^{b}	1.18 (1.30)^{bc}	1.17 (1.29)^{bc}	1.17 (1.29)^{bc}	1.47 (1.40)^{b}	1.45	74.07
T_8	4.12 (2.14)^{a}	1.67 (1.45)^{bc}	0.89 (1.17)^{bcd}	0.81 (1.13)^{bcd}	0.79 (1.12)^{bcd}	1.09 (1.25)^{bc}	1.05	80.82
T_9	4.12 (2.14)^{a}	0.82 (1.15)^{c}	0.43 (0.97)^{d}	0.35 (0.92)^{d}	0.33 (0.91)^{d}	0.62 (1.06)^{c}	0.51	90.67
T_{10}	4.13 (2.15)^{a}	0.89 (1.18)^{c}	0.53 (1.01)^{cd}	0.41 (0.95)^{cd}	0.40 (0.95)^{cd}	0.70 (1.09)^{c}	0.58	89.34
T_{11}	4.09 (2.14)^{a}	2.27 (1.66)^{bc}	1.19 (1.30)^{b}	1.43 (1.38)^{b}	1.65 (1.45)^{b}	1.93 (1.55)^{b}	1.69	68.88
T_{12}	4.11 (2.14)^{a}	2.31 (1.67)^{b}	1.21 (1.31)^{b}	1.54 (1.42)^{b}	1.90 (1.52)^{b}	2.20 (1.62)^{b}	1.83	66.41
T_{13}	4.15 (2.14)^{a}	4.91 (2.32)^{a}	2.48 (1.72)^{a}	5.82 (2.51)^{a}	6.81 (2.70)^{a}	7.56 (2.84)^{a}	5.52	0.00
SEm±	0.144	0.090	0.065	0.065	0.067	0.052		
CD (p=0.05)	NS	0.265	0.189	0.192	0.196	0.152		

Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at p≤0.05.

Table 5: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during 2nd Season and 2nd Spray (*pre-kharif* Season: 2019; January to Jun)

Treatment no.	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_1	1.30 (1.34)^{bc}	0.72 (1.10)^{bc}	0.59 (1.04)^{bc}	0.49 (0.99)^{bcd}	0.24 (0.86)^{bc}	0.23 (0.86)^{b}	0.45	55.77
T_2	0.82 (1.15)^{c}	0.33 (0.91)^{c}	0.26 (0.87)^{c}	0.14 (0.80)^{d}	0.05 (0.74)^{c}	0.04 (0.74)^{b}	0.16	74.97
T_3	0.85 (1.16)^{c}	0.35 (0.92)^{c}	0.31 (0.90)^{c}	0.18 (0.82)^{d}	0.09 (0.77)^{bc}	0.08 (0.76)^{b}	0.20	70.37
T_4	1.39 (1.37)^{bc}	0.77 (1.12)^{bc}	0.63 (1.06)^{bc}	0.53 (1.01)^{bcd}	0.26 (0.87)^{bc}	0.25 (0.87)^{b}	0.49	55.59
T_5	1.32 (1.34)^{bc}	0.72 (1.10)^{bc}	0.60 (1.04)^{bc}	0.50 (0.99)^{bcd}	0.25 (0.86)^{bc}	0.24 (0.86)^{b}	0.46	55.73
T_6	0.98 (1.22)^{c}	0.37 (0.93)^{c}	0.34 (0.91)^{c}	0.25 (0.86)^{cd}	0.13 (0.80)^{bc}	0.10 (0.77)^{b}	0.24	69.45
T_7	1.91 (1.55)^{b}	1.05 (1.25)^{b}	0.90 (1.18)^{b}	0.74 (1.11)^{bc}	0.37 (0.93)^{b}	0.36 (0.93)^{b}	0.69	54.53
T_8	1.42 (1.37)^{bc}	0.78 (1.12)^{bc}	0.64 (1.06)^{bc}	0.54 (1.01)^{bcd}	0.27 (0.87)^{bc}	0.26 (0.87)^{b}	0.50	55.54
T_9	0.80 (1.14)^{c}	0.32 (0.91)^{c}	0.25 (0.87)^{c}	0.13 (0.79)^{d}	0.04 (0.74)^{c}	0.04 (0.73)^{b}	0.16	75.23

Table 5: Continue...

Treatment no	Mean no of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_{10}	0.91 (1.19)^{c}	0.36 (0.93)^{c}	0.33 (0.91)^{c}	0.20 (0.83)^{d}	0.10 (0.77)^{bc}	0.09 (0.77)^{b}	0.21	70.21
T_{11}	2.27 (1.66)^{b}	1.57 (1.42)^{bc}	1.46 (1.37)^{b}	1.31 (1.32)^{b}	0.78 (1.10)^{b}	0.66 (1.07)^{b}	1.16	36.33
T_{12}	2.66 (1.76)^{b}	1.70 (1.45)^{b}	1.60 (1.42)^{b}	1.42 (1.35)^{b}	0.90 (1.15)^{b}	0.73 (1.10)^{b}	1.27	40.31
T_{13}	8.95 (3.07)^{a}	9.53 (3.16)^{a}	8.83 (3.05)^{a}	7.10 (2.75)^{a}	5.03 (2.35)^{a}	4.81 (2.29)^{a}	7.06	0.00
SEm±	0.061	0.053	0.049	0.050	0.034	0.058		
CD (p=0.05)	0.180	0.156	0.143	0.148	0.101	0.171		

Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at $p \leq 0.05$.

Table 6: Bio-efficacy of the different insecticides against chilli thrips (*S. dorsalis*) during 2nd Season and 3rd Spray (*Pre-kharif* Season: 2019; January to Jun)

Treatment no	Mean no. of thrips leaf^{-1}						Post mean (No.)	ROC (%)
	PTC	1 DAA	3 DAA	7 DAA	10 DAA	14 DAA		
T_{1}	0.69 (1.09)^{b}	0.28 (0.88)^{bcd}	0.13 (0.80)^{c}	0.11 (0.78)^{c}	0.08 (0.76)^{c}	0.02 (0.72)^{b}	0.13	78.22
T_{2}	0.45 (0.97)^{b}	0.07 (0.75)^{c}	0.04 (0.73)^{c}	0.03 (0.73)^{c}	0.02 (0.72)^{c}	0.01 (0.71)^{b}	0.03	91.09
T_{3}	0.46 (0.98)^{b}	0.07 (0.75)^{c}	0.04 (0.74)^{c}	0.04 (0.73)^{c}	0.03 (0.73)^{c}	0.01 (0.71)^{b}	0.04	90.19
T_{4}	0.73 (1.10)^{b}	0.32 (0.90)^{bcd}	0.14 (0.80)^{c}	0.12 (0.79)^{c}	0.09 (0.77)^{c}	0.02 (0.72)^{b}	0.14	77.06
T_{5}	0.70 (1.09)^{b}	0.29 (0.89)^{bcd}	0.14 (0.79)^{c}	0.11 (0.78)^{c}	0.09 (0.77)^{c}	0.02 (0.72)^{b}	0.13	77.73
T_{6}	0.49 (1.00)^{b}	0.10 (0.77)^{c}	0.06 (0.75)^{c}	0.08 (0.76)^{c}	0.04 (0.73)^{c}	0.01 (0.72)^{b}	0.06	86.10
T_{7}	1.01 (1.23)^{b}	0.55 (1.02)^{b}	0.47 (0.98)^{b}	0.46 (0.98)^{b}	0.35 (0.92)^{b}	0.08 (0.76)^{b}	0.38	54.96
T_{8}	0.73 (1.11)^{b}	0.33 (0.91)^{bcd}	0.15 (0.80)^{bc}	0.13 (0.79)^{c}	0.09 (0.77)^{c}	0.02 (0.72)^{b}	0.14	76.53
T_{9}	0.43 (0.96)^{b}	0.06 (0.75)^{c}	0.04 (0.73)^{c}	0.03 (0.73)^{c}	0.02 (0.72)^{c}	0.01 (0.71)^{b}	0.03	91.14
T_{10}	0.48 (0.99)^{b}	0.08 (0.76)^{c}	0.05 (0.74)^{c}	0.04 (0.74)^{c}	0.03 (0.73)^{c}	0.01 (0.71)^{b}	0.04	89.25
T_{11}	1.11 (1.27)^{b}	0.89 (1.16)^{bc}	0.84 (1.14)^{b}	0.89 (1.15)^{b}	0.65 (1.05)^{b}	0.11 (0.78)^{b}	0.68	27.02
T_{12}	1.26 (1.32)^{b}	1.01 (1.20)^{b}	0.96 (1.18)^{b}	0.97 (1.18)^{b}	0.75 (1.09)^{b}	0.13 (0.79)^{b}	0.76	27.31
T_{13}	6.01 (2.53)^{a}	6.18 (2.58)^{a}	6.22 (2.59)^{a}	6.27 (2.60)^{a}	4.91 (2.29)^{a}	1.45 (1.37)^{a}	5.00	0.00
SEm±	0.075	0.043	0.033	0.030	0.083	0.052		
CD (p=0.05)	0.219	0.126	0.098	0.087	0.244	0.153		

Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts at 1day before application; DAA: Days after application; NS: Non-significant; ROC: Reduction over control. Means followed by same letter are not significantly different according to Tukey's HSD test at $p \leq 0.05$.

Table 7: Poole mean of thrips population of the different insecticides against chilli thrips (*S. dorsalis*)

Treatment no.	Mean thrips population (No./plant)		
	First season 2018	Second season 2019	Pooled Mean
T_1	0.91 (1.19)[cde]	0.51 (1.01)[def]	0.71 (1.10)[d]
T_2	0.38 (0.94)[f]	0.25 (0.86)[g]	0.31 (0.90)[e]
T_3	0.45 (0.98)[f]	0.26 (0.87)[g]	0.36 (0.93)[e]
T_4	0.98 (1.21)[cd]	0.56 (1.03)[d]	0.77 (1.13)[d]
T_5	0.93 (1.20)[cd]	0.52 (1.01)[de]	0.72 (1.11)[d]
T_6	0.65 (1.07)[def]	0.31 (0.90)[egf]	0.48 (0.99)[e]
T_7	1.63 (1.46)[b]	0.84 (1.16)[c]	1.23 (1.32)[c]
T_8	1.06 (1.25)[c]	0.57 (1.03)[d]	0.81 (1.15)[d]
T_9	0.37 (0.93)[f]	0.24 (0.86)[g]	0.30 (0.90)[e]
T_{10}	0.51 (1.00)[ef]	0.28 (0.88)[fg]	0.40 (0.95)[e]
T_{11}	1.83 (1.53)[b]	1.17 (1.29)[b]	1.50 (1.42)[b]
T_{12}	2.00 (1.58)[b]	1.29 (1.34)[b]	1.64 (1.46)[b]
T_{13}	6.78 (2.70)[a]	5.89 (2.53)[a]	6.33 (2.61)[a]
SEm±	0.078	0.043	0.032
CD (p=0.05)	0.229	0.127	0.098

*Data presented in parentheses indicate √(x+0.5) transformed value. PTC: Pre-treatment counts; DAA: Days after application. NS: Non-significant; %ROC: Percent reduction over control; ** Figures marked by a common letter are not significantly different according to Tukey's HSD test at $p \leq 0.05$.

untreated control (46.22 q ha^{-1}). The maximum fruit yield was obtained in Broflanilid 20% SC @ 25 g a.i. ha^{-1} (80.52 q ha^{-1}) which was statistically superior over almost all the treatments except Spinosad 45 % SC @ 73 g a.i. ha^{-1} (72.15 q ha^{-1}), Fipronil 5% SC @ 50 g a.i. ha^{-1} (70.25 q ha^{-1}), Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (68.52 q ha^{-1}) and Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (68.02 q ha^{-1}). Other treatments yield was followed, λ-cyhalothrin 5% EC @ 15 g a.i. ha^{-1} (61.22 q ha^{-1}), Imidacloprid 17.80 % SL @ 25 g a.i. ha^{-1} (59.22 q ha^{-1}), Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (58.63 q ha^{-1}), Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (57.51 q ha^{-1}), Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (56.71 q ha^{-1}), Profenofos 50% EC @ 500 g a.i. ha^{-1} (55.71 q ha^{-1}) and Azadirachtin 3% @ 15 g a.i. ha^{-1} (52.92 q ha^{-1}).

Analysis of the incremental benefit-cost ratio revealed the superiority of Broflanilid 20% SC over other treatments. The Incremental benefit-cost ratio was in order of Broflanilid 20% SC @ 25 g a.i. ha^{-1} (2.28) > Spinosad 45 % SC @ 73 g a.i. ha^{-1} (2.14) > Fipronil 5% SC @ 50 g a.i. ha^{-1}. (2.08) > Spirotetramat 15.31% OD @ 60 g a.i. ha^{-1} (1.92) > Tolfenpyrad 15% EC @ 150 g a.i. ha^{-1} (1.71) > Imidacloprid 17.80% SL @ 25 g a.i. ha^{-1} (1.22) > Lamdacyhalothrin 5% EC @ 15 g a.i. ha^{-1} (1.38) > Difenthiuron 50% WP @ 300 g a.i. ha^{-1} (1.10) > Thiamethoxam 25% WG @ 25 g a.i. ha^{-1} (1.06) > Dinotefuran 20% SG @ 30 g a.i. ha^{-1} (0.89) > Profenofos 50% EC @ 500 g a.i. ha^{-1} (0.76) > Azadirachtin 3% @ 15 g a.i..ha^{-1} (0.55). The yield of the second season followed the same trend (Table 9).

Benefit-cost ratios were also computed by Vanisree et al. (2013) who recorded Spinosad as most cost-effective

Table 8: Fruit yield and economics of chilli cultivation in different treatments during 2018

Treatment no	Production cost (₹ ha^{-1})	Plant protection cost (₹ ha^{-1})	Total cost (₹ ha^{-1})	Yield (q ha^{-1})	%Yield increased over control	Gross realization (₹ ha^{-1}) @ ₹ 6,000/qt.	Net realization over control (₹ ha^{-1})	Net gain (₹ ha^{-1})	IBCR
T_1	60000	3360	63360	59.22	28.13	355333	140400	77040	1.22
T_2	60000	9318	69318	72.15	56.09	432900	217967	148649	2.14
T_3	60000	6975	66975	70.25	51.98	421500	206567	139592	2.08
T_4	60000	4035	64035	61.22	32.45	367340	152407	88372	1.38
T_5	60000	3308	63308	57.51	24.42	345067	130133	66826	1.06
T_6	60000	11400	71400	68.02	47.16	408120	193187	121787	1.71
T_7	60000	6330	66330	56.71	22.69	340267	125333	59003	0.89
T_8	60000	5160	65160	58.63	26.85	351800	136867	71707	1.10
T_9	60000	21750	81750	80.52	74.20	483120	268187	186437	2.28
T_{10}	60000	7142	67142	68.52	48.24	411120	196187	129045	1.92
T_{11}	60000	6126	66126	55.17	19.36	331037	116103	49977	0.76

Table 8: Continue...

Treatment no.	Production cost (₹ ha^{-1})	Plant protection cost (₹ ha^{-1})	Total cost (₹ ha^{-1})	Yield (q ha^{-1})	% Yield increased over control	Gross realization (₹ ha^{-1}) @ ₹ 6,000/qt.	Net realization over control (₹ ha^{-1})	Net gain (₹ ha^{-1})	IBCR
T_{12}	60000	5985	65985	52.92	14.49	317527	102593	36608	0.55
T_{13}	60000	2400	62400	46.22	0.00	277333	62400	0	0.00
SEm±				2.296					
CD (p=0.05)				6.742					

IBCR: Incremental benefit-cost ratio; Production cost includes all inputs and labour cost excluding plant protection cost (cost of insecticides + labour cost for spraying)

Table 9: Fruit yield and economics of chilli cultivation in different treatments during 2019

Treatment no.	Production cost (₹ ha^{-1})	Plant protection cost (₹ ha^{-1})	Total cost (₹ ha^{-1})	Yield (q ha^{-1})	%Yield increased over control	Gross realization (₹ ha^{-1}) @ ₹ 6,000/qt.	Net realization over control (₹ ha^{-1})	Net gain (Rs ha^{-1})	IBCR
T_1	60000	3360	63360	62.25	23.65	373493	133827	70467	1.11
T_2	60000	9318	69318	72.12	43.25	432720	193053	123735	1.79
T_3	60000	6975	66975	71.02	41.07	426120	186453	119478	1.78
T_4	60000	4035	64035	64.01	27.14	384059	144393	80358	1.25
T_5	60000	3308	63308	60.74	20.66	364459	124792	61485	0.97
T_6	60000	11400	71400	69.15	37.35	414900	175233	103833	1.45
T_7	60000	6330	66330	60.04	19.26	360235	120568	54238	0.82
T_8	60000	5160	65160	61.73	22.62	370384	130717	65557	1.01
T_9	60000	21750	81750	80.12	59.14	480720	241053	159303	1.95
T_{10}	60000	7142	67142	70.12	39.28	420720	181053	113911	1.70
T_{11}	60000	6126	66126	58.69	16.57	352112	112446	46320	0.70
T_{12}	60000	5985	65985	56.70	12.63	340223	100557	34572	0.52
T_{13}	60000	2400	62400	50.34	0.00	302067	62400	0	0.00
SEm±				2.606					
CD (p=0.05)				7.652					

IBCR: Incremental benefit-cost ratio; Production cost includes all inputs and labour cost excluding plant protection cost (cost of insecticides + labour cost for spraying)

treatment followed by Diafenthiuron, Pymetrozine and Fipronil. Surbhi et al. (2018) also reported that maximum yield loss can be avoided with spray application of thiamethoxam 25 WG @ 0.10%+spinosad 45 SC @ 0.0135% (90.64%) followed by imidacloprid 30.5 SC @ 0.12%+spinosad 45 SC @ 0.0135% (83.16%) as compared to control.

4. CONCLUSION

Broflanilid 20% SC, Spinosad 45% SC, Fipronil 5% SC, Spirotetramat 15.31% OD, Tolfenpyrad 15% EC, and Difenthiuron 50% WP are all formulations that have the potential to successfully control the insect population while also increasing fruit production. The results of the incremental benefit cost ratio showed that the treatments were very beneficial in terms of higher economic return, which suggested that these more recent chemicals may be recommended for the management of chilli thrips.

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