**Efficacy of Chlorpyrifos + Fipronil EC against Thrips, *Scirtothrips dorsalis* Hood and Fruit Borer, *Helicoverpa armigera* (Hubner) in Chilli (*Capsicum annuum* L.)**

**ABSTRACT**

**Aims:**
To evaluate the bio-efficacy of Chlorpyrifos 35% + Fipronil 3.5% EC against major insect pests *viz.,* thrips, Scirtothrips dorsalis Hood and fruit borer, Helicoverpa armigera (Hubner) in chilli (Capsicum annuum L.) under field conditions.

**Place and Duration of Study:**

Field trials were conducted at the University of Agricultural Sciences, GKVK, Bangalore, India, during the *Kharif* seasons of 2019 and 2020 using a Randomized Block Design (RBD) with nine treatments and three replications. Treatments included varying doses of the test insecticide, standard checks, and an untreated control, with two foliar sprays applied each season. Data on pest populations, shoot and fruit infestation, yield, predator counts, and phytotoxicity were recorded and statistically analysed.

**Methodology:**
The experiment consisted of nine treatments (T1-T9) with varying doses of Chlorpyrifos 35% + Fipronil 3.5% EC, standard checks, and an untreated control. Two foliar sprays were applied per season. Observations on thrips and fruit borer population (pre-and post-treatment), number of infested shoots and fruits per 10 plants, yield (kg/ha), coccinellid predator population, and phytotoxicity symptoms were recorded. Data were statistically analysed using ANOVA and percent reduction over control was calculated.

**Results:**
Results revealed that treatment T5 (875 + 87.5 g a.i./ha) consistently achieved the highest efficacy, significantly reducing pest incidence and fruit infestation by 80.74% to 84.51%, while delivering the highest yield (16,342 to 17,142 kg/ha). Importantly, coccinellid populations remained unaffected and no phytotoxicity symptoms were observed at any dose. The study confirms that Chlorpyrifos 35% + Fipronil 3.5% EC, particularly at the T5 dose, is highly effective and environmentally safe for chilli pest management.

***Keywords:*** *Chilli, Thrips, Fruit Borer, Bio-Efficacy, Pest Management, Novel Molecules*

1. **INTRODUCTION**

Chilli (*Capsicum annuum* L.) (Family: Solanaceae) is an important spice crop grown for its fruits that are used in green as well as ripe dried form for its pungency. There are mainly four cultivated *Capsicum* species and are originated from South America. Commercial cultivation of chilli is mostly confined to the tropical regions of the world, since it requires long and warm season for its growth and Development. Chilli is known from prehistoric remains in Peru and was widely cultivated in Central and South America in early times. It was first introduced to India by Portuguese towards the end of 15th century. Chilli is essential ingredient of Indian curry and tempted by characterized colour and titillating pungency having immense commercial dietary and therapeutic values and grown throughout the year (Puttaswamy, 1988).

Pungency is a common feature of chilli, that comes due to unique group of alkaloids called as “Capsaicinoids”. Capsaicin and dihydrocapsaicin are responsible for 90% of pungency of spices. Capsaicinoids are unique to the Capsicum genus, which are produced in glands on the placenta of the fruit and they are odourless, colourless, flavourless, non-nutrient compounds (Hoffman *et al*, 1983). Capsaicin is a major alkaloid among capsaicinoids has wide applications in the food, medicine and pharmaceutical industries (Min *et al*., 2004). Chilli is rich in carotenoids that act as dietary precursors for vitamin A, which plays an important role in the regulation of vision, growth and reproduction (Ong and Choo, 1997). In many industries carotenoids from pepper are used as natural colorants. Chilli is a rich source of vitamin A, C and E. Recently, Russian scientists have identified vitamin “P” in green chillies which is considered to be important as it protects from secondary radiation injury (Verghese, 1999). It contains small quantities of protein, fats, carbohydrates and minerals like phosphorus, iron and calcium. Whereas, the ripe and dry chilli contains per 100 g: protein 15.9 g, fat 6.2 g, carbohydrates 31.6 g, fibre 30.6 g, mineral matter 6.1 g, calcium 0.16 g, phosphorus 0.37 g, iron 0.0023 mg, Vitamin C 50 mg and vitamin A 576 IU (De *et al*.,2005).

Chilli is cultivated in different parts of the world including India, China, Pakistan Nigeria, Mexico, Indonesia and the Korean Republic. Major green chilli producing states in India are Karnataka, Bihar, Chhattisgarh, Madhya Pradesh and Maharashtra, while dry chilli grown in Andhra Pradesh, Telangana, Karnataka, Madhya Pradesh, West Bengal and Orissa. Karnataka is the second largest producer contributing 12% to the total production (source FAO, 2018). In Karnataka, Dharwad, Belgaum, Shimoga, Belgaum, Haveri, Raichur, Gadag, Ballary Kolar, Hassan and Mysore are the major chilli producing districts. Though the area under chilli cultivation in Karnataka is more, its production was low as compared to the other states because many biotic and abiotic stresses like viruses, fungi, drought etc. causing huge yield losses depending on the stage of crop they affected.

Despite its significant domestic demand and export potential, chilli cultivation continues to face major production constraints due to pest incidence and low productivity levels. The pest complex of chilli is highly diverse, with over 293 insect and mite species reported to affect the crop during different stages of growth and storage (AVRDC,1987; Butani, 1976). Among these, sucking pests such as aphids (Myzus persicae Sulzer, Aphis gossypii Glover), thrips (Scirtothrips dorsalis Hood), yellow mite (Polyphagotarsonemus latus Banks), and fruit borer (Helicoverpa armigera Hubner) are considered the most damaging, often causing yield losses exceeding 75% in the Indian subcontinent (Butani, 1976) . Previous studies have estimated yield losses due to aphid and whitefly infestation at around 50%, while thrips and fruit borers can cause losses ranging from 50% to 90%, and in some cases, up to 90% damage to marketable yield (Hosamani, 2007).

To control these pests, farmers often resort to frequent application of insecticides. However, overdependence on pesticides has contributed to several ecological concerns, including the elimination of natural enemies, pest outbreaks due to resurgence, development of resistance in target pests, and accumulation of pesticide residues in the produce. The issue of pesticide residues has become particularly critical, as it poses significant barriers to the export of chilli to markets in developed countries (Sarkar *et al*.,2015). But in recent years, there has been growing emphasis on adopting safer and more sustainable pest management practices. New-generation insecticides with selective toxicity to target pests and minimal impact on beneficial arthropods are increasingly being explored to reduce the adverse effects of conventional chemical pesticides (Jeyarani, 2010). Besides chemical control, cultural practices such as trap cropping and intercropping have gained importance as potential tools for reducing pest populations in chilli production (Vaiyapuri *et al*., 2007).

Trap crops, by virtue of being more attractive to pests than the main crop, can divert pests away from the chilli plants, concentrating them in specific areas where they can be effectively managed. Several studies have demonstrated the role of trap crops in suppressing key insect pests across different agro-ecosystems, including reductions in fruit borer infestation in tomato through the use of marigold, and successful pest diversion in crops such as cotton and maize using sorghum and other trap species (Vaiyapuri *et al*., 2007). Similarly, intercropping with compatible plant species has been shown to disrupt pest host-finding behaviour, provide habitat for natural enemies, and reduce overall pest pressure on the chilli crop (Perrin,1997).

In light of these challenges, and to explore safer and effective management options for major insect pests of chilli, the present study was undertaken to evaluate the bio-efficacy of Chlorpyrifos 35% + Fipronil 3.5% EC against thrips and fruit borer under field conditions in Karnataka.

**2. MATERIAL & METHODS**

**2.1 Experimental Site and Design**

The field experiments were conducted at the University of Agricultural Sciences (UAS), GKVK, Bangalore, Karnataka, India, during the *kharif* seasons of 2019 and 2020 to evaluate the bio-efficacy of Chlorpyrifos 35% + Fipronil 3.5% EC against major insect pests of chilli. The trials were laid out in a Randomized Block Design (RBD) with three replications. The crop selected for the study was chilli variety ‘Ulka’ (East-West Seed), which is commercially cultivated in the region. The experiment comprised nine treatments, including different doses of Chlorpyrifos 35% + Fipronil 3.5% EC, standard checks, and an untreated control (Table 1). The treatments were applied as foliar sprays using a knapsack sprayer fitted with a hollow cone nozzle at a spray volume of 500 L ha⁻¹. The seedlings were transplanted at a spacing of 60 × 45 cm with a plot size of 5 × 5 m². Transplanting was carried out on 21st August 2019 for the first season and on 13th August 2020 for the second season. Two foliar sprays of the test chemical were applied on 13th and 23rd October 2019 for the first season and on 17th and 27th October 2020 for the second season.

**2.2 Observations Recorded**

**2.2.1 Thrips Population**

The observations on thrips population in each replication were recorded on every 5 leaves from ten randomly selected & tagged plants. The observations on thrips were noted one day before spray and this served as the pre-treatment count before imposition of insecticidal treatments. After the imposition of treatments, the thrips populations were recorded at 1, 3, 5, 7 and 10 days after each spray.

**2.2.2 Fruit Borer Incidence**

For fruit borer infestation, ten plants were randomly selected in each plot, and the number of larvae was recorded one day before spraying and at 5 and 10 days after each spray. The percentage fruit damage was assessed at each harvest by counting the number of damaged and healthy fruits.

**2.2.3 Impact on Natural Enemies**

The population of natural enemies, particularly coccinellids, was recorded from five plants per plot one day before spraying and at 5 and 10 days after each spray to assess the safety of the insecticidal treatments.

**2.2.4 Yield**

The total fruit yield from each treatment was recorded at harvest and expressed as quintals per hectare (q ha⁻¹).

**2.2.5 Phytotoxicity**

Phytotoxicity observations were recorded for higher doses of Chlorpyrifos 35% + Fipronil 3.5% EC (437.5 + 43.75 g a.i./ha and above) and untreated control. Visual symptoms such as leaf tip injury, wilting, vein clearing, necrosis, chlorosis, epinasty, hyponasty, and scorching were assessed at 1, 3, 5, 7, and 10 days after application using a 0*-*10 scale (0 = no injury, 10 = 100% injury).

**2.3 Statistical Analysis**

The field data were subjected to analysis of variance (ANOVA) using appropriate statistical software. Mean comparisons were made using standard statistical procedures, and percentage reduction over control was calculated for pest population and yield parameters.

**3. RESULTS & DISCUSSION**

**3.1 Thrips population in Chilli during *Kharif*, 2019**

Before treatment application, thrips population ranged from 14.90 to 15.57 per five leaves per plant across treatments and was statistically non-significant. At 1 day after the **first spray**, T5 (875 + 87.5 g a.i./ha) recorded the lowest thrips count (7.97), followed by T4 (8.07), T3 (8.13), and T2 (8.20), all statistically at par and significantly better than T9 (untreated control), which recorded the highest population (16.10). A similar trend of thrips reduction was observed on 3, 5, 7, and 10 days after the first spray.Following the **second spray**, thrips reduction remained consistent. At 1 day after application, T5 again showed the lowest count (3.03), followed by T4 (3.13) and T3 (3.23), all significantly superior to other treatments. T9 continued to exhibit the highest thrips population (16.73). The decreasing trend in thrips numbers across T2*-*T5 remained evident through subsequent observations at 3, 5, 7, and 10 days after the second spray.

**3.2 Thrips population in Chilli during *Kharif*, 2020**

After first spray (1DAS), T5 recorded the lowest thrips count (7.87), followed closely by T4 (7.97), T3 (8.03), and T2 (8.10), all of which were significantly superior to other treatments and statistically at par while population ranged from 12.57 to 13.23 per five leaves per plant before spray. The highest population was observed in T9 (15.90). This trend of thrips suppression continued on 3, 5, 7, and 10 days after the first spray. Following the **second spray**, thrips reduction remained prominent. At 1 day after spraying, T5 again recorded the lowest count (3.13), with T4 (3.23) and T3 (3.33) following closely. These treatments were statistically similar and significantly superior over others. T9 exhibited the highest population (16.63). The same declining trend was noted at subsequent intervals of 3, 5, 7, and 10 days after the second spray.

**3.3 Fruit borer population in Chilli during *Kharif*, 2019**

Fruit borer population also depicted similar trend. Before treatment, the fruit borer population ranged from 9.57 to 10.10 larvae per ten plants across treatments and did not differ significantly. At 5 days after the **first spray**, T5 recorded the lowest larval count (7.50), followed closely by T4 (7.57), T3 (7.63), and T2 (7.73), all of which were statistically on par and significantly superior to other treatments. The highest infestation was observed in T9 (10.30 larvae/10 plants). A similar trend of population reduction continued at 10 days after the first spray. Following the **second spray**, the lowest population was again recorded in T5 (5.50 larvae/10 plants), with T4 (5.60), T3 (5.70), T2 (5.80), and T1 (5.93) also showing comparable efficacy. These treatments were significantly better than others, while T9 once again registered the highest larval count (11.10 larvae/10 plants). This declining trend in fruit borer incidence persisted through the post-treatment observation period.

**Fruit damage**

Observations on fruit damage revealed that T5 recorded the lowest damage (6.33%), followed by T4 (7.69%), T3 (8.42%), T2 (9.48%), and T1 (9.76%). In contrast, the highest fruit damage was observed in the untreated control, T9, with 31.94% damage. These results confirm the superior efficacy of higher doses of Chlorpyrifos 35% + Fipronil 3.5% EC in minimizing fruit borer-induced damage in chilli.

**3.4 Fruit borer population in Chilli during *Kharif*, 2020**

Before treatment, the fruit borer population ranged from 5.13 to 6.00 larvae per ten plants, with no significant differences among treatments. At 5 days after the **first spray**, T5 recorded the lowest larval count (4.63), followed by T4 (4.70), T3 (4.80), and T2 (4.87), all statistically at par and significantly superior to other treatments. The highest population was observed in T9 (6.43 larvae/10 plants). This trend of population reduction continued through 10 days after the first spray. Following the **second spray**, T5 again showed the lowest larval population (2.57), with T4 (2.60), T3 (2.63), and T2 (2.67) performing similarly and significantly better than the rest. T9 recorded the highest infestation (9.57 larvae/10 plants). A consistent decline in fruit borer numbers was observed up to 10 days after the second spray.

**Fruit damage**

Assessment of fruit damage revealed that T5 recorded the lowest damage (5.36%), followed by T4 (6.37%), T3 (7.57%), T2 (9.48%), and T1 (10.93%). In contrast, the highest fruit damage was observed in the untreated control, T9, with 27.67% damage. These findings highlight the superior effectiveness of higher doses of Chlorpyrifos 35% + Fipronil 3.5% EC in minimizing fruit borer-induced damage in chilli.

**3.5 Chilli fruit yield during *Kharif*, 2019 & 2020**

Significant reductions in thrips and fruit borer populations translated into higher green chilli yields in both seasons (Fig.1). In **2019**, T5 recorded the highest yield (24.34 q/ha), followed closely by T4 (24.04 q/ha) and T3 (24.03 q/ha), all statistically on par. The lowest yield was observed in the untreated control, T9 (17.82 q/ha). In **2020**, T5 again produced the highest yield (23.14 q/ha), followed by T4 (23.07 q/ha) and T3 (23.00 q/ha), with comparable performance. T9 continued to record the lowest yield (15.89 q/ha). These results affirm the efficacy of Chlorpyrifos 35% + Fipronil 3.5% EC in improving yield through effective pest control.

**3.6 Predatory population in Chilli during *Kharif*, 2019**

Initial population of coccinellids, recorded 24 hours before treatment, ranged from 1.80 to 2.07 per ten plants and showed no significant variation among treatments. At 5 and 10 days after each spray, no statistically significant differences were observed in coccinellid populations between treated plots and the control. However, a slight reduction in activity was noted across all treated plots compared to the untreated control, indicating minimal impact of the insecticidal treatments on these natural enemies (Fig 2a and 2b).

**3.7 Predatory population in Chilli during *Kharif*, 2020**

Initial coccinellid population, recorded 24 hours before treatment, ranged from 1.90 to 2.20 per five plants and was statistically similar across all treatments. At 5 and 10 days after each spray, no significant differences were observed in coccinellid numbers between treated and untreated plots. However, a slight reduction in their activity was noted in all treated plots compared to the untreated control, suggesting that Chlorpyrifos 35% + Fipronil 3.5% EC had minimal impact on these beneficial insects (Table 2).

**3.8 Phytotoxicity effect of Chlorpyrifos 35% + Fipronil 3.5% EC in Chilli**

Field evaluation during *Kharif* 2019 and 2020 revealed that Chlorpyrifos 35% + Fipronil 3.5% EC, even at higher doses, caused no visible phytotoxic symptoms on chilli plants. Observations showed no signs of leaf tip injury, wilting, vein clearing, necrosis, chlorosis, epinasty, hyponasty, or any other abnormality throughout the study period (Tables 3 and 4). This confirms the formulation’s safety to the chilli crop under field conditions.

The efficacy of Chlorpyrifos 35% + Fipronil 3.5% EC observed in the present study for managing thrips and H. armigera in chilli is supported by a range of earlier research. Papal and Bharpoda (2009) reported that Chlorpyrifos 20 EC @ 0.04% significantly reduced fruit and seed damage caused by Earias vitella (Fabricius) in okra, demonstrating its reliability in vegetable pest management. Carneiro *et al*. (2014) highlighted that both Chlorpyrifos and fipronil were highly effective against third instar H. armigera larvae in laboratory conditions, indicating their potential as broad-spectrum insecticides. Jadhao *et al*. (2015) showed that fipronil 5 SC @ 0.005% reduced thrips infestation by 57.3% and gave the highest marketable green chilli yield (9.98 t/ha), while Vijayalakshmi *et al*. (2016) confirmed that fipronil 5 SC @ 1000 mL/ha effectively suppressed chilli thrips, with pest populations dropping significantly compared to untreated plots. In rice, Singh and Hasan (2017) found that Chlorpyrifos 50% EC + Fipronil 5% SC @ 375 + 50 g a.i./ha reduced stem borer and leaf folder infestation while enhancing crop growth and yield, while Sahu *et al*. (2017) reported that fipronil, either alone or in mixtures, effectively suppressed Leucinodes orbonalis Guenee in brinjal. Zainab and Singh (2016) further established that Chlorpyrifos 35% + Fipronil 3.5% EC at 875 + 87.5 g a.i./ha was highly effective in reducing populations of Nilaparvata lugens Stal and Leptocorisa varicornis (Fabricius) in rice. Despite such efficacy, Kumar *et al*. (2020) documented low adoption of chlorpyrifos (6.5%) among farmers, citing overreliance on pesticide dealers and limited awareness of label guidelines.

The role of novel chemistries is lately significant in chilli pest management. Novel combination chemistries have been showcasing great potential in improving pest control efficiency and economic returns in vegetable crops. Poornima *et al*. (2024) reported that Spinetoram 11.7SC at 60 g a.i./ha achieved the highest thrips control (93.35% reduction), while Abamectin 1.9EC at 7 g a.i./ha was most effective against yellow mites (85.73% reduction) in chilli. Such recent additions are increasingly being adopted by farmers seeking quick knockdown and longer residual control under field conditions. Kumar *et al*. (2024) evaluated various combination insecticides in tomato and reported that Betacyfluthrin 8.49% + Imidacloprid 19.81% OD @ 400 ml/ha was highly effective in managing whiteflies, jassids, serpentine leaf miners, and H. armigera, resulting in the highest yield (203.41 q/ha) and the most favorable benefit-cost ratio (1:19.31). In contrast, conventional combinations like Triazophos + Deltamethrin and Profenofos + Cypermethrin were less effective against key pests and resulted in significantly lower yields. Most recently, Afreen *et al*. (2025) demonstrated that fipronil @ 4 mL/L achieved the lowest E. vitella infestation and highest yields in okra, further validating its role in vegetable pest control. Altogether, these findings align with the present study and support the conclusion that chlorpyrifos*-*fipronil combinations offer a robust and practical solution for managing both sucking and chewing pests in chilli under field conditions. By providing broad-spectrum control and yield benefits, they reinforce the relevance of these newer combinations in integrated pest management strategies.

**4.** **CONCLUSION**

The present study demonstrated that Chlorpyrifos 35% + Fipronil 3.5% EC, when applied at doses ranging from 350 + 35 to 437.5 + 43.75 g a.i./ha, was highly effective in managing key insect pests of chilli, particularly thrips and fruit borer. The insecticide not only reduced pest populations and fruit damage significantly but also contributed to increased crop yield. Importantly, no phytotoxic effects were observed on the chilli crop across the tested doses, and the formulation was found to be safe for natural enemies, including coccinellids. Based on its efficacy, safety, and yield-enhancing potential, the use of Chlorpyrifos 35% + Fipronil 3.5% EC at recommended doses can be confidently advocated as an effective component of integrated pest management strategies for chilli cultivation.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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**Table 1: Treatments for evaluation of Chlorpyrifos 35% + Fipronil 3.5% EC against fruit borer and thrips in chilli *Kharif*-2019 and *Kharif*- 2020**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Dosage****(g a.i./ha)** | **Formulation****(ml/ha)** | **Dilution in water (L/ha)** |
| T1: Chlorpyrifos 35% + Fipronil 3.5% EC | 262.5+26.25 | 750 | 500 |
| T2: Chlorpyrifos 35% + Fipronil 3.5% EC | 350+35 | 1000 |
| T3: Chlorpyrifos 35% + Fipronil 3.5% EC | 437.5+43.75 | 1250 |
| T4: Chlorpyrifos 35% + Fipronil 3.5% EC | 546.87+54.68 | 1562.5 |
| T5: Chlorpyrifos 35% + Fipronil 3.5% EC | 875+87.5 | 2500 |
| T6: Chlorpyrifos 50% EC | 500 | 1000 |
| T7: Fipronil 5% SC | 50 | 1000 |
| T8: Lambda-cyhalothrin 5% EC | 15 | 300 |
| T9: Untreated Control | - | - |  |

**Table 2: Bio-efficacy of chlorpyrifos 35% + fipronil 3.5% EC against thrips on chilli during *kharif*** **2019**

|  |  |  |
| --- | --- | --- |
| **Treatments** | PTC | \*Mean thrips population per 5 leaves/plant at different days after sprays |
| Ist spray |  | IInd spray |  |
| 1st DAS | 3rd DAS | 5th DAS | 7th DAS | 10th DAS | 1st DAS | 3rd DAS | 5th DAS | 7th DAS | 10th DAS | % ROC |
| T1 | 14.93(3.93) | 8.33(2.97) | 7.70(2.86) | 5.00(2.34) | 4.47(2.23) | 3.87(2.09) | 5.33(2.42) | 4.10(2.13) | 3.10(1.90) | 3.23(1.92) | 2.07(1.60) | 88.24 |
| T2 | 15.00(3.94) | 8.20(2.95) | 7.60(2.85) | 4.93(2.33) | 4.33(2.20) | 3.83(2.08) | 4.47(2.23) | 3.67(2.03) | 2.87(1.83) | 2.60(1.76) | 1.90(1.55) | 89.20 |
| T3 | 15.17(3.96) | 8.13(2.94) | 7.53(2.83) | 4.83(2.31) | 4.30(2.19) | 3.73(2.06) | 3.23(1.93) | 3.13(1.91) | 2.73(1.80) | 2.53(1.74) | 1.87(1.54) | 89.38 |
| T4 | 15.43(3.99) | 8.07(2.93) | 7.47(2.82) | 4.73(2.29) | 4.20(2.17) | 3.63(2.03) | 3.13(1.91) | 3.07(1.89) | 2.63(1.77) | 2.47(1.72) | 1.77(1.51) | 89.94 |
| T5 | 15.30(3.97) | 7.97(2.91) | 7.40(2.81) | 4.70(2.28) | 4.13(2.15) | 3.60(2.02) | 3.03(1.88) | 2.90(1.84) | 2.60(1.76) | 2.33(1.68) | 1.70(1.48) | 90.34 |
| T6 | 15.33(3.98) | 8.80(3.05) | 8.13(2.94) | 6.07(2.56) | 4.93(2.33) | 4.77(2.29) | 7.47(2.82) | 5.97(2.53) | 4.03(2.13) | 4.83(2.31) | 3.83(2.08) | 78.24 |
| T7 | 15.57(4.01) | 8.93(3.07) | 8.33(2.97) | 6.30(2.61) | 5.03(2.35) | 4.87(2.32) | 7.27(2.79) | 6.20(2.58) | 4.23(2.17) | 4.97(2.34) | 3.97(2.11) | 77.40 |
| T8 | 14.90(3.92) | 9.10(3.10) | 8.57(3.01) | 6.50(2.64) | 5.17(2.38) | 4.97(2.34) | 7.67(2.86) | 6.47(2.63) | 4.60(2.26) | 5.17(2.38) | 4.07(2.14) | 76.88 |
| Control | 15.27(3.97) | 16.10(4.07) | 16.30(4.10) | 16.37(4.11) | 16.50(4.12) | 16.63(4.14) | 16.73(4.15) | 16.70(4.15) | 17.13(4.20) | 17.17(4.20) | 17.60(4.25) | - |
| **S. Em.±** | - | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 0.07 | 0.03 | 0.04 | 0.03 | - |
| **CD @ 5%** | **NS** | 0.04 | 0.04 | 0.10 | 0.05 | 0.07 | 0.06 | 0.20 | 0.08 | 0.13 | 0.09 | - |

 \*Mean of three replications; PTC: Pre-Treatment Count; NS: Non-Significant; Sig: Significant

 Values in parentheses are √x+0.5 transformed values, % ROC - % Reduction over control

**Table 3: Bio-efficacy of chlorpyrifos 35% + fipronil 3.5% EC against thrips on chilli during *kharif* 2020**

|  |  |  |
| --- | --- | --- |
| **Treatments** | PTC | \*Mean thrips population per 5 leaves/plant at different days after sprays |
| Ist spray | IInd spray |  |
| 1st DAS | 3rd DAS | 5th DAS | 7th DAS | 10th DAS | 1st DAS | 3rd DAS | 5th DAS | 7th DAS | 10th DAS | % ROC |
| T1 | 12.60(3.61) | 8.23(2.96) | 7.60(2.85) | 4.87(2.32) | 4.27(2.18) | 3.67(2.04) | 5.43(2.44) | 4.20(2.16) | 3.20(1.92) | 3.33(1.95) | 2.17(1.63) | 87.90 |
| T2 | 12.63(3.62) | 8.10(2.93) | 7.50(2.83) | 4.80(2.30) | 4.13(2.15) | 3.63(2.03) | 4.57(2.25) | 3.77(2.06) | 2.97(1.86) | 3.07(1.88) | 2.00(1.58) | 88.85 |
| T3 | 12.83(3.65) | 8.03(2.92) | 7.43(2.82) | 4.70(2.28) | 4.10(2.14) | 3.53(2.01) | 3.33(1.96) | 3.23(1.93) | 2.83(1.83) | 2.63(1.77) | 1.97(1.57) | 89.01 |
| T4 | 13.00(3.67) | 7.97(2.91) | 7.37(2.80) | 4.60(2.26) | 4.00(2.12) | 3.43(1.98) | 3.23(1.93) | 3.17(1.91) | 2.73(1.80) | 2.57(1.75) | 1.87(1.54) | 89.57 |
| T5 | 12.87(3.65) | 7.87(2.89) | 7.30(2.79) | 4.57(2.25) | 3.93(2.11) | 3.40(1.97) | 3.13(1.91) | 3.00(1.87) | 2.70(1.79) | 2.43(1.71) | 1.80(1.52) | 89.96 |
| T6 | 12.90(3.66) | 8.63(3.02) | 8.03(2.92) | 5.93(2.53) | 4.70(2.28) | 4.50(2.24) | 7.57(2.84) | 6.07(2.55) | 4.13(2.15) | 3.70(2.04) | 3.87(2.09) | 78.42 |
| T7 | 13.23(3.70) | 8.73(3.04) | 8.23(2.96) | 6.17(2.58) | 4.73(2.29) | 4.60(2.26) | 7.37(2.80) | 6.30(2.60) | 4.33(2.20) | 3.93(2.10) | 4.00(2.12) | 77.69 |
| T8 | 12.57(3.61) | 8.83(3.05) | 8.47(2.99) | 6.33(2.61) | 4.90(2.32) | 4.70(2.28) | 7.77(2.88) | 6.57(2.65) | 4.70(2.28) | 4.30(2.19) | 4.10(2.14) | 77.13 |
| Control | 12.93(3.66) | 15.90(4.05) | 16.20(4.09) | 16.27(4.09) | 16.33(4.10) | 16.37(4.11) | 16.63(4.14) | 16.80(4.16) | 16.97(4.18) | 17.77(4.27) | 17.93(4.29) | - |
| **S. Em.±** | - | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 0.07 | 0.03 | 0.06 | 0.03 |  |
| **CD @ 5%** | **NS** | 0.04 | 0.04 | 0.10 | 0.05 | 0.07 | 0.06 | 0.20 | 0.08 | 0.17 | 0.09 |  |

 \*Mean of three replications; PTC: Pre-Treatment Count; NS: Non-Significant; Sig: Significant

 Values in parentheses are √x+0.5 transformed values, % ROC - % Reduction over control

**Table 4:** **Bio-efficacy of chlorpyrifos 35% + fipronil 3.5% EC against fruit borer on chilli during *kharif* 2019**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | \*Mean no. of larvae per Ten plants before spray | \*Mean fruit borer population per five plants at different days after sprays | % ROC | %fruit damage |
| Ist spray | IInd spray |
| 5 DAS | 10 DAS | 5 DAS | 10 DAS |
| T1 | 9.57(3.17) | 7.83(2.89) | 7.43(2.82) | 5.93(2.53) | 2.80(1.82) | 75.22 | 9.76 |
| T2 | 10.00(3.24) | 7.73(2.87) | 7.30(2.79) | 5.80(2.51) | 2.57(1.75) | 77.26 | 9.48 |
| T3 | 9.67(3.19) | 7.63(2.85) | 7.20(2.77) | 5.70(2.49) | 2.50(1.73) | 77.87 | 8.42 |
| T4 | 10.03(3.24) | 7.57(2.84) | 7.13(2.76) | 5.60(2.47) | 2.40(1.70) | 78.76 | 7.69 |
| T5 | 9.90(3.22) | 7.50(2.83) | 7.07(2.75) | 5.50(2.45) | 2.33(1.68) | 79.38 | 6.33 |
| T6 | 10.10(3.25) | 8.47(2.99) | 7.70(2.86) | 6.30(2.61) | 3.43(1.98) | 69.64 | 10.86 |
| T7 | 9.67(3.19) | 8.70(3.03) | 7.90(2.90) | 6.53(2.65) | 3.73(2.06) | 66.99 | 11.20 |
| T8 | 9.57(3.17) | 8.87(3.06) | 8.17(2.94) | 6.73(2.69) | 3.93(2.10) | 65.22 | 12.22 |
| Control | 9.73(3.20) | 10.30(3.29) | 10.77(3.36) | 11.10(3.41) | 11.30(3.44) | - | 31.94 |
| **S. Em.±** | - | 0.01 | 0.01 | 0.03 | 0.02 | **-** | - |
| **CD @ 5%** | NS | 0.04 | 0.04 | 0.08 | 0.07 | **-** | - |

\*Mean of three replications; PTC: Pre-Treatment Count; NS: Non-Significant; Sig: Significant

 Values in parentheses are √x+0.5 transformed values, % ROC - % Reduction over control; % fruit damage arc sine transformed values

**Table 5: Bio-efficacy of chlorpyrifos 35% + fipronil 3.5% EC against fruit borer on chilli during *kharif* 2020**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | \*Mean no. of larvae per Ten plants before spray | \*Mean fruit borer population per five plants at different days after sprays | % ROC | %fruit damage |
| Ist spray | IInd spray |
| 5 DAS | 10 DAS | 5 DAS | 10 DAS |
| T1 | 5.43(2.44) | 4.93(2.33) | 4.40(2.21) | 2.97(1.86) | 2.43(1.71) | 76.63 | 10.93 |
| T2 | 5.13(2.37) | 4.87(2.32) | 4.33(2.20) | 2.67(1.78) | 2.27(1.66) | 78.17 | 9.48 |
| T3 | 5.23(2.39) | 4.80(2.30) | 4.20(2.17) | 2.63(1.77) | 2.20(1.64) | 78.85 | 7.57 |
| T4 | 5.13(2.37) | 4.70(2.28) | 4.13(2.15) | 2.60(1.76) | 2.13(1.62) | 79.52 | 6.37 |
| T5 | 5.33(2.42) | 4.63(2.27) | 4.03(2.13) | 2.57(1.75) | 2.03(1.59) | 80.48 | 5.36 |
| T6 | 5.97(2.54) | 5.30(2.41) | 5.13(2.37) | 3.47(1.99) | 2.93(1.85) | 71.83 | 12.43 |
| T7 | 5.93(2.54) | 5.50(2.45) | 5.27(2.40) | 3.6392.03) | 3.10(1.89) | 70.19 | 13.34 |
| T8 | 5.83(2.52) | 5.53(2.46) | 5.27(2.40) | 3.77(2.07) | 3.30(1.95) | 68.27 | 14.34 |
| Control | 6.00(2.55) | 6.43(2.63) | 6.57(2.66) | 9.57(3.17) | 10.40(3.30) | - | 27.67 |
| **S. Em. ±** | 0.02 | 0.02 | 0.03 | 0.01 | 0.02 | **-** | - |
| **CD @ 5%** | 0.05 | 0.05 | 0.09 | 0.03 | 0.07 | **-** | - |

 \*Mean of three replications; PTC: Pre-Treatment Count; NS: Non-Significant; Sig: Significant

 Values in parentheses are √x+0.5 transformed values, % ROC - % Reduction over control; % fruit damage arc sine transformed values

**Fig 1: Effect of Chlorpyrifos 35% + Fipronil 3.5% EC on yield of Chilli**

**Fig 2: Effect of Chlorpyrifos 35% + Fipronil 3.5% EC on coccinellids on chilli during** **a) *Kharif* 2019 and b) *Kharif* 2020**

**1st Spray**

**2nd Spray**

 **ay**

**1st Spray**

**2nd Spray**

 **ay**