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A COMPARATIVE EVALUATION OF VARIOUS SYNTHETIC INSECTICIDES ON THE MANAGEMENT OF TOMATO LEAF MINER (*TUTA ABSOLUTA*) UNDER FIELD CONDITION

Qaisar Hamad[1], *Javaid Iqbal[2], Irum Gul[3], Azaz Ahmad[1], Shehzad Zareen[3], Shamaila Arif[4], Umer Musaab[5], Abdul Majid[3], Hafiz Muhammad Zohaib[5], Jahan Zaib[6]

1 Department of Entomology, The University of Agriculture Peshawar

2 Department of Plant Protection, MNFSR

3 Kohat University of Science and Technology

4 University of Poonch Rawalakot

5 Department of Agriculture and Agribusiness Management, University of Karachi

6 Directorate Agriculture Research Medicinal Plant, Kalat

Corresponding author: Javaid Iqbal*

Abstract

The research, conducted at the Agriculture Research Institute Swabi in 2022, sought to ascertain the most potent insecticide against *Tuta absoluta*. Findings unveiled a comprehensive evaluation of various synthetic insecticides in terms of diminishing *T. absoluta* infestations, mine formation, and leaf damage subsequent to spray applications. Remarkably, Coragen consistently emerged as the most efficacious, exhibiting superior performance in reducing pest populations, mine formation, and leaf damage. Belt, Woolmer, and Chlorfenapyr followed suit in effectiveness, while the Discount treatment consistently demonstrated the lowest efficacy throughout the study.

Keywords: Belt, Chlorantraniliprole, Chlorfenapyr, Emamectin benzoate, *T. absoluta*, Woolmer

Introduction

Given the global economic significance of tomato production, there has been a steady increase in its cultivation; however, the full yield potential is hindered by the impact of various insect pests, leading to substantial reductions in productivity. Among these pests, *Tuta absoluta* stands out as a noteworthy threat to tomato crops. First identified in the Southern regions of Punjab and KP in 2018 (Ishtiaq *et al*., 2020), this oligophagous insect, commonly known as the South American tomato leaf miner or pinkworm, originally hails from South America (Blanca *et al*., 2015; Biondi *et al*., 2018). While it targets the entire Solanaceae family, its primary hosts are tomato and potato, alongside alternative crops like eggplant (Biondi *et al*., 2018; Zhang *et al*., 2020b). With the commercial importance of tomato, *T. absoluta* has swiftly spread from infested areas due to its oligophagous nature (CABI, 2021). A comprehensive understanding of the prediction, relative abundance, and geographical distribution of this pest is crucial for risk assessment and management before an infestation (Lenzner *et al*., 2019). The invasive nature of *T. absoluta* has led to its presence across Europe, Africa, and Asia (Biondi *et al*., 2018; Han *et al*., 2019). The detection of *T. absoluta* in various regions of the KP province underscores the potential for widespread economic damage at a national level. Consequently, our research endeavors focus on the paramount objective of identifying the most effective insecticides against *T. absoluta*. Given its invasive characteristics, the study emphasizes the chemical control for the successful implementation of integrated pest management (IPM) against this pest under field conditions.

Materials and Methods

Study area

The present study was performed in the Agriculture Research Station Swabi, during 2022.

Treatments

Different chemicals were tested against the *Tuta absoluta* infestation in tomato crop such as; Discount (Emamectin benzoate), Coragen (Chlorantraniliprole), Chlorfenapyr, Belt (Flubendiamide + Thiacloprid), Woolmer (Emamectin benzoate + lufenuran).

Procedure

The spray solution for each chemical was meticulously prepared at the prescribed dosage. These treatments were administered using a knapsack sprayer, strategically timed to coincide with the moment *T. absoluta* reached its economic threshold level (2.25 larvae/plant). Subsequently, data on leaf miner incidence was diligently collected at intervals of 24 hours, 48 hours, 72 hours, 7 days, and 14 days following the spray application. Within each treatment, a comprehensive analysis was conducted, focusing on a range of parameters to gauge the effectiveness of the applied chemicals.

Parameter

Incidence of leaf miner

Infested leaves data were meticulously recorded on five randomly selected plants 24 hours before the application of the spray treatment. Subsequent observations were made after specific intervals, namely 24 hours, 48 hours, 72 hours, 7 days, and 14 days following the application of the spray. This comprehensive timeline allowed for a detailed assessment of the impact and sustained efficacy of the spray application on leaf infestation levels.

Number of Mines per leaves

The data collection involved randomly selecting five plants within each treatment, followed by the random selection of five infested leaves from each of the sampled plants.

The number of mines in each selected leaf was then meticulously counted. The average mining per leaf was subsequently calculated using the following formula:

$$\text{Average leaf mines} = \frac{\text{Total mines in each sample plant}}{\text{Total leaves taken to count mines}}$$

Leaf damage percentage

The data pertaining to tomato leaf miner were systematically recorded by randomly selecting five plants within each treatment, commencing 24 hours before the application. Subsequent observations were made at specific intervals post-treatment, including 24 hours, 48 hours, 72 hours, 7 days, and 14 days. In instances where necessary, each treatment application was repeated at a 14-day interval. The percentage of leaf damage caused by the tomato leaf miner population was calculated using the following formula:

$$\%\text{Leaf Damage} = \frac{\text{Damage no.leaf}}{\text{Total no.leaf}} \times 100$$

Statistical analysis

The collected data underwent analysis of variance (ANOVA), and subsequent separation of means was carried out using the LSD test at a 5 percent level of significance. STATISTIX 8.1 was employed as the statistical tool for these analyses.

Results

Occurrences of *Tuta absoluta* post-spray application

Table 1 provides a comprehensive evaluation of the effectiveness of various synthetic insecticides against leaf miner incidence after application in the year 2022. Prior to spraying, no significant differences were observed among all the tested treatments. One day post-spray, the highest reduction in pest population was noted in the tomato crop treated with Coragen (2.75), followed by Belt (3.14), Woolmer (3.27), and Chlorfenapyr (3.45). The minimum population was recorded in the Discount treatment (3.62) compared to the control treatment (6.29). A similar trend persisted after two days of spraying, with Coragen (2.22) exhibiting the highest pest reduction, followed by Belt (2.62), Woolmer (2.75), and Chlorfenapyr (2.93). The Discount treatment showed the minimum population (3.10) in comparison to the control treatment (6.58). Three days post-spray, Coragen (1.82) demonstrated the highest pest reduction, followed by Belt (2.22), Woolmer (2.35), and Chlorfenapyr (2.53). The Discount treatment recorded the minimum population (2.70) compared to the control treatment (6.77). However, after seven days, a decline in efficacy was observed, with Coragen (1.21) still showing the highest pest reduction, followed by Belt (1.60), Woolmer (1.73), and Chlorfenapyr (1.91). The Discount treatment recorded the minimum population (2.08) compared to the control treatment (7.03). Fourteen days post-spray, Coragen (2.14) exhibited the highest reduction, followed by Belt (2.54), Woolmer (2.67), and Chlorfenapyr (2.85), while the Discount treatment showed the minimum population (3.02) compared to the control treatment (7.29). Overall mean data indicated that the maximum reduction in pest population was achieved with Coragen (2.03), followed by Belt (2.42), Woolmer (2.55), and Chlorfenapyr (2.73), while the Discount treatment recorded the minimum population (2.90) in comparison to the control treatment (7.55).

Table 1: The effectiveness of various synthetic insecticides against leaf miner incidence post-spray in 2022.

Treatments	Before spraying	Days after spray					Mean
		1	2	3	7	14	
Discount	4.36 b	3.62 b	3.10 b	2.70 b	2.08 b	3.02 b	2.90 b
Coragen	3.48 c	2.75 d	2.22 d	1.82 e	1.21 d	2.14 e	2.03 d
Chlorfenapyr	4.19 b	3.45 bc	2.93 bc	2.53 bc	1.91 bc	2.85 bc	2.73 bc
Belt	3.88 bc	3.14 c	2.62 cd	2.22 d	1.60 c	2.54 d	2.42 c
Woolmer	4.01 b	3.27 bc	2.75 bc	2.35 cd	1.73 bc	2.67 cd	2.55 c
Control	6.17 a	6.29 a	6.58 a	6.77 a	7.03 a	7.29 a	7.55 a
LSD $_{(0.05)}$	0.50	0.35	0.40	0.25	0.34	0.28	0.32

Mean in columns followed by the same letters are non-significant p value 5 %

The reduction of mines after spray application

Table 2 presents a comprehensive assessment of the efficacy of various synthetic insecticides in reducing the number of mines caused by leaf miner after application in 2022. Before spraying, no significant differences were observed between all the tested treatments. One-day post-spray, the highest reduction in pest population was recorded in the tomato crop treated with Coragen (3.14), followed by Belt (3.18), Woolmer (3.24), and Chlorfenapyr (3.29). The minimum population was recorded in the Discount treatment (3.30) compared to the control treatment (6.37). A similar pattern was observed after two days of spraying, with the highest reduction recorded from Coragen (2.31), followed by Belt (2.35), and Woolmer (2.41), while the minimum population was recorded in treatments Chlorfenapyr (2.46) and Discount (2.46) compared to the control treatment (6.57). Three days post-spray, the highest reduction was recorded in Coragen (1.64), followed by Belt (1.68), Woolmer (1.74), and Chlorfenapyr (1.79). The minimum population was recorded in the Discount treatment (1.80) compared to the control treatment (6.91). Seven days post-spray, the highest reduction was recorded in Coragen (1.06), followed by Belt (1.11), Woolmer (1.17), and Chlorfenapyr (1.22), with the minimum population recorded in the Discount treatment (1.23) compared to the control treatment (7.01). However, after 14 days, a decline in efficacy was observed, with the highest reduction recorded in Coragen (1.75), followed by Belt (1.80), Woolmer (1.86), and Chlorfenapyr (1.91). The minimum population was recorded in the Discount

treatment (1.92) compared to the control treatment (7.23). Overall mean data indicated that the maximum reduction in pest population was achieved with Coragen (1.98), followed by Belt (2.02), Woolmer (2.08), and Chlorfenapyr (2.13), while the minimum population was recorded in the Discount treatment (2.14) compared to the control treatment (6.82).

Table 2: The effectiveness of various synthetic insecticides against the number of leaf miner mines post-spray in 2022.

Treatments	Before spraying	Days after spray					Mean
		1	2	3	7	14	
Discount	3.49 b	3.30 b	2.46 b	1.80 b	1.23 b	1.92 b	2.14 b
Coragen	3.32 b	3.14 b	2.31 b	1.64 b	1.06 b	1.75 b	1.98 b
Chlorfenapyr	3.48 b	3.29 b	2.46 b	1.79 b	1.22 b	1.91 b	2.13 b
Belt	3.37 b	3.18 b	2.35 b	1.68 b	1.13 b	1.80 b	2.02 b
Woolmer	3.43 b	3.24 b	2.41 b	1.74 b	1.17 b	1.86 b	2.08 b
Control	6.17 a	6.37 a	6.57 a	6.91 a	7.01 a	7.23 a	6.82 a
LSD $_{(0.05)}$	0.50	0.45	0.44	0.53	0.55	0.44	0.48

Mean in columns followed by the same letters are non-significant p value 5 %

The percentage of leaf damage after spray application

Table 3 offers a comprehensive evaluation of the efficacy of various synthetic insecticides against the percentage of leaf miner damage post-application in 2022. Prior to the spray, no statistically significant differences were discerned among all the tested treatments. One day after the spray, the plot treated with Coragen showcased the highest reduction in percent leaf damage (12.08), followed by Belt (14.31), Woolmer (16.54), and Chlorfenapyr (16.88). The Discount treatment displayed the minimum percent leaf damage (18.77) compared to the control treatment (25.71). A similar trend was observed two days after spraying, with the Coragen-treated plot exhibiting the most significant reduction in leaf damage (7.63), followed by Belt (9.86), Woolmer (12.09), and Chlorfenapyr (12.42). Once again, the Discount treatment showed the minimum percent leaf damage (14.32) compared to the control treatment (27.94). Three days post-spray, the highest percent leaf damage reduction was attributed to Coragen (5.28), followed by Belt (6.15), Woolmer (8.38), and Chlorfenapyr (8.71). The Discount treatment demonstrated the minimum percent leaf damage (10.61) compared to the control

treatment (30.17). Seven days post-spray, Coragen (3.74) demonstrated the most pronounced reduction, trailed by Belt (5.11), Woolmer (6.71), and Chlorfenapyr (7.79). Once more, the Discount treatment revealed the lowest percentage leaf damage (8.94) compared to the control treatment (32.40). However, after 14 days, a diminishing trend in efficacy emerged, with Coragen (6.71) still leading the reduction, followed by Belt (7.45), Woolmer (9.68), and Chlorfenapyr (10.02). The Discount treatment recorded the lowest percentage leaf damage (11.17) compared to the control treatment (34.63). The overall mean data underscored that Coragen (7.09) achieved the utmost control in percentage leaf damage, followed by Belt (8.45), Woolmer (10.68), and Chlorfenapyr (10.83), while the Discount treatment demonstrated the minimum percent leaf damage reduction (12.76) compared to the control treatment (30.17).

Table 3: The effectiveness of various synthetic insecticides against leaf miner % leaf damage post-spray in 2022.

Treatments	Before spraying	Days after spray					Mean
		1	2	3	7	14	
Discount	23.97 a	18.77 b	14.32 b	10.61 b	8.94 b	11.17 b	12.76 b
Coragen	17.28 d	12.08 e	7.63 e	5.28 c	3.74 c	6.71 c	7.09 d
Chlorfenapyr	21.47 b	16.88 c	12.42 bc	8.71 bc	7.79 b	10.02 bc	10.83 bc
Belt	19.51 c	14.31 d	9.86 d	6.15 c	5.11 bc	7.45 c	8.45 cd
Woolmer	21.74 b	16.54 c	12.09 c	8.38 bc	6.71 bc	9.68 bc	10.68 bc
Control	23.97 a	25.71 a	27.94 a	30.17 a	32.40 a	34.63 a	30.17 a
LSD (0.05)	0.46	0.77	1.98	3.91	3.84	3.55	2.59

Mean in columns followed by the same letters are non-significant p value 5 %

Discussion

Tomato (*Solanum lycopersicum* L.) (Solanaceae) stands out as one of the most crucial and widely cultivated vegetables globally. However, this vital crop faces the onslaught of numerous insect pests, with *Tuta absoluta* emerging as a significant threat, leading to substantial annual losses. In response to this menace, the current experiment was conducted to identify the most effective insecticide against *Tuta absoluta*. The results indicated that Coragen exhibited the highest level of control in terms of leaf miner incidence, reduction in the number of mines, and percentage of leaf damage, followed by Belt, Woolmer, and Chlorfenapyr. Conversely, the lowest level of control was observed with Discount. These findings align with Oliveira *et al*. (2008), highlighting Coragen's remarkable efficacy against leaf miner infestations, attributed to its unique mode of action targeting the insect's ryanodine receptor, inducing paralysis and eventual death. Similarly, Belt demonstrated proven effectiveness in controlling *T. absoluta* by disrupting its muscular function and feeding behavior, as reported by Matsumoto *et al*. (2007). The distinct modes of action of Coragen and Belt underscore their significance in chemical control strategies, offering a valuable approach to combat resistance. However, it's worth noting that while emamectin benzoate proves effective against various insect pests, its efficacy against *T. absoluta* may be limited due to different mechanisms of action and potential resistance development, as suggested by Bagnall *et al*. (2020).

Conclusion and Recommendations

In conclusion, the evaluation of synthetic insecticides against *Tuta absoluta* infestation revealed that Coragen exhibited the most effective performance. Coragen emerged as a successful control measure and is highly recommended, particularly in areas where the pest poses a significant threat.

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