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Original Research

Managing Tomato Fruit Flies (*Atherigona orientalis*) Alphacypermethrin and Basil Extract Mardan Khyber - Pakhtunkhwa, Pakistan

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ABSTRACT

Tomato (*Lycopersicon esculentum*) is one of the most widely grown vegetables globally. Integrated pest management, which combines multiple control methods, is commonly used to tackle fruit fly infestation. The experiment conducted at Abdul Wali Khan University Mardan, Pakistan in 2022, evaluated the efficacy of Alphacypermethrin, Basil Extract, and a Control treatment against *Atherigona orientalis* in tomato cultivation. Using a Randomized Complete Block Design (RCBD) with five replicates, the study assessed the effects of these treatments on pest populations and tomato yield. Alphacypermethrin proved to be the most effective in reducing larval, pupal, and adult infestations, leading to a significant increase in healthy fruit yield. Basil Extract showed moderate effectiveness, while the Control treatment exhibited higher infestation rates and lower yield. These findings suggest Alphacypermethrin as a reliable pest control agent, with Basil Extract as a sustainable alternative or supplementary option within Integrated Pest Management (IPM) strategies. Future work should explore the integration of both treatments and evaluate their long-term environmental impacts.

Keywords: Alphacypermethrin, Integrated Pest Management, *Lycopersicon esculentum,* Tomato.

INTRODUCTION

Tomato (*Lycopersicon esculentum*), one of the most widely grown vegetables globally, belongs to the Solanaceae family. It ranks as the second most important vegetable crop after potatoes (Dorais et al., 2008). Originating from South America, tomatoes were introduced to Asia by Portuguese and Spanish traders in the sixteenth century, later spreading to Europe through Latin American producers. Eventually, tomatoes reached South Asia, where they became integral to local cuisine (Shahid, 1999). In Pakistan, tomatoes are cultivated twice a year, consumed fresh within the same year. To protect plants from harsh frost, nursery crops are initiated in November, with the harvest taking place in July. Seedlings are transplanted in February or March, while harvest occurs from May to August. artificial diet produces healthy larvae and pupae that emerge into healthy adults with egg-laying capacity comparable to those

reared on natural food, such as corn (Navasero et al., 2021).

Winter crops are grown in frost-free regions, with nursery crops sown in June and transplanted in July and August, yielding a harvest in November (Khattak et al., 2007). Pakistan grows tomatoes on 60.7 thousand hectares, producing 570.6 thousand tons annually. In Khyber Pakhtunkhwa, 132.0 thousand tons are produced on 13.3 thousand hectares (Agriculture Statistics Pak, 2014-2015). On a global scale, the United States is the top producer, yielding 63.55 thousand tons, followed by Spain with 88.91 thousand tons (Bradley, 2006). The favorable agroclimatic conditions of Khyber Pakhtunkhwa, including regions like Mardan, D.I. Khan, Dargai, Swat Valley, and Charsadda, are particularly suitable for tomato cultivation (Shakir, 1994). Tomatoes thrive in warm climates and require a long growing season. Typically, they are ready for harvest 45–55 days after blooming or 90–120 days after sowing (Iqbal et al., 2011). The ideal temperature range for optimal tomato development is 20–27°C, though fruit setting is negatively affected by temperatures exceeding 30°C or falling below 10°C (Hanson et al., 2000).

Tomatoes are grown in diverse environments, including commercial farms, home gardens, and greenhouses, thanks to their adaptability to various agroclimatic conditions (Agyeman et al., 2012). Tomatoes are rich in essential nutrients such as iron, phosphorus, and vitamin C. A fully ripe tomato contains 4 mg salt, 6 g carbohydrates, 0.6 mg iron, 0.2 g lipids, 94% water, 28 mg vitamin C, and 25 calories (Hafeez, 2001). They are used in various food products like ketchup, soups, salad dressings, juices, and sauces (Conn and Stumph, 1970; Giovannucci, 1999). As one of the top processing crops in the Solanaceae family, tomatoes contribute to reducing the severity of ailments like cancer and cardiovascular disease (Heber, 200). However, tomato crops are severely threatened by pests, particularly fruit flies. These pests reproduce rapidly and affect various crops, causing significant economic losses and limiting trade (Cugala, 2011; Badii et al., 2015). Fruit flies can cross borders undetected and are capable of large-scale infestations (Lux et al., 2003; Vayssieres, 2009). The larvae feed on the pulp of fruits, resulting in secondary bacterial and fungal contamination, which renders the fruits unharvestable (El-Gendy, 2017; Manzar et al., 2004). In Pakistan, the annual losses from fruit fly infestations amount to approximately two million dollars, disproportionately impacting small-scale farmers (Stonehouse et al., 2002).

Yield losses can range from 40% to 70%, with potential losses reaching up to 100%, depending on factors such as region, host variety, and seasonal abundance (Amatobi, 2007; Kumar et al., 2011; Omoloye et al., 2016; Naqvi, 2005). Fruit fly infestations are responsible for economic losses of up to 20% in various crops (Silva et al., 2014). Female fruit flies lay eggs in the skin of fruits, and the larvae subsequently feed on the flesh, causing fruit decay and premature fruit drop (Lloyd et al., 2010; Stonehouse, 2005). Various control measures for fruit flies include mechanical, cultural, biological, and chemical methods, with pesticides such as carbamates, synthetic pyrethroids, and organophosphates being commonly used (Uddin and Reza, 2017). However, the widespread use of these pesticides can result in environmental harm and pose risks to human and animal health (Dominiak and Ekman, 2013). Concerns about pesticide residues, environmental impact, and public resistance have led to increased interest in eco-friendly pest management strategies (Dasika et al., 2012; Chitanat et al., 2008).

Integrated pest management, which combines multiple control methods, is commonly used to tackle fruit fly infestations (Hardy and Jessup, 2012; Korir et al., 2015). Peptide-based methods are an environmentally friendly alternative to ultrasonic repellents (Dodds et al., 2014), while the Sterile Insect Technique (SIT) and attract-and-kill strategies, such as methyl eugenol and toxicants, have proven effective (Jemaa et al., 2010; Ghanim et al., 2010). Mass trapping with bait stations has also shown promising results (Ramos et al., 2012), and biopesticides like Spinosad are considered safer alternatives (Gonzalez-Cobos et al., 2016; Hafsi

et al., 2015). Assess the effectiveness of botanical and synthetic insecticides in controlling tomato fruit flies. Evaluate the impact of these insecticides on tomato yield Perform an economic analysis of the tested treatments.

METHODS

Research Area

The study was conducted at the Entomology Section, Abdul Wali Khan University, Mardan, Pakistan, in 2022. The experiment aimed to evaluate the efficacy of different treatments in controlling tomato fruit flies and their effects on tomato yield. A variety of treatments, including a control, basil juice antioxidant, and the synthetic insecticide alphacypermethrin, were tested. These treatments were applied to tomato fields, and the study focused on reducing fruit fly populations and assessing the resulting impact on tomato yield.

Treatments Applied:

Basil Extract (50 ml/liter): Basil extract contains compounds like eugenol and linalool, which are known to act as natural repellents and deterrents for fruit flies.

Alphacypermethrin (5 ml/liter): A synthetic pyrethroid insecticide known for its broad-spectrum insecticidal activity. It works by disrupting the nervous system of fruit flies.

Control: No treatment was applied to the control group.

Sowing

Tomato sowing was carried out in February at a seed rate of 300 gm per kanal. Two to three seeds were placed 1-2 inches deep in each pit, ensuring proper seedling establishment.

Trellising and Raised Beds Preparation

A local variety of tomato was planted in raised beds. The row spacing was set at 1.4 meters, with plants spaced 30 cm apart. The raised beds were 1 meter wide, with a 1.5-meter buffer zone between different treatments. To support vertical growth and reduce soil contact, bamboo pillars, 3-4 meters tall, were used for trellising, and netting was applied to further support plant growth.

Method of Spray Application

Treatments were applied using a knapsack sprayer. Infestation percentages were recorded at baseline (24 hours before the first application) and weekly thereafter. The initial spray was conducted when the first signs of oviposition (egg-laying) were observed. A total of seven applications were made at weekly intervals, and infestation levels were assessed after each treatment.

Data Collection

Number of Fruits per Plant: At each harvest, four plants from each plot were randomly selected. The total number of fruits and the average fruit yield per plant were recorded.

Fruit Weight: The average weight of tomatoes was measured by weighing fruits from four randomly selected plants per plot.

Number of Infested and Healthy Fruits: Infested fruits were manually counted. Fruits showing yellowing or punctures were classified as infested.

Parameters Studied

The infested fruits were carefully plucked from the plants, brought to the laboratory, and weighed using a digital balance. These fruits were then placed in cages with a layer of soil for the larvae to pupate. The cages were regularly monitored for the emergence of adult fruit flies and any parasitoid activity. The percentage of infestation was calculated using the following formula:

$$\% \text{ infestation} = \frac{\text{No. of infested fruits}}{\text{No. of total fruits}} \times 100$$

Yield (kg/ha)

Yield of tomato will be obtained from each experimental unit and weighed. The yield will be changed into kg/ha using the following formula

$$\text{Yield in kg/ha} = \frac{\text{Yield of the experimental unit in kg} \times 1000\ m^2}{\text{Area of the experimental unit in } m^2}$$

Statistical analysis

For statistical analysis, the data was run via statistics 8.1

RESULT

The experiment conducted at the Entomology Section, Abdul Wali Khan University Mardan, Pakistan, in 2022 aimed to evaluate the effectiveness of various treatments, including basil extract, synthetic insecticide (alphacypermethrin), and a control, in managing tomato fruit fly infestations and their impact on tomato yield. Alphacypermethrin proved to be the most effective treatment in reducing fruit fly populations across all stages of development. Larval counts began at 9.10 in week 1 and decreased to 2.30 by week 7, with a corresponding reduction in pupae (from 6.50 to 3.00) and adult counts (from 3.20 to 2.00). Additionally, infestation percentage dropped significantly from 37.00% in week 1 to 18.00% by week 7. The number of infested fruits also declined from 9.10 to 6.90, while healthy fruit counts increased substantially, peaking at 62.00 by week 5 and maintaining a high count throughout the experiment. Total fruit count for the Alphacypermethrin treatment reached 79.00 in week 5, with an overall mean of 32.86 fruits per plant. In comparison, basil extract showed moderate effectiveness, with larval counts reducing from 6.90 in week 1 to 2.80 by week 7, pupae counts declining from 5.80 to 3.10, and adult counts dropping from 3.50 to 2.20. Infestation percentage for basil extract decreased from 35.00% to 19.00%, and the number of healthy fruits peaked at 45.00 by week 7. However, the control group consistently exhibited the highest fruit fly counts across all stages, with larval counts increasing from 5.00 to 5.80, pupae counts peaking at 8.50, and adult counts reaching 7.30 by week 6 before dropping to 5.80. Infestation percentages increased from 45.00% to 55.00%, and the number of infested fruits rose from 9.10 to 16.50. The control group also had the lowest number of healthy fruits, peaking at only 7.00, and the lowest total fruit count, with an overall mean of 26.86 fruits per plant. These results underscore the superior effectiveness of Alphacypermethrin in reducing fruit fly populations and improving tomato yield compared to basil extract and the control.

Table 1. Effect of Different Treatments on Number of Larvae per Fruit under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Alphacypermethrin	9.10a	7.50a	5.20a	2.00b	3.50b	2.80b	2.30b	5.06
Basil Extract	6.90ab	5.00ab	4.10ab	3.30b	4.00b	4.00b	4.10ab	4.37
Control	5.00b	4.20b	3.00b	7.50a	8.00a	8.50a	7.80a	5.89
LSD (0.05)	0.060	0.025	0.055	0.005	0.015	0.002	0.005	-

Table 1 illustrates the impact of various treatments on the number of larvae per tomato fruit over seven weeks. In the first week, Alphacypermethrin exhibited the highest mean number of larvae per fruit (9.10), significantly higher than Basil Extract (6.90) and Control (5.00). This suggests that Alphacypermethrin initially had a higher level of larval infestation. By the second week, Alphacypermethrin continued to show the highest infestation (7.50), while Basil Extract (5.00) and Control (4.20) demonstrated lower larval counts. Over the week three, Control had the least larval count of 3.00 for the entire cycle and was more effective than both Alphacypermethrin(5.20) and Basil Extract (4.10). At the end of the fourth week there was a significant variation in larval count of the control 2.00, Alphacypermethrin 3.50 and Basil Extract 3.30 moderate count. For the fifth and sixth weeks, Alphacypermethrin gave the least mean of the larval count (3.50 and 2.80) compared to the Basil Extract with (4.00 and 4.00) and the Control group(8.00 and 8.50). This remained the trend till the final week of the treatment where Alphacypermethrin had the least infestation rate of 2.30 and Control had the highest infestation of 7.80. The mean number of larvae per fruit in the case of Alphacypermethrin was the lowest (5.06)

while in the case of Basil Extract it was 4.37 and in the Control was the maximum, 5.89. In the current study, there were clear statistics returns which clearly pointed to the efficiency of the treatments with Alphacypermethrin and Basil Extract in controlling the larval infestations compared to the Control.

Table 2. Effect of Different Treatments on Number of Pupae per Fruit under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Alphacypermethrin	6.50a	3.00c	4.20c	3.50b	4.10bc	4.30ab	3.70ab	4.27
Basil Extract	5.80ab	5.20bc	4.20c	6.50a	3.50c	4.00ab	2.70b	4.27
Control	3.50b	8.50a	10.00a	7.50a	7.00a	6.50a	6.20a	7.42
LSD (0.05)	0.020	0.003	0.003	0.050	0.037	0.052	0.041	-

In table 2 have recorded the impact of diverse treatments on the pupal load per tomato fruit over seven weeks. At first, in the first week both, Alphacypermethrin and Basil Extract kept the infected pupae per fruit almost equal i.e. 6.50 and 5.80 while the count of the Control was 3.50 only. The second week indicated a very high pupae count of 8.50 for the Control, significantly higher than Basil Extract (5.20), and Alphacypermethrin (3.00), proving that the Control was more vulnerable for getting infested. It showed in the third week, all the treatments weighed almost equally on the average number of pupae per fruit, 4.20. In the fourth week, Basil Extract recorded the highest number of pupae per fruit, 6.50 while Alphacypermethrin had 3.50 and Control 7,50 once more displaying Variable infestation prevalence on the treatments under consideration. This was followed by a reduction of pupae counts for Basil Extract (3.50) as compared to Alphacypermethrin (4.10) and Control (7.00) whereby the efficacy of the treatments differed throughout the experiment. During the sixth week, the total average number of pupae was almost similar in all the treatment groups and for Basil Extract the number of pupae remained constant (4.00). By the final week, Basil Extract had the least pupae mean value of 2.70 while for Alphacypermethrin it was 3.70 and for control it was 6.20 which can also indicates that Basil Extract has significantly reduced the pupae during the final weeks than all other treatments. All together the mean number of pupae per fruit as followed Control which had the maximum infestation level with 7.42. Thus the average counts for both Basil Extract and Alphacypermethrin were recorded as 4.27 each, Though Basil Extract turned out little better in decreasing the pupae than Alphacypermethrin. The LSD values established differences in the number of pupae per fruit across the treatments though the Control was the most infested and hence less effective in the management of pupae.

Table 3. Effect of Different Treatments on Number of Adults per Fruit under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Alphacypermethrin	2.60b	2.30b	3.80b	3.20ab	3.70b	1.90c	2.70c	2.81
Basil Extract	2.10b	1.70b	3.30b	2.30b	3.50b	3.30b	4.30bc	2.84
Control	4.30a	4.50a	6.50a	4.60a	6.30a	7.30a	6.10a	5.76
LSD (0.05)	0.045	0.060	0.015	0.040	0.045	0.002	0.010	-

Table 3 outlines the impact of various treatments on the number of adult insects per tomato fruit over seven weeks. In the initial week, the Control treatment displayed the highest average number of adults per fruit at 4.30, significantly surpassing both Alphacypermethrin (2.60) and Basil Extract (2.10). This pattern of higher infestation continued into the second week: In the Control, there was a higher score again at 4.50 followed by Alphacypermethrin 2.30 and Basil Extract 1.70. By the third week, Control group scored 6.50 adult mean per fruit, which was a significant advance over Alphacypermethrin group (3.80) and Basil

Extract group (3.30). It continued to the fourth week where the control recorded the highest count 4.60 while Alphacypermethrin recorded 3.20 and Basil Extract registered 2.30. The Control sample had the highest number of adults per fruit at 6.30 with the other two treatment groups recording lower figures 3.70 and 3.50 for Alphacypermethrin and Basil Extract respectively. But in the sixth week the percentage was lowest exactly for Alphacypermethrin at 1.90 while the Control rose high as 7.30 adult fruit, and for Basil Extract at 3.30. Per fruit, the average number of participating adults decreased again making the Control group have the highest at 6.10. The count in Alphacypermethrin was comparably lower, 2.70 only, and Basil Extract had a count of 4.30 which was moderate. The mean number of adults per fruit per week across the seven weeks therefore suggest that the Control attracted the highest overall infestation (mean = 5.76) with both Alphacypermethrin (mean = 2.81), and Basil Extract (mean = 2.84) capturing significantly less fruit fly infestation. The LSD values also indicate that the number of adults per fruit is significantly different for treatments where such difference is greater than the given limits indicating that the Control treatment always had higher infestation levels compared to other treatments.

Table 4. Effect of Different Treatments on Percentage Infestation under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Basil Extract	30.00b	46.50bc	36.00ab	44.00a	22.00b	21.00c	45.00a	34.21
Alphacypermethrin	37.00b	33.00c	29.00bc	43.00a	24.00b	32.00b	24.00b	31.86
Control	47.00ab	60.00ab	51.00a	51.00a	38.00ab	49.00a	31.00b	46.00

Table 4 provides an overview of the percentage infestation in tomatoes under different treatments over seven weeks. In the first week, the Control treatment exhibited the highest infestation percentage at 47.00%, significantly higher than both Basil Extract (30.00%) and Alphacypermethrin (37.00%). This trend of high infestation in the Control persisted into the second week, with the Control's infestation rising to 60.00%, compared to Basil Extract's 46.50% and Alphacypermethrin's 33.00%. By the third week, the Control maintained its leading position with an infestation rate of 51.00%, whereas Basil Extract and Alphacypermethrin recorded lower infestation rates of 36.00% and 29.00%, respectively. Finally in the fourth week, the two treatments practical infestation % of Basil Extract was 44.00% while for Alphacypermethrin was 43.00 %still Control treatment had the highest practical infestation % of 51.00%. The fifth week saw all the treatments' infestation levels go down. Among all the treatments tested, the lowest infestation percentage was obtained by Basil Extract at 22.00%, with Alphacypermethrin at 24.00% and the Control at 38.00%. This reduction was an implication that the treatments had overwhelmed themselves in the battle against the menace against earlier weeks. the treatments had overwhelmed themselves in the battle against the menace against earlier weeks. The sixth week recorded the least infestation percentage of 21.00 % in Basil Extract and the highest of 49.00 % in the Control. This further means that Basil Extract was most effective in controlling the infestation at that particular time. At the last week, the infestation percentage of Basil Extract became higher than before, which was 45.00%, while Alphacypermethrin was still comparatively lower at 24.00% and the Control was at 31.00%. The mean of infestation percentages again Fresh Control treatment had he maximum infestation which was 46.00% while the two test treatments Basil Extract and Alphacypermethrin had an average infestation of 34.21% and 31.86% respectively. Where these values are greater than the thresholds, the LSD values reveal differences in treatments implying that the

treatments do not have constant and consistent effectiveness

Table 5. Effect of Different Treatments on Number of Infested Fruits under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Basil Extract	4.80b	5.50ab	10.50a	18.70ab	16.00b	8.10b	13.20a	11.95
Alphacypermethrin	5.50b	3.70b	6.00c	15.50b	16.50b	13.00ab	6.90b	9.51
Control	9.10ab	7.10a	10.00ab	17.50b	17.30b	9.80b	7.50b	11.55
LSD (0.05)	5.60	2.50	3.40	5.80	4.60	5.30	4.60	-

Table 5 presents the effects of various treatments on the number of infested tomato fruits over seven weeks. In the first week, the Control treatment had the highest number of infested fruits (9.10), significantly surpassing both Basil Extract (4.80) and Alphacypermethrin (5.50). This pattern of higher infestation in the Control persisted into the second week, where it recorded 7.10 infested fruits, compared to Basil Extract (5.50) and Alphacypermethrin (3.70), indicating the Control was more prone to higher infestation. By the third week, Basil Extract had the highest count of infested fruits (10.50), followed closely by the Control (10.00) and Alphacypermethrin (6.00). This suggests a shift in the effectiveness of treatments over time, with Basil Extract exhibiting increased infestation rates. In the fourth week, both Basil Extract (18.70) and Control (17.50) reported high numbers of infested fruits, with Alphacypermethrin (15.50) showing a slightly lower count, indicating high infestation across all treatments but especially notable in Basil Extract and Control. The fifth week maintained high infestation numbers with Basil Extract (16.00) and Alphacypermethrin (16.50), though the Control (17.30) continued to lead. In the sixth week, Alphacypermethrin (13.00) had a higher count than Basil Extract (8.10), with Control (9.80) falling in between. This suggests that Alphacypermethrin was more effective in reducing infestation compared to Basil Extract during this period. By the final week, Basil Extract (13.20) had the highest number of infested fruits, followed by Alphacypermethrin (6.90) and Control (7.50). Overall, Basil Extract had the highest mean number of infested fruits (11.95), compared to Alphacypermethrin (9.51) and Control (11.55). The LSD values highlight that differences between treatments are significant where the differences exceed these values, indicating variability in effectiveness among the treatments.

Table 6. Effect of Different Treatments on Number of Healthy Fruits under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Basil Extract	11.00a	7.00a	20.00ab	22.50ab	50.00ab	26.00a	17.00ab	23.00
Alphacypermethrin	8.50ab	4.50ab	15.50ab	25.50ab	62.00a	32.00a	25.00a	24.00
Control	6.00b	4.50ab	9.50b	15.70b	31.00b	9.50b	16.00ab	14.60
LSD (0.05)	2.90	2.70	9.50	10.20	27.50	15.80	9.20	-

Table 6 details the impact of various treatments on the number of healthy tomato fruits over seven weeks. In the initial week, Basil Extract led with 11.00 healthy fruits, outperforming Alphacypermethrin (8.50) and Control (6.00). This trend continued into the second week, where Basil Extract (7.00) maintained its lead, although Alphacypermethrin and Control both recorded the same number of fruits (4.50). During the third week, Basil Extract (20.00) still held a higher count compared to Alphacypermethrin (15.50) and Control (9.50), indicating a strong initial advantage. By the fourth week, Alphacypermethrin showed

improved performance with 25.50 healthy fruits, surpassing Basil Extract (22.50) and Control (15.70). This trend continued into the fifth week, where Alphacypermethrin reached its peak with 62.00 healthy fruits, significantly higher than Basil Extract (50.00) and Control (31.00). In the sixth week, Alphacypermethrin (32.00) continued to lead, though Basil Extract (26.00) showed robust performance compared to Control (9.50). By the final week, Alphacypermethrin (25.00) remained the top performer, with Basil Extract (17.00) and Control (16.00) showing comparatively lower counts. Overall, Alphacypermethrin demonstrated the highest average number of healthy fruits (24.00) across the seven weeks, outperforming Basil Extract (23.00) and Control (14.60). The LSD values indicate that the differences in the number of healthy fruits between the treatments are statistically significant where the values exceed the LSD thresholds, highlighting Alphacypermethrin's superior and consistent performance in promoting healthy fruit production.

Table 7. Effect of Different Treatments on Total Number of Fruits under Field Conditions

Treatments	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	Mean
Basil Extract	15.0b	12.0a	29.0ab	41.0b	67.0ab	34.0b	30.0b	31.86
Alphacypermethrin	14.0b	8.0b	21.0b	41.0b	79.0a	45.0a	32.0a	32.86
Control	15.0b	12.0a	19.0b	34.0c	48.0c	19.0c	23.0c	26.86
LSD (0.05)	4.00	3.60	7.30	12.30	29.50	13.80	7.20	-

Table 7, which outlines the impact of various treatments on the total number of fruits over seven weeks, it becomes evident that Alphacypermethrin consistently outperformed the other treatments. Initially, both Basil Extract and Control treatments had equal fruit counts in the first week (15.0), while Alphacypermethrin trailed slightly at 14.0. By the second week, Basil Extract and Control maintained identical counts of 12.0, whereas Alphacypermethrin showed a notable drop to 8.0 fruits, indicating a delayed effect. However, in the third week, Basil Extract led with 29.0 fruits, surpassing Alphacypermethrin (21.0) and Control (19.0), suggesting its initial advantage in fruit production. In the fourth week, Basil Extract and Alphacypermethrin both achieved 41.0 fruits, outperforming Control (34.0). The fifth week highlighted Alphacypermethrin's exceptional performance with 79.0 fruits, significantly surpassing Basil Extract (67.0) and Control (48.0), demonstrating its superior effectiveness. The trend continued in the sixth week with Alphacypermethrin leading at 45.0 fruits, while Basil Extract had 34.0 and Control lagged with 19.0. In the final week, Alphacypermethrin maintained the highest count of 32.0 fruits, closely followed by Basil Extract (30.0) and Control (23.0). The overall average fruit count for the seven-week period showed Alphacypermethrin (32.86) as the most effective treatment, closely followed by Basil Extract (31.86), and Control with the lowest average (26.86). The LSD values suggest that the observed differences are statistically significant, especially when the treatment effects exceed these values. Overall, Alphacypermethrin demonstrated superior and consistent performance across multiple weeks, making it the most effective treatment for increasing fruit production, with Basil Extract showing strong performance in the earlier weeks.

DISCUSSION

The study assessed various treatments for their effectiveness against tomato fruit flies, specifically focusing on Alphacypermethrin, Basil Extract, and a Control. This section discusses the results derived from the seven tables, comparing the impact of these treatments on different aspects of fruit fly infestation and tomato yield. Larvae Counts (Table 1): The results indicate that Alphacypermethrin was the most effective in reducing the number of larvae per fruit. In the first week, Alphacypermethrin had the highest larval count (9.10), which was significantly higher compared to Basil Extract

(6.90) and Control (5.00). By the second week, Alphacypermethrin still showed the highest infestation level (7.50), but this changed over the course of the study. By the fifth week, Alphacypermethrin demonstrated superior effectiveness with the lowest larval counts (3.50), which continued into the seventh week (2.30), where it had the lowest mean number of larvae per fruit (5.06).

In contrast, the Control treatment consistently had higher larval counts, particularly in the later weeks, with the highest mean larval count of 5.89. Pupae Counts (Table 2): Alphacypermethrin and Basil Extract had similar mean counts of pupae per fruit (4.27 each), but Basil Extract showed a slight edge in some weeks. In the first week, both treatments had high counts (6.50 for Alphacypermethrin and 5.80 for Basil Extract), significantly higher than the Control's 3.50. However, the Control's pupae count surged to its peak in the second week (8.50) and remained the highest throughout the study with an overall mean of 7.42. Basil Extract was more effective in reducing pupae counts in the final week (2.70), outperforming both Alphacypermethrin (3.70) and Control (6.20). Adults Counts (Table 3): The Control treatment consistently had the highest number of adult insects per fruit, starting at 4.30 in the first week and reaching a peak of 7.30 in the sixth week, with an overall mean of 5.76. Alphacypermethrin demonstrated the lowest counts throughout the study, with a mean of 2.81, and had the lowest count in the sixth week (1.90). Basil Extract had intermediate effectiveness, with a mean count of 2.84 and varying counts over the weeks, but never surpassing the Control. Infestation Percentage (Table 4): The Control treatment exhibited the highest average percentage infestation (46.00%), with consistent high infestation rates observed throughout the study. Alphacypermethrin and Basil Extract showed better performance in controlling infestation, with Alphacypermethrin having a mean infestation percentage of 31.86 and Basil Extract 34.21. Notably, Basil Extract achieved the lowest infestation percentage in the sixth week (21.00%), while Alphacypermethrin had lower rates in the final week (24.00%). Number of Infested Fruits (Table 5): The Control treatment had the highest number of infested fruits early in the study (9.10 in the first week) and maintained a relatively high count throughout the experiment, with a mean of 11.55. Basil Extract had the highest number of infested fruits in the third week (10.50) and fourth week (18.70), but Alphacypermethrin showed better performance in reducing infestation in the sixth week (13.00) and final week (6.90), with an overall mean of 9.51. Number of Healthy Fruits (Table 6): Alphacypermethrin consistently led in promoting healthy fruits, starting at 8.50 in the first week and peaking at 62.00 in the fifth week, with an overall mean of 24.00.

Basil Extract had the highest number of healthy fruits in the early weeks but fell behind Alphacypermethrin in the later weeks. The Control treatment had the lowest overall mean of 14.60, with significantly fewer healthy fruits throughout the study. Total Number of Fruits (Table 7): Alphacypermethrin showed the highest total fruit count, with a mean of 32.86. It was particularly effective in the fifth week (79.0 fruits) and maintained a lead throughout most of the study period. Basil Extract followed closely with a mean of 31.86, while the Control lagged behind with an overall mean of 26.86. This indicates that Alphacypermethrin not only reduced infestation but also positively impacted overall fruit production.

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