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The Effect of Some Pesticides on Population Reduction Rates of Four Aphid Species in Sugar Beet Fields in Kafr El-Sheikh Governorate, Egypt

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Abstract: This study evaluated the efficacy of four insecticides, Fenitrothion, Abamectin, Imidacloprid, and Thiamethoxam in controlling aphid infestations in sugar beet fields over two consecutive growing seasons (2022 and 2023) in Kafr El-Sheikh Governorate, Egypt. The results demonstrated that all four insecticides significantly reduced aphid populations compared to untreated control plots. Imidacloprid was the most effective, achieving total reductions of 97.69% (2022) and 95.01% (2023), followed by Fenitrothion and Thiamethoxam, which also showed strong efficacy with reductions exceeding 93% in both seasons. Abamectin exhibited variability in performance, with a total reduction of 77.01% in 2022, which improved to 94.63% in 2023. Temporal reduction patterns revealed that all insecticides achieved their highest efficacy 10 days post-treatment, with gradual increases in reduction percentages over time. Untreated control plots experienced a steady increase in aphid populations, confirming the effectiveness of the insecticides. The findings highlight the importance of selecting appropriate insecticides for sustainable pest management in sugar beet cultivation, with Imidacloprid emerging as the most reliable option. However, the variability in Abamectin's performance underscores the need for further research to optimize its use. This study contributes to the development of integrated pest management strategies that balance efficacy with environmental sustainability.

Key words: Aphid control, Sugar beet, insecticides, Population reduction, Pest management.

1. Introduction

Sugar beet (*Beta vulgaris*) is a globally significant crop, particularly in Egypt, where it contributes substantially to sugar production and agricultural sustainability **(Fergani *et al.*, 2023).** In Egypt, sugar beet occupies a pivotal role in the agro-economy due to its adaptability to saline soils and arid climates, offering an efficient alternative to sugarcane in meeting the country's sugar demands **(Farag *et al.*, 2023).**

Aphids, such as *Myzus persicae*, *Aphis gossypii*, *Aphis craccivora*, and *Aphis graminum*, are among the most harmful pests affecting sugar beet cultivation. These pests inflict direct damage by feeding on phloem sap, leading to reduced plant vigor, chlorosis, and stunted growth. Moreover, they act as vectors for several plant viruses, including Beet yellows virus (BYV) and Beet mosaic virus (BtMV), further compromising crop yield and quality **(Blackman and Eastop, 2000; Van Emden & Harrington, 2017).** The cumulative damage from aphid infestations can result in substantial economic losses, particularly in regions with intensive sugar beet production.

Chemical control remains the cornerstone of aphid management in agricultural systems. However, the effectiveness of insecticides depends on several factors, including the active ingredient, application method, environmental conditions, and the emergence of resistance within aphid populations **(Bass *et al.*, 2015; Foster *et al.*, 2020).** Resistance to neonicotinoids and other pesticide classes is increasingly reported among aphid species, posing challenges to sustainable pest management **(Nauen *et al.*, 2019).**

This study evaluates the efficacy of four pesticides—Fenitrothion, Abamectin, Imidacloprid, and Thiamethoxam—against aphid infestations in sugar beet fields over two consecutive growing seasons (2022 and 2023). The findings aim to inform the development of optimized pest management strategies that balance effective aphid control with reduced environmental impact, ultimately contributing to sustainable sugar beet production in Egypt.

2. Materials and methods

2.1. Tested Insecticides

1. **Fenitrothion (Sumithion® 50% EC)**: applied at a rate of 1000 cm³ per 200 liters of water.
2. **Abamectin (Gold® 1.8% EC)**: Applied at a rate of 40 cm³ per 200 liters of water.
3. **Imidacloprid (Shinolak® 35% EC)**: Applied at a rate of 300 cm³ per 200 liters of water.
4. **Thiamethoxam (Actara® 25% EC)**: Applied at a rate of 20 g per 200 liters of water.

2.2. Field Studies

This study was conducted during two consecutive sugar beet planting seasons (2022 and 2023) at the Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt. The experiment followed a completely randomized block design, utilizing the local sugar beet variety "FARIDA," planted on September 15th (2022) and September 16th (2023). The experimental area encompassed 168 m², divided into four equal-sized plots (42 m² each) for each treatment. Each treatment included treated and untreated control plots, separated by two unsprayed plant rows to prevent cross-contamination. The insecticides were applied once per season on December 16th (2022) and December 17th (2023). A motorized 20-liter backpack sprayer was used to apply the aqueous insecticide solutions at the recommended field doses, as outlined by the Agricultural Pesticide Committee (http://www.apc.gov.eg/ar/APCRelease s.aspx). The control plots received only water. Standard agricultural practices were consistently maintained across treatments. Aphid population assessments were conducted by randomly selecting ten plants per plot for each treatment. Sampling was performed at four time points: A few hours before the first application. One, Seven, and Ten days post-application. Both nymphs and adult aphids, regardless of species, were counted, and field readings were recorded. The percentage reduction in aphid population density was calculated for each treatment using the **Henderson and Tilton (1955)** formula:

$$\text{Reduction \%} = \left\{1 - \frac{n\ in\ Co\ before\ treatment\ x\ n\ in\ T\ after\ treatment}{n\ in\ Co\ after\ treatment_{x}\ n\ in\ T\ before\ treatment}\right\} \times 100$$

n: Insect population, C: control, T: treated.

The insect population data were statistically analyzed using one-way analysis of variance (ANOVA) to determine significant differences, with the analysis performed using SPSS **software (2004).**

3. Results and Discussion

The efficacy of four insecticides—Fenitrothion (Sumithion® 50% EC), Abamectin (Gold® 1.8% EC), Imidacloprid (Shinolak® 35% EC), and Thiamethoxam (Actara® 25% EC)—in controlling aphid infestations in sugar beet fields was evaluated over two consecutive growing seasons (2022 and 2023). The results are summarized in Tables 1 and 2.

Impact of the evaluated insecticides on the occurrence of aphid infestations

In the 2022 season

All four insecticides significantly reduced aphid populations compared to the untreated control plots. The temporal reduction in aphid populations increased over time, with the highest reductions observed 10 days post-treatment. Imidacloprid was the most effective insecticide, achieving a total reduction of 97.69%. The reduction percentages were: 24.57%, 68.20% and 90.38% for 1st, 7th and 10th consequently. Fenitrothion also performed well, with a total reduction of 97.35%. The reduction percentages were: 24.76%, 66.66% and 89.45% for 1st, 7th and 10th consequently. Thiamethoxam showed similar efficacy, with a total reduction of 97.62%. On the other hand, Abamectin had the lowest total reduction (77.01%). The reduction percentages were: 24.11%, 66.59% and 89.25% for 1st, 7th and 10th consequently. In the untreated control plots, aphid populations increased significantly over time, from 53.5 ± 0.56 after 1 day to 78.25 ± 1.78 after 10 days.

In the 2023 season

The insecticides again demonstrated significant efficacy in reducing aphid populations, with similar trends observed in temporal reduction. Imidacloprid remained the most effective insecticide, achieving a total reduction of 95.01%. The reduction percentages were: 23.12%, 60.10% and 83.67% for 1st, 7th and 10th consequently. Fenitrothion showed strong performance, with a total reduction of 93.97%. The reduction percentages were: 22.89%, 60.77% and 80.07% for 1st, 7th and 10th consequently. On the other hand, Abamectin improved significantly compared to the 2022 season, achieving a total reduction of 94.63%. In the untreated control plots, aphid populations increased from 69 ± 0.79 after 1 day to 90.75 ± 0.74 after 10 days.

In both seasons, aphid populations in untreated control plots increased significantly over time. In the 2022 season, aphid densities rose from 53.5 ± 0.56 after 1 day to 78.25 ± 1.78 after 10 days. Similarly, in the 2023 season, aphid populations increased from 69 ± 0.79 after 1 day to 90.75 ± 0.74 after 10 days. This confirms the effectiveness of the insecticides in controlling aphid infestations, as untreated plots experienced a steady increase in aphid numbers.

Table (1). Reduction Percentage of Aphids in Sugar Beet Field after Treatment with Tested Insecticides (2022 Season)

Treatment	Before Treatment (Mean ± SE)	1 Day	7 Days	10 Days	Total Reduction
Fenitrothion	51 ± 0.61	40.25 ± 0.74[a] (24.76%)	20.5 ± 0.25[a] (66.66%)	8.25 ± 0.42[a] (89.45%)	97.35%[a]
Abamectin	51.5 ± 0.75	41 ± 0.5[a] (24.11%)	20.75 ± 0.42[a] (66.59%)	8.5 ± 0.56[a] (89.25%)	77.01%
Imidacloprid	51.5 ± 1.25	40.75 ± 0.82[a] (24.57%)	19.75 ± 0.42[a] (68.20%)	7.6 ± 0.25 [b] (90.38%)	97.69%[a]
Thiamethoxam	51.75 ± 1.14	41.5 ± 0.56[a] (23.29%)	20.5 ± 0.25[a] (67.16%)	7.5 ± 0.75[b] (90.56%)	97.62%[a]
Untreated Area	51 ± 0.36	53.5 ± 0.56	61.5 ± 0.56	78.25 ± 1.78	-

-In a column, means followed by the same letters are non-significantly different, P≥0.05

Table (2). Reduction Percentage of Aphids in Sugar Beet Field after Treatment with Tested Insecticides (2023 Season)

Treatment	Before Treatment (Mean ± SE)	1 Day	7 Days	10 Days	Total Reduction
Fenitrothion	62 ± 0.36	50.75 ± 0.42[a] (22.89%)	29.75 ± 0.22[a] (60.77%)	17.25 ± 0.42 (80.07%)	93.97%
Abamectin	62 ± 0.61	50.25 ± 0.65[a] (23.64%)	30.75 ± 0.55[a] (59.45%)	15 ± 0.36[a] (82.67%)	94.63%[a]
Imidacloprid	62.5 ± 0.56	51 ± 0.36[a] (23.12%)	30.5 ± 0.25[a] (60.10%)	14.25 ± 0.90[a] (83.67%)	95.01%
Thiamethoxam	64 ± 0.36	51.75 ± 0.82[a] (23.82%)	30.5 ± 0.75[a] (61.03%)	15.75 ± 0.42[a] (82.37%)	94.76%[a]
Untreated Area	65 ± 0.36	69 ± 0.79	79.5 ± 0.56	90.75 ± 0.74	-

-In a column, means followed by the same letters are non-significantly different, P≥0.05

3. Discussion

The results of this study demonstrate the efficacy of four insecticides Fenitrothion, Abamectin, Imidacloprid, and Thiamethoxam in controlling aphid infestations in sugar beet fields at the Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt. In over two consecutive growing seasons (2022 and 2023). The findings highlight the importance of selecting appropriate insecticides for effective pest management while considering their impact on sustainable agriculture.

Imidacloprid showed the most effective insecticide in both seasons, achieving total reductions of 97.69% (2022) and 95.01% (2023). This aligns with previous studies that have reported the high efficacy of neonicotinoids, such as imidacloprid, against aphid species due to their systemic action and long-lasting residual effects **(Bass *et al.*, 2014 and Foster *et al.*, 2020).** The consistent performance of imidacloprid across both seasons underscores its reliability as a key tool for aphid management in sugar beet cultivation.

Fenitrothion and Thiamethoxam also demonstrated high efficacy, with total reductions exceeding 93% in both seasons. Thiamethoxam, another neonicotinoid, showed results comparable to imidacloprid, which is consistent with findings by **Nauen *et al.* (2019),** who reported that neonicotinoids are highly effective against aphids. Fenitrothion, an organophosphate, performed well, but its use may be limited by environmental and regulatory concerns due to its broader ecological impact **(Van Emden and Harrington, 2017).** Abamectin showed variability in performance, with a significant improvement in efficacy from 77.01% in 2022 to 94.63% in 2023. This variability may be attributed to differences in environmental conditions, application methods, or the development of resistance in aphid populations. Abamectin, a macrocyclic lactone, is known for its effectiveness against a wide range of pests, but its performance can be influenced by factors such as temperature and UV exposure **(Bass *et al.*, 2015).** The obtained reduction data revealed that all tested insecticides achieved their highest efficacy 10 days post-treatment. This gradual increase in reduction percentages over time is consistent with the mode of action of these insecticides, which often require time to fully impact pest populations. For example, neonicotinoids like imidacloprid and thiamethoxam act systemically, disrupting the nervous system of aphids over several days **(Foster *et al.*, 2020).** Similarly, Fenitrothion and Abamectin, which act through contact and ingestion, respectively, also showed progressive reductions in aphid populations. The overall reduction in aphid populations was slightly higher in the 2023 season compared to the 2022 season for most insecticides. This improvement may be attributed to better application techniques, favorable environmental conditions, or changes in aphid population dynamics. The significant improvement in Abamectin's efficacy in 2023 suggests that adjustments in application rates or timing may enhance its performance. However, further research is needed to understand the factors influencing the variability in insecticide efficacy across seasons.

4. Conclusion

This study demonstrates that Imidacloprid, Fenitrothion, and Thiamethoxam are highly effective in controlling aphid infestations in sugar beet fields, with Imidacloprid being the most reliable option. Abamectin showed variability in performance, indicating the need for further research to optimize its use. The findings underscore the importance of integrating chemical control with sustainable practices to ensure effective pest management while minimizing environmental impact.

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