Field Efficacy and residues of Pyrethroid, Neonicotinoid, and Anti-Feeding Insecticides versus Aphids in Egyptian Sugar Beet

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Abstract: Aphid infestations are a severe threat to sugar beet (*Beta vulgaris L.*) production in Egypt, hence efficient and sustainable control measures are required. Aphid populations and residue analysis of three insecticides—lambda-cyhalothrin, flonicamid, and acetamiprid—in sugar beet fields in Kafr El-Sheikh Governorate, Egypt were evaluated over two years (2022–2023) using four insecticides: lambda-cyhalothrin (pyrethroid), flonicamid (anti-feeding agent), acetamiprid, and imidacloprid (neonicotinoids). Henderson and Tilton's method was used to evaluate population decline rates at 1, 7, and 10 days' post-treatment. By Day 10, all insecticides showed great efficacy, with more than 98% population decline. While flonicamid showed a delayed but continuous anti-feeding impact, lambda-cyhalothrin gave quick initial knockdown. While neonicotinoids showed moderate initial control, they had significant residual activity. At various time intervals, one-way ANOVA showed notable variations ($p < 0.05$) among pesticide categories. The results underline the need of choosing insecticides for integrated pest management (IPM) programs according on their modes of action and effectiveness timeframes. Flonicamid is very useful for sustainable aphid control given its anti-feeding qualities and minimal resistance risk. Future studies should emphasize tracking resistance growth and improving application techniques under Egyptian agroecosystem settings.

Preceding field trials, the pesticide formulations under investigation were analyzed both before and after accelerated storage at 54 ±2 °C for 14 days. The evaluation of active ingredient content, suspensibility, dissolution, and solution stability, along with several other factors, demonstrated compliance with the required chemical and physical specifications.

Regarding the pesticide residues, no notable variations were found in the analytical findings between the two seasons for the three insecticides applied in the experiment, for both the leaves and roots of sugar beet. In the 2022 season, results showed that leaves had residues more than roots, the residues in leaves ranged between 1.6±0.1 to 3.2±0.85 mg/kg and un roots ranged between 0.018±0.002 to 0.06±0.002 during the two tested seasons. Residue amounts in sugar beet plants (leaves and roots) treated with the insecticide flonicamid were higher than those presented in treated plants with lambda cyhalothrin or acetamiprid, these finding are due to the differences in the recommended rates of the three used insecticides. Based on the maximum residue limit (MRL), the pre harvest intervals (PHI) for lambda cyhalothrin, flonicamide and acetamiprid were 3, 9 and 6 days post treatment, respectively. This indicates that sugar beet roots treated with the three insecticides are safe for used after these intervals.

Keywords: integrated pest management; neonicotinoids (imidacloprid–acetamiprid); lambda-cyhalothrin; flonicamid; insecticide$_{fe}$ analysis; residues; sugar beet; aphid control.

1. Introduction:

A crop of global economic relevance, sugar beet (*Beta vulgaris L.*) is especially important in Egypt **(Farag *et al*., 2023)**, where it significantly promotes agricultural sustainability and local sugar output (FAO, 2022; **Fergani *et al*., 2023)**. Aphid infestations, on the other hand, endanger sugar beet harvests by means of viral transmission, photosynthetic efficiency decline, and plant development slowing **(Dewar & Cooke, 2006)**. Though their efficacy differs with active components, application time, and pest resistance, chemical pesticides are still the principal control tool **(Bass *et al*., 2015)**. Direct feeding damage is caused by *Myzus persicae* (green peach aphid) and Aphis fabae (black bean aphid), two of the most troublesome aphid species in sugar beet, which also carry Beet yellows virus (BYV) and Beet mild yellowing virus (BMYV) **(Stevens *et al*., 2004)**. Sustainable pest management depends on the assessment of newer insecticidal groups since traditional pesticides are losing efficacy **(Foster *et al*., 2007)**. This study assesses the efficacy of four different insecticide classes: Lambda-cyhalothrin (Belof® 5% CS), a neurotoxic pyrethroid compound targeting insect voltage-gated sodium channels **(IRAC, 2023)**; Flonicamid (Ketdown® 50% WG), a selective chordotonal organ modulator that inhibits aphid feeding behavior **(Jeschke *et al*., 2011)**; Acetamiprid (Newset® 20% SP), a systemic neonicotinoid acting as a nicotinic acetylcholine receptor agonist **(Elbert *et al*., 2008)**; and Imidacloprid (Confedent® 35% SC), a widely deployed neonicotinoid exhibiting growing resistance patterns in pest populations **(Bass *et al*., 2015)**. While lambda-cyhalothrin offers fast knockdown, earlier studies indicate flonicamid has significant anti-feeding effects **(Morita *et al*., 2007)**. Neonicotinoids such as imidacloprid and acetamiprid, on the other hand, are resisted in certain areas **(Sparks & Nauen, 2015)**. Using **Henderson & Tilton's (1955)** formula for exact efficacy assessment, this study assesses their field performance under Egyptian conditions over two consecutive growing seasons—2022 and 2023. The results will guide farmers in maximizing insecticide use under integrated pest management (IPM) plans; hence reducing resistance concerns **(Pretty & Bharucha, 2015)**.

This study measures the aphid control efficacy of four chemically different insecticides—lambda-cyhalothrin, flonicamid, acetamiprid, and imidacloprid—in Egyptian sugar beet fields during 2022–2023. The results allow for data-driven optimization of insecticide application to obtain balanced results in pest management effectiveness, resistance prevention, and environmental protection inside Egypt's sugar production field.

Key points in new insecticide discovery include high potency and selectivity, low residual and resistance **(Lamberth, Jeanmart, Luksch, & Plant, 2013)**. Pesticides, however, are possibly harmful to non-targeted species **(World Health Organization [WHO], 2018)**.Sugar beet field persistent residues can build up in post-harvest residues and possibly harm non-target species, soil health, and environmental safety **(Zhang *et al*., 2018)**. Commonly used in sugar beet farming, neonicotinoids and pyrethroids have been found in soil and surface water systems, therefore raising environmental issues because of their toxicity to pollinators and aquatic species **(Goulson, 2013)**.

Therefore, the scope of the present work was to contribute towards a better knowledge of the two following points:

1- Efficiency of lambda-cyhalothrin, flonicamid, and acetamiprid against aphids in testing sugar beet plants.
2- Verification of the tested pesticide formulations complies with the specifications and Residue determination of the used insecticides in sugar beet leaves and roots

2. Materials and methods:

Tested Insecticides:

1. **Lambda-cyhalothrin (Belof® 5% CS)**: applied at a rate of 40 cm³ per 100 liters of water.
2. **Flonicamid (Ketdown® 50% WG)**: Applied at a rate of 80 gm per fed. of water.
3. **Acetamiprid (Newset® 20% SP)**: Applied at a rate of 25 gm per 100 liters of water.
4. **Imidacloprid (Confedent® 35% SC)**: Applied at a rate of 75 cm³ per 100 liters of water.

2.1.Analytical methods

2.1.1.Verification of the tested pesticide formulations complies with the specifications:

2.1.1.1.Accelerated storage procedures

The two-season pesticide formulations under study are stored in a digital oven at 54 ±2 °C for 14 days. This is in accordance with **CIPAC (Collaborative International Pesticides Analytical Council) MT 46 (1995)**. After this time, the samples are withdrawn from the oven, and subsequently, the pesticide formulation samples are prepared for HPLC injection.

2.1.1.2Suspensibility

A suspension of Lambda-cyhalothrin 5% CS, Flonicamid 50% WG, and Imidacloprid 35% SC in CIPAC standard water D (prepared according to **CIPAC MT 18.1 (1995))** is prepared, placed in a measuring cylinder maintained at constant temperature, and allowed to stand undisturbed for a predetermined period. The upper section containing 9/10ths of the total sample is decanted; the remaining

1/10th is quantitatively analyzed through gravimetric methods. Methods for suspensibility determinations were proposed by **CIPAC MT 184 (2003)**.

2.1.1.3.Degree of dissolution and solution stability

The formulation of Acetamiprid 5% SP is dissolved in CIPAC standard water D in a 250 ml graduated cylinder. The degree of dissolution is assessed after 15 inversions of the test cylinder and a 5-minute standing time by decanting the test cylinder's contents through a 75 µm sieve. Any residue is collected and quantified. Solution stability is assessed by standing the filtrate for 24 hours and then re-filtering through the 75 µm sieve. Any residuals are again quantified. **CIPAC MT 179.1 (2014)** described this method.

2.2.Field Studies

Conducted in Abdel-Aziz Okasha in Shino village, Kafr El-Sheikh Governorate, Egypt, this study covered two consecutive sugar beet growing seasons—2022 and 2023. Using the sugar beet cultivar "FARIDA," which was sowed on October 15, 2022, and October 16, 2023, the study applied a completely randomized block design. Covering 168 m², the overall experimental area was divided into four equal-sized plots (42 m² each) for each treatment. Treated plots and untreated control plots were spaced by two unsprayed rows to prevent interference. On December 19, 2022, and December 22, 2023, insecticide treatments were done once each season. Insecticide treatments at the advised field rates were delivered using a motorized 20-litre backpack sprayer, as directed by the **Agricultural Pesticide Committee (http://www.apc.gov.eg/ar/APCReleases.aspx)**. Water alone treated control plots. Every plot got consistent standard farming procedures. Randomly collecting ten plants per plot for each treatment allowed us to assess aphid numbers. Four times were used to evaluate: Just before the first insecticide application, one, seven, and 10 days post-application. Field data were recorded and both nymphs and adult aphids, regardless of species, were counted. For each treatment, **the Henderson and Tilton (1955)** formula was used to compute the decline in aphid population density.

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

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

One-way analysis of variance (ANOVA) statistically examined the insect population data to identify significant variations; the analysis was done using **SPSS software (2004)**.

2.3.Residue analysis:

Our method is quite successful for finding and measuring lambda-cyhalothrin, flonicamid and acetamiprid residues in Sugar beet, as shown in this work. We followed the SANTE/12682/2019 guidelines—which involve assessing several performance criteria including matrix effects, accuracy, limit of quantification (LOQ), precision, linearity, and bias—to guarantee the dependability of our approach.

We prepared standard solutions of lambda-cyhalothrin, flonicamid and acetamiprid at varying doses to evaluate how well the procedure works by testing its linearity. We built a calibration curve with five concentration points (0.01, 0.1, 0.5, 1.25, 2.5, and 5 µg/ml) using high-performance liquid chromatography (HPLC) with UV detector and evaluated the correlation coefficient (R^2) to verify the consistency of the response.

We also looked for matrix effects by contrasting the signals from standard solutions in a pure solvent with those from blank samples of Sugar beet leaves and roots processed using the same extraction technique and spiked with identical pesticide dosages. Conducted at same concentration points—0.01 to 5 mg/kg—this comparison was crucial to guarantee that the precision of our measurements was not compromised by the presence of the meal matrix.

The extraction and clean-up procedure used the original QuEChERS approach created by **Anastassiades *et al*. (2003)**. First, 10 g of homogenized Sugar beet leaves and roots were weighed and put into 50 mL Teflon tubes. 10 mL of acetonitrile was then added, and the mixture was agitated violently for one minute. Then 1.0 g of sodium chloride and 4.0 g of anhydrous magnesium sulfate were added, followed by a 1-minute vigorous shaking. Then, in a refrigerated centrifuge set at 5°C, the tubes were spun straight at 4000 rpm for five minutes.

Using 25 mg of primary secondary amine (PSA), 150 mg of anhydrous magnesium sulfate, and 10 mg of graphitized carbon black (GCB), 1 mL of the supernatant was cleaned up following centrifugation. The mixture was centrifuged at 4000 rpm for five minutes and shook forcefully for one minute. At last, a 0.22 m PTFE syringe filter (Millipore, Billerica, MA) was used to filter 0.5 mL of the cleaned supernatant into an HPLC vial for injection into a High-Performance Liquid Chromatography system. **(Rania Abdel-Hamid *et al* 2024)**.

Recovery percentages were illustrated in table (1) and revealed that means recovery percentages were 98.87, 94.67, 93.33; 97.67, 95.33 and 95.33 for lambda-cyhalothrin, flonicamid and acetamiprid in leaves and roots, respectively. The obtained results were corrected depending on the recovery rate. Half -life (T½) and rate of degradation of the used insecticides were calculated mathematically according to **(Moye *et al* 1987)**.

Table (1): Average of recovery rates of the three pesticides under study

Pesticide	Sample types	Spiking levels (mg./kg.)	Average detected concentrations (mg/kg)	recovery %	Mean recovery %
lambda-cyhalothrin	leaves	1	0.95±0.14	95	98.67
		0.1	0.1±0.0125	100	
		0.01	0.0101±0.0009	101	
	roots	1	0.96±0.023	96	97.67
		0.1	0.099±0.0021	99	
		0.01	0.098±0.0027	98	
flonicamid	leaves	1	0.92±0.031	92	94.67
		0.1	0.098±0.002	98	
		0.01	0.0094±0.0014	94	
	roots	1	0.96±0.047	96	95.33
		0.1	0.097±0.0081	97	
		0.01	0.0093±0.0053	93	
acetamiprid	leaves	1	0.91±0.05	91	93.33
		0.1	0.094±0.015	94	
		0.01	0.0095±0.001	95	
	roots	1	0.93±0.018	93	95.33
		0.1	0.095±0.019	95	
		0.01	0.0098±0.0013	98	

3.Results:

a-Before treatment

3.1.Effect of accelerated storage on the content of the tested pesticides at 54 ±2 ˚C for 14 days

Table 2 explains how storing the tested pesticide formulations at 54 ±2 °C for 14 days influenced their content in two seasons, 2022 and 2023. The information on the test formulations indicated that there were no significant changes in concentration pre- and post-storage at 54±2ºC for 14 days. This implies that the formulations remain stable at those temperature conditions for the duration tested, as they met the specifications and showed no substantial change.

Table (2): Effect of accelerated storage on the content of the tested pesticides at 54 ±2 ºC for 14 days

Active ingredients	Lambda-cyhalothrin (w/v) %		Flonicamid content (w/w) %		Acetamiprid content (w/w) %		Imidacloprid (w/v) %	
Seasons	2022	2023	2022	2023	2022	2023	2022	2023
Before storage (0)	4.85 ±0.5*	4.91 ±0.5	48.95 ±2.5	49.45 ±2.5	19.95 ±1.2	19.71 ±1.2	34.25 ±1.75	34.73 ±1.75
After storage (14 d)	4.77 ±0.5	4.79 ±0.5	48.55 ±2.5	49.15 ±2.5	19.51 ±1.2	19.35 ±1.2	34.34 ±1.75	34.52 ±1.75

-Samples before (0 d) and following (14 d) the accelerated storage stability test were examined concurrently to minimize analytical error.
-Each value signifies the mean of three replicates.
-*FAO tolerance

3.2.Suspensibility of Lambda-cyhalothrin 5% CS, Flonicamid 50% WG, and Imidacloprid 35% SC before and after storage at 54 ±2 ˚C

The FAO/WHO guideline specifies that at least 60% of the evaluated pesticide formulations must remain in suspension after 30 minutes in CIPAC standard water D at a temperature of 30 ± 2°C. Results demonstrated that suspensibility, both prior to and following storage, adheres to FAO/WHO standards.

3.3.Degree of dissolution and solution stability of Acetamiprid 20% SP before and after storage at 54 ±2 ˚C

Upon the conclusion of the designated time, we did not detect any insoluble substances in the cylinder, so the findings demonstrated that the dissolution degree and solution stability before and after storage adhered to FAO/WHO standards.

b-After treatment

Aphid populations in sugar beet fields during the 2022 and 2023 growing seasons in Kafr El-Sheikh Governorate, Egypt were used to assess the field efficacy of four insecticides—lambda-cyhalothrin (pyrethroid), flonicamid (anti-feeding agent), acetamiprid, and imidacloprid (neonicotinoids). Using **Henderson and Tilton's (1955)** model, population reduction rates were evaluated at 1, 7, and 10 days post-treatment.

3.4.Impact of the evaluated insecticides on aphid populations

Lambda-cyhalothrin in the 2022 season demonstrated quick knockdown of aphid populations, falling from a mean of 20¦ before treatment to 3.25¦ at 10 days post-application, thereby attaining a total reduction of 98.77%. With a cumulative drop of 98.96%, Flonicamid's anti-feeding mode caused a sluggish first effect, lowering the aphid population from 20.25 ± .85 to 2.5 ± .5. With a total drop of 98.48%, acetamiprid lowered aphid numbers from 19.75 ± 1.11 to 4 ± 0.40. Although imidacloprid treatment effectively reduced aphid numbers (98.90% from 20.75±2.63 to 2.5±0.57), untreated regions had a significant population rise (20.5±0.28 to 38±1.47). With all treatments achieving their maximal efficacy at the 10-day observation point, the experimental insecticides produced progressively higher aphid population reductions across the assessment period, exhibiting notable differences from the control plots.

Lambda-cyhalothrin cut aphid numbers from 19.75¦±0.48 before treatment to 3¦±0.41 at 10 days post-application, hence reducing them by 99.01% overall. With a cumulative drop of 99.05%, flonicamid lowered aphid counts from 20.5¦ to 2.75¦ 48. A total drop of 99.2% was therefore achieved with acetamiprid, which lowered aphid numbers from 20.75¦ 0.25 to 2.25¦ 0.25. Imidacloprid treatment had a 99% control efficacy by drastically lowering aphid density from 20 (Â±0.41) to 2.75 (Â±0.25). Over the same time, the untreated region exhibited an increase in aphid numbers from 20.25 ± 0.25 to 40.5 ± 0.64. Relative to untreated control plots, all tested pesticides showed statistically significant effectiveness in reducing aphid numbers. The insecticidal effects showed a time-dependent trend; the most significant population drops became clear at the 10-day post-application evaluation interval.

In the 2022 season, lambda-cyhalothrin's leaf residue levels after 1 day, 7 days, and 10 days of application were 1.6±0.1, 0.75±0.13, and 0.21±0.027 ppm, whereas in 2023 they were 1.7±0.2, 0.77 ±0.095 and 0.22±0.024 ppm. The residues in the roots were 0.02±0.001 and 0.018±0.002 ppm in season 2022 and 2023, respectively.

Flonicamid's leaf residue levels were 3.1±0.91, 1.62±0.25, and 0.54±0.02 ppm after 1 day, 7 days, and 10 days of treatment in 2022; in sugar beet roots, the levels were 0.06±0.002, 0.013±0.001, and 0.028±0.003 ppm, respectively. The leaf residues in the 2023 season were 3.2±0.85, 1.59±0.35, and 0.56±0.035 ppm; in the roots, they were 0.05±0.004, 0.14±0.01, and 0.027±0.002 ppm, respectively at the same time intervals.

With respect to acetamiprid, the leaf residue values in 2022 were 2.25±0.88, 1.9±0.33, and 0.65±0.027 ppm for 1 day, 7 days, and 10 days post treatment, respectively. The root levels were 0.03±0.005, 0.15±0.015, and 0.008±0.002 ppm. The leaf residues in the 2023 season were 2.3±0.44, 1.7±0.29, and 0.69±0.044ppm; in the roots, they were 0.04±0.001, 0.12±0.014, and 0.009±0.004 ppm on days 1, 7, and 10, respectively.

4.Discussion:

Our two-year study (2022–2023) at the Sakha Agricultural Research Station revealed the notable effectiveness of four pesticide classes against aphid infestations in Egyptian sugar beet fields. Though their temporal efficacy patterns showed different modes of action **(IRAC, 2023)**, all investigated compounds—lambda-cyhalothrin (pyrethroid), flonicamid (anti-feeding agent), and the neonicotinoids acetamiprid and imidacloprid—achieved >98% population reduction by Day 10 (Tables 3–4).

Consistent with its neurotoxic effect on insect voltage-gated sodium channels, the pyrethroid lambda-cyhalothrin showed a typical fast knockdown (29–33% drop at Day 1) **(Ware & Whitacre, 2004)**. Early intervention after first aphid colonization is especially beneficial because of this instant impact **(Dewar & Cooke, 2006)**. Efficacy, however, plateaued after seven days (80.1–80.6% reduction), perhaps because of restricted residual activity and possible behavioural avoidance among surviving aphids **(Foster *et al*., 2007)**.

Flonicamid's efficacy progressed in a novel way; by Day 7, it had a gradual but consistent effect (78.1–80.85%; by Day 10, 93.34–93.50%). This pattern fits its mode of action as a selective chordotonal organ modulator upsetting feeding behavior **(Jeschke *et al*., 2011)**. Flonicamid might be most beneficial, the delayed peak efficacy implying, when used preventatively, before economic limits are reached. A vital factor given aphids' role as vectors for beet yellows viruses, its anti-feeding activity also has the extra advantage of lowering virus transmission risk **(Stevens *et al*., 2004)**.

Reflecting their systemic character and ongoing plant uptake, neonicotinoids showed moderate initial effectiveness (26.19–30.60% at Day 1) but high residual activity (89.08–94.58% by Day 10) **(Elbert *et al*., 2008)**. Their slower onset, meanwhile, might restrict their use against current populations, and recorded resistance in Egyptian aphid populations **(Bass *et al*., 2015)** calls for prudent resistance management. After Day 1, one-way ANOVA showed notable efficacy variations ($p < 0.05$): pyrethroids beat neonicotinoids ($p = 0.02$), in line with their fast neurotoxic effect **(IRAC, 2023)**. Reflecting their systemic and anti-feeding durability **(Jeschke *et al*., 2011)**, flonicamid and neonicotinoids outperformed pyrethroids ($p = 0.01$) between Days 7–10.

All treatments' nearly total (>98%) population declines after 10 days show their promise for efficient aphid control in Egyptian sugar beet production. Field implementation, on the other hand, has to take into account issues including resistance management requirements **(Sparks & Nauen, 2015)**, non-target effects on beneficial insects **(Fergani *et al*., 2023)**, economic thresholds and application costs, environmental persistence, and legal status. These findings back the inclusion of these insecticides into IPM initiatives combining cultural practices and biological control agents with chemical control for sustainable aphid management **(Pretty & Bharucha, 2015)**. Future studies should track field-evolved resistance patterns and assess the efficacy of these pesticides under various application techniques and environmental settings.

In all seasons, lambda-cyhalothrin residues fell dramatically in the leaves from day one to day ten, suggesting fast breakdown on foliar surfaces. On day 1, the levels fell from 1.6±0.1 ppm (2022) and 1.7±0.2 ppm (2023) to 0.21±0.027 ppm and 0.22±0.024 ppm by day 10, respectively. The remnants in roots were small (0.02±0.001 ppm in 2022 and 0.018±0.002 ppm in 2023), hence verifying its poor systemic action and little transfer from foliage to below-ground tissues. This is in line with earlier research that found lambda-cyhalothrin to be a contact insecticide with little systematic mobility **(Anagnostopoulos *et al*., 2020)**.

With day 1 values of 3.1±0.91 ppm (2022) and 3.2±0.85 ppm (2023), flonicamid showed more early leaf residues than lambda-cyhalothrin. By day 10, the residues had dropped to 0.54±0.02 ppm and 0.56±0.035 ppm, suggesting moderate persistence. In root samples, values ranged from 0.06±0.002 ppm to 0.028±0.003 ppm in 2022 and from 0.05±0.004 ppm to 0.027±0.002 ppm in 2023, with an unexpected peak of 0.14±0.01 ppm on day 7 in the 2023 season. As documented in varying root translocation under different soil and moisture conditions **(Sparks *et al*., 2013)**, this could imply delayed systemic uptake or environmental factors influencing pesticide behavior.

Known systemic neonicotinoid acetamiprid showed considerable leaf dissipation, with levels falling from 2.25±0.88 ppm and 2.3±0.44 ppm (day 1, 2022 and 2023) to 0.65±0.027 ppm and 0.69±0.044 ppm by day 10, respectively. Especially, root residues peaked on day 7 (0.15±0.015 ppm in 2022 and 0.12±0.014 ppm in 2023), suggesting notable systematic migration. These results are consistent with research showing that acetamiprid easily moves inside plants, temporarily collects in roots before breaking down **(Tomizawa & Casida, 2005)**.

With residue behavior affected by their physicochemical qualities, all three pesticides demonstrated consistent dissipation patterns over the 10-day timeframe. Acetamiprid showed considerable translocation to roots, flonicamid displayed moderate systemic behaviour, while lambda-cyhalothrin stayed largely on leaf surfaces. These findings are crucial for guaranteeing safe pre-harvest intervals for sugar beet crops and for maximizing application timing.

Conclusion:

Although all pesticides shown great final efficacy (>98% decrease), their unique qualities suggest various IPM functions. While pyrethroids are still significant for fast knockdown, flonicamid's unique anti-feeding function and lower resistance risk make it especially useful. Because of resistance issues, neonicotinoids need cautious use. Future studies should track field resistance development and assess economic thresholds under Egyptian growing circumstances.

Over a 10-day timeframe, all three pesticides showed a consistent pattern of fast dissipation in sugar beet leaves across two growing seasons. Though systematic chemicals like flonicamid and acetamiprid exhibited some transport to root tissues, residues in roots were consistently lower. The findings imply that whereas lambda-cyhalothrin stays mostly on leaf surfaces, acetamiprid and flonicamid could have higher possibility for root contamination because of their systemic characteristics. These results are crucial for determining pre-harvest intervals and evaluating the safety of pesticide use in sugar beet farming.

Table (3): Reduction percentage of Aphids in sugar beet fields after treatment with tested insecticides (2022 Season)

Treatment	Before Treatment (Mean ± SE)	1 Day (Mean ± SE)	7 Days (Mean ± SE)	10 Days (Mean ± SE)	Total Reduction
Lambda-cyhalothrin	20±0.4	15±0.40a (29.31%)	5±0.81^{b} (80.1%)	3.25±0.5^{b} (91.24%)	98.77%
Flonicamid	20.25±0.85	15.25±0.47^{a} 29.02%)(	5.5±1.29^{b} (78.10%)	2.5±0.5^{b} (93.34%)	98.96%
Acetamiprid	19.75 ±1.11	15.25 ± 0.47^{a} 27.22%)(	4.75±0.25^{b} (80.85%)	4 ±0.40^{b} (89.08%)	98.48%
Imidacloprid	20.75± 2.63	16.25±0.75^{a} (26.19%)	6± 1.41^{b} (76.98%)	2.5±0.57^{b} (93.50%)	98.90%
Untreated Area	20.5± 0.28	21.75±0.25^{b}	25.75±0.8^{a}	38±1.47^{a}	-

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

Table (4): 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
Lambda-cyhalothrin	19.75±0.48	14.75±0.25^{a} (32.79%)	5.25±0.14 (80.60%)	3 ±0.41^{b} (92.41%)	(99.01%)
Flonicamid	20.5±0.29	15.75±0.48^{a} (30.85%)	5.75±0.14 (79.53%)	2.75± 0.48^{b} (93.30%)	(99.05%)
Acetamiprid	20.75±0.25	16± 0.40^{a} (30.60%)	6±0.4 (78.89%)	2.25± 0.25^{b} (94.58%)	(99.2%)
Imidacloprid	20±0.41	15.5±0.5^{a} (30.25%)	5.25±0.48 (80.84%)	2.75± 0.25^{b} (93.13%)	(99%)
Untreated Area	20.25±0.25	22.5±0.57^{b}	27.75±0.75^{a}	40.5± 0.64^{a}	

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

Table (5): Residues of lambda-cyhalothrin detected in Sugar beet leaves and roots

intervals (days)	Season 2022				Season 2023			
	Leaves		Roots		Leaves		Roots	
	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss
1	1.6±0.100	0	0.02±0.001	0	1.7±0.200	0	0.018±0.002	0
7	0.75±0.130	53.13	UND		0.77±0.095	54.71	UND	
10	0.21±0.027	86.88	UND		0.22±0.024	87.06	UND	
EU MRL(ppm)		0.01					0.01	
PHI (days)	14		3		14		3	
t½ (days)	5.8		2		5.6		1.8	

Table (6): Residues of flonicamid detected in Sugar beet leaves and roots

intervals (days)	Season 2022				Season 2023			
	Leaves		Roots		Leaves		Roots	
	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss
1	3.1±0.91	0	0.06±0.002	0	3.2±0.85	0	0.05±0.004	0
7	1.62±0.25	47.74	0.13±0.001	__	1.59±0.35	50.31	0.14±0.01	__
10	0.54±0.02	82.58	0.028±0.003	53.33	0.56±0.036	82.5	0.027±0.002	46
EU MRL(ppm)		0.03					0.03	
PHI (days)	16		9		16		9	
t½ (days)	6.4		8		6.2		7.9	

Table (7): Residues of acetamiprid detected in Sugar beet leaves and roots

intervals (days)	Season 2022				Season 2023			
	Leaves		Roots		Leaves		Roots	
	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss	Residues (ppm)	% Loss
1	2.25±0.880	0	0.03±0.005	0	2.3±0.44	0	0.04±0.001	0
7	1.90±0.330	15.56	0.15±0.015	__	1.7±0.29	26.87	0.12±0.014	__
10	0.65±0.027	42.22	0.008±0.002	73.33	0.69±0.044	70	0.009±0.004	77.5
EU MRL(ppm)		0.01					0.01	
PHI (days)	18		6		19		6	
t½ (days)	3.45		9		3.55		8.8	

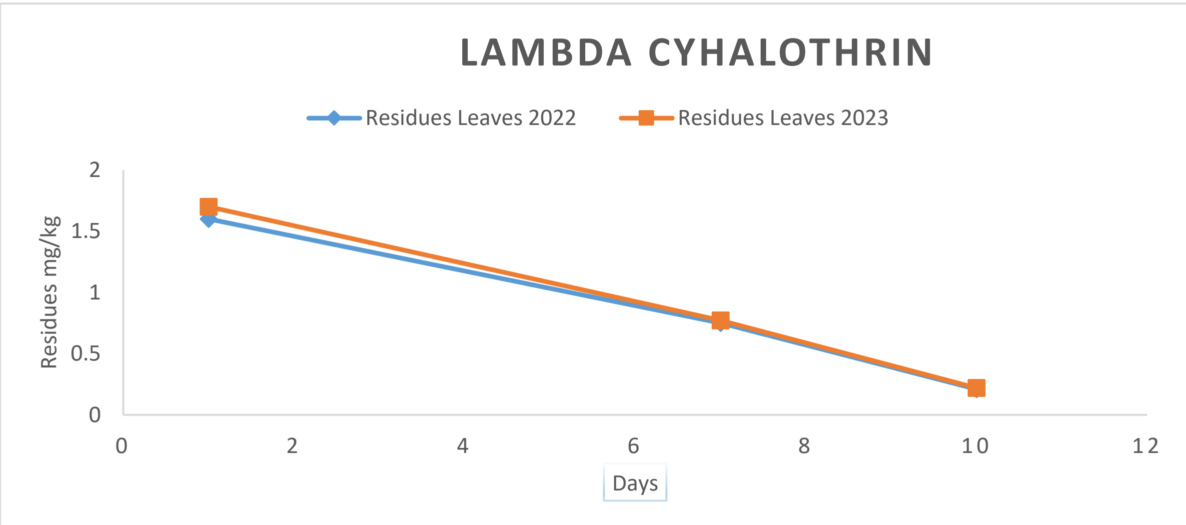

Fig. 1: Dissipation behavior of lambda-cyhalothrin in Sugar Beet Leaves Season 2022-2023under field conditions

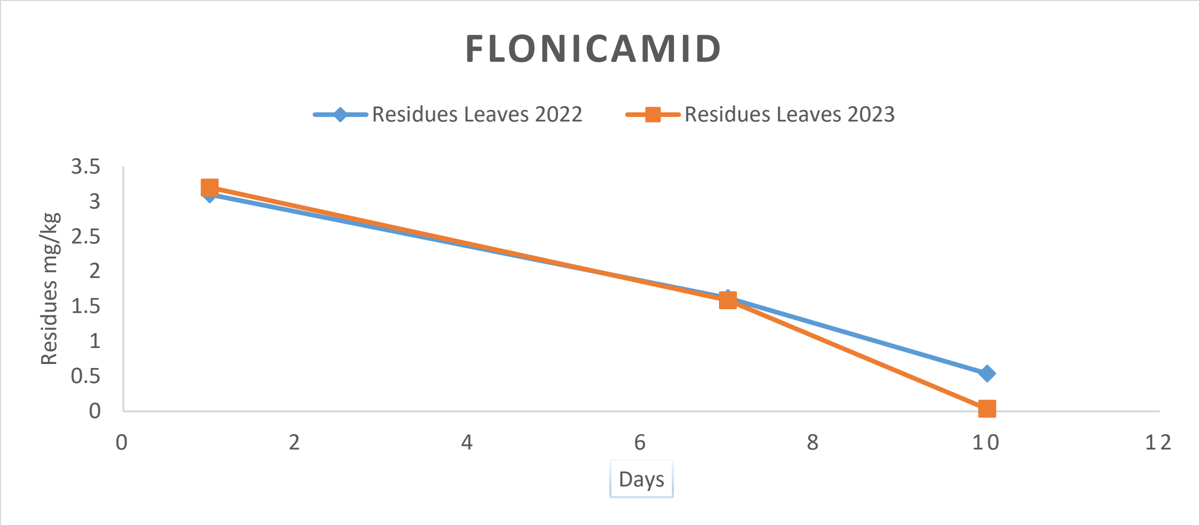

Fig. 2: Dissipation behavior of Flonicamid in Sugar Beet Leaves Season 2022-2023under field conditions

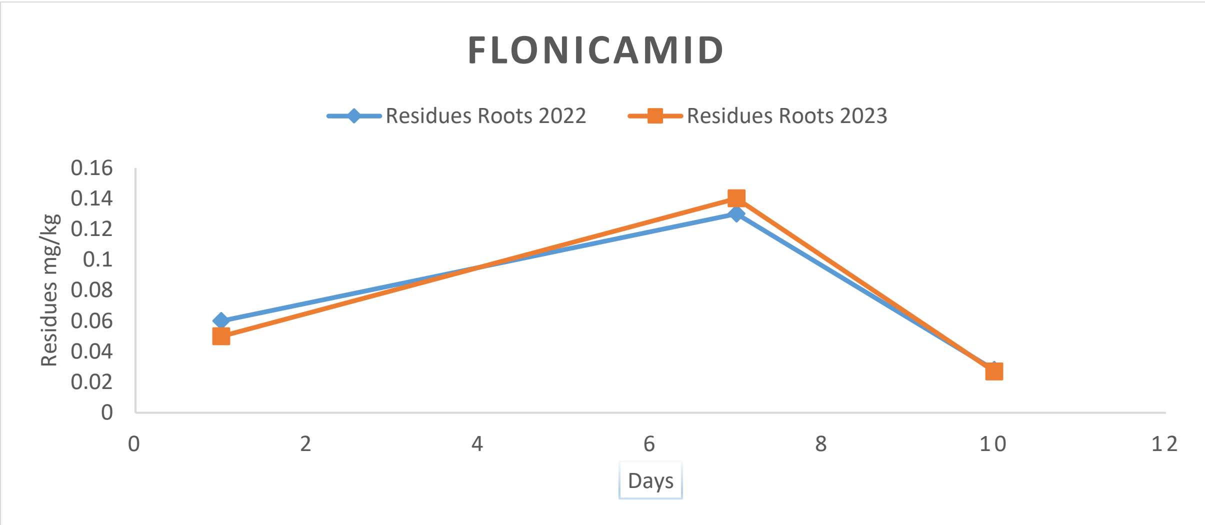

Fig. 3: Dissipation behavior of Flonicamid in Sugar Beet Roots Season 2022-2023under field conditions

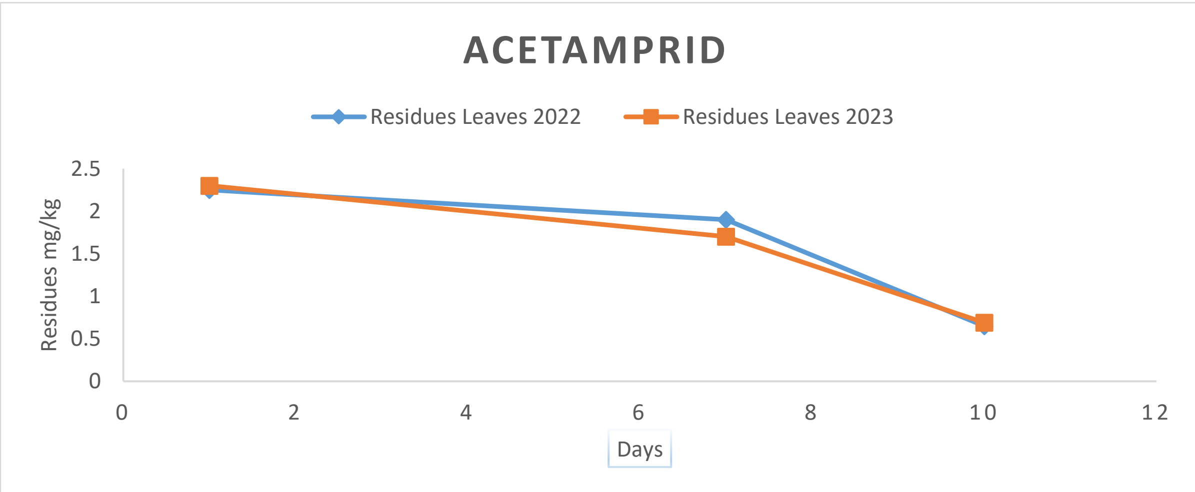

Fig. 4: Dissipation behavior of Acetamprid in Sugar Beet Leaves Season 2022-2023under field conditions

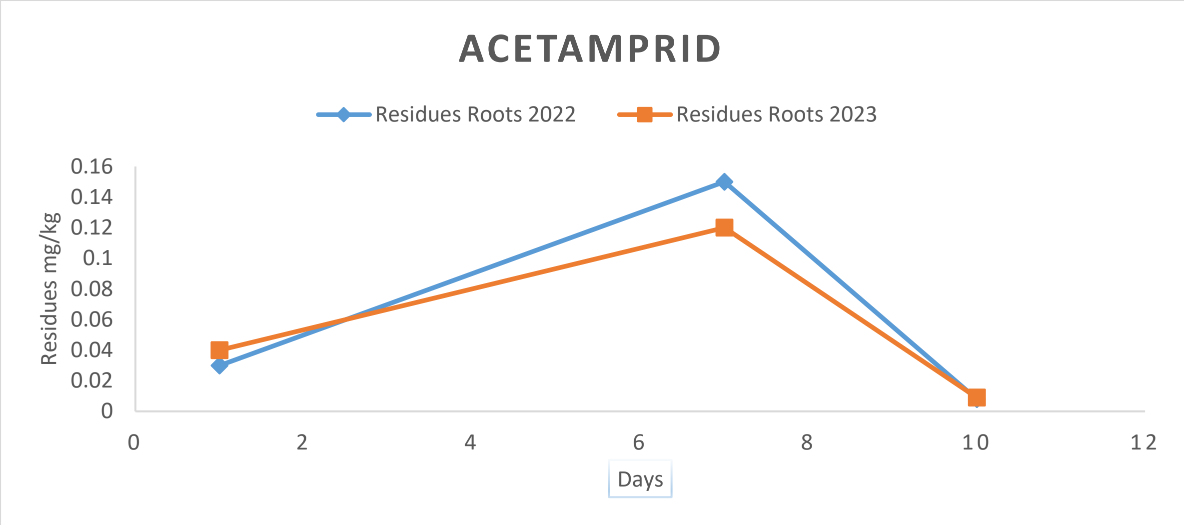

Fig. 5: Dissipation behavior of Acetamprid in Sugar Beet Roots Season 2022-2023under field conditions

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الفعالية الحقلية ومتبقيات المبيدات الحشرية البايريثرويدية والنيونيكوتنويدية والمضادة للتغذية ضد حشرات المن في بنجر السكر المصري.

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الملخص العربى:

تـ شكل إ صابات المنّ تهديدًا شديدًا لإنتاج بنجر الـ سكر في مـ صر، لذا فإن هناك حاجة إلى اجراءات فعالة ومـ ستدامة. تم تقييم أعداد المنّ وتحليل بقايا ثلاثة مبيدات حـ شرية—لامبدا- سيهالوثرين، فلونيكاميد، وا سيتامبريد في حقول بنجر الـسكر في محافظة كفر الـشيخ، مـصر على مدار مو سمين (٢٠٢٢-٢٠٢٣) با ستخدام أربعة مبيدات حـ شرية: لامبدا- سيهالوثرين (مبيد حـ شري من نوع البايريثرويدية)، فلونيكاميد (عامل مـ ضاد للتغذية)، وا سيتامبريد ، وإيميداكلوبريد (نيونيكوتنويد). تم ا ستخدام طريقة هندر سون وتيلتون لتقييم معدلات انخفاض الأعداد بعد ١، ٧، و١٠ أيام من المعالجة. بحلول اليوم العا شر، أظهرت جميع المبيدات حـ شرية فعالية كبيرة، حيث كان هناك انخفاض في الأعداد بنـ سبة تزيد عن ٩٨%. بينما أظهر فلونيكاميد تأثيرًا مضادًا للتغذية متأخرًا ولكنه مستمر، قدم لامبدا-سيهالوثرين تأثيرًا سريعًا في البداية. بينما أظهرت النيونيكوتنويد تحكمًا أوليًا معتدلًا، كان لها نشاط متبقي كبير. في فترات زمنية مختلفة، أظهرت تحليل التباين الأحادي (ANOVA) اختلافات ملحوظة ($p < 0.05$) بين فئات المبيدات. تؤكد النتائج على ضرورة اختيار المبيدات الحشرية لبرامج إدارة الآفات المتكاملة (IPM) يُعتبر فلونيكاميد مفيدًا جدًا للتحكم المستدام في المنّ نظرًا لخصائصه المضادة للتغذية وانخفاض خطر المقاومة.

قبل التجارب الميدانية، تم تحليل تركيبات المبيدات الحشرية التي تم التحقيق فيها قبل وبعد التخزين عند ٥٤ ±٢ درجة مئوية لمدة ١٤ يومًا. أظهر تقييم محتوى المادة الفعالة، وقابلية التعلق، والانحلال، وثبات المحلول، بالإ ضافة إلى عدة عوامل أخرى، التوافق مع الموا صفات الكيميائية والفيزيائية المطلوبة.

فيما يتعلق بمتبقيات المبيدات، لم يتم العثور على اختلافات ملحوظة في النتائج التحليلية بين المو سمين للمبيدات الحشرية الثلاثة المستخدمة في التجربة، سواء في أوراق أو جذور بنجر الـ سكر. في مو سم ٢٠٢٢، أظهرت النتائج أن الأوراق تحتوي على متبقيات أكثر من الجذور، حيث تراوحت المتبقيات في الأوراق بين ١,٦ ±٠,١ إلى ٣,٢ ±٠,٨٥ ملغم/كغم، وفي الجذور تراوحت بين ٠,٠١٨ ±٠,٠٠٢ إلى ٠,٠٦ ±٠,٠٠٢ خلال المو سمين اللذين تم اختباره. كانت كميات المتبقيات في نباتات بنجر الـ سكر (الأوراق والجذور) المعالجة بالمبيد الحـ شري فلونيكاميد أعلى من تلك الموجودة في النباتات المعالجة بمبيد لامبدا سيهالوثين أو أ سيتامبريد، وهذه النتائج تعود إلى الاختلافات في المعدلات المو صى بها للمبيدات الثلاثة المـ ستخدمة. بناءً على الحد الأقـ صى لمـ ستوى المتبقيات (MRLs)، كانت فترات ما قبل الحـ صاد (PHI) لمبيد لامدا سيهالوثين، فلونيكاميد، وأ سيتامبريد ٣، ٩، و٦ أيام بعد المعالجة، على التوالي. وهذا يـ شير إلى أن جذور بنجر الـ سكر المعالجة بالمبيدات الثلاثة آمنة للا ستخدام بعد هذه الفترات.