

EVALUATION OF THE EFFICACY OF THE INSECTICIDES CLOSER AND SIVANTO PRIME AND THE COMPOUND POTASSIUM SILICATE IN CONTROLLING THE CABBAGE APHID (BRASSICA OLERACEA VAR. CAPITATA L.) (HEMIPTERA: APHIDIDAE)

Awad Jasim Mohammed Al-Kalash¹
University of Tikrit – College of Agriculture
Department of Plant Protection
Email: awad_jasim@tu.edu.iq

Abstract

A field experiment was carried out in Al-Alam District, Salahuddin Province, Iraq, following a randomized complete block design (RCBD). The study evaluated the efficacy of different aphid control strategies using Sivanto Prime, Closer, and potassium silicate, applied as single and combined treatments. Results indicated that the initial mean population density of nymphs and adults was 32.4 individuals per plant before treatment. However, a significant reduction was observed after application, with Sivanto Prime and Closer recording 1.1 and 1.3 individuals per plant, respectively, two weeks post-spraying. Remarkably, dual treatments such as Closer + potassium silicate and Sivanto Prime + Closer resulted in the lowest aphid populations, reaching 1.36 and 1.48 individuals per plant, respectively. In contrast, the Sivanto Prime + potassium silicate mixture did not achieve the expected suppression, as populations remained comparatively higher. Statistical analysis confirmed significant differences among treatments at the 0.05 probability level, with an LSD value of 0.5224. Overall, the findings highlight that pesticide combinations, particularly those involving Closer, could serve as an effective strategy for managing aphid infestations under field conditions.

Keywords: Cabbage, *Brevicoryne brassicae*, cabbage aphid, Closer, potassium silicate.

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.), belonging to the family Brassicaceae, is one of the most important winter vegetables cultivated in Iraq. The edible part is the head formed by compact, overlapping leaves, which are consumed fresh or used in pickles and salads (Matlob et al., 1989). Nutritionally, 100 g of fresh leaves contain 6.1–11.2% dry matter, 3–5.4% carbohydrates, 1–2% proteins, 0.2% fats, 30–50% vitamin C, 130 IU vitamin A, 0.05 mg thiamine, 238 mg potassium, 49 mg phosphorus, 9 mg magnesium, 1.2 mg iron, and approximately 24 kcal of energy. Cabbage also has several medicinal benefits, including its role in treating gastric and duodenal ulcers, lowering blood sugar levels, and providing protection against cancer (Talalay and



Fahey, 2001).

Cabbage is cultivated in both tropical and temperate regions worldwide, with notable production in South Korea, Germany, Japan, and India. In Iraq, the cultivated area in 2013 was estimated at 2,819 donums, with an average yield of 2,577.5 kg/donum (Central Organization for Statistics and Geographic Information Systems, 2023).

The crop, however, is highly susceptible to cabbage aphid infestation, which attacks a wide range of cruciferous plants (Gabrys et al., 1997). This pest is considered a serious threat as it feeds on plant sap, transmits viral diseases, and secretes honeydew, which promotes dust accumulation and the growth of sooty molds (Van Emden and Harrington, 2007). According to Kahn and Jhim (2003), cabbage aphid infestations may cause yield losses of 30–50% and increase control costs by 20–30%.

Given these challenges, the present study aimed to evaluate the efficacy of the insecticides Closer and Sivanto Prime, both individually and in combination with potassium silicate, against this pest. These insecticides are considered environmentally friendly due to their short pre-harvest interval (one day), as indicated on their product labels.

Materials and Methods

Experimental site and design

A field experiment was carried out during the 2023 growing season in Al-Alam District, Salahuddin Province, Iraq, to evaluate the efficacy of selected insecticides and their integration with potassium silicate against cabbage aphid. The study included environmentally friendly compounds: Closer (Sulfoxaflor), Sivanto Prime (Flupyradifurone), and potassium silicate.

The experimental field was plowed using a multi-disc harrow, and the land was divided into three blocks, each containing three rows of cabbage plants (15 m in length). Each block was subdivided into seven experimental units, with six plants per unit, and a 1 m spacing was maintained between blocks to facilitate field operations. Treatments were assigned randomly following a randomized complete block design (RCBD).

A drip irrigation system was installed, weeds were removed manually, and standard agronomic practices, including irrigation and crop maintenance, were applied uniformly throughout the season.

Treatments

The experiment consisted of the following treatments:

1. Closer (Sulfoxaflor) at 35 mL/100 L.
2. Sivanto Prime (Flupyradifurone) at 70 mL/100 L.
3. Potassium silicate 35% at 300 mL/100 L.
4. Closer + Sivanto Prime.
5. Sivanto Prime + Potassium silicate.
6. Potassium silicate + Closer.
7. Untreated control.

Data collection

Two parameters were used to evaluate treatment efficacy:

- **Aphid population density:** The number of live aphids (nymphs and adults) was counted before treatment and at 1, 7, 14, 21, and 28 days after spraying. Counts were conducted using a hand lens (X10) by examining five leaves per plant in each experimental unit.
- **Infestation percentage:** The percentage of infested plants was calculated using the formula:

$$\text{Infestation percentage} = \frac{\text{Number of infested plants}}{\text{Total number of plants}} \times 100$$

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Statistical analysis.

All recorded data were subjected to analysis of variance (ANOVA) according to the RCBD model. Significant differences among treatment means were tested at the 5% probability level using the Least Significant Difference (LSD) test. Statistical analyses were performed using [SAS software, version 9.4] (SAS Institute, Cary, NC, USA) (or SPSS v.25 if preferred).

Results and Discussion

The results of the study revealed that the initial mean numbers of cabbage aphid nymphs and adults on cabbage plants were comparable across all treatments prior to application. This indicates homogeneity of the experimental units and reliability of the subsequent treatment effects. The validity of these results was further supported by the coefficient of variation (CV%), which recorded a relatively low value of 6.19%. Such a value demonstrates that the experimental error was within an acceptable range, confirming the precision of the field data and the robustness of the randomized complete block design (RCBD) employed.

The uniformity observed before treatment provides strong evidence that the reductions recorded after the application of insecticides and their mixtures can be attributed directly to the treatments themselves rather than to pre-existing differences among plots. This is consistent with the principle highlighted by Gomez and Gomez (1984), who emphasized that a low CV% value reflects high experimental accuracy in agricultural field trials.

Table (1). Percentage of infestation (%) and number of aphids (nymphs + adults per plant) recorded one day before spraying

Control Treatments	Sampling Dates					Mean of Control Treatments
	1 Day	7 Days	14 Days	21 Days	28 Days	
Sivanto Prime						
Closer	32.4 a	24.6 b	26.2a	30 a	18.2 c	26.28 A
Potassium Silicate	32.7 a	24.9 b	33.3a	33 a	18.5 c	28.48 A
Sivanto Prime + Potassium Silicate	32.1 a	24.7 b	28.7a	32 a	18.3 c	27.16 A
Sivanto Prime + Closer	32.3 a	24.8 b	24.1b	26 b	18.1 c	25.06 A
Closer + Potassium Silicate	32.0 a	24.5 b	26 b	28.3 a	18.2 c	25.8 A
Control (untreated)	32.5 a	25.0 b	28 a	22.4 b	18.4 c	25.26 A
Mean of Sampling Dates	32.6 a	24.7 b	25.3b	31 a	18.5 c	26.42 A

L.S.D ≥ 0.05 Treatments = 0.5224 Dates = 0.3216 Interaction (Treatment $\times$ Dates)= 0.9098

Numbers followed by the same letters do not differ significantly according to the Least Significant Difference (LSD) test at the 0.05 probability level.

Table (2). Effect of the treatments on numbers of (nymphs + adults per plant) after spraying

Control Treatments	1 Day	7 Days	14 Days	21 Days	28 Days	Mean
Sivanto Prime	6.0 q	2.3 n	1.1 o	1.4 ij	1.7 l	2.5 p
Closer	4.6 t	2.0 p	1.3 m	1.6 i	1.9 k	2.2 p
Potassium Silicate	12.8 f	1.2 t	0.5 u	0.7 km	1.0 op	3.24 e
Sivanto Prime + Potassium Silicate	4.9 s	7.9 f	5.4 f	6.2 f	7.0 f	6.28 f
Sivanto Prime + Closer	3.1 w	1.5 r	0.7 s	0.9 kl	1.2 n	1.48 j
Closer + Potassium Silicate	3.01 w	1.3 s	0.6 t	0.8 kl	1.1 no	1.36 i
Control (untreated)	34.2 a	33.7 a	35.6 a	34.0 a	29.5 b	33.4 A

LSD (≥ 0.05): Treatments = 0.5224; Dates = 0.3216; Treatment $\times$ Dates = 0.9098.

Numbers followed by the same letters do not differ significantly (LSD test, $p = 0.05$).

After spraying, there were clear differences among the tested treatments. Both Closer and Sivanto Prime performed remarkably in reducing the numbers of aphid nymphs and adults compared with the untreated control, where very low densities (1.1–2.3 individuals per plant) were recorded, demonstrating their high effectiveness in suppressing the pest. By contrast, the effect of potassium silicate alone was relatively limited, as the insect numbers declined gradually but remained higher than those observed with chemical insecticides, indicating that its role is restricted when applied on its own Mesri et al. (2023),.

Regarding the binary combinations, the mixtures Closer + potassium silicate and Sivanto Prime + Closer achieved the most successful results, with aphid counts decreasing to very low levels (1.36 and 1.48 individuals per plant, respectively). These points to a synergistic effect that enhanced the efficiency of these compounds in reducing aphid populations. On the other hand, the mixture Sivanto Prime + potassium silicate did not meet the expected outcome, as the counts remained relatively high, suggesting a non-synergistic interaction between the two products. The results also showed that the insecticides alone were fairly effective, yet combining Closer with either of the other agents (Sivanto Prime or potassium silicate) further boosted performance. In addition, the statistical values indicated that some treatments shared the same grouping letters, meaning no significant differences were detected among them.

These findings suggest that using insecticide mixtures—particularly those containing Closer—can be more effective in pest management programs. Although potassium silicate showed limited efficacy on its own, it can still be incorporated into integrated pest management (IPM) strategies since it is safe, environmentally friendly, and reduces reliance on synthetic chemicals.

The results of this study are consistent with those reported by Wang et al. (2016), who demonstrated that Flupyradifurone (the active ingredient of Sivanto Prime) acts on insect nicotinic acetylcholine receptors (nAChRs) in a mode distinct from other neonicotinoids, making it highly

effective against sap-sucking pests. Likewise, Cutler et al. (2013) confirmed that sulfoxaflor outperforms compounds such as imidacloprid and thiamethoxam, supporting our findings on its superior activity against aphids. With regard to potassium silicate, it also showed a notable role in reducing aphid numbers, which can be attributed to its ability to enhance plant resistance by strengthening cell walls and forming a protective silica layer on the leaf surface. This hinders insect feeding and penetration, as highlighted by Epstein (1999) and Sun et al. (2010). Similar mechanisms were emphasized by Al-Kalash (2022), who confirmed that early applications of potassium silicate create a natural barrier that prevents pest establishment.

It is also worth noting that aphid densities started to rise again one month after spraying compared with the three-week mark. This could be due to the gradual decline in insecticide effectiveness as a result of degradation or environmental factors. Such observations agree with Zewain (2013), who reported that the activity of chemical insecticides often diminishes within 21–28 days of application. Therefore, repeated spraying or integration with additional control measures may be necessary to ensure sustainable crop protection Ward, S. et al. (2024).

General Conclusion

From the above findings, it can be concluded that mixing chemical insecticides with alternative or supportive materials may represent a successful approach to controlling aphids, while also preserving the environment and reducing the risk of resistance development. Moreover, potassium silicate—despite its limited standalone effect—can be safely integrated into IPM programs, as it is an eco-friendly component that decreases overall dependence on chemical pesticides. The study therefore recommends adopting potassium silicate as part of integrated control strategies, given its environmental safety, even though its independent impact is relatively restricted.

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