# Comparative Efficacy of Three Doses of COLAM 247 SC in the Management of Cabbage Insect Pests in Western Burkina Faso

Comment [H1]: Is that trade or common name?


**ABSTRACT**

**Aims:** Contribute to protect Cabbage crops by evaluating the biological efficacy of a new binary, COLAM 247 SC.
**Study design:**A completely randomized Fisher block with five treatments and four replicates.
**Place and Duration of Study:**The study was carried out in a farming environment on the developed perimeter of the Vallée du Kou between September and December 2022.
**Methodology:**Treatments included Colam 1 (0.075 ml/ha), Colam 2 (0.15 ml/ha), Colam 3 (0.25 ml/ha), K-optimal (1/ha) and the untreated control. Each elementary plot covered an area of 24 $m^2$. The distance between elementary plots was 1 m and that between blocks was 2 m. Plant spacing was 0.5 m between bunches and 0.8 m between rows, for a total of 60 plants per elementary plot
**Results:**More than 80% of Aphids populations was reduced by the three doses of Colam 247 SC and K-optimal. The low reduction rates of diamondback moth larvae population were observed with the three doses of Colam 247 SC (14.36 to 21.79%) while K-optimal failed to reduce the larvae population of this insect pest.Chemical insecticide used contributed to improve cabbage yield (74.5 to 89.30 t/ha) as compared to the control (73.50 t/ha) even though statistical analyses did not reveal any significant difference (*P*> .05).
**Conclusion:**The Colam 247 SC at the dose of 0.15 l/ha can be used by farmers as an additional insecticide in the control of cabbage insect pests.


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**Keywords**: *Cabbage crop, density, yield, insecticide, chemical control, caterpillar*


## 1. INTRODUCTION

In Burkina Faso, agriculture employs 80% of the population and contributes an average of 33% to gross domestic product **[1]**. The area of arable land is estimated at 9 million hectares and includes cereal, cash and vegetable crops **[2]**. Market gardening is generally practiced in the dry season and helps to combat unemployment and the food crisis **[3]**. They are grown in areas where water is accessible, i.e. in low-lying areas, rivers and dams **[4]**. Several types of vegetable are produced, both exotic and local. Among these, cabbage (*Brassica oleracea* L.), from the Brassicaceae family, is one of the main vegetable crops produced in Burkina Faso. It is one of the most widely grown vegetable crops in the world. According to statistics of the **[5]**, cabbage is grown in almost 150 countries, with an annual production of 70 million tons. In Burkina Faso, this crop ranks third after bulb onions and tomatoes, with national production of 107,476 tonnes. Almost all of this production is marketed (99.1%), with relatively high-income levels for producers. The annual profit generated by cabbage growing is estimated at over 14.47 billion F CFA, or 18% of total vegetable production **[6]**. The most productive regions in Burkina Faso are Centre, Centre-Ouest and Hauts-Bassins **[6]**. It is renowned for its nutritional values, notably its richness in vitamins A, C, K, B6 and antioxidants **[7]**. Consumption of cabbage reduces the risk of contracting certain diseases such as cancer, cardiovascular disease, cataracts and diabetes **[8]**. However, this vegetable falls victim to the attacks of several insect pests, which constitute a major constraint to its production. In Africa, the main insect pests infesting cabbage are diamondback moth (*Plutella xylostella*), cabbageworm (*Helula undalis*), cabbageworm (*Pieris brassicae*), cabbage aphid (*Brevycoryne brassicae*), cabbage looper (*Trichoplusia ni*) and green peach aphid (*Myzus persicae*) **[9; 10]**. However, the diamondback moth and cabbageworm are the most destructive insect pests of Brassica vegetable crops in many parts of African countries, and are especially damaging in tropical and subtropical regions **[1112]**. These insects attack the leaves, apical bud, head and stem, causing enormous damage to cabbage **[13;14]**. Indeed, insect pests can cause production losses ranging from 10 to 30% on crops **[15]**. These insect pests infest *Brassica oleracea* crops at different growth stages, causing enormous destruction to cabbage crops during the growing stages and resulting in huge yield losses in the fields **[16 ;11]**. Damage and its impact on yield depend on the cabbage variety grown and other ecosystem elements such as natural enemies, weather conditions, fertilizer and water availability **[17 ;12]**.

Smallholder farmers in African countries rely intensively on the application of synthetic broad-spectrum pesticides to control cabbage insect pests **[18]**. Most pesticides (around 79%) used are synthetic broad-spectrum insecticides, including organophosphates (OPs) (profenofos, WHO class II), pyrethroids (cypermethrin and deltamethrin, WHO class II) and avermectin preparations (abamectin, WHO class Ib), with WHO class Ib considered very hazardous and WHO class II moderately hazardous **[18; 19]**.

Several molecules are used to control cabbage insect pests, most of them belonging to the pyrethroid group. These pyrethroids are a new generation of pesticide which, thanks to their liposolubility, pass through the insect membrane and act on the nervous system **[20]**. But the permanent and continuous use of the same molecules could lead to resistance in insect pests **[18; 21]**. To help provide growers with a wide range of products, a new binary insecticide under the trade name COLAM 247 SC, consisting of Lambda-cyhalothrin 106 g/l + Thiamethoxam 141 g/l, was tested on farmers. It is a broad-spectrum, highly systemic, translaminar, long-acting contact insecticide, particularly suited to the control of larvae and adults of chewing, biting-sucking and sucking insects. It belongs to the neonicotinoid pyrethroid family. The general aim of this study is to assess the biological efficacy of COLAM 247 SC against aphid and caterpillar pests of cabbage. More specifically, the aim will be to determine the dose needed to reduce the population density of insect pests, and to compare this dose with that of the product commonly used by growers to manage these pests.

## 2. MATERIAL AND METHODS

### 2.1. Study site

The study was carried out in a farming environment on the developed perimeter of the Vallée du Kou. This perimeter is in the rural commune of Bama, which is located 25 km, northwest of the city of Bobo-Dioulasso. It is located between 11˚23'48'' North latitude, 4˚25'37'' West longitude and at an altitude of 300 m.

**Comment [H5]:** Add country name.

### 2.2. Material

The biological material used is the cabbage variety (*Brassica oleracea* var. capitata L) Oxylus F1. This variety can be grown all year round, with a cycle of 70-75 days. The technical equipment consisted of a 16-l backpack sprayer and personal protective equipment (PPE). The phytosanitary products used were the test product, Colam 247 SC, with the active ingredients' lambda-cyhalothrin 106 g/l and thiamethoxam 141 g/l, and the reference product, K-Optimal, with the active ingredients' lambda-cyhalothrin 15 g/l and acetamiprid 20 g/l.

### 2.3. Methods

**2.3.1. Experimental set-up**(ARIAL, BOLD, 10 FONT, LEFT ALIGNED, underlined)

The experimental set-up was a completely randomized Fisher block. Each block consisted of five (5) treatments repeated four (4) times. Each elementary plot covered an area of 24 m2. The distance between elementary plots was 1m and that between blocks was 2m. Plant spacing was 0.5 m between bunches and 0.8 m between rows, for a total of 60 plants per elementary plot (Figure 1).

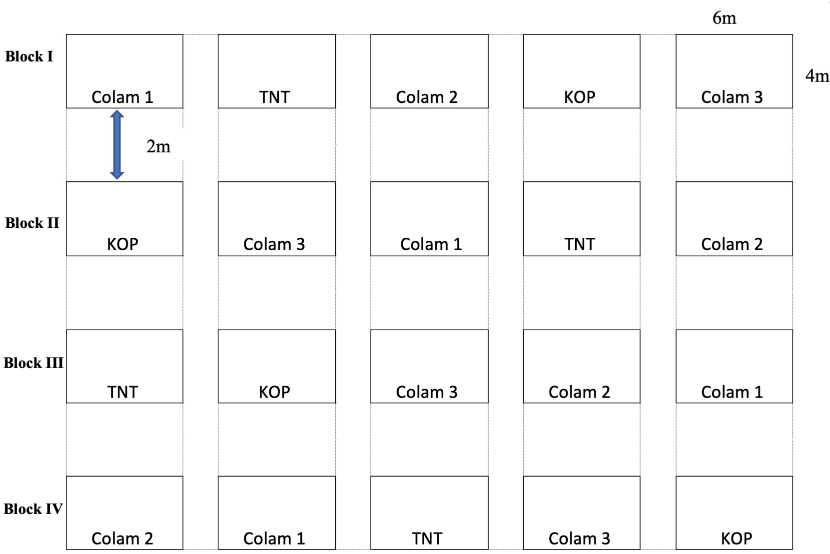


**Figure 1:** Experimental set-up of the trial (KOP= K-Optimal; TNT= Control; Colam 1= dose of 0.075l/ha; Colam 2= dose of 0.15l/ha; Colam 3= dose of 0.25 l/ha)

**2.3.2. Cultivation management**

Prior to planting, a nursery was set up and maintained to produce healthy and vigorous plants. No insecticide treatments were applied to the plants in the nursery. Regular watering was carried out while the plants were in the nursery. Four weeks later, the plants were transplanted according to the above-mentioned experimental set-up. A well-decomposed organic fertilizer was applied after transplanting. An application of 0.5 t/ha of NPK fertilizer (15-15-15) was made in two fractions of 0.25 t/ha. The 1$^{st}$ application was made two weeks after transplanting and the second after 45 days. Irrigation and weeding operations were carried out on demand.

**2.3.3. Insecticide applications**

Insecticide applications were made every 14 days to all cabbage plants in each elementary plot, in accordance with the dose and treatment indicated (Table 1). Three doses of COLAM 247 SC were compared with each other and with the effective dose of the reference product. The first application was made as soon as insect pests appeared in the cabbage plots. Sprays were applied with a backpack pressure washer, taking care to rinse the washer between treatments. A total of five treatments were carried out during this study.

**Table 1: Summary of objects to be compared**

| Treatments | Active substance | Dose (l/ha) | Quantity of material / 96 $m^2$ |
|---|---|---|---|
| COLAM 1 | lambda-cyhalothrine 106 g/l + thiaméthoxame 141 g/l | 0.075 | 0.75 ml diluted in 5 l of water |
| COLAM 2 | lambda-cyhalothrine 106 g/l + thiaméthoxame 141 g/l | 0.15 | 1.5 ml diluted in 5 l of water |
| COLAM 3 | lambda-cyhalothrine 106 g/l + thiaméthoxame 141 g/l | 0.25 | 2.5 ml diluted in 5 l of water |
| K-Optimal | acétamipride 20 g/l + lambda cyhalothrine15 g/l | 1 | 10 ml diluted in 5 l of water |
| Untreated Control | - | - | - |

<u>**2.3.4. Evaluation of insect pest population density**</u>

To assess the density of insect pests, a sample of 10 cabbage plants taken at random from the central rows of each elementary plot was selected for observation. These observations consisted in identifying and counting aphid populations and lepidopteran larvae (*Hellula undalis* and *Plutella xylostella*). A first observation was made in all plots before the application of the products to assess the initial insect density (aphids and caterpillars), then at one-week intervals until the end of the experiment.

<u>**2.3.5. Evaluation of insect infestation levels on cabbage**</u>

The infestation rate of cabbage plants was assessed on 10 plants in each elementary plot. These plants were marked to avoid double counting. Careful observations were made on these plants to check for the presence of insect pests. A plant is considered non-infested if no insects or symptoms of damage are observed on it. It is considered infested if at least one insect pest is found. Infestation rates were assessed on $23^{th}$DAT (before treatment) and $30^{th}$DAT (one week after the first treatment). Infestation rates were calculated using the following formula:

T= $\left(\frac{A}{B}\right) * 100$T= infestation rate; A= total number of infested plants; B= total number of observed plants

<u>**2.3.6. Cabbage yield assessment**</u>

At maturity, all cabbages in the central rows of each elementary plot were harvested. They were then counted and weighed using a balance. All unheaded cabbages due to insect attack were also identified and counted in each elementary plot. The unheaded cabbages listed had characteristics such as the presence of several “heads” or completely perforated leaves. The presence of several cabbage “heads” is a plant response to *H. undalis* larvae attack.

**2.4. Data analysis**

The data collected were subjected to Shapiro's and Fligner's tests using R software to verify normality and homogeneity of variances. As the data did not meet these criteria, a non-parametric Kruskal-Wallis test was performed to compare the different means. In the event of significant differences between treatments, the pairwise-test was used to separate the different means at the 5% probability threshold. The following formula of[22]was used to calculate the biological efficacy of insecticides tested during the study.

$$Ep(\%) = \left[1 - \left(\frac{DTa}{DTb} \times \frac{DCb}{DCa}\right)\right] \times 100$$ , where

DTb and DCb = pest density before pesticide application in treated and control plots respectively; and DTa and DCa = pest density after pesticide application in treated and control plots respectively.

The parameters considered in these analyses were:

- Average number of insects / cabbage plant according to observation and product application periods;
- Cabbage yield obtained for each treatment;
- Infestation rates.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

#### 3.1.1. Cabbage insect pests' population fluctuations during the study

The most important insect pests found on cabbage plots during the study were aphids and larvae of the butterflies *Plutella xylostella* and *Helulla undalis*. Aphids were the most abundant, with a total number of 14,196 individuals, followed in sequence by *P. xylostella* larvae (1,539 individuals) and *H. undalis*larvae (85 individuals).

##### *3.1.1.1. Aphid population fluctuations as a function of treatments*

**Figure 2** illustrates the effect of treatments on aphid population fluctuation. In this figure, it can be seen that the three doses of COLAM 247 SC and K-Optimal significantly reduced aphid density compared with the control (***P* < .001**).

In fact, immediately after the first treatment, which was carried out at 23 days after transplanting (DAT), aphid density decreased in all treated plots and was cancelled out from 30$^{th}$DAT onwards. Over the same period, aphid density in untreated plots increased rapidly until the end of the experiment. Aphid density reduction rates for Colam 1, Colam 2, Colam 3 and K-Optimal were 89%, 97.74%, 99.81% and 99.64% respectively, compared with the untreated control (Table 2).

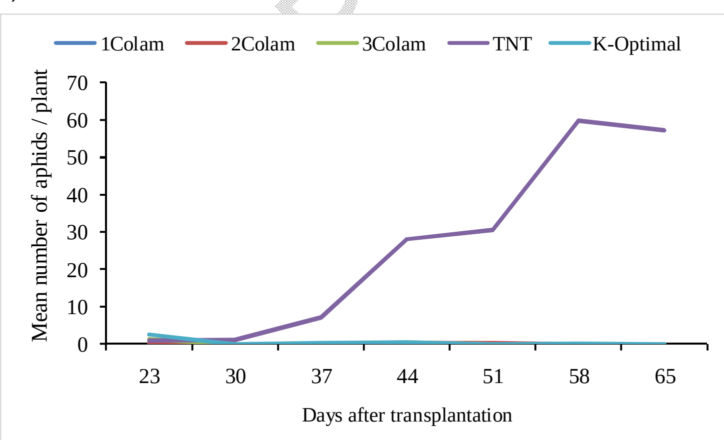

**Figure 2**: Aphid populations' fluctuation depending on the treatments

**Table 2**: Biological efficacy rate of different treatments on aphids

| Treatments | Mean efficacy rate (%) |
|---|---|
| Control | - |
| COLAM 1 | 89 |
| COLAM 2 | 97.74 |
| COLAM 3 | 99.81 |
| K-Optimal | 99.64 |

***3.1.1.2. Fluctuations in P. xylostella larvae populations as a function of treatments***

The average number of *P. xylostella* larvae varied in a sawtooth pattern across all treatments (**Figure 3**). After the first insecticide applications, the population density of *P. xylostella* larvae decreased in all plots, in contrast to the untreated plots. From the 37$^{th}$ DAT, when the second insecticide application took place, the density of the diamondback moth larvae increased significantly in plots treated with K-Optimal and Colam 2, before declining from the 44$^{th}$ DAT. The lowest pest larvae density was obtained with Colam 3.

Observation of the variation curves for *P. xylostella* larvae population density shows that the different doses of Colam used were less effective in reducing *P. xylostella*larvae density. As for the K-Optimal, it wasineffective against*P. xylostella* larvae, so that plots treated with this product had a gain in insects compared with the untreated ones. Reduction rates were 14.36%, 16.06%, 21.79% and -193.20% respectively for Colam 1, Colam 2, Colam 3 and K-Optimal.

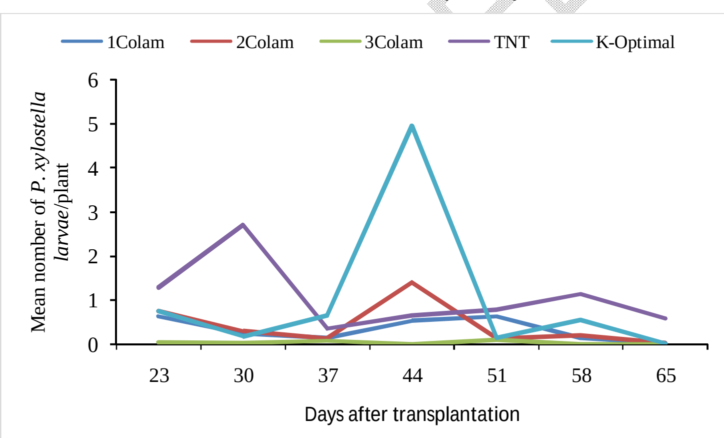


**Figure 3**: Fluctuation of the populations of*P. xylostella* larvae according to the treatments

**Table 3: Biological efficacy rates of different treatments on *P. xylostella* larvae**

| Treatments | Mean efficacy rate (%) |
|---|---|
| Untreated control | - |
| COLAM 1 | 14.36 |
| COLAM 2 | 16.04 |
| COLAM 3 | 21.79 |
| K-Optimal | -193.20 |

***3.1.1.3. Fluctuation in Hellula undalis larvae populations according to the treatments***

In both treated and control plots, the average number of *H. undalis* larvae was very low, ranging from 0 to 0.2 individuals/plant. **Figure 4** illustrates the fluctuating density of *H. undalis* larvae populations were highest in untreated control plots.

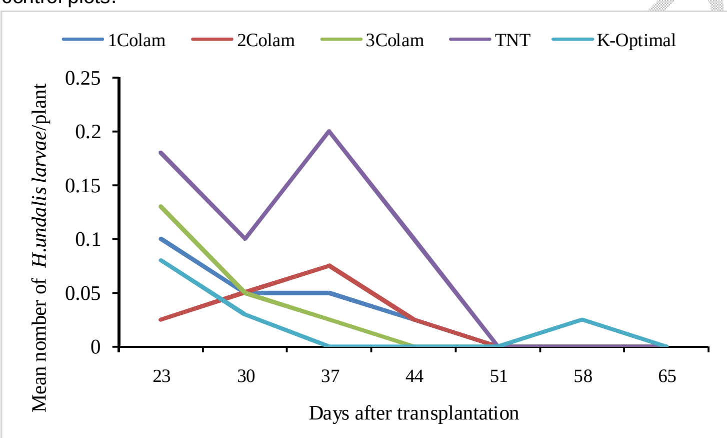


**Figure 4 :**Fluctuation of populations *H. undulis* larvae according to the treatments

**3.1.2. Effect of treatments on plant infestation levels**

**Table 4** shows the effect of different treatments on plant infestation levels. Statistical analyses show a significant difference between treatments (*P*=.01). Rates of infested cabbage plants ranged from 43.75 ± 21.34% for those treated with K-Optimal to 73.75 ± 10.61% for untreated controls. Plots treated with all three doses of colam had less infested cabbage plants compared with the control plot.

**Table 4:** Effect of the treatments on cabbage infestations by insect pests

| Treatments | Infestation rates (%) |
|---|---|
| Untreated control | 73.75 ± 10.61 a |
| COLAM 1 | 46.25 ± 20.66 b |
| COLAM 2 | 46.25 ± 16.85 b |
| COLAM 3 | 40.00 ± 14.14 b |

| | |
|---|---|
| K-Optimal | 43.75 ± 21.34 b |
| ***P*** | ***.01**** |

**3.1.3. Cabbage yields**

Cabbage yields recorded according to each treatment are presented in Table 5. Statistical analysis revealed no significant difference between treatments (*P* = .68), but plots treated with the three doses of Colam 247 SC and the single dose of K-Optimal were better (74.5 to 89.30 t/ha) than untreated plots (73.3 t/ha). These yields were related to the number of apples obtained, which was high, with larger apples in the treated plots than in the control plots. The average number of unapple cabbages obtained at harvest was higher in the control plots than in the treated ones.

**Table 5:** Effect of treatments on cabbage yields

| Treatments | Average number of head cabbage | Average number of headless cabbages | Yield (t/ha) |
|---|---|---|---|
| TNT | 123 ± 11.80 | 10 ± 2.12 | 73.30 ± 10.61 |
| COLAM 1 | 123.75 ± 6.75 | 6.25 ± 1.65 | 74.50 ±11 |
| COLAM 2 | 124.25±11.17 | 9.25 ± 2.95 | 77.20 ±10.98 |
| COLAM 3 | 137.25 ± 13.40 | 8.25 ± 2.39 | 88.50 ± 11.88 |
| K-Optimal | 142.50 ± 7.58 | 3.75 ± 1.38 | 89.30 ± 9.11 |
| **P** | .45 | .28 | .68 |

## 3.2. Discussion

**Comment [H6]:** Add more discussion with other common compounds.

The main insect pests observed on Cabbage plots during our study were already encountered in cabbage fields in other African countries such as Côte d'Ivoire, Senegal, Ghana and Tanzania **[23;14; 20]**. *Plutella xylostella* is an oligophagous species, and its larvae feed mainly on plants of the brassica family, such as cabbage **[24; 25]**. The larvae of this insect pest can attack cabbage from the nursery to the field causing damage **[(26;18]**. *H. undalis* larvae attack the "heart" of the cabbage, which can lead to its death. A single larva can destroy an entire plant **[27; 28]**. Aphids, for their part, have been found on both sides of leaves and can cause the death of the plant in the absence of any phytosanitary treatment. Attacks inflicted by these insect pests on cabbage limit its productivity and consequently economic losses **[16; 11]**. To control these insect pests, several synthetic products are used with the aim of minimizing production losses **[18; 29]**.

The biological efficacy of the three doses of the chemical insecticide, Colam 247 SC, was evaluated in comparison with the reference control and the untreated control. Statistical analyses showed that the efficacy of Colam 247 SC differed depending on the pest. In fact, the three doses of Colam 247 SC and the reference control (K-Optimal) reduced the aphid population by over 80%. Both products are broad-spectrum binary insecticides, acting by contact or systemically, and with active ingredients that certainly give them a better effect on aphids. These results corroborate those of**[30]** who found that K-Optimal rapidly reduced the aphid population density. These results are also in accordance with those presented by**[31],**who showed that the combined use of thiamethoxam + lambda-cyhalothrin significantly reduced aphid population density.

As for *P. xylostella* larvae, the reduction rate was very low and varied from one dose of Colam 247 SC to another. The highest reduction rate (21.79%) was obtained with the high dose of Colam (Colam 3).

The use of K-Optimal did not control the insect pest compared with the untreated control, although this insecticide is commonly used by growers in the control of cabbage insect pestsin Burkina Faso. These results show that *P. xylostella*has developed a certain resistance to insecticide products, making it difficult to control its larval populations. Studies have shown that *P. xylostella* larvae are resistant to over fifty insecticides and to *Bacillus thuringiensis***[32; 33; 34; 35; 36]**. In Burkina Faso, the Hauts-Bassins region is one of the most important cabbage-growing areas, and this crop is grown all the year round with insecticide treatments. This practice could lead to insecticide resistance in certain insect pests. Indeed, several authors have stated that in areas where cabbage is grown all year round, the level of resistance is very high due to the continuous use of insecticides **[37; 29;38].**

The density of *H. undalis* larvae found on the plants during the study was very low, so statistical analysis revealed no significant difference between treatments. However, symptoms of damage caused by this insect pest were observed in the plots. Indeed, some cabbages with several heads were often observed in cabbage plots during the experiment, as also showed by **[39]** in Senegal on plants attacked by *H. undalis* larvae.

The average infestation rates in plots treated with the three doses of Colam 247 SC and K-Optimal were significantly low compared with the control plots; this was obvious given that the number of individuals of the various insect pests recorded was high in the control plots. Studies have shown that the degree of infestation of cabbage by insect pests was higher in control plots than in plots treated with chemical insecticides **[10; 28]**. The results of statistical analyses on cabbage yield show that these infestations did not cause any damage that could affect the cabbage head. Therefore, in our study conditions, Cabbageyield was not correlated with cabbage pest infestation rates. Although the effects were not significant, the average number of cabbages harvested in the treated plots was higher than in the untreated control plots, which translated into higher yields. In fact, the cabbage harvested in the treated plots were larger as compared to those recorded in control plots.

**4. CONCLUSION**

The aim of this study was to evaluate the biological efficacy of three doses of Colam 247 SC on cabbage insect pests, compared with the reference control, K-Optimal, and the untreated control. The results showed that all three doses of Colam 247 SC (0.075 ml/ha; 0.15 l/ha; 0.25 l/ha) significantly reduced aphid population density. The same applies to K-optimal, which was effective against aphids. On the other hand, *P. xylostella* larvae remained active in all plots throughout the trial, despite the treatments. The low density of *H. undalis* in the individual plots made it impossible to assess the efficacy of the product. According to the results of the statistical analyses, the treatments had no effect on marketable cabbage yields, but the numerical values showed an advantage in the treated plots. The three doses of Colam 247 SC tested, and in particular the dose of 0.15 l/ha, can be recommended to vegetable growers for optimum protection of their cabbage fields against aphids.  For effective protection of cabbage plots, it is preferable to integrate this product into an integrated control system, as a single control method cannot protect fields from insect pests'attack.

**Comment [H7]:** Briefly mention the most important result.

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