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RESEARCH ARTICLE

INSECTICIDAL POTENTIAL OF BOTANICAL PLANTS (ALLIUM SATIVUM, CARICA PAPAYA, EUCALYPTUS SP) ON THE CONTROL OF PESTS OF COUCH (BRASSICA OLERACEA) IN THE LOCALITY EBOLOWA (SOUTH-CAMEROON)

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ABSTRACT

The main aim of the present study, carried out in the southern Cameroon region, was to assess the insecticidal potential of a number of botanical plants, namely garlic (*Allium sativum*), papaya leaf (*Carica papaya*) and eucalyptus leaf (Eucalyptus sp), in controlling cabbage (*Brassica oleracea*) pests. The experimental set-up was completely randomized, with 03 blocks containing 05 treatments (T0: negative control, T1: garlic treatment, T2: papaya leaf treatment, T3: eucalyptus leaf treatment, T4: chemical treatment). The various pests were identified. Physiological growth parameters (number of leaves, stem height, collar diameter, leaf area) were recorded and evaluated. Pest prevalence was determined by the number of perforated leaves. Statistical analyses were performed using SPSS software. ANOVA, SNK and Tukey variance tests were performed. The results show that the various pests identified were: *Dysdercus subfasciatus, Nezara virudula, Helix pomatia, Orthoporus ornatus, Plutella* sp and Formicidae. Treatment T1 (based on garlic extract) showed a considerable difference in leaf number (11.47±4.59), stem height (6.03±1.96 cm) and collar diameter (0.2±0.041 cm), while T2 (based on papaya leaf) had a considerable effect on leaf area (246±4.28 cm^2) and T3 (based on eucalyptus leaf) a considerable effect on leaf diameter (0.2±0.041 cm).

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INTRODUCTION

Agriculture is not only the most important activity, but also the lungs of economic development in most African countries, and more specifically in Cameroon, where the rural sector occupies a predominant place in the national economy (FAO, 2007). This encourages the improvement of agricultural production to meet the food needs of the population. Cabbage is one of the world's leading vegetable species (Laure Gry, 1992; Roger, 2014). Its global production is 37 million tonnes, and its total surface area is estimated at 1.7 million hectares. After tomatoes (64 million tonnes), cabbage is the most widely grown vegetable in the world (FAO, 2007), as it is rich in plant fiber, vitamins, minerals and trace elements (Pamplona-Roger, 2002). National production is essentially in the western highlands, including the western and north-western regions, where the fairly cold climate favours its cultivation (Djomaha et al., 2016). This production amounted to 37,000t on 3,000 ha with a yield of 12.3 t/ha in 2007 (FAO, 2007). Like other crops, cabbage is subject to major production constraints, such as disease and pests (Charleston et al., 2005). Insects are the group of pests whose damage is greatest because of the climatic conditions that favor their development (Imam et al., 2010; Walangululu and Mushagalusa, 2000). Cameroon, like many African countries, is recognized as being vulnerable to climate change; its economy is based on agricultural production systems specific to the five agro-ecological zones (PIACRC, 2020). Chemical fertilizers are used to meet yield and productivity requirements, and to counter the advance of pests. These chemical fertilizers, although effective, reveal their limitations through harmful effects on the ecosystem, fauna, flora and, consequently, on humans (Jean et al., 2010). Indeed, pesticides accumulate in food chains (a small concentration in water can lead to a high concentration in the fatty tissues of carnivores and consumers in general) (Anonymous, 2006). Furthermore, in developing countries, the abusive use of banned or strictly regulated chemical insecticides, the lack of training and information on handling chemical pesticides, and the failure to comply with regulations (Agboyi, 2006) are all factors that expose producers and consumers of market garden produce to serious health risks. It is therefore necessary and advantageous to look for alternatives to the frequent use of these products, which moreover leads to the selection of non-susceptible individuals (Glitho et al., 2008). It is for this reason that in Cameroon, as in many other countries, studies are being carried out to find alternatives to chemical fertilizers. Nowadays, the new compounds used in chemical control in general, and in chemical control of cabbage pests in particular, are those that affect insect development processes, such as inhibition of chitin synthesis, juvenile hormone mimicry, inhibitors of ecdysone, respiration, nicotine acetylcholine receptor and salivary gland secretion in insects (Martin et al., 2006). These chemical pesticides can have harmful effects on target organisms, including humans (Anonymous, 2006). In the search for cheaper, environmentally-friendly alternatives, the use of natural plant extracts would seem to be a promising avenue, hence the general aim of this work is to highlight the fungicidal and insecticidal effect of a few botanical plants (garlic, papaya and eucalyptus leaves) on cabbage protection. More specifically, the aim was to i) identify the various cabbage pests in the field; ii) assess the effect of treatments on agronomic parameters; iii) distinguish the effect of treatments on insect prevalence.

MATERIAL AND METHODS

Study area and exprimental design: The experimental site is located in the town of Ebolowa, capital of the South region and Mvila department. Ebolowa is located in the northeast (2° 54 north latitude, 11°9 east longitude); it has a surface area of 47,191 km² and an estimated population of 132,000. The experimental design is a completely randomized block design comprising five treatments (T0: negative control; T1: papaya leaf treatment; T2: garlic extract treatment; T3: eucalyptus leaf treatment; T4: positive control). Three replications were carried out, with each block consisting of five plots, each 2m×1m in size.

Obtaining and using extract

Garlic extract : Garlic extract was obtained naturally (LVD, 2016) by finely grinding 60 g of garlic cloves, macerating in 03 liters of water and fermenting for 24 hours in a 10-liter can. The solution was then filtered and 10 g of detergent added (as a wetting agent) before use.

Papaya leaf extract: This was obtained using the method described by Jean et al., 2010, by harvesting 300g of leaves one day before treatment, then crushing them and soaking them in 03 liters of water for 24 hours. The mixture was then filtered and 10g of detergent was added to obtain the extract.

Eucalyptus leaf extract: Eucalyptus leaf extract is obtained using the method of jean et al., 2010, which involves harvesting 300g of leaves one day before treatment, then crushing and soaking them in 03 liters of water for 24 hours. Finally, filter the mixture well and add 10g of detergent to obtain the extract.

Use method: The various extracts were placed in a 2-liter sprayer 24 hours after maceration, and then sprayed onto each plant in the field, in accordance with the experimental set-up. After spraying a product (extract), the sprayer was rinsed with clean water each time.

Pest identification: Pests were identified visually and photographed every morning, at the times when they are most vulnerable. The results were carefully collected and taken to the entomology laboratory of the University of Yaoundé I for identification and to obtain their exact names.

Taking agronomic parameters : To carry out our study, we assessed the growth and development parameters: stem size (using a graduated ruler or caliper), neck circumference (using a caliper), number of leaves (by visual counting), leaf area (by measuring leaf length and width using a graduated ruler) of cabbage plants; this was done at the second phenological growth stage of the crop. Data was collected weekly. The time taken for data collection was from 9 a.m. after field service (watering, weeding, hoeing and treatment) to 4 p.m. in the evening. The information gathered following sampling was recorded on collection sheets.

Statistical analysis: Statistical analyses were carried out using Excel spreadsheets to enter and process the raw data, and a number of software programs including: SPSS (ANOVA) to determine whether the difference between mean values is statistically significant; SNK variance test to identify sample means that are significantly different from one another; TUKEY test to determine significant differences between group means in an analysis of variance.

RESULTS

Pest identification: Following observations, harvesting and identification, 06 pests were recorded (figure 1):

Dysdercus Subfasciatus

Orthoporus

Helix pomatia

Oecophylla smaragdina ***Plutella sp***

Effect of biopesticides on agronomic parameters

Number of leaves: The figure below shows the evolution of the number of leaves during the experiment as a function of time and treatments at the second phenological stage. Generally speaking, it shows a progressive evolution in the number of leaves as a function of treatments from the first to the fourth week of data collection. Thus, 32 days after sowing, the highest number of leaves was found in treatment T1 (11.47±4.59), but no statistically significant difference was observed between treatments during the first and second weeks. In the third week, there were no significant differences between T2 (6.73±4.60), T3 (6.06±3.65) and T0 (6.40±4.10); likewise between T1 (7.46±3.20) and T4 (7.85±3.10), but at the probability threshold P ' 0.05 there was a statistically significant difference between T2 (6.73±4.60), T3 (6.06±3.65), T0 (6.40±4.10) and T1 (7.46±3.20), T4 (7.85±3.10) in the same week. In the fourth week, T1 (11.47±4.59) has a positive effect on T2 (8.33±6.45), T3 (7.86±5.55) and T4 (8.42±5.73); also T2 (8.33±6.45), T3 (7.86±5.55), T4 (8.42±5.73) have a positive effect on the control T0 (7.06±6.05) (figure 2). In sum, the SNK variance test shows a peak of T1 (11.47) at the fourth week closely followed by T4 (8.42) then T2 (8.33) then T3 (7.86) and finally T0 (7.06) with a margin of error of 32.626.

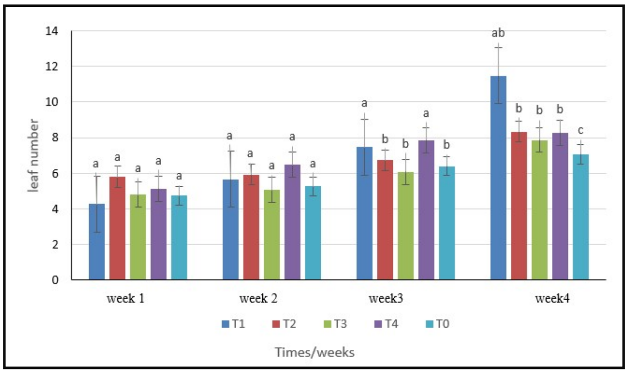

Figure 2. **Weekly leaf count trend**

Stem height: The figure below shows the evolution of plant height during the experiment as a function of time and treatments. Overall, there was a progressive evolution in leaf height as a function of treatment from the first to the fourth week of data collection. However, from the first to the second week, there was no statistically significant difference in stem height between the different treatments. On the other hand, there was a significant difference at least between control T0 (3.84±2.90 cm) and all other treatments T1 (4.96±1.71 cm), T2 (3.91±2.46 cm), T3 (4.57±2.51 cm) and T4 (3.93±2.72 cm); similarly, a significant difference was also observed between T1 (4.96±1.71 cm), T4 (3.93±2.72 cm) and T2 (3.91±2.46 cm); T3 (4.57±2.51 cm) and an unpronounced difference between T1 and T4; T2 and T3 of the same week. However, from the point of view of descriptive statistics, there was a significant difference between garlic treatment T1 (6.02±1.96 cm) over all other treatments T2 (3.99±3.02 cm), T3 (4.67±2.67 cm), T4 (4.57±2.72 cm) and T0 (3.95±2.57 cm) (figure 3). In sum, according to Tukey's hot test, we observe a high number of stem heights at the last week, with a peak at T1 (6.03 cm) and a margin of error of 7.23.

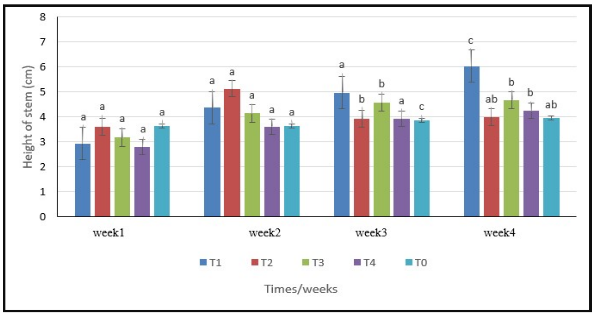

Figure 3. Weekly change in stem height

Crown diameter: The figure below shows the evolution of collar diameter as a function of time and treatments during the plant's development cycle. Statistical analysis reveals an increase in crown diameter as a function of time and each treatment. At 32 days after sowing, precisely at the first week, no significant difference was recorded between treatments (T0: 0.20±0.075 cm; T1: 0.16±0.097 cm; T2: 0.20±0.092 cm; T3: 0.18±0.11 cm; T4: 0.16±0.12 cm). Furthermore, the same observation is made at the second week, as shown in the figure: no statistically descriptive difference is visible between treatments (T0: 0.23±0.06 cm; T1: 0.27±0.14 cm; T2: 0.28±0.83 cm; T3: 0.26±0.11 cm; T4: 0.22±0.14 cm) (figure 4). However, the test of between-subjects effects (ANOVA) revealed that, the probability threshold P>0.05. The null hypothesis is not accepted, so there is a significant difference in T1 (0.40±0.13 cm) between T0 (0.23±0.21 cm) and T4 (0.22±0.14 cm) at the third. Similarly, at week four, there was also a significant difference in T0 (0.23±0.23 cm) between T1 (0.42±0.18 cm) and T2 (0.38±0.32 cm). As a result, the SNK (Student-Newman-keuls) test of separations of means showed that during the third and fourth weeks the T1 garlic treatment (0.42±0.041cm) proved more effective, followed by T2 papaya leaf (0.35±0.041 cm); then T3 eucalyptus (0.29±0.041 cm); T4 (0.27±0.041 cm

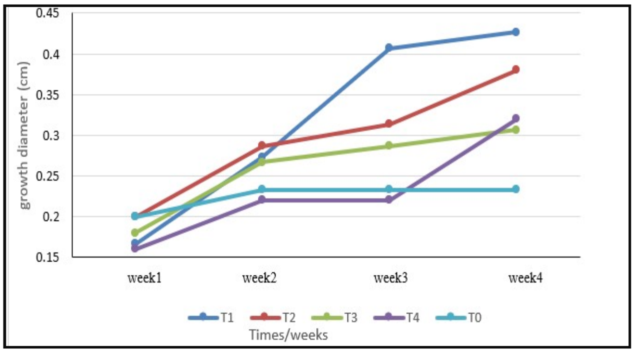

Figure 4. Weekly change in crown diameter

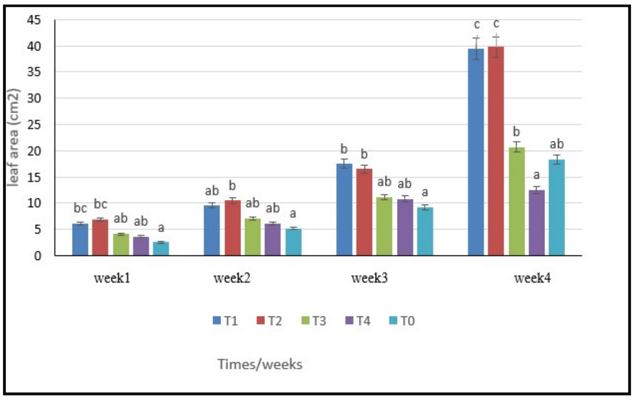

Figure 5. Weekly change in leaf area

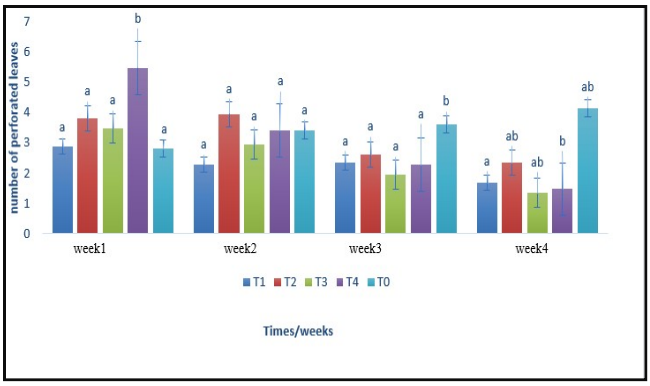

Figure 6. Weekly trend in the number of perforated leaves

Pest classification

Table I. below summarizes the families, classes, orders and genera of these different pests.

Pests	Familly	Classe	Order	Gender
Dysdercus subfasciatus	Pyrrhocoridae	Insecta	Hémiptéra	Dysdercus
Nezara virudula (punaise verte)	Pentatomidae	Insecta	Hémiptéra	Nézara
Orthoporus ornatus (iule)	spirostreptidae	Diplopoda	Spirostreptida	Orthoporus
Helix pomatia (escargot)	Helicidae	Gastéropodes	Stylommatophora	Helix
Oecophylla smaragdina (fourmis)	Formicidae	Insecta	Hymenoptera	Camponotus
Plutella sp (teigne)	Plutellidae	Insecta	Lepidoptera	Plutella

Table II. Attack sites for the main pests identified on plants

Pests	State of attack
Dysdercus subfasciatus	Punctures cabbage leaves
Nezara virudula (punaise verte)	Pierces leaves, forming holes on them
Orthoporus ornatus (iule)	Feeds on leaves
Helix pomatia (escargot)	Feeds on leaves and stems, eventually eating the whole plant until it disappears.
Oecophylla smaragdina (fourmis)	Attacks roots
Plutella sp (teigne)	Punctures and attacks leaves

Leaf area: The figure below shows the weekly evolution of leaf area according to the different treatments. There is an increasing trend in leaf area with the different treatments over time. However, in the first week, no significant difference is observed between T1 (6.12±3.91 Cm^2) and T2 (6.86±3.41 Cm^2); similarly between T3 (4.14±2.85 Cm^2) and T4 (3.65±2.66 Cm^2), but there is a significantly descriptive difference between all these treatments (T1, T2, T3, and T4) compared with T0 (2.51±1.80 Cm^2). Similarly, there was a significant difference between T2 (10.47±4.28 Cm^2) and T0 (5.21±2.96 Cm^2), although there was no significant difference between T1 (9.50±7.59 Cm^2), T3 (7.03±4.0 Cm^2) and T4 (6.07±4.29 Cm^2) at the second week. Furthermore, at week 3, descriptive statistical analysis showed that there was a significant difference at the 5% threshold between T0 (9.26±16.82 Cm^2) and all other treatments (T1 (17.49±17.64 Cm^2) and T2 (16.47±14.37 cm^2); T3 (11.11±8.56 Cm^2) and T4 (10.84±12.14 Cm^2)). Similarly, there was a significant difference from T1 (39.45±30.51 Cm^2) and T2 (39.74±42.58 Cm^2) to T3 (20.71±22.18 Cm^2), T4 (12.48±20.66 Cm^2) and T0 (18.31±30.31 Cm^2) at week four. Accordingly, Tukey's significant difference test revealed that papaya leaf treatment T2 (246 Cm^2) was more effective during the last two weeks, followed closely by garlic treatment (2.00 Cm^2), then T3 (1.63 Cm^2), T0 (3.86 Cm^2) and T4 (1.86 Cm^2), with a margin of error of 4.28 (figure 5).

Effect of biopesticides on pests

Number of perforated leaves: The evolution of the number of perforated leaves as a function of time and treatments during the plant's development cycle is shown in the figure below. Statistical analysis reveals a general decrease in the number of perforated leaves as a function of time and each treatment. Thus, in terms of descriptive statistics, there was no significant difference between T1 (2.86±1.24), T2 (3.80±3.36), T3 (3.46±1.50), T4 (5.46±4.37) in the first week; on the other hand, there was a slight significant difference between all these treatments and the T0 control (2.80±1.42) in the same week. However, in the second week, there was no significant difference between treatments (T0; T4) in the number of perforated leaves. Furthermore, in the third week, there was a significant difference between the T0 control (3.60±3.81) and the other treatments T1 (2.33±1.91), T2 (2.60±1.18), T3 (1.93±1.66), T4 (2.26±2.93); these other treatments showing no significant difference between them. Furthermore, there was a significant difference at the 5% probability level between T1 (1.66±1.11) and T4 (1.46±1.30), followed by a non-significant difference between T2 (2.33±2.31), T3 (1.33±1.34) and T4 (1.46±1.30) at week 4 (figure 6). In sum, the SNK variance test revealed that the T3 eucalyptus treatment (1.63) appears to be the most effective on pests and the reduction in the number of perforated leaves; it is closely followed by the T4 chemical treatment (1.86), then the T1 garlic treatment (2.00), then the T2 (2.46) and finally the T0 (3.86) with a margin of error of 4.28 over the last two years.

DISCUSSION

Because of their negative effects on the environment, the use of chemical insecticides has become increasingly restrictive; it leads to ecotoxicological disorders accompanied by a spectacular increase in the number of resistant species; the application of natural products remains the method that offers many advantages for the health of living beings and for their environment compared with chemical synthesis products that globally contaminate the biosphere (Bechaddad, 2022). The insect pests found in the field are of various orders: hemipterans (*Dysdercus subfasciatus*, *Nezara virudula*, and formicidae), orthopterans (cricket), lepidopterans (*plutella* sp) and stylommatophorans (helix pomatia); their presence in the field is justified by their palatability, their ability to seek out a source of food. These results are similar to those reported by San-whouly et al., 2021, who showed that attacks by Orthoptera *Z. variegatus* and *P. conica* were characterized by leaf consumption from the edges, while feeding by the Coleoptera *H. elaterii* consisted of superficial gnawing on the underside of leaves. As far as aphids are concerned, these insects bite both leaves and apples. This results in stunted plant growth. Analysis of variance of plants treated with garlic extracts showed a highly significant difference between plants not treated with garlic extracts in T1 leaf number (11.47±4.59), T1 stem height (6.03±1.96 cm) and T1 crown diameter (0.2±0.041 cm), providing ample evidence that the extract controlled cabbage pests, preventing them from causing slower plant height growth and delayed photosynthesis. The effectiveness of the garlic extract was due to the presence of lectin, a homodimeric 25-KDa protein with insecticidal properties. These results corroborate those of Kulimuschi, 2012 in Goma, who showed that plants treated with garlic extracts had a repulsive effect on bean aphids. Treatment T2 (based on papaya leaf extracts) was secondary in that it had a significant effect on agronomic parameters (notably on leaf area T2=246 cm2 ±4.28), which facilitated cabbage growth by controlling pests. The effectiveness of this extract could be explained by the fact that papain, the active ingredient in papaya leaves, seems to control cabbage pests. This assertion is in line with the findings of Jean et al., 2010, in Côte d'Ivoire, who showed that papaya leaf extracts controlled cabbage pests at different doses; Similarly, Ndongo DIOUF, 2022 showed that tomato growth and production parameters were greater in plants treated with biopesticides. Extracts of papaya leaf and garlic provided better control and significantly reduced the development of insect populations (P ' 0.05), which is in line with the findings of Ndongo Diouf,2022 in Morocco, who showed that biological extracts of neem leaf and chili pepper provided better control of insect populations. These results are similar to those of Mondedji et al. 2014, who revealed that the hydroethanol extract of neem leaves was the best biological treatment product. Treatment T3 (based on eucalyptus leaf extracts) had a significant and positive effect on the number of perforated leaves in that it was the most effective T3= 1.63±4.28, which would be justified by the fact that it has interesting inhibition potential vis-à-vis the pathogens responsible for leaf-perforating diseases and pests. This result is confirmed by Meksen, 2018 in Algeria, who showed that extracts from 02 plants of the myrtaceae family (*Eucalyptus globulus*, *Eucalyptus camaldulensis*) have interesting inhibition potentialities against pathogens responsible for certain disastrous crop diseases *'Botrytis cinesen*, *Altenaria altenata.* In this study, results showed that data on the evolution of the number of attacked leaves parameter were almost similar for treatments at T1, T2, T3, T4, in contrast to the T0 control, where the evolution of damage was significant. This situation can be explained by the fact that the biopesticides used, albeit of low persistence, managed to keep the pest population below the nuisance threshold. Furthermore, the similarity between biopesticides and chemical pesticides could be explained by the fact that biopesticides play almost the same role as chemical pesticides. These results are similar to those of Younoussou, 2021, who showed that data on the evolution of the number of attacked leaves and number of attacked pods were similar for the organic treatments (T1, T2, T3 and T4) than for the control, where the evolution of damage was significant. The insecticide GREBTAB 100 EC is effective in controlling cabbage pests, but not at all observed infestation periods; this lack of effectiveness at certain dates could be explained by the phenomenon of lepidopteran resistance to several insecticide families. This assertion is similar to the results of Sane, 2019, who showed that the pyrethroid insecticide CONQUEST was not effective at all observed periods; this phenomenon has also been demonstrated in the case of Helicoverpa armigira in Africa (Martin et al., 2002). The non-significant results of the observations in the first and second weeks could be explained by the fact that botanical pesticides, as with many natural products, have a delayed action time on the treated plant under field conditions, due to temperatures, UV rays, sunlight, pH on the treated plant, rainfall and other environmental and ecological factors exerting a more or less negative influence on the active ingredient (Schmutterer, 1988).

CONCLUSION

The general aim of this work was to evaluate the insecticidal potential of a number of botanical plants (garlic, papaya leaf and eucalyptus leaf) for controlling cabbage pests in the field, while at the same time making available to farmers a less costly means of pest control that takes human health and therefore the environment into account. This suggests that botanical plants used as biopesticides have the same effect as chemical insecticides, the main pest of cabbage in the field being helix pomatia. However, treatment T1 with garlic extract proved more effective in controlling agronomic parameters, notably leaf number T1= 11.47±4.59; stem height T1= 6.03± 1.96 cm and crown diameter T1= 0.2± 0.041 cm. The papaya leaf extract treatment was also effective on plant leaf area T2= 246±4.28 cm^2. In terms of pest management, the eucalyptus leaf treatment T3= 1.63±4.28 was more effective, reducing the number of perforated leaves. Given the efficacy of these biopesticides, they can be introduced into programs to improve cabbage crop protection.

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