THE INFLUENCE OF CHEMICAL AND BIOLOGICAL SUBSTANCES IN REDUCING *PIERIS BRASSICAE* POPULATION IN *BRASSICA OLERACEA* CULTURE

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Abstract. *In Romania, the culture of cabbage (Brassica oleracea) occupies a significant area, 46000 ha, being frequently found in the plain area of the south and west of the country, but also in the hill area of Transylvania and Moldova. The production of this crop is closely related to phytophagous insects. Among these insects, the cabbage white butterfly, Pieris brassicae (Order: Lepidoptera: Family: Pieridae), is an important pest that can heavily infest cabbage crops. The effect of chemical (deltamethrin 100 g/l and cyantranilyprol 100 g/l) and biological (Baccillus thuringiensiss – strain ABTS-351 540g/kg) insecticides on the mortality of Pieris brassicae larvae, the number of plants attacked and the number of leaves that showed attack was studied in Belinț area, Timiş county, in 2021. Each product (treatment) represent a variant, thus the experimental field contained four treatments in three repetitions. The "De Buzău" white cabbage variety was used in the experiment. Phytosanitary treatments were applied when the PED was reached (2-3 larvae/m2). In order to establish the effectiveness of chemical and biological insecticides, evaluations were performed at intervals of 3, 7 and 10 days following application. Following the study, the resoults revealed that the biopeoduct Baccillus thuringiensiss - strain ABTS-351 determined a mortality rate of 67% (3 days after application) in the larval population of Pieris brassicae. At 6 days and 10 days respectively, it was observed that the effectiveness of the bioproduct, Baccillus thuringiensiss -strain ABTS-351, in the control of Pieris brassicae larvae decreases. The chemical insecticides based on deltamethrin 100 g/l and cyantranilyprol 100 g/l, significantly reduced the larval population of Pieris brassicae, the percentages obtained being superior to the biological substance.*

Keywords*: Pieris brassicae, control, deltamethrin, cyantranilyprol, Baccillus thuringiensiss - strain ABTS-351, Brassica oleracea*

INTRODUCTION

Autumn cabbage (*Brassicae oleracea var. capitata L.*), is a vegetable much requested by the population of our country. Among the three vegetation cycles of cabbages that follow each other throughout the year, autumn cabbage (*Brassica oleracea var. capitata L.*) occupies the largest areas, being confronted with abundant populations of pests, which formed, successively, on summer cabbage and on spring. Pests that attack autumn cabbage - approx. 20 – have an obvious economic impact on production. The vast majority of them are known to vegetable growers under the popular names of cabbage weevil (*Mamestra brassicae* - L.), large white butterfly (*Pieris brassicae* - L.), cabbage moth (*Plutella xylostella* - L.), gray cabbage aphid (*Brevicoryne brassicae* – L.), cabbage fly (*Delia brassicae* – Meig.), cabbage fleas (*Phyllotreta* spp.), snail without a shell (*Deroceras laeve*) (GEORGESCU, 2006, STOLERU ET AL., 2012, STANCA-MOISE, 2017). These pests affect all cruciferous vegetable crops (cabbage, cauliflower, radishes, collards, mustard), but develop preferentially on edible cabbage.

Among these pest species, the cabbage white butterfly is one of the most important. This phytophagous insect heavily infests cabbage crops (HASAN and ANSARI, 2010). It is a cosmopolitan species, being present on the continents: Africa, Asia, Europe, Oceania, South America (https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.41157#sec-7). In Europe, *Pieris brassicae* L. (Lepidoptera: Pieridae) is present in 36 countries (CABI, 2022) (Figure 1). In Romania, the pest has been present since 1964 (Popescu-GORJ A, 1964).

Figure 1 – Presence of *Pieris brassicae* species in Europe (CABI, 2022)

Pieris brassicae L. (Lepidoptera: Pieridae) is a phytophagous species, the larvae feed on plants containing glucosinolates, this group of secondary metabolites are present in some plant species, including plants from the *Brassicaceae* family (OKAMURA et al., 2019). *Pieris brassicae* attack and causes significant damage to 15 plant species (oligophagus), including cabbage, cauliflower, mustard, radish, turnip and turnip.This pest attacks in all plant growth stage, from emergence to flowering. A single larva can consume 74-80 cm^2 of leaves. The attack produced by *Pieris brassicae*¸ in the years 1961-1963, was reported by Prasad, as causing production losses of 70-98% in the cabbage crop. In India, during the years 1991-1992, production losses of 68.5% were reported (THAKUR, 1996). *Pieris brassicae* causes yield losses of over 40% in various vegetable crops (ALI and RIZVI, 2007; HASAN and ANSARI, 2011). Similar losses were also recorded in Turkey, in 1985 and 1986, with an average of 40.45% (in cabbage) and 27.06% in cauliflower (ATALAY and HINCAL, 1992). In Sierra Nevada, western USA, SHAPIRO (1975) reported that *Pieris brassicae* caused annual losses of 41% in crucifers. Extreme infestations of *P. brassicae* completely destroy the plant foliage and eventually lead to plant death (HASAN and ANSARI, 2010). Damage caused by large cabbage butterfly larvae is correlated with population size and climatic conditions (high temperatures associated with precipitation and low relative humidity favor population growth) (SOOD and BHALLA, 1996).

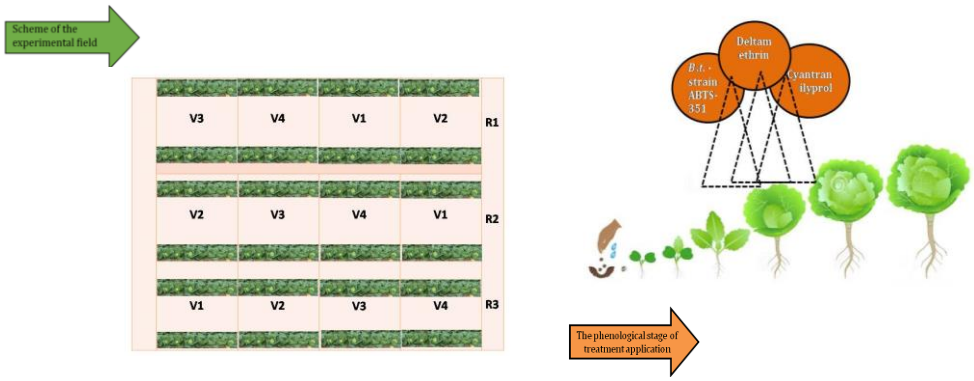
The attack of this pest reduces the market value of cabbage, consequently, lowering the profit of the farmers.

At the farmer level, the management of pests in the cabbage crop was mainly done by using broad-spectrum synthetic insecticides. The bibliographic studies show that the farmers applied mainly synthetic insecticides. These practices affects human health and the environment, such as the development of resistance to insecticides by commonly targeted insect pests and the destruction of non-target organisms such as pollinators and natural enemies of pests, among others (FENNING et al. 2013, 2014, FERNANDES et al. 2010 cited by NGOSONG et al., 2020). The use of insecticides and failure to respect the pre-harvest period (stated for every insecticides as residual time) also compromise food safety, cabbage plants showing pesticide residues, sometimes above maximum residue limits (ARMAH 2011). To reduce the

impact on humans and the environment, farmers must include the use of bioproducts (Afreh). COULIBALY et al. 2007). The use of selective bio-rational pesticides, associated with crop varieties that are more tolerant or less sensitive to pest attack. Biorational pesticides are toxic only to the target pest, have low toxicity to non-target organisms including beneficial insects, and less environmental hazards (LIU et al. 1999). One such pesticide based on *Bacillus thuringiensis* produces a toxin that causes paralysis of the digestive tract (GUERENA, 2006) in a susceptible insect that ingests it. This toxin breaks down the intestinal wall, allowing the spores to invade the insect's body, resulting in death by starvation, septicemia, and/or osmotic shock within 24 to 48 hours (NGOSONG et al., 2020). SMITH (1989) stated that despite the overwhelming success of resistant crop varieties, their adoption in the management of insect pests in vegetable crops such as cabbage has been very limited. The current study explored the potential of 3 bio-rational pesticides (1) as effective alternatives to synthetic pesticides (2) in pest management. The present study aimed to reduce the population of *Pieris brassicae* in the cabbage crop by using chemicals and some biopreparations

MATERIAL AND METHODS

The trial, regarding the control of the population of *Pieris brassicae*, was placed in 2021, in area of Belinț, Timiș county. Cabbage plants were observed periodically, to determine when the economic damage threshold was reached (2-3 larvae/m^2). After reaching the damage threshold of the *Pieris brassicae* species, 3 phytosanitary products were applied (deltamethrin 100 g/l, cyantranilyprol 100 g/l, *Baccillus thuringiensiss* -strain ABTS-351). The treatments were applied on August 10. As host for *P, brassicace*, the Buzău variety was used, a variety with a long vegetation period (145-165 days). Each product means a variant, thus the experimental field contained four treatments in three replications. The variants presented an analysis area of 30 m^2 (10*3 m).



The effectiveness of chemical and biological insecticides was determined at 3, 7 and 10 days after application. At each evaluation, 20 plants were analyzed and the larvae present on the cabbage plants were counted in order to establish the population dynamics of *Pieris brassicae.* Insecticide efficacy was determined using the Abbott calculation formula:

$$\text{Abbott \%} = \left(1 - \frac{n \text{ in } T}{n \text{ in } C}\right) x\ 100$$

- n - insect population; T- treated variant; C- untreated (control)

At 10 days after the application of the treatments, the effectiveness of the insecticides was established through the number of plants attacked as well as the severity of the attack (number of leaves attacked) produced by *Pieris brassicae*. The frequency and severity of the attack was established by the number of plants and leaves infested, from the 20 randomly chosen from each plot.

RESULTS AND DISCUSSIONS

At 3 days after application, a significantly lower number of larvae was recorded in the plot treated with cyantranilyprol 100 g/l and deltamethrin 100 g/l (0.5 larvae/20 plants and 1.0 larvae/20 plants respectively), the effectiveness achieved by insecticides was 91.23% and 82.46% (figure 1). Plots treated with the bioproduct *Baccillus thuringiensiss* - strain ABTS-351 540g/kg reduced the *Piers brassicae* population by 67%, with 2.0 larvae/20 plants found on the plants.

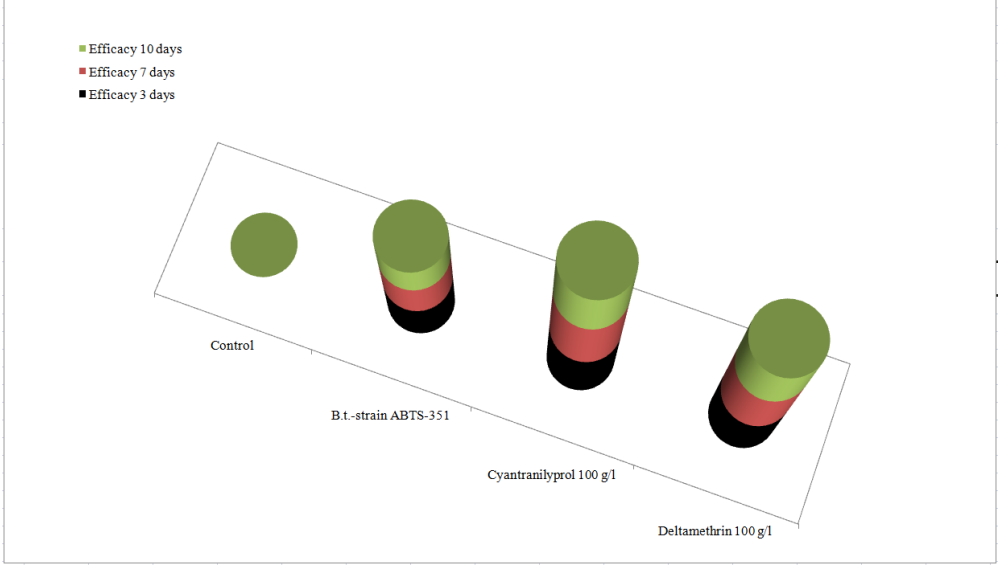


Figure 1 – Treatment efficacy in *Pieris brassicae* population control

At 7 days after application, the lowest number of larvae was observed with when cyantranilyprol 100 g/l was applied, which provided a protection of the cabbage crop up to 92.65%, the population of *Pieris brassicae* remaining at the same level as in the previous evaluation. The number of larvae in the untreated variant continued to increase up to 6.8 larvae/20 analyzed plants. On the cabbage plants treated with the *B.t.*-strain ABTS-351 biopreparation and the deltamethrin 100 g/l, insecticide, 7 days after application, an increase in the number of *Pieris brassicae* larvae was recorded by 0.2 to 1.0. The efficacy of *Bacillus thuringiensis* strain ABTS-351 and deltamethrin was lower at 7 days after application compared to 3 days. The product *B.t.*-strain ABTS-351 (Bactospeine DF), at 10 days after application, caused a mortality of 44.44% among the population of *Pieris brassicae*. Compared to the control treatment, the number of larvae/plants analyzed was much lower 5.1 -5.4 in the

plots where the chemical insecticides Benevia (cyantranilyprol 100 g/l) and Decis Expert (deltamethrin 100 g/l) were applied.

The evaluations carried out (at 3 days, 7 days and 10 days respectively) showed that the number of larvae, in the untreated plot, continued to increase, so the population of *Pieris brassicae* was still higher (5.7-7.4 larvae/plant analyzed) (figure 2). At the 3rd assessment, an increase in the population of *Pieris brassicae* was observed in all the experimental plots.

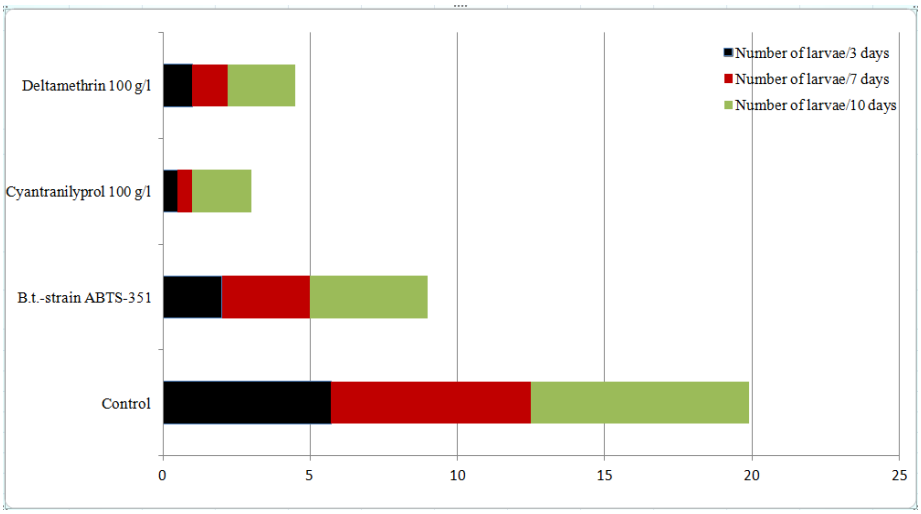


Figure 2 –*Pieris brassicae* population assessment in the variants following treatments

The data showed in respect of mortality percentage when bioproduct based on *B.t.*-strain ABTS-351 was used, 0.16% was lethal for *Pieris brassicae* larvae with the maximum mortality of 64.91%, 3 days after application. Cyantranilyprol 100 g/l and deltamethrin 100 g/l insecticides caused a maximum mortality, over the 10-day period, of 72.97 - 92.65% and 68.92 - 82.46% of larvae of *Pieris brassicae*.

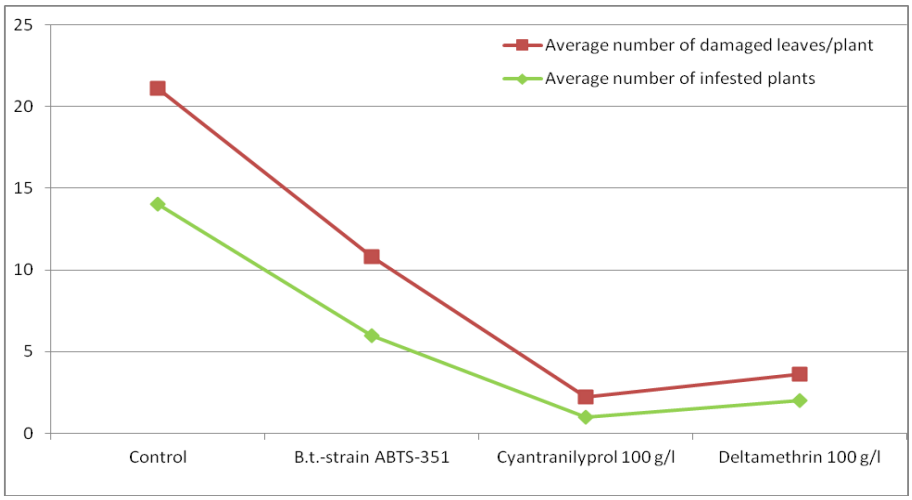


Figure 3 – Assessment of treatments in terms of number of plants and leaves attacked

The number of plants and leaves infested, from the 20 randomly chosen from each plot (figure 3), showed differences compared to untreated. There was lower damage in plots treated with alpha cypermethrin compared to other pesticides; however, the effect of Benevia was similar to Decis Expert. The highest number of damaged leaves was observed in plots treated with *B.t.*-strain ABTS-351, compared to other treatments.

The existence of numerous studies on the chemical and biological control of the *Pieris brassicae* species highlights the interest of researchers in this species. The outcome, of this study, in respect of cabbage white butterfly control by means of synthetic pyrethroids and the bioproduct based on *Baccilus thuringiensis* are similar to those recorded by MAHABIR et al. (1992); RAHMAN et al. (1999); REDDY and MANJUNATHA (2000); THAKUR and PARMAR (2000); SZWEJDA et al., (2002); SINGH et al. (2003); GUPTA and SOOD (2003). The studies carried out by MAHABIR et al. (1992) ranks permethrin > decamethrin [deltamethrin] > cypermethrin > endosulfan > malathion > fenvalerate in terms of *Piersi brassicae* species mortality.

RAHMAN et al. (1999) applied both insecticides (Commondo and Nogos) and bioproducts (Florbac, Atabron) to control the species *Pieris brassicae*. The results showed that Nogos and Commondo killed 99.69% and 98.28% of *Pieris brassicae* larvae, respectively, while Florbac (*Bacillus thuringiensis*) and Atabron controlled the pest by 76.91-77.86%. THAKUR and PARMAR (2000) tested 8 different insecticides based on: cypermethrin, decamethrin [deltamethrin] and fenvalerate which provided complete protection to Brassica crops against *Pieris brassicae*.

SZWEJDA et al., (2002) reported the efficiency of tank-mix application of Nurelle D 550 EC [chlorpyrifos-methyl+cypermethrin] (0.3 l/ha instead of the recommended 0.6 l/ha) with Supervit foliar fertilizers K (4 liters/ha) and Mikrosol U (6 l/ha) against cabbage pests.

The bioproducts Biobit, Biolep, Agree/Hill BTK, Dipel/Delfin, Halt and Endosulfan used by GUPTA and SOOD (2003) in the control of *Pieris brassicae* in cabbage crops caused a mortality of 10-90% in the first 48 hours after application and 8-100% at 120 hours.

CONCLUSIONS

The larval population of *Pieris brassicae* was at lowest range in plots treated with Benevia and Decis Expert.

The bioproduct Bactospeine DF determined a mortality of *Pieris brassicae* larvae in range of 44.44-64.91%, with this control the biological preparation ranked third.

Benevia and Decis Expert insecticides protect the cabbage crop against the *Pieris brassicae* pest for 7 days, after this period their effectiveness decreases.

The bioproduct Bactospeine DF determined the highest mortality of *Pieris brassicae* larvae at three days after application, after this period its effectiveness decreases.

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