Biological control: Sustainably controlling pests in the vegetative phase of corn

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ABSTRACT
Brazil is considered the country with the greatest agricultural potential in the world, as it is in a region with a tropical climate, and this contributes positively to the increase in agriculture. Among the numerous segments of the production chain, corn stands out as one of the main grains produced in the country. The continuous cultivation of grass leads to a high incidence of pests, significantly affecting the productive potential of the crop and great losses to producers. A viable alternative to sustainably control these undesirable insects is biological control, allowing to reduce the population density of another organism, through living beings or natural substances, thus acting as pest control agents in agriculture, promoting balance in the crop and contributing to the reduction of agrochemicals in the field, favoring sustainability. since chemical pesticides are harmful to crops and human health.

Keywords: Sustainability, Corn, Pests.

1 INTRODUCTION

Biological control promotes balance between insects, pests and natural enemies, in addition to reducing and even replacing the use of agrochemicals in the field, contributing to sustainability (BORGES, 2011).

Brazil is a world leader in the use of biological products in crops and already exports technologies to other countries (LOBATO, 2019). According to Alexandre de Sene Pinto, "All the technology of biological products that other countries are using for large areas is coming from Brazil." The growth of biologics in the last two decades is notorious, and in number of registrations, they have already surpassed chemical products in the same period (LOHBAUER, et. al, 2022).

In 2020, an annual record was registered in Brazil, 96 new biological products registered, reaching in March 2022, 484 registrations since the year 2000, they are classified as low impact, which can be natural chemical substances, called semiochemicals, or biochemical compounds that induce behavioral responses in target organisms, such as pheromones and allelochemicals, which have a natural origin and control pests and diseases, as hormones regulating growth. There are

microbiological control agents on the market, which are viruses, bacteria, protozoa and fungi, and macrobiological agents, conferred by insects, mites, and even nematodes (LOHBAUER, et. al, 2022).

Maize (Zea Mays) is among the oldest crops in the world, having been cultivated for over 5,000 years. The importance and diversity of the use of grain are characterized in several agro-industrial segments, from human to animal food, as a direct source of food for the low-income population, even if in small proportions, and as a raw material in the formulation of feed and other segments of the chain, requiring high technological investment in order to maintain the health of crops (FRANCHU, 2021).

Brazil has consolidated its third position in the world among the largest corn producers in the world (EMBRAPA, 2022). In the 2022/23 harvest, Brazil reached a total production of 130 million tons of corn, attributed to the increase in planted areas of second crop corn, and recovery of productivity in the third crop (CONAB, 2023). However, one of the factors that most influence the yield of production is the attack of insect pests, which are divided into three main groups. The first group includes soil insects, also called initial pests, the second group is leaf area and stem insects, and the third group is composed of end-of-harvest insects that cause damage to ears (VALICENTE, et. al, 2015), requiring management in seed treatment and during the vegetative development of the crop.

In view of the facts mentioned, the importance of the corn crop in Brazil is observed, and based on this the following problem arises, do all producers have access to assertive information about the use and efficiency of biological products to control insect pests in corn crops, in addition to it being a means of contributing to the ecosystem?

Thus, this work is justified by the lack of reliable and accessible information about biological products and their efficiencies in controlling insect pests in the vegetative phase of corn, meanwhile, they are new products in the market that have been gaining prominence only in the last decades, and many producers are still afraid to use or replace them with chemical control. even though it has already proven its efficiency.

The general aim of this article is to report on the biological control of insect pests in the vegetative phase of maize crop. Presenting the following specific objectives: To address the importance of biological control, to inform the means of action of biological control and to present the main pests present in the vegetative phase of corn, in addition to demonstrating the main types of biological control, and presenting the main pests in the vegetative phase of the crop.

The work was developed based on a descriptive bibliographic research that includes exploratory research, referring to the use of biological control in the fight against pests in the vegetative phase in the corn crop, always thinking about contributing to a sustainable ecosystem. The research was developed with the help of books, magazines, links and scientific articles on the referred topic. The keywords used were: Sustainability, Corn and Pests.

2 LITERATURE REVIEW

2.1 BIOLOGICAL CONTROL IN BRAZIL

Brazil is considered the country with the greatest agricultural potential in the world (VANTINI, 2017), as it is located in a region with a tropical climate, a fact that contributes positively to the increase in agriculture, in addition to being extremely favorable for the cultivation of numerous crops throughout the year (MONNERAT, et. al, 2020), however the continuous cultivation and the increasing expansion of agricultural areas cause a high incidence of pests (VALICENTE, Et. al, 2015).

One of the viable alternatives to sustainably control these insects is biological control, which consists of reducing the population density of another organism. This alternative has been used since the third century, by the Chinese, with the manipulation of ants released in citrus to control pests (MONNERAT, et. al, 2020), although the management technique is old, in Brazil, only in recent decades has it been conquering the market, due to its cost, efficiency, and increased productivity (MONDIN, et. al, 2022).

In order for biological control to be solidified, it is necessary to invest more and more in education and knowledge transfer, because there are still many rural producers in the country who are unaware of the benefits and efficiency of biologicals as well as encouraging continuous development and innovation in this sustainable sector, contributing to the environment and human health (MONDIN, et. al, 2022).

Biological control is used to control sanitary problems, such as pests, diseases, and can be applied by four means, the natural one which consists when the populations of organisms are kept in balance, by natural occurrence, the conservationist environment, which man acts stimulating the prevention and natural increase of beneficial agents in the field, the classical means that is based on the collection of natural enemies usually in the region of origin, to release in desired areas and increase biocontrol, and augmentative, which consists of the application of parasitoids, predators, and entomopathogens, which is already known and used by farmers with inoculation in seed treatment (PIERO et. al, 2022).

2.2 MEANS OF ACTION OF BIOLOGICAL CONTROL

Biologics are living organisms or derived from them and are employed as active ingredients in formulations. In addition to inoculating, natural predatory enemies, which are organisms that feed on others to survive, are also considered biopesticides, especially ladybugs and earwigs (MONDIN, et. al, 2022).

Parasitoids, on the other hand, necessarily need a living host to complete their life cycle, and belong to the order Hymenoptera, in which wasps act positively on crops by parasitizing eggs, egg-larvae, larvae, pupae and aphids, such as Trichogramma pretiosum, Chelonus insularis, Cotesia

marginiventris, Tetrastichus Howard and Rhopalosiphum maidis, respectively, and are efficient means to control insect pests (CRUZ, 2022).

Entomopathogens contribute positively to the elimination of insect pests through viruses, bacteria and fungi, which contaminate the hosts, penetrating the integument and colonizing their body by the hemolymph, thus causing epizootics, that is, diseases that lead to death in addition to interfering with the feeding and reproduction of insects and mites, Beauveria bassiana, Metarhizium anisopliae and Baculoviridae are some of the most studied organisms for pest control (ROHRIG, 2021).

This shows that biological control is effective in reducing populations of agricultural pests, thus maintaining a population below the control level, in addition to minimizing damage caused by pests, and reducing the cost of chemical products to control them, because natural enemies, or agents have the ability to reproduce and survive in the environment, do not leave residues of agricultural products and do not cause resistance, benefiting the environment and consumers (PASSOS, MENDONÇA, 2020).

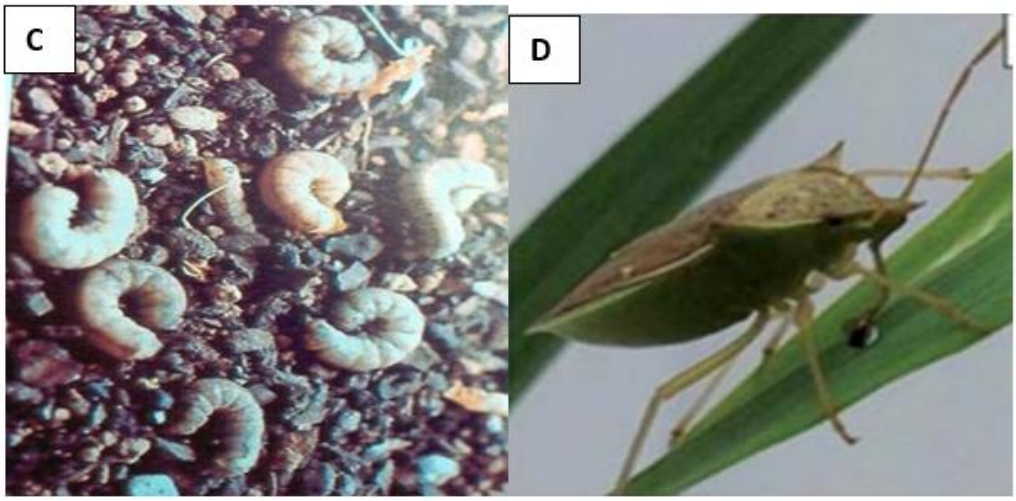
2.3 PESTS IN THE VEGETATIVE PHASE OF CORN

The occurrence of insect pests in corn cultivation significantly affects the productive potential of the crop, and during its cycle it is attacked by numerous pests and at different stages, and in the vegetative phase edaphoclimatic conditions, phenological stage, cropping system and biotic factors, directly influences the occurrence of these organisms (PARENTONI, et. al, 2022).

Of the pests of the vegetative phase, stem pests are mentioned, such as the sugarcane borer (Diatraea saccharalis) (Figure 1a), which in its larval stage feeds on the stalk, thus reducing the translocation of photoassimilates (CEREZA, et. al, 2021). The elasmo caterpillar (Elasmoplpus lignosellus) (Figure 1b), which destroys the growth point, thus causing wilting and death of the central leaves (VALICENTE, et. al, 2015). The screwworm (Agrotins ípsilon) (Figure 1c), which has a negative phototropic characteristic, because during the day it remains in the soil, and at night it is capable of sectioning several plants (CAMARGOS, et. al, 2021). And the green-bellied stink bug (Dichelops melacanthus) (Figure 3d), which feeds on sap in the xylem vessels, and injects toxic substances through the sheath to the inner leaves, causing lesions, in addition to causing curling of the younger leaves that do not open, forming a kind of "cigar" (MIRANDA, et. al, 2021).

Figure 1: Stem pests (A) Sugarcane borer - Diatraea saccharalis; (B) Elasmo caterpillar - Elasmoplpus lignosellus; (C) Screwworm - Agrotins ipsilon; (D) Green-bellied stink bug - Dichelops melacanthus.

Source: Cana online (2020). Source: Embrapa (2022).



Source: Embrapa (2022). Source: Embrapa (2015).

In the leaf part, there are significant pests in economic damage to the corn crop, sucking insects such as the corn leafhopper (Dalbulus maidis) (Figure 2a), which sucks sap from the phloem, reducing the development of the root system, in addition to transmitting phytopathogens, as well as the pasture leafhopper (Deois flavopicta) (Figure 2b), which feeds on the leaves causing chlorosis, yellowing, necrosis, and can cause the death of the entire plant (CRUZ, et. al, 2015). On the other hand, the corn aphid (Rhopalosiphum maidis) (Figure 2c) sucks the sap of the plant. and eliminates sugary liquid that contributes to the formation of smoke on the leaves, hindering photosynthetic actions, in addition to being vectors of various viruses (SIEG, et. al, 2021). In the case of chewing insects, the fall armyworm (Spodoptera frugiperda) (Figure 2d) feeds on leaf tissue, leaving holes in the plant cartridge, and produces the characteristic of a row of perforations on the leaves (VALICENTE, et. al, 2015).

Figures 2: Leaf area pests (A) Corn leafhopper - Dalbulus maidis (B) Pasture leafhopper - Deois flavopicta (C) Corn aphid - Rhopalosiphum maidis (D) Fall armyworm - Spodoptera frugiperda.

Source: Embrapa (2020). Fonte: Aegro (2019).

Source: Rural Magazine (2020). Fonte: 3rlab (2021).

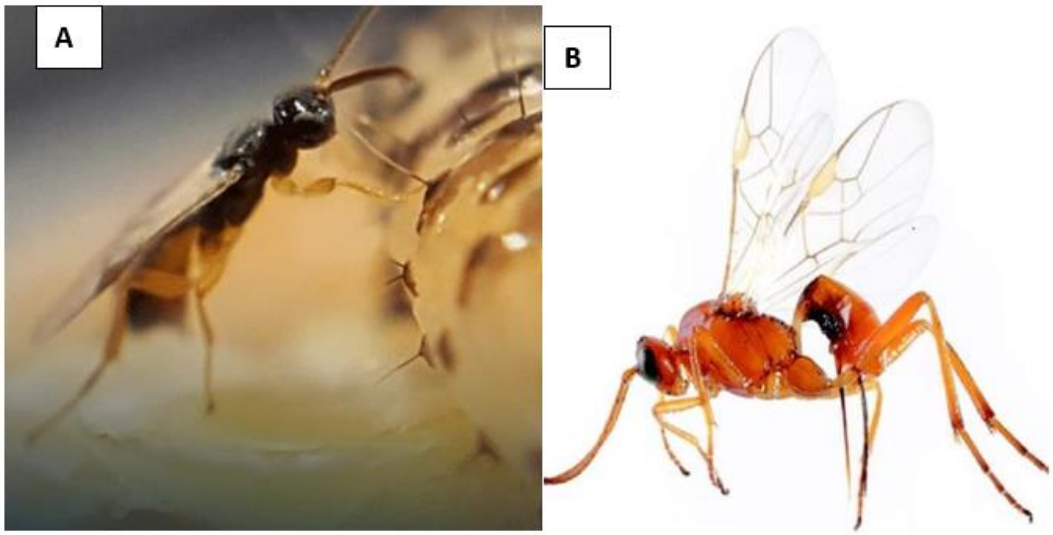
Pest attacks compromise the leaf area, significantly affecting corn crop productivity, and with this it is important to use assertive management, and the identification and monitoring of pests, as they are essential factors to facilitate decision-making, aiming at reducing losses and increasing profitability in corn crops (FILHO, et. al, 2016).

2.4 BIOLOGICAL CONTROL APPLIED TO PESTS IN THE VEGETATIVE PHASE OF MAIZE CROPS

Pest attack compromises the leaf area, significantly affecting the it is notorious that new technologies have been adopted, and through them pests can be controlled in a sustainable way, and biological control fits as a key piece in this category (VALICENTE, et. al, 2015), the use of living beings and natural substances as pest control agents in agriculture, and considered harmful to crops, through the use of other species due to their antagonism, through it, biological techniques in

agricultural production, applying only natural resources, have been present in society for centuries (MONDIN, et. al, 2022).

Figures 3: Biological control by means of parasitoid: (A) Cotesia flavipes, parasitoid of the sugarcane borer, (B) Meteorus laphygmae, parasitoid of the screwworm (C), Ectophasiopsis sp, parasitoid of the green-bellied stink bug.



Source: Genic, 2022 Fonte: Research Gate, 2020

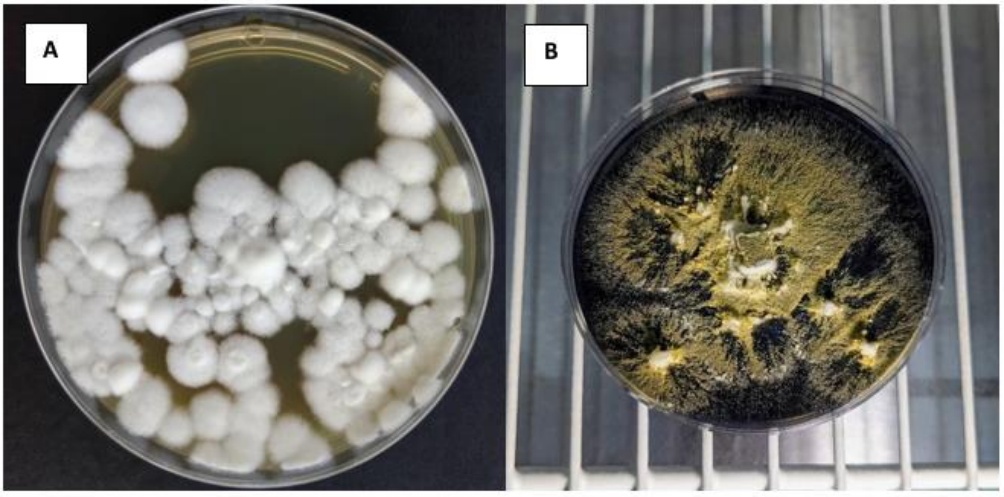
Source: Embrapa, 2015

However, the use of biological control in crops to control the grazing of the vegetative part of corn is found in the case of the parasitoid Cotesia flavipes of the borer (D. saccharalis) (Figure 3a), this parasitism occurs through the ovopposition of the wasp inside the caterpillar, these eggs hatch larvae and they feed on the tissues of the caterpillar that dies exhausted (NAVA, Et. al, 2009), the control of the screwworm can be done by beneficial insects through microhymenoptera and dipterans (Figure 3b) (FILHO, GUIMARÃES, MOURA, 2022), and in the case of the green-bellied stink bug, there is Ectophasiopsis sp (Figure 3c), a species of parasitoid fly of the adult stink bug, which lay eggs on the pest's body, characteristic of its light coloration, that after penetrating the insect body they

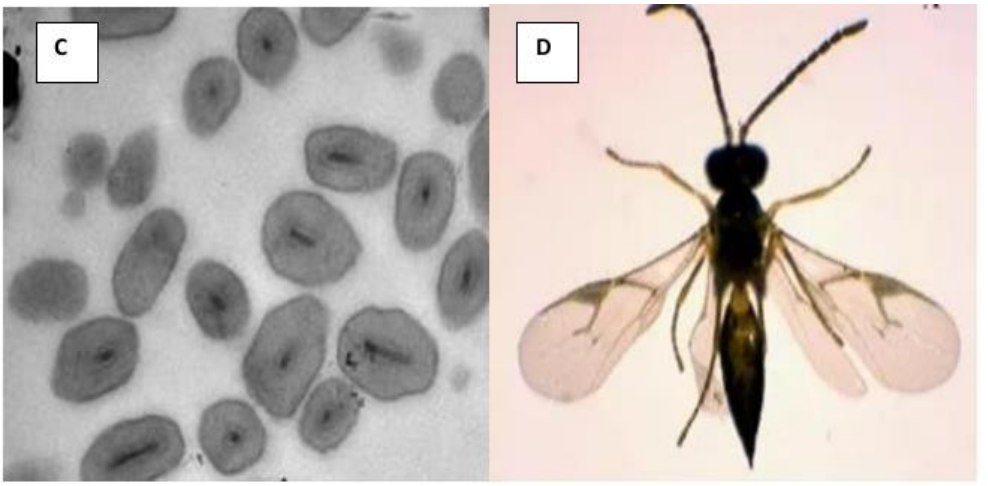
become darkened, so the larva enters the digestive tract, and feeds on the pest, killing it (PANIZZI, et. al, 2015).

The corn leafhopper, pasture leafhopper and elasmo caterpillar can be controlled by entomopathogenic fungi, Beauveria bassiana (Figure 4a) and Metarhizium anisopliae (Figure 4b) have the ability to infect these insects and use them as hosts for germination of their spores and release of conidia in their corpses after 72 hours of infection (NOGUEIRA, et. al, 2022), (MATIOLI, 2020), (VIANA, 2009), in addition, among several means of sustainable control of fall armyworm, the biological insecticide Baculoviridae (Figure 4c) is mentioned, which after contact with the pest, reduces its feeding and causes death (CRESPO, et. al, 2021), and the aphid can be controlled by parasitizing wasps of the genus Lysiphlebus, (Figure 4d) that lay eggs inside the pest, and the lavas feed on the inside of the insect, causing death, a mode of action similar to Cotesia flavipes (VICENTE, JUNIOR, 2011).

Figure 4: Biological control of pests, through entomopathogens and natural enemy (A) Beauveria bassiana, control of the corn leafhopper and elasmo caterpillar (B) Metarhizium anisopliae, control of the grassland leafhopper (C) Baculoviridae, control of fall armyworm (D) Lysiphlebus, natural enemy of the corn aphid.



Source: Embrapa (2017). Source: Embrapa (2017).



Source: Embrapa (2016). Source: Cultivar Magazine (2023).

The release of biological control is determined by the release of a large amount of beneficial insects into the so-called flooded field, and in small areas of the environment quantities and calcified as an inoculant, and it is important to stress that these insects are originated in laboratories (CRUZ, 2022).

3 CONCLUSION

Biological control in the fight against pest infestations in the vegetative phase of corn is a promising alternative for producers, as it reduces the population of agricultural pests, leaving production areas with a population below the control level, thus optimizing decision-making, and causing reduction or replacement of chemical insecticides in crops, favoring agricultural balance and sustainability.

Brazil is among the largest producers of corn in the world, and pests are key to the drop in crop yield, and biological control is relevant, because control agents have the ability to reproduce and survive in the environment, if well managed, thus contributing to farmers, reducing production costs, and assisting in future harvests.

Biological control is a broad means that consists of controlling pests by different means and agents, thus being able to vary in pest control, as different formulations and natural enemies are found on the market for the same cause of damage, helping producers to make a vast decision, in addition, it does not leave residues to employees, consumers and the environment.

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