Advances in conservation biological control using arthropods

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Abstract –

Conservation biological control (CBC) in arthropods and more recently in plants, is a rapidly growing field of research. The objective of this project is to develop new biological control agents for the control of invasive plant species that are not yet under any regulatory control across the world. The goal of this research is to take overview of recent literature aimed at signifying biocontrol agents for controlling invasive plant species, and across the globe where they have been introduced. These biocontrol agents will be developed by using a combination of laboratory tests and field trials with native or non-native hosts, as well as by using advanced molecular techniques such as DNA fingerprinting, RNAi technology and gene expression profiling (e.g., microarray analysis). This work will help identify genes that are essential for the survival or growth of the target pest population (or populations) within their host(s), which can then be used to engineer strains with these genes knocked out so that they cannot survive on their natural hosts.

Keywords – Conservation biological control, Biological control agents, Invasive plant species, DNA fingerprinting, RNAi technology

1. Introduction

The success of biological control in arthropods is dependent on the ability to establish and maintain a viable population (Alvarez et al. 2016, Green et al. 2016, Hajek et al. 2016). The most successful biological control programs have been those that have established populations of one or more species at sufficient levels to achieve their objectives. In order for a biological control agent to be effective it must be present in sufficient numbers so that the target pest is exposed to an adequate number of parasitoids and predators (Gillespie, Gurr and Wratten 2016). This can only occur if there are enough individuals available for each stage of the life cycle (reproduction, development, dispersal) as well as adults capable of mating with potential hosts (Estrada-Peña et al. 2015, Green et al. 2016). For example, there may not be enough females available for egg laying when eggs hatch out into larvae; thus, adult males would need to be present in order for reproduction to take place.

Insect conservation efforts focus on three major areas: habitat preservation (including restoration), research into insect biology and ecology (including population monitoring), and pest management (including crop protection) (Kergunteuil et al. 2016, Tscharntke et al. 2016). These activities benefit not only insects themselves but also all life forms that depend upon them—from humans to birds to bats—and the environment itself. Insects are the most diverse group of animals on Earth, and they have been around for more than 500 million years. They play an important role in every ecosystem from deserts to forests. Insects provide food for other organisms, pollinate plants, control pests, and serve as a source of genetic material for many species. Insects also help scientists understand basic biological processes such as how populations change over time or how diseases spread between individuals.

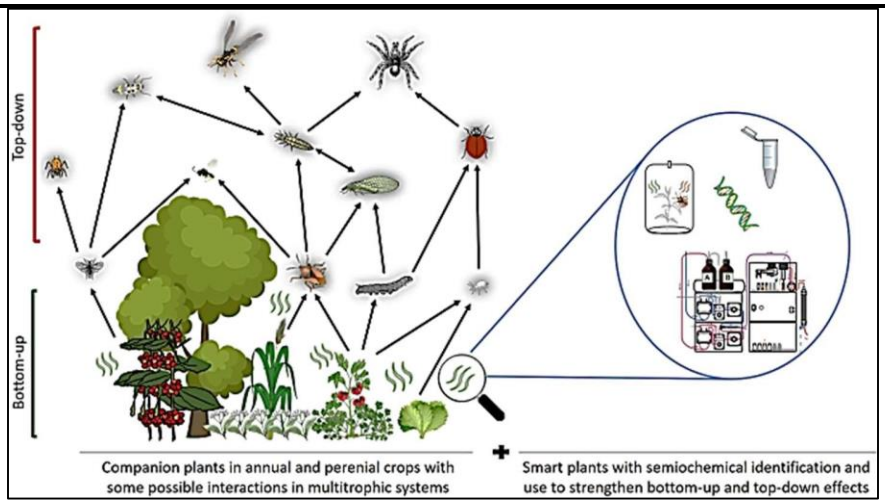

Fig.1 Functional overview of conservation biological control (CBC)

2. Literature review

2.1 Approaches in conservation biological control

One approach used by some researchers is to introduce multiple species into a single area where they compete with each other and thereby reduce overall population size (Moran, Hartig and Bell 2016). As mentioned above this method has been successfully employed by others using several different arthropod groups (Nadell, Drescher and Foster 2016, Pugh et al. 2016) and insects belonging to other orders such as Hymenoptera (Zepeda-Paulo et al. 2015). However, these studies often involve introducing many non-native species simultaneously which could result in undesirable ecological effects. Furthermore, these methods do not always work because the introduced organisms may become extinct before achieving their intended objective due either directly or indirectly through competition from native species already present in the area being invaded by exotic ones.

Fig.2 “Rodolia cardinalis, the vedalia beetle, was imported from Australia to California in the 19th century, successfully controlling cottony cushion scale”

Fig.3 Assassin bug (family Reduviidae) preys on spotted cucumber beetle (Diabrotica undecimpunctata)

A second approach involves releasing only one or two highly specialized parasites per site so that they can expand rapidly within their host range while minimizing competition from native pests which might limit their growth rate or cause them extinction before attaining their full potentials (Estrada-Peña et al. 2015, McMullan et al. 2015). These authors also demonstrated how certain combinations of parasites could provide effective biocontrol agents against several agricultural pests even though they were widely distributed. (Peralta 2016) showed how biocontrol strategies based on combining several closely related parasite taxa were superior over those based on introducing just one type alone since both types had similar reproductive capacities but differed greatly in distribution patterns between continents making them ideal candidates for combined releases across large areas under conditions where local environmental factors did not significantly affect either group's performance.

2.2 Conservation biological control: An overview

Non – prey food resources sometimes play important role early life growth stages in CBC using arthropods (Colares et al. 2015, Nilsson et al. 2016). The use of biological control agents is an increasingly popular method for controlling pests in agriculture (Hajek et al. 2016, Holmes, Upadhyay and Mandjiny 2016, Labuschagne et al. 2016, Lacey et al. 2015). The most common insects used as biocontrol agents are parasitic wasps and flies, which lay their eggs inside the pest host. When the eggs hatch, the larvae feed on or kill the pest, thereby reducing its population and preventing further damage to crops. In addition to biological control agents, other methods of pest management include: Insecticides are used to control pests (Wojciechowska, Stepnowski and Gołębiowski 2016). Insecticides can be either contact or systemic (Gerbig et al. 2015), and they may be applied as a spray (Ngufor et al. 2016), dust (Richards et al. 2016) or granule (Mahmood et al. 2016).

3. Advantages of CBC using arthropods

1. Less impact on the environment than chemical pesticides (Guedes et al. 2016), which can be harmful to humans and wildlife.
2. Can reduce the need for chemical pesticides by reducing crop damage caused by pests (Sarwar and Technology 2015).

3. Biological control is more sustainable because it does not harm non-target organisms such as pollinators (Douglas, Rohr and Tooker 2015) or other beneficial insects in the ecosystem that are important for natural pest control (Fahad et al. 2015).
4. The use of biological controls has been shown to be effective in controlling major pests, including mosquitoes and termites (Samuels et al. 2016).

4. Conclusion

Thus, using biocontrol agents like arthropods may help preserve biodiversity at all levels— from individual plants and animals through entire ecosystems—by providing an alternative method for managing pests beyond those currently available based on chemical pesticides alone or integrated with other methods such as cultural practices like Integrated Pest Management (IPM) programs designed specifically to minimize pesticide use while maintaining ecological balance within an ecosystem by targeting specific pest problems without harming non-target organisms such as pollinators or other beneficial insects in the ecosystem that are important for natural pest control.

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