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DEVELOPING STRATEGIC RESEARCH FOR BIOLOGICAL CONTROL OF NEW PEST THREATS: THE PASSION VINE MEALYBUG, PLANOCOCCUS MINOR AS A CASE STUDY

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ABSTRACT. Classical biological control is one of the key approaches to the management of invasive alien pests. This typically involves the importation and release of natural enemies from the pest's area of origin. Due to increased concerns about the ecological safety of imported biocontrol agents, regulatory requirements for information during the importation process have increased considerably in recent years. Thus, a considerable amount of knowledge has to be generated before a natural enemy can be introduced. This also means that a considerable amount of time can be lost before implementation of biological control program. In principle, the process can be speeded up if research on potential threats is done in advance. However, the challenge to such a pre-emptive approach is that there are many potential threats and only limited resources. This paper discusses ongoing pre-emptive research on Planococcus minor, a high risk pest threat to the United States and other countries in the Caribbean Basin. It also discusses the value and application of such strategic research, and identifies key considerations for institutionalizing this approach.

KEY WORDS: Pre-emptive biological control, invasive species, Planococcus minor

INTRODUCTION

The management of invasive alien species (IAS) continues to be a major challenge to plant protection authorities, and despite increased efforts, new problematic invasive species have continued to emerge at an alarming rate. In part, this is not surprising because, many countries are still a long way from establishing all the required safeguarding mechanisms. However, it is important to emphasize that even with the best safeguarding systems in place, it is impossible to have a totally impermeable system, that is, unless all trade and movement of people and goods ceases. Countries are, therefore, taking a pragmatic approach based on risk analysis as espoused in the WTO-SPS agreement. However, once an IAS becomes established in a new environment, efforts switch to risk management and classical biological control is one of the central approaches for managing an established IAS.

The decision to implement classical biological control is, however, frequently delayed for various reasons including: 1) initial emphasis may be placed on eradication efforts which could go on for several years, 2) there may be a desire to carry out research to assess the role of indigenous natural enemies, which may adapt to attack the new IAS, and 3) non-availability of essential financial or human resources. Typically, pre-introductory research on agents for weed control may easily take 5-10 years, before the first releases are made. Whereas for arthropod pests, it was not uncommon for releases to be made within 1-3 years of initiating the effort. The

increasingly stringent regulatory requirements now may require considerable research to support requests for introduction and release of biological control agents. This means that such efforts to introduce natural enemies of an IAS are increasingly requiring considerably greater investment in resources and time to undertake the necessary work. Greater availability of knowledge on potential pests and their natural enemies can enhance the process and thus reduce delays in the introduction and release of biological control agents. This paper discusses the potential for and value of pre-emptive/strategic research of this nature.

SCOPE FOR STRATEGIC RESEARCH

'Strategic research', from our perspective means research aimed at imminent or eventual major pest threats, i.e., to generate knowledge which will bolster mitigation efforts across the continuum from prevention to management activities. Therefore our interest is on those species for which there is sufficient reason for concern. Pests are deemed to be of concern if they are listed on the Cooperative Agricultural Pest Survey (CAPS) list (USDA, 2005) or other prioritized lists. The CAPS list includes pests which have become established but have a limited distribution and pests which have not yet been found in the United States, but which are frequently intercepted. The list is ranked on basis of potential environmental and economic impact. Our primary focus is on pests which are not yet established in the United States. The knowledge available on such species varies considerably, from those where there is a wealth of information available, to those where little, if anything is known.

The broad goal of our strategic research is to generate knowledge which will bolster mitigation efforts across the continuum from prevention to management activities. For instance some of our work is focused on development of digital identification tools on some high priority taxa. However, this paper is concerned with research that is focused on aspects of management of invasive alien species and especially biological control.

For logistic and other reasons, we have also narrowed our taxonomic and geographic focus to mealybugs and to the Caribbean respectively. Recent history has shown that the Caribbean is an important source area as well as conduit for the introduction of pests into the United States as demonstrated in the case of the pink hibiscus mealybug, Maconellicoccus hirsutus (Green)

On the other hand, mealybugs are among the most important pest invaders in the United States. For instance, at least two mealybug species became established in the United States during every decade of the last century and in the 1990s, this number rose to seven (Miller et al., 2002). We are primarily interested in two species, the passion vine mealybug, Planococcus minor and, the coffee mealybug, Planococcus lilacinus. The former is one of the high priority pests on the CAPS list. Both species are among the top 10 listed by Miller et al. (2002) with highest risk of entry into the United States. In this paper we use P. minor to illustrate the scope of the strategic research being conducted.

Planococcus minor IN THE WESTERN HEMISPHERE

The passionvine mealybug is a polyphagous pest with a host range exceeding 200 plant species. The pest is native to Asia, but has been recorded in several countries in the Caribbean and

Central, and South America (Table 1). These records suggest that the mealybug has been in the region for quite a few years yet despite records increasingly frequent interceptions, this pest has not become established in the United States. Taxonomic experts have, however, pointed to the fact that the species is very similar morphologically to the citrus mealybug, Planococcus citri, and there is a possibility that the validity of the records from the Region may be questionable. Assuming that the records of the pest in the region are accurate, then, this begs the question why no major outbreaks have been reported in the respective countries. Against this background, our research was initiated with the following objectives:

1. To confirm the presence of the mealybug in the region and to assess its pest status and identify its main host plants.
2. To generate information on various aspects of the pest's biology and ecology including: development and reproduction at different temperatures, phenology, surveys to identify natural enemies.
3. Conduct studies to understand the biology and impact of key natural enemies.
4. Develop techniques for surveillance based on pheromones; also develop rearing techniques for the mealybug and any potential natural enemies.

The overarching purpose of this research was to develop technology for surveillance and control of the pest.

Table 1. Distribution of passionvine mealybug in the Western Hemisphere (Watson and Chandler, 2002; Williams and Granara de Willink, 1992)

Insular Caribbean	Central and South America
Antigua and Barbuda	Brazil
Cuba	Colombia
Dominica	Costa Rica
Guadeloupe	Guatemala
Grenada	Guyana
Haiti	Honduras
Jamaica	Mexico
St Lucia	Uruguay
US Virgin Islands	
Trinidad	

PRELIMINARY FINDINGS

The research on P. minor in Trinidad is ongoing and will be fully reported later. Here we highlight some of the significant findings. The passionvine mealybug has been found at various locations in Trinidad and this insect has been positively confirmed as P. minor. To date, the closely related species, P. citri, which is most often confused with P. minor, has not been found in Trinidad.

The weight of evidence collected thus far suggests that in Trinidad P. minor is restricted to only a few host plants. Cocoa is the most important host plant in Trinidad and the pest prefers feeding on cocoa pods.

Populations of the mealybug are very low at all locations and it is attacked by a complex of natural enemies including both predators and parasitoids (Table 2). Research continues to quantify the impact of the key natural enemies and to understand their ecology. However, it seems that the existence of this broad natural enemy complex may explain the low prevalence of the mealybug.

Two of the most important parasitoids recovered, are already present in the United States.

Table 2. Some of the common natural enemies of Plannococcus minor from Trinidad (Francis et al., in prep.).

Species	Location
Leptomastix dactylopii, parasitic wasp, Encyrtidae	Maracas-St. Joseph ,La Reunion Station, Santa Cruz, Lopinot , Fishing Pond
Coccidoxenoides perminutus, parasitic wasp, Encyrtidae	Biche, Fishing Pond
Gahaniella tertia, parasitic wasp, Encyrtidae	Maracas-St. Joseph
Signiphora n. sp. #11 mexicanus group*, parasitic wasp, Signiphoridae	La Reunion Station
Coccidoctonus trinidadensis, parasitic wasp, Encyrtidae	Lopinot
Diadiplosis coccidarum, predaceous larvae, Cecidomyidae	All sites
Several Coccinelid spp. , predaceous larvae and adults	

DISCUSSION AND CONCLUSIONS

Benefits of strategic research: Strategic research allows for better preparedness, and has the potential to minimize delays in implementation of biological control. Strategic research will also save considerable time should the pest become introduced. The invasion of Florida by the pink hibiscus mealybug is a good example of the benefits of strategic research. Because USDA-APHIS and Caribbean partners had developed and tested the methods for management of the pest, this meant that natural enemies were introduced within a very short time (weeks) of the first reports of the pest in Florida. Furthermore, key stakeholders were already well informed and this helped to avoid panic, inappropriate regulatory measures and huge economic losses.

Strategic research is also critical in guiding complimentary research in other countries. In the case of P. minor a priority for other affected countries in the Caribbean would be to conduct

surveys to establish whether or not some of the specialist natural enemies are already present. If not, countries may wish to make a decision to introduce specific natural enemies.

Assuming that all of us are convinced that it is important to develop action plans for priority high risk invasive alien species, it would be useful to consider how this can best be done, given the regional interest as demonstrated in this symposium to increase collaboration and synergy between Caribbean Basin partners interested in strengthening regional safeguarding. An important starting point might be the development of a list of regional pest priorities. This could begin by listing species that are already in the region but have a limited distribution. It will also be important to identify the institutions and people working on particular species. Such an effort can be effectively implemented through established networks such as the Caribbean Invasive Species Working Group (CISWG). Information exchange would be critical.

A typical strategic plan for biological control of new pest threats should contain (1) a summary of available knowledge, (2) identification of key gaps which require research and (3) an assessment of the requirements and complexity of implementing classical biological control for specific targets. Other useful information will include a listing of potential collaborators across the globe.

In conclusion, it is clear that any knowledge generated in advance of a pest becoming established in a new country is likely to be of immense value in guiding the development of responsive action. Strategic research is therefore inherently beneficial. Given the common nature of many pest problems affecting the Caribbean Basin, the development of partnerships and networking will be immensely beneficial. It is anticipated that with more examples of successful research, increased awareness and interest for other scientists to conduct related research will develop.

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