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Biological control of insect pests: Success and failure of various programs

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ABSTRACT

Man has probably been plagued by insect pests ever since he began to grow crops and rear animals. Worsened by the ability of these pests to emerge and re - emerge, man, his crops, livestock as well as his socio - economic status stand on the threshold of destruction. Challenged by this danger and frustrated by the demerits of chemical pest control, man began to explore the use of identified natural enemies as agents of biocontrol to manage potentially damaging population below levels that they can cause economic injury. Such agents as predators, parasitoids, parasites, pathogens pose a very bright promise as tools within the context of integrated pest management especially in agriculture and public health. Augmentation, conservation and importation are the three basic approaches of biocontrol. Of these three, importation/classical biocontrol has undoubtedly proved to be the most rewarding while augmentation is least sustainable. Irrespective of the approach adopted, biological control has recorded tremendous success. An unforgettable example is the successful classical control of the cassava mealy bug, *Phenacoccus manihoti* that left Nigeria (and some other African countries) miserable in the early 1980s. Undoubtedly, biological control has much appreciable merits over other pest control methods. It is devoid of environmental pollution, cost effective and generally maximizes pest mortality. Indeed, the technological and political challenges facing biological control at least in Nigeria necessitated the need to assess its current status with a view to finding out the successes or failures of various programs. The study projected that despite some constraints, a more sustainable biological control of insect pests could await its advocates if the sustainable factors become availably consistent.

KEYWORDS

Plagued;
Threshold;
Economic injury;
Classical;
Sustainable;
Advocates.

INTRODUCTION

Insect pests are obnoxious and notorious insects that cause visible / physical harm / damage to plants, animals or their products in which man has an economic or aesthetic interest. To qualify as a pest, the species has to be present in sufficient or significant number, so that the economic depreciation caused, can be appre-

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ciated[17,18,24,25,28]. These insect pests at all stages (immature and adult) are associated with various degrees of economic importance, which in some cases prove devastating under certain conditions. Insect pests are known to reduce the quantity and quality of agricultural produce of man, attack and kill the livestock of man, implicate the health/life of man himself and render him penury through control ventures[1,7,18,20,24,25,26] and this is just to mention but a few.

Meanwhile, biological control is a deliberate action by man using identified natural enemies as agents of control to manage potentially damaging populations of pests below levels that they can cause economic injury[26] and by employing this, the maximum yield potentials of crops, livestock and health of man can be realized. Virtually all insect pests have some natural enemies. Managing these natural enemies can effectively control many pests[19,33]. The employment of insects to save crops from other pests is not new. Old records have shown that Ants were used by the Arabians more than two hundred (200) years ago for protecting date trees[5]. However, the conscious use of living beneficial organisms to control pests has attained more advancement in technology. One must acknowledge the fact that some trials of biological control of insect pests did not yield any sustainable result while some others have been tremendously successful.

While progress in the development of biological control agents has been substantial and work in progress appears promising, this review is aimed at summarizing insect pests biological control efforts; with a focus on the success and failure of various programs and taking a look into the future of this beneficial and environmentally - friendly method of pest control. Based on the outcome of the study, this paper will also make recommendations. While informing current policies and control, our large readers will also be updated on the future status of biocontrol of insect pests.

RESULTS AND DISCUSSION

Success and failure of various biocontrol programs on insect pests

Biological control of insect pests has received much attention in recent times and has been the subject of numerous reviews. Incidentally, only few original works on biological control have been recorded, at least in my country, Nigeria. For instance and at the classical level, biological control of the cassava mealy bug, *Phenacoccus manihoti* was successfully conducted. *Phenacoccus manihoti* was first discovered in Zaire in 1973[22] but was accidentally introduced into Africa in the early 1970s. It subsequently spread over most of the continent. Through its feeding damage and stunting of the cassava shoot tips, it dramatically reduced tuber yields, thereby becoming the most important pest of cassava[21]. To combat this new pest in collaboration with numerous national and international agencies, the Biological Control Program of the International Institute of Tropical Agriculture (IITA) was established[13]. Following extended exploration in South America[33] and quarantine at the International Institute of Biological Control (IIBC) in the United Kingdom, the solitary and host - specific wasp *Epidinocarsis lopezi* was imported into Africa, reared, and first released in Nigeria in 1981[15]. By 1988, it had been successfully established in 21 African countries and had spread over an area of over 1.5 million km^2[16,22]. Cassava mealy bug populations declined after the release and have remained low since[12,13,23]. Studies on the potentials of parasites and nematodes in the biological control of *Acanthacris* in Jos, Nigeria have also been reported. These studies showed that the presence of nematodes and insect parasites restricted ovarian development in female grasshoppers and caused sluggishness in male grasshoppers. Thus, these parasites may play significant role in the biological control of *Acanthacris.* Other biological control programs of insect pests have been achieved outside Nigeria. In fact, the successful classical biological control of the cottony cushion scale in California United States of America has brought into prominence the use of parasites and predators in insect pest management. Precisely, the Ladybird beetle, *Rhodalia cardinalis* was imported from Australia to control the cottony cushion scale, *Icerya purchasi* threatening the citrus industry in California[9,14]. Thereafter, the successful control of the cottony cushion scale in 1889, the ladybird beetle (Coccinellid) achieved complete control of the same pest in 25 other countries[8].

Since the end of the last century, about 150 different species of insect pests have been controlled successfully by biological control method. The control of the Kenyan coffee mealy bug *Planococcus kenyae* with *Anagyrus* sp., control of Mosquito larvae by the use of

larvivorous fish *Gambusia affinis* are more examples[4,31]. The large species of lchneumon - fly that preys on the larvae of the Great Wood Wasps has also been sent to New Zealand. These larvae were destroying much valuable timber, but were soon reduced in number by their imported enemies. Other useful insects have been sent to North America by Britain, and these include Chalcid flies, which behave like lchneumon - flies in destroying larvae and eggs of harmful species[6]. However and disappointingly, all efforts made to control the cassava green spider mite (*Mononychellus tanajoa*)[33] and the obnoxious and notorious Mosquitoes biologically have not yielded any functional result. Ordinary, one would think that studies should intensively focus on the potentials of dragon fly to control mosquitoes. This is because; any organism chosen to control mosquitoes must have a powerful flight and searching ability (like the Dragon fly). Incidentally, the possible use of dragon flies as natural enemies for Mosquito control was clearly recognized but the enormous difficulties associated with the colonization and management of these insects quickly erased any idea for the practical use of these predators for Mosquito control. Indeed, the use of Mosquito fish (*Gambusia affinis*) and few other natural enemies to control Mosquitoes received enormous attention between 1900 to 1940s[3,4] but the spectacular result of use of synthetic organic insecticide against Mosquitoes, other Flies and Lice after World War II quickly and significantly reduced other control strategies. Interest in the use of biological control against pests arose again when the arrays of chemicals developed during the 1940s and 1950s began to fail, due to the development of genetic resistance in pest populations.

Since then, scientists have demonstrated the potency of biological control of insect pests[30] and much as some trials have recorded tremendous success and some others failed, efforts should be continued towards augmenting their efficacy through further biological studies.

Proper identification of sibling species of parasitoids during search and importation of control agents, determine the success of a biological control programs. More recently, it is now possible to separate sibling species of parasitoids through the use of internally transcribed spacer 2DNA sequences of the nuclear ribosomal gene. Definitely, accumulated evidences from these lines, no doubt have shifted biological control researchers forward beyond bio-ecological studies.

Classical biological control

Modern quarantine laws are intended to eliminate the introduction of new pests, but even now, serious new pests, such as the Russian Wheat Aphid, find their way into the United States, become established and cause damage[19]. In classical biocontrol, International Agencies, Federal Agencies (especially the United States Department of Agriculture), and State Agencies (State Departments of Agriculture and the Land Grant Universities) are responsible for identifying potential target pests, locating their natural distributions, searching these areas for candidate natural enemies and introducing selected natural enemies into the necessary areas[11]. Therefore, proper authorization has to be received from the United States Department of Agriculture before private individuals or agencies can introduce non - native organisms (including natural enemies) into a given area. Hence, natural enemies must be carefully screened by trained personnel under rigid quarantine conditions to be certain that they will provide benefit in controlling the target pest, they will not themselves become pests, and they do not harbor their own natural enemies that might interfere with their effectiveness or that of other natural enemies.

Other approaches to insect biological control

The two other general methods of insect biological control are 'augmentation' and 'conservation'[27,32]. The classical biological control differs from augmentation and conservation because it is not directly conducted by the farmer or gardener rather by International, Federal and State Agencies[10,11]. To many people, biological control means buying and releasing beneficial natural enemies to control insect and mite pests. This approach is known as augmentation. However, of these three general approaches to insect biological control, augmentation is the least sustainable because it requires the regular or periodic purchase of products. Nonetheless, in some pest situations it is highly efficacious, cost effective and environmentally sound approach to pest management. The practice of augmentation is based on the idea that in some situations there are not adequate numbers or species of natural enemies to provide optimal biological control, but that the numbers can be increased (and control improved) by releases. This requires a ready available source of large numbers of natural enemies. This need has fostered the development of

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companies (called insectaries) to produce a variety of predatory and parasitic insects; other companies produce and market insect pathogens for use as microbial insecticides. There are two general approaches to augmentation: inundative releases and inoculative releases. Inundation involves releasing large numbers of natural enemies for immediate reduction of a damaging or near - damaging pest population while inoculation involves releasing small numbers of natural enemies at intervals throughout the period of pest activity starting when the pest population is very low. It may interest you to learn that many augmentation programs do work and are cost effective. Regrettably, augmentation cannot be considered the "the silver bullet" of biological control. It is not fool proof, and it requires a certain level of knowledge and understanding to make it work. Additionally, effective commercial natural enemies are available for only a small percentage of all the types of pests we must manage. It is the most costly and least sustainable form of biological control. However, where it does work, and is cost effective, augmentation can be very useful. Beside augmentation, conservation can always be resorted to, as a biocontrol method. Simply put, conservation of natural enemies means avoiding practices which harm natural enemies and implementing practices which benefit them[2,10]. It may sound like good common sense, but the tricky part comes in understanding exactly what practices can be integrated into a production system.

CONCLUSION

The future of biological control of insect pests and recommendation

Undoubtedly, there has been significant progress worldwide in all areas of biocontrol. Notably, such significant progress has opened up new frontiers in the exploration and selection for natural enemies and development of modern technology for mass rearing of both the pest and natural enemies. These developments have left bright hope for biocontrol. In Nigeria, however, critical examination shows that there were some constraints to previous biocontrol programs. No wonder the efficacy and stability of insect biocontrol are described as far - reaching and more than can be tucked inside a subprogram in the existing National Agricultural Research Institutes (NARIs). At the same time, it is hoped that in the nearest future, there will be a separate institute for insect biological control or at least a biological control institute and this will increase the efficacy of biocontrol. In addition, it is also hoped that the Government will become more responsible in the future and see the need to invest in biocontrol. However, challenges for the future of biological control include additional studies to identify the complex of natural enemies in cultivated crops, understand the biology and population dynamics of the natural enemies associated with the major pest species, and determine how the different IPM practices can best be used to ensure their compatibility with the natural enemies. Also needed are studies to evaluate the impact of predators, parasites, and diseases to find ways to improve biological control through conservation, augmentation, and importation. Investing into having an outstanding and separate Biological Control Institutes in the third world countries (like Nigeria) will greatly foster researches from which tremendous (biocontrol) benefits will be derived.

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