

Biological control as a pest management strategy



**ASSIGN
BUSTER**

Several researches were carried out by different organisations in Mauritius to implement biological control in Mauritius as a component of our local Integrated Pest Management strategies. However, it can still be observed that most of the natural enemies which have been introduced over the past few years are unable to match up with their expected efficacy on the field. Only a portion of the introduced natural enemies are very efficient in pest control and maintaining their level of infestation below the economic threshold level, for example, natural enemies used in sugar cane field are very effective and necessitates no pesticide and herbicide use to control pests thus, reducing the cost of sugar cane production. However, those vegetables planters in Mauritius that are aware of the principles of biological control tend to misjudge the use of biological control as a method of pest management, they are both right and wrong in certain ways.

Based on the data collected during this research, it can be clearly seen that the efficacy of natural enemies differ from region to region. Depending on the natural enemy species, some are more effective in certain regions compared to others. Some natural enemies have the potential of being a very good effective biological control, however, it is seen that their performance on field is not sufficiently satisfactory. Before implementing a new biological control programme, several procedures are followed so as to choose the best performing natural enemies. Threats to natural enemies' efficacy are present in many forms. The biggest threat and most common one is the application and overuse of chemicals such as pesticides and insecticides. Based on the survey data obtained, it is seen that most farmers apply pesticide every week. The use of chemical pesticides has increased

significantly during the past 10 years. The application and pesticide residuals are severe threats to natural enemies, most especially parasitic wasps, flies and predators. A good example would be planter N01 where a sample of *Plutella xylostella* (L) was collected to evaluate the parasitoid *Cotesia plutellae*. The farmer makes use of selective pesticides and applies a minimum amount on his infected plants and the rate of pesticide application is every 2 weeks.

The efficacy of *Cotesia plutellae* in his field was seen to be as much as 50% that is, half of the larvae evaluated were parasitized by the wasp. On the other hand, another sample of *Plutella xylostella* (L) was collected on planter's W02 field and the efficacy of *Cotesia plutellae* evaluated was found to be much lower than the N01 sample, 16% respectively. From the survey data, it was seen that planter W02 makes use or a larger selection of chemicals and applies them every week, the rate of pesticide application is twice as more for planter W02 than for N01. Another interesting observation made while carrying out the survey. It was the way some of the planters prepare their pesticide solution, some of them clearly use much more pesticide than the amount recommended. Some of them tend to mix several pesticides together and made a pesticide "cocktail" out of them, making the final solution have a broader spectrum. Though the prepared pesticide cocktail solution might be effective against the pest, but it also has a negative impact on natural enemies present on the field or the surrounding fields. Due to the "cocktail effect", it is possible that chemicals in the mixture might interact to produce an increase in its toxicity. This might be a reason for the low efficacy of natural enemies. Farmer A may be taking good

measures of IPM and using less chemicals, but the overuse and misuse of pesticides by the other nearby farmer(s) will surely affect biological control on farmer's A field.

Another case encountered with high natural enemy efficacy is with sample W01 which consisted of *Aphis gossypii* collected at Saint Martin, a village situated in the West of Mauritius. The efficacy of the parasitoid wasp *Lysiphlebus testaceipes* was 48%. The sample was collected on a calabash plant. What was most interesting was that calabash was not the planter's main crop, only a few trees were planted at the corner of the field and left to grow without taking care of and no pesticide and other chemical application. This might be why the efficacy of the parasitoid was relatively high. A very important cause of biological control failure is the planter's attitude and knowledge about natural enemies and biological control. Most farmers surveyed had very good knowledge about the pest threat they usually face, they also can identify the damage-causing pest and use appropriate measures. On the contrary, it was found that most of them (97%) do not have any knowledge on biological control, they did not know the existence of beneficial organisms controlling damage-causing ones.

For this reason, they cannot be expected to recognise and adopt conservative measures to preserve natural enemies, such as formerly mentioned, reduce pesticide use, habitat management and modify biological and ecological aspects to enhance natural enemies such as elimination of secondary enemies. It is believed that sensitisation by the responsible authorities is important to the planters so as to improve the overall IPM in Mauritius.

On the other hand, even if proper sensitisation is made to all planters, it might still be quite challenging to increase the natural enemy efficacy. Most planters in Mauritius have a mindset that makes them disbelief in something they do not see with their own eyes. Also, farmers won't be willing to abandon their traditions which were passed on to them by their parents and grandparents. The use of chemicals in Mauritian agriculture is far from being regulated. Farmers say that their budget are often limited and that they cannot take risks of trying something new due to the fear of it not being a success and of losing everything. This is due to the fact that biological control does not completely eliminate the pest population but in fact it only reduces the pest level to a minimum acceptable level. This is usually unacceptable to the farmer who wants to see his field entirely free of any pest. If no proper conservative measures and natural enemy monitoring are applied, another pest outbreak may occur inflicting losses to planters. These are reasons why planters in Mauritius prefer to use pesticides as a method of pest control. Also, though most planters are not willing to change their traditional way of pest control, some of them are sometimes willing to adopt new IPM strategies in order to control pests, such as the use of bait traps and sticky traps, but those traps also act against natural enemies, mostly tiny parasitic wasps. Some good agricultural practices also can contribute in biological control failure, for example, crop rotation is a good way of reducing pest population, but if the host plant essential for the pest survival is not available, neither will be the pest or their respective natural enemy. The use of pest resistant varieties is also a good way to avoid pest outbreaks but if the crop is too resistant to pests, biological control will be very hard to establish if no other sources of habitat and food are present.

Another aspect having an effect on natural enemy efficacy evaluated during this research was the climatic factor in the different regions that is mainly the microclimate present in the different sites selected for sample collection. It was found that climate change has an impact on insect phenology and the distribution of phytophagous insects especially Lepidoptera. This explains the rapid development and vast distribution of the pest *Plutella xylostella* throughout Mauritius. In the chi square test done and presented in table 3. 8 in the previous chapter, it was found that the p-value to be less than 0. 05 for the natural enemy *Cotesia plutella* , meaning that the efficacy of the parasitoid is dependent to the climatic factor in different region. In fact, both the hymenoptera parasitoid evaluated was seen to be dependent on climatic factors compared to the other natural enemies evaluated in the chi square test (Refer to Appendix 1).

This describes the difference in efficacy of the parasite around Mauritius. It was found by Nofemela, 2004 that the parasitoid *Cotesia plutellae* can develop on a wide range of temperatures (8. 14 ° C - 33 ° C), thus, another deduction that can be made about the efficacy of *Cotesia plutellae* is that the parasitoid density present in the different regions is not the same. In all cases of planter interviewed, it is found that the planters noticed an increase in temperature and in change in rainfall pattern and intensity. The planters also mentioned that the warmer it is, the more the risk of a pest outbreak, for this reason, they usually apply more pesticides in summer. It is concluded a changing (warming) climate and use of chemicals in agriculture are directly and positively related. Despite the fact that some pests became resistant to pesticides and other chemicals, farmers still apply pesticides knowing that

no results will be seen. To some extent, climate change will be responsible for the increasing overuse of chemicals and agriculture which can in turn lead to a decrease in biological control efficacy. A change in insect phenology might also affect the host and natural enemy synchrony, a fail in synchronisation with the host life cycle might cause drastic decline in biological control for reproductive failure.

Other factors which was seen to affect the efficacy of natural enemies was the coexistence of the pest with other organisms which provide protection to the pest against natural enemies. The two species of mealy bug studied, the *Paracoccus marginatus* and the *Icerya seychellarum* were seen to coexist with ants in all the pest samples collected. The ants harvest a substance called honeydew from them which is secreted by the mealy bugs, and in return they provide protection against natural enemies, mostly predators. The efficacy of the *Paracoccus marginatus* predator *Exochomus laeviusculus* might not be the same on the field than the one evaluated in the lab, on the field, especially on papaya trees where the *Paracoccus marginatus* samples were collected the mealy bugs were found to be compacted on the trees, stems and fruit, like a large white cottony lump. A waxy texture was present on all the mealy bug colonies, this may explain why the pest is being hard to control. The waxy substance prevents chemicals to penetrate into the colony layer and natural enemies can only feed on the lonely nymphs wondering around with no protection. Also several species of ladybugs and other predators like spiders and sparrows were seen on the same tree. Such cases might generate a competition among predators and the efficacy of a selected predator for example the coccinellid *Exochomus laeviusculus* may

not be the same compared to a scenario where the coccinellid is the only predator preying on the pest.

A very low parasitism rate was recorded for the parasitoid *Cryptochetum monophlebi* biological control of the pest *Icerya seychellarum*, this might be because of the presence of ants, chemicals present in that particular environment, but also, the *Cryptochetum monophlebi* being the order Diptera. It is known that Dipterans are the favourite food of lizards and some other insectivorous reptiles. Due to the presence of those reptiles on tree fruits, it can be a reason why the efficacy of the parasitoid is too low.

The efficacy of the ladybug *Nephaspis bicolor*, predator of *Aleurodicus dispersus* was also evaluated in the lab and its efficacy, just like other natural enemies evaluated was seen to vary from region to region. However the efficacy was seen to be very low, although no ants were present where the *Aleurodicus disperses* sample were collected, the efficacy of the *Nephaspis bicolor* was as low as for the *Exochomus laeviusculus*. Coccinellid are more effective when several of them are present, for an efficient biological control using ladybugs, a high population must be available and maintained in the field throughout the crop cycle on which the pest is present. When no food is present, the ladybug beetle will tend to move away to another area where the pest is present or find another sources of food so as for them not starve to death. If only a few are present, they will only prey on a fewer amount of pests, making no differences to the pest population, also, they might get eaten up by birds or lizards present on the field.

However both the ladybugs evaluated are independent to the climatic factor present in the regions in which they were collected ($P > 0.05$). It means that

<https://assignbuster.com/biological-control-as-a-pest-management-strategy/>

the regions from which they were collected does not have an effect on their efficacy.

Another aspect of IPM for sustainable pest control would be the use of biopesticides, such as microbial pesticides and botanical pesticides. Only 32% of all the planters interviewed know about the availability of this kind of pesticide. Most of them think they are expensive and ineffective. However, since biopesticides are not manufactured locally, the price of the biopesticides is almost the same as for chemical pesticides. This is a reason why planters prefer to buy chemical pesticide and don't take the risk of purchasing something they are not sure about. Planters also think it is troublesome to prepare their own botanical pesticides using locally available plants such as neem and citronella and much more. Botanical pesticides do not harm the environment and the efficacy of natural enemies will be sure to be boosted if more planters adopt the use of biopesticides.

Another interesting observation made while processing the results obtain. It was that the efficacy of natural enemies evaluated in the different agro ecological zones selected does not differ greatly. The efficacies are in the range of 15.8% to 20.2% respectively. It can be concluded that the natural enemies evaluated have a good adaptability to the local climate, which is a major characteristic for being a good natural enemy as failure to adapt to the climate and environmental factors is among the factors in biological control failure. Nevertheless, it is observed the average efficacy is lower in super humid regions compared to sub humid regions. As mentioned earlier, this might be due to the practices of the planters on their farm and also the

difference in temperature, causing changes in both the natural enemy and the host pest's phenology.

In crops producing fields in Mauritius, it was deduced that the use of natural enemies is effective to certain extent, but not as effective to be able to control a pest by themselves. This was the case in every area investigated regardless of the land use diversities. The land use also can prove to be very determining in biological control. An example would be the pest *Aleurodicus disperses*, the sample (CO5) was collected in Vacoas where the citrus trees were in a field situated in a residential area. The trees were found on the road side and were heavily infected near the stem and underneath the leaves. The beetle *Nephaspis bicolor* was scarce and very difficult to count. On the other hand, sample CO8 of *Aleurodicus disperses* was collected at Ripailles, the trees were found in a field surrounded by other vegetable fields and sugarcane. The tree was rich in ladybug population, and the beetle *Nephaspis bicolor* could be easily collected. This proves that land use and vegetative cover has an impact on the presence of natural enemies. For example, maize areas have a positive effect on ladybug density present and thus, this explains the low pesticide use in maize crops (Zhou, 2014).

Vegetative covered areas provide food and shelter for natural enemies. A region of high vegetative cover will tend to have greater densities of natural enemies compared to a region of low vegetative cover or bare land with no vegetation at all. Other crops or trees have abilities to attract some natural enemies, so planting those trees on the field will tend to enhance biological control. Some farmers, especially large scale farmers often wipe out their field to remove everything left after harvesting, this also is a very bad

approach if we want biological control to succeed. With no vegetation to provide shelter, the beneficial organisms will tend to move to another habitat or die out.

A good monitoring schedule must be setup in order to ensure the status of natural enemies and their efficacy must be evaluated regularly. This is mainly to make sure that biological control is going on smoothly and whether human intervention is needed to provide a boost to the natural enemies in order to increase their performance. However, none of these seem to be present on the field where the evaluations were carried out. Although a very good method of foreign exploration and introduction of natural enemies were done by local organisations, no further monitoring programs are carried out.

In some areas of the country, for example Saint Martin, Surinam and Belle Mare, in all which a pest sample was collected, several small planters are present ad a few large scale planters. Their field are close to each other and can be combined together to form a very large area for crop production. The efficacy of the respective natural enemies was very low compared to other areas. The reason might be because each and every farmer makes use of their own type of pesticides in their own personal ways. And pesticides being applied to such a large area will surely cause toxicity to the land and water resources found nearby. Such a large amount of pesticide application decreases the density of the available natural enemies. A lower natural enemy density and failure to reproduce will lead to a fewer amount of parasitized or preyed pest.

Ladybug beetles tend to be very good pest destroyers as both the larvae and adults are voracious eaters. However, a very interesting observation was made on a papaya tree infested with mealy bugs. Several species of ladybugs were present on the tree. Some unusual activities were observed. A ladybug larva was seen feeding on another ladybug larva which was of a different species. Cannibalism might also be a factor of low efficacy among coccinellids. This is an issue of host specificity and competition among pest predators. Concerning the parasitoids evaluated no cases of hyperparasitism, multiparasitism or superparasitism were detected.