THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY (ICIPE)

Hans Herren and Bernard Löhr describe the work of ICIPE in the area of IPM in horticultural crops

Introduction

The International Centre of Insect Physiology and Ecology (ICIPE), based in Nairobi, Kenya, was established in 1970 as an advanced research institute amidst growing global concern about the misuse and overuse of synthetic pesticides. ICIPE was registered as an intergovernmental organisation in 1986, with governance through a 16-member international Governing Council. Due to its broader mandate encompassing health and environment as well as agriculture, ICIPE has remained outside (although closely linked to) the CGIAR system, whose work is primarily commodity-oriented.

Today, ICIPE continues to follow its original mandate of developing technologies to alleviate world poverty and to ensure food security and good health for the peoples of the tropics through management and control of both harmful and useful arthropods. ICIPE's current activities centre around improving and promoting the "4H's" – human, animal, plant and environmental health – by interdisciplinary teams of scientists working in population and ecosystems science, behavioural biology and chemical ecology, molecular biology and biotechnology and social sciences. Research support is provided by biostatistics, bioinformatics, entomopathology, animal breeding and quarantine and biosystematics units, and information technology and services. The 300-some staff originate from 25 countries.

Horticulture

Horticulture is one of the fastest growing sectors of tropical agriculture. Whether grown in the home garden or by large-scale producers, fruits and vegetables offer the double benefit of improving the local diet by supply of micronutrients and providing increasing opportunities for income generation for cash-strapped tropical countries. For these reasons, while not ignoring our history of past research on the staple crops, ICIPE has changed its emphasis to include the IPM of horticultural crops in its portfolio. ICIPE is helping farmers to rationalise and minimise pesticide use, while still producing high quality produce for the local and international markets. We are doing this by developing technologies for biological control such as the use of bacteria, fungi and natural enemies; cultural methods such as intercropping; botanicals (*e.g.* neem); habitat management; behavioural manipulations; and more rational use of pesticides.

Figure 1. **Diamondback moth (*Plutella xylostella*) larva and pupa – a serious pest of brassicas**

Brassicas

One of the most common insect pests on brassicas is the diamondback moth (DBM), *Plutella xylostella* (Figure 1). DBM often completely destroys dry-season cabbage crops in spite of pesticide application, having developed resistance to many conventional synthetic pesticides, and in some areas of

Figure 2. ***Diadegma* (female) – a wasp which parasitises the diamondback moth**

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Kenya, even to some biopesticides. We are developing several eco-friendly options, such as the use of neem for DBM control in cabbage. Screenhouse experiments indicate that seed bed treatment with neem cake powder (NCP) and foliar spraying with NCP water extract and neem oil can also give good control of the moth.

ICIPE started a new international DBM Biocontrol Project in July 2000 with support from the German Ministry for Economic Cooperation and Development. Our activities in the first phase, scheduled to last for three years, have now been extended from the original four countries in East Africa (Ethiopia, Kenya, Tanzania and Uganda) to include South Africa.

The major areas of work are:

- Countrywide surveys in all four eastern African countries: documentation of pest status of DBM; collection, identification and impact assessment of local natural enemies, including *Diadegma* spp. (Hymenoptera: Ichneumonidae) (Figure 2).
- Conventional and molecular taxonomic studies of African and exotic *Diadegma* spp.
- Biological studies of local and exotic parasitoids to select for species adapted to African environmental conditions.
- Pilot introduction into, release and impact monitoring of, at least one species in Kenya and Tanzania.
- Search for and introduction of pupal parasitoids (additional to *Diadromus collaris)* adapted to tropical lowland crucifer growing conditions in Asia.

The first four of these topics will be handled by our ICIPE programme in East Africa, with the national research organisations (our main co-operation partners in the African countries) responsible for most of the work on the ground. The last topic on improvement of biological control in tropical lowlands is being implemented by the Asian Vegetable Research and Development Centre (AVRDC), our project partner in Taiwan.

Our progress so far is the near-completion of the in-country surveys in Ethiopia, Kenya and Tanzania; molecular characterisation of *Diadegma mollipla* collections from Ethiopia, Kenya and Tanzania; initiation of biological studies on *D. mollipla*; establishment of pilot release sites with routine data collection; and the processing of a permit for importation into Kenya of three DBM parasitoids. AVRDC, in collaboration with USDA Montpellier, has introduced a heat-tolerant *Diadromus collaris* to Taiwan. This species is currently being studied at the AVRDC HQ by Dr. Talekar.

In addition to the work on DBM on crucifers, we have started to work on DBM on peas. This is a new host to which DBM switched about two years ago in Kenya. We observed that DBM was first restricted to sugar snap peas, but then it moved over to mangetouts as well, and has since become a real problem on the new host.

Onions

Thrips (*Thrips tabaci*) is one of the main insect pests of onion, and on-station trials have shown that it can cause yield losses of up to 54%. Onion is a long duration crop (around 5–6 months), and thrips can attack the crop at any time. We have carried out studies to determine the phenological (growth) stage of onion at which most loss occurs. This was done by treating the cultivar Red Creole with different protection regimes of endosulfan sprays at all crop growth stages. Yield was highest when the crop was protected from thrips attack from week 13 to 21 after emergence, when yield increased by 143%. Protection was especially important from the 13th to 17th WAE (yield gain of 111%). These observations provide a basis for need-based protection decisions. Confirmatory trials are in progress to relate the seasonal thrips population changes with crop phenology effects.

Tests with our new fungal pathogen, Metathripol®, a strain of *Metarhizium anisopliae*, show that onion thrips can effectively be controlled with spray applications directed at the leaf base of the plant. The bulb yield in plots sprayed weekly or twice-weekly with the fungus is comparable to insecticide-treated plots. We are also testing various strains of this fungus for control of other species of thrips in tomatoes and ornamentals (carnations, roses, chrysanthemum), as well as on French bean, snowpea and cowpea, all with very promising results. We are continuing to improve the product for larger-scale trials and eventual commercial application.

Tomato

Tomato is one of the most important vegetables in Africa, yet yields in smallholder production systems are low, due in large part to the presence of pests and diseases. Red spider mites (RSM) (Figure 3), *Tetranychus* spp., are among the most important pests in semi-arid regions, where most tomatoes are grown. The most serious species, *T. evansi*, was accidentally introduced into southern Africa in the 1980s, most probably from South America.

ICIPE's Red Spider Mite Project is studying the distribution of RSM species in eastern and southern Africa, the bioecology of RSM in different agro-ecological zones, and

ADDITIONAL IPM WORK BEING CARRIED OUT AT ICIPE

Control of fruit flies – development of new baits for trapping; insect pathogens; natural enemies;post-harvest fruit treatment

Control of banana weevils – IPM using an artificial device baited with host-plant attractants, use of suitable pathogens, and neem preparations

Control of stemborers – biocontrol using *Cotesia flavipes* or *C. sesamiae* wasps; push-pull, or attractant-diversionary strategies using a trap crop like Napier grass (*Pennisetum purpureum*) or Sudan grass (*Sorghum sudanese*) together with a repellent plant such as *Desmodium ssp.* or *Melinus minutifolia*; use of neem preparations

Control of termites – biocontrol with the fungus *Metarhizium anisopliae*

Control of locusts – by manipulating the chemical communication signals between the locusts themselves and their environment, and combining pheromone treatment with pathogens and/or biopesticides

For further information on the work of the ICIPE please see http://www.icipe.org/ or email the Director General at icipe@icipe.org

Figure 3. **Webbing caused by red spider mite (*Tetranychus* ssp.).**

the distribution and impact of natural enemies. We are also looking at the effect of crop age and mite infestation levels in relation to damage, and at various management practices that are compatible with reduced acaricide application; mite resistance to acaricides is also being studied. Tomato germplasm from all over the world is being tested for resistance to RSM. Our collaborator in Brazil at the University of Sao Paulo is working with us to investigate the possibilities for classical biological control of the mite. The mite is presumed to originate in northeastern Brazil, and we are hopeful of finding effective natural enemies there that can be introduced into Africa to help control this pest.

The fruit borer, *Helicoverpa armigera,* (Figure 4) is an important pest of tomato in Africa, for instance causing fruit losses of up to 24% in Kenya. Based on natural field infestation, we have categorised several tomato lines as being highly susceptible, susceptible and moderately tolerant to *H. armigera* damage; 17 lines have been advanced for further evaluation. Some of the promising lines include Heinz, 93KT82, Early Pearson, Sixpack, Alok, 94RT316 and Elin F1. Confirmatory studies on the reaction of these lines to *H. armigera* under increased pest challenge are in progress.

Figure 4. **Fruit borer (*Helicoverpa armigera)* – an important tomato pest**

Another important tomato pest is whitefly, *Bemisia tabaci* (Figure 5). Originally this insect affected mainly industrial crops like tobacco and cotton, but we have noticed that lately, it has diversified its taste and habitat to include vegetables, especially tomatoes, cucurbits and cassava. In Africa, whitefly is also a vector of several viral plant diseases. ICIPE is participating in a System-wide Whitefly Initiative of international agricultural research centres (IARCs) to study the whitefly problem, including the search for natural enemies (parasitoids) and other non-chemical methods to keep this new global pest in check.

Figure 5. **Whitefly (*Bebisia tabaci*) – an important tomato pest**

Neem products have been tested on tomatoes to control leafminers, fruit borers and fusarium wilt, a fungal condition caused by *Fusarium oxysporum* f.sp *lycopersici*. Control of root knot nematodes is also being studied by soil amendments with neem cake powder.

Hans R. Herren is the Director General of ICIPE, and former Director of the International Institute of Tropical Agriculture (IITA) Plant Health Division, Nigeria. He was awarded the World Food Prize for his work on the design and implementation of the Africa-wide cassava mealybug biological control programme, and is a Foreign Associate of the US National Academy of Sciences.

Bernard Löhr is an expert in IPM with special interest in horticultural crops, and is the Leader of ICIPE's Horticultural Pests Sub-Division. He has worked in several countries in South America and East Africa.