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Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa

Increasing Knowledge, Building Capacity and Developing Adaptation Strategies

POLICY BRIEF 10
November, 2014

Integrated Pest Management for Control of Population Dynamics, Distribution and Abundance of Pests

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Introduction

In small holder farming in Africa, climate change induced temperature variation is considered as the most important abiotic factor affecting population dynamics, distribution and abundance of pests. Climate variability and change have the potential to disrupt ecological interactions that are the basis for insect dynamics in nature. For example, they may disrupt synchrony between insect pests and their natural enemies and contribute to pest outbreaks. In this context, early predictions of such climate change induced pest risks can help farmers to adapt and adopt adequate pest management strategies.

This Policy Brief is part of a series following the fifth edition released on February 2014, which focused on the general status of key crucifer pests and their parasitoids in the Eastern Arc Biodiversity Hotspot (EABH) of East Africa. In this edition, potential impacts of seasonality changes on pest constraints of crucifer agro-ecosystems along altitudinal gradients of EABH are presented with recommendations on improving crucifer cropping systems in order to adapt to climate changes.

Crucifers – a high value crop for smallholders in East Africa

Crucifer crops form a family of vegetables such as cabbage, kale, Chinese spinach, broccoli, Ethiopian mustard and cauliflowers. These vegetables are largely grown by smallholders and are one of the most widely consumed in East Africa. They are grown in a wide range of agro-ecological and altitudinal zones. The pest complexity, intensity and management strategies practiced vary over these locations (*Nyambo and Löhr, 2005*).

Diamondback moth (DBM) (*Plutella xylostella*) is a major pest of crucifer plants in the region. The pest thrives in a wide range of temperature between 7.84 and 320C (*Golizadeh et al., 2007*) and it is generally resistant to control with synthetic insecticides. Being exotic to East Africa, control of the pest by indigenous natural enemies had been relatively ineffective. In 2000, an ICIPE-led classical biological control program was initiated. Successful implementation of the program kept the pest under control in several regions of Kenya and Tanzania. However, in the context of changing climate, the permanent success of biological control is not guaranteed. Seasonal changes can prompt changes in the growth and distribution of insect species. Furthermore, along altitudinal gradients, there is a high probability of the disruption of pest-parasitoid synchrony, especially so when the interacting species respond differently to temperature, which is a key factor for insects' growth, development and survival.

Integrating wild crucifers in cultivation of crucifer vegetables reduces infestation levels of DBM in the crop. Photo by: CHIESA Team

Above: Structural complexity of Chagga homegardens attract parasitoids. A homegarden is a cropping system in which different crops are grown in a mixed farming set up, supplied with traditional surface irrigation and fertilizers from farm yard manure.
Photo by: CHIESA Team

Currently, there is no baseline information on the influence of graded climate changes and weather variability on population dynamics of DBM, the key pest of crucifers in the region. Lack of such knowledge impedes efforts to maintain the DBM and parasitoid synchrony which is the basis for a successful biological control program, potentially risking DBM outbreaks.

In this regard, field surveys of DBM and its parasitoids were conducted in Mt. Kilimanjaro in Tanzania and Taita hills in Kenya to establish the spatial and temporal population dynamics of this pest and its parasitoids with the intention of identifying possible areas of interventions to sustain biological control efforts of DBM.

Sites of study

Mt. Kilimanjaro and Taita hills were selected for the study.

Both altitudinal gradients were divided into three zones: low, medium and high. The medium and high zones of Mt. Kilimanjaro were characteristically composed of Chagga home gardens. A home garden is a cropping system in which different crops are grown in a mixed farming set up, supplied with traditional surface irrigation and fertilizers from farm yard manure. The vegetation structure is composed of four key layers: trees at the top, bananas, coffee and vegetables at the bottom (*Hemp and Hemp, 2008*). Taita hills were composed of mountain ranges with comparatively fewer tree components.

Key findings

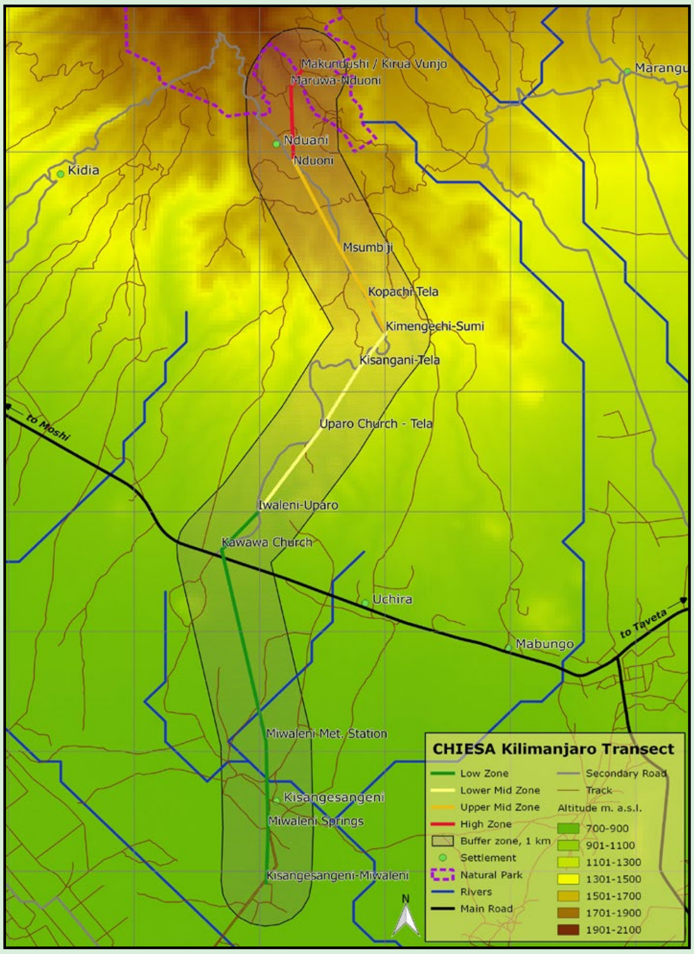
- Population dynamics of DBM in both gradients vary with seasons over the year.
- Growth and development of the pest were accelerated during the long periods of dry spells in the short rainfall seasons
- Occasional recovery of Cotesia vestalis and Oomyzus sokolowskii (larval parasitoids adapted to high temperatures of lowlands) in the cooler medium and high zones suggests movement of parasitoids shift towards the high zones during warmer seasons.
- Types and numbers of wild crucifers were the highest in the high zones and they decreased downwards to the low zone.
- The greater ecological complexity of crucifer farms in the medium and high zones of Mt. Kilimanjaro probably provided adequate food resources for parasitoids such as nectar and pollen as indicated by the wider diversity of parasitoids and more efficient parasitism in Mt. Kilimanjaro.
- Farmers in the medium and high zones of Taita hills are still using synthetic insecticides for managing DBM and other insect pests. This is probably contributing into resurgence of DBM as observed in Taita hills.

Potential implications

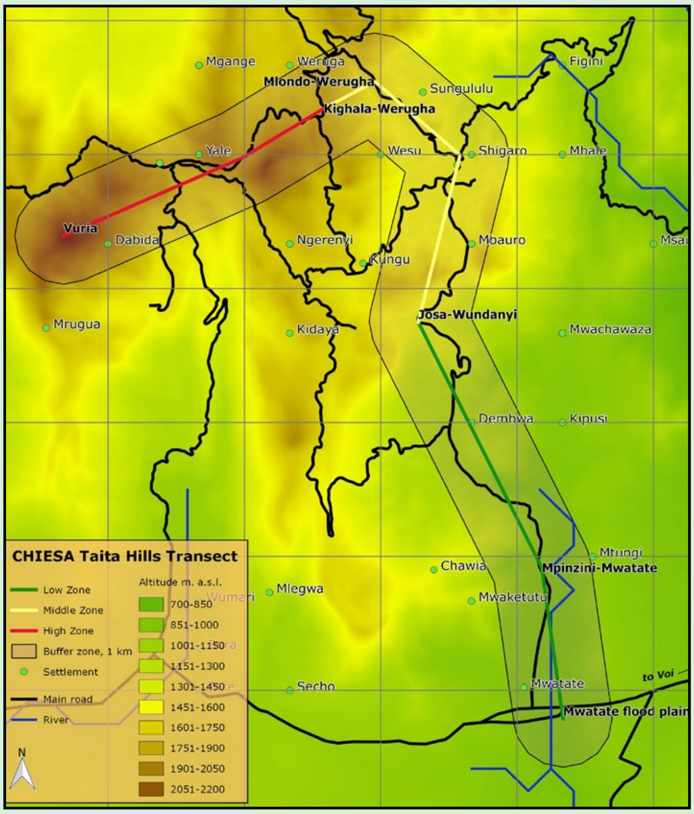
- Absence of wild crucifers in the low zones means absence of alternative plant refuge which could provide habitats and foods (nectar, pollen and honeydew secreted by available aphids) to parasitoid species which could result in DBM outbreaks in crucifer crops of this region
- More attacks of DBM in monoculture crucifer cropping systems of the low zone of Mt. Kilimanjaro and in all altitudinal zones of Taita hills.
- Any long term application of insecticides risks eliminating the parasitoids.

What do we need to do?

- Integrate wild crucifers as companion crops where irrigation is possible to conserve parasitoids and ensure biological control of DBM
- Diversify the plant structural composition in our cropping systems to cushion against adverse impacts of seasonal changes which in the process, attract gene pool of parasitoids.
- Reduce applications of synthetic insecticides and promote Integrated Pest Management (IPM) based methods e.g. adoption of biological control agents and biopesticides.



Mt. Kilimanjaro transect (above) showing point locations where farms were sampled and the three altitudinal zones: low (green), medium (yellow-pink) and high (red). Taita hills transect (below) shows point locations and the three zones: low (green), medium (yellow) and high (red). In both transects, the width (line raster texture) is two km.
Maps by: CHIESA Team



What is CHIESA?

The Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (CHIESA) is a four-year research and development project aimed at increasing knowledge on the impacts of climate change on ecosystem services in the Eastern Afromontane Biodiversity Hotspot (EABH).

CHIESA is funded by the Ministry for Foreign Affairs of Finland, and coordinated by the International Centre of Insect Physiology and Ecology (icipe) in Nairobi, Kenya.

Through research and training, CHIESA will build the capacity of research communities, extension officers and decision makers in environmental research, as well as disseminate adaptation strategies in regard to climate change. The general areas for environmental research are in agriculture, hydrology, ecology and geoinformatics.

CHIESA activities focus on three mountain ecosystems in Eastern Africa, namely Mt. Kilimanjaro in Tanzania, the Taita Hills in Kenya and Jimma Highlands in Ethiopia. The project consortium monitors weather, detects land use/land cover change, and studies biophysical and socio-economical factors affecting crop yields and food security.

The project also builds the climate change adaptation capacity of East African research institutions, stakeholder organizations and decision-makers through research collaboration and training.

Together with local communities, the project will develop, test and disseminate climate change adaptation tools, options and strategies at the farm level.

Further, CHIESA provides researcher training for staff members of the stakeholder organizations, enhances monitoring and prediction facilities by installing Automatic Weather Stations, and disseminates scientific outputs to various actors from farmers to policy-makers.

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