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A development plan for the introduction of Integrated Pest Management in the Kenyan Chillies and Beans Sector

A mission to Equator Products Ltd

Eefje den Belder

Plant Research International B.V., Wageningen
November 2007

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Summary

This mission report is on the main outcomes of the first visit, as well as on the outcomes of discussions in the Netherlands.
Actually one of the key problems is the virus in chillies. Identification of alternative control strategies for pesticide use (which possibly enhance virus infections) are increase of plant vigor (good agronomic practices as fertilization and irrigation), mechanical barriers (maize), rouging (elimination of infected plants) seed treatment with imidachloprid and mineral oils against aphids. With the pests' ability (whitefly but also thrips and aphids) to develop resistance in a short time chemical control will not only fail to resolve the pest problem but it will often seriously aggravate it by both destroying the natural enemies and accelerating the populations. Alternative control methods will be tested in 2008.

Evaluation of the actual scouting programme by the whole group (staff, field workers) resulted in a very lively discussion and accurate way to improve the monitoring of the pest pressure. The observation schedule will be adjusted. The sampling method Equator Products is developing considers three types of variables:

- Binominal sampling (absence/presence) at 36 individual plants divided over 4 strata in the field,
- hot spot sampling: whitefly, red spider mite, aphids and thrips (this part still needs improvement) and
- complementary codified levels such as crop development stages, flowering, parasitism, caterpillars and diseases.

Using this system the following months, we will test if this system offers reliable information. Actually, Equator Products will start a transition from broad-spectrum pesticide use to the use of more specific products.
The set-up of two field trials has been discussed. The idea is to start with the release of two predators against a combination of whitefly, aphids and thrips and the use of a naturally occurring parasitoid against leaf miner. We have discussed the possibility to link the monitoring training and improvement of the control strategies with the farmer field school approach. This participatory learning has recently been started with smallholder chilly farmers at 6 locations.

Eefje den Belder (eefje.denbelder@wur.nl)

Wageningen,
November 2007

Acknowledgements

I would like to express my gratitude to all farmers, who took the time, effort and enthusiasm to meet with me.
I also would like to thank Almut and Jan Willem for facilitating in various ways my mission and making my stay such a pleasant one. I would also like to thank Thijs for the very useful discussions. The discussions with Almut, Jan Willem, Thijs and the farm staff and farm workers have been very valuable to bring clearness and different points of view on the table for a prolongation of the project.

1. Introduction

1.1 Project rationale

Equator Products Ltd. is a newly established private company in Kenya, with the objective to supply the market with high quality dehydrated fruits and vegetable products, requiring labour intensive farming. A prime example is solar dried African Bird's Eye Chillies of Premium quality. Products are exported worldwide and, as a minimum, comply with regulatory requirements as defined for the European Union.

Corporate Social Responsibility

The management of Equator Products Ltd. believes strongly that a sustainable working relationship with contracted smallholder farmers can only be achieved by empowerment, rather than by creation of dependency. Therefore the company offers its farmers generic and practical hands-on training.

In addition, farmers benefit from the first rate starting material, at subsidized prices, from the company's own nurseries. Certified seed and other plant materials are imported from the finest varieties to ensure farmers the best possible start.

Where possible and necessary, the company assumes an intermediating role between groups of farmers and micro-finance institutions, and with suppliers of agricultural inputs, etc., to reduce input costs for the farmers and maximize profits to them. An example is the company's initiated project to support Kwayo Cooperative Producer's Society. The project receives funding from development oriented organizations as Rabobank Foundation, ICCO, and SNV.

In order to obtain Premium Quality African Bird's Eye Chillies (*Capsicum frutescens*) Equator Products Ltd. has a unique procedure of centrally drying its fresh produce. Products are grown from certified seed under well controlled Good Agricultural Practices (GAP).

The company is complying with:

- European Food Safety Requirements (EU Food Law)
- The Quality Management System is based on requirements defined for ISO 9000
- Good Agricultural Practices (GAP)
- HACCP process guidelines
- GMP provisions as defined in EC/96/46 Practices.

Development Sustainable Crop Protection

The development of sustainable crop protection is crucial to enhance the opportunities in the production of high quality products. In order to support this development, it is necessary that the production developed for the regional circumstances, goes hand in hand with the optimization of the indoor/outdoor abiotic conditions and an environmentally friendly growing system including integrated pest management.

The programme has formulated the following general objectives related to the usage of pesticides:

- Identification of key pests in chillies and beans.
- Limitation the usage of pesticides for cost reduction, avoiding resistance development in pests, quality and health demands of the marketable products, health of the employers, limiting environmental pollution.
- Development of alternative control strategies including candidate natural enemies.

Visit to Kenya

The first visit took place from 7 to 12 October 2007. At the first visit, three main priority areas were identified within the broad field of Integrated Pest Management:

- Identification of key pests in chillies and beans and the actual control strategies.
- Improvement of scouting/registration methods.
- Identification of alternative control strategies for pesticide use.

At the first visit, two locations have been visited.
With the rapid development of the sector public concerns within and outside Kenya are growing regarding labour conditions at the farm, the environmental impact and human health due to the use of pesticides and fertilizers. In response to these concerns the Equator Products Ltd. has taken the initiative to develop alternative control strategies. The development of this integrated pest control (including a plan for implementation) is supported by the Royal Netherlands Embassy in Nairobi.

The heavy use of pesticides in current hot pepper/beans has introduced the following consequences:

- High costs on products and labour (about 25% of expenditures).
- Yield reduction due to phytotoxicity and stimulation of virus infection.
- Pesticide residues in product, soil and water.
- Effects on workers' health, environment including naturally occurring natural enemies of aphids, whitefly and thrips.

It should be stressed that Equator Products in Kenya sees an urgent need for implementation of Integrated Pest Management. Without IPM, there exists a serious danger of losing productivity. Additionally it can create a competitive market advantage.

Steps forwards in IPM in chillies and beans are from preventive use of chemicals, to guided control based on field observations, to integrated pest management in which a healthy crop is a cornerstone and sanitation, biological control are essential elements, while pesticide use is the last solution (Figure 1).

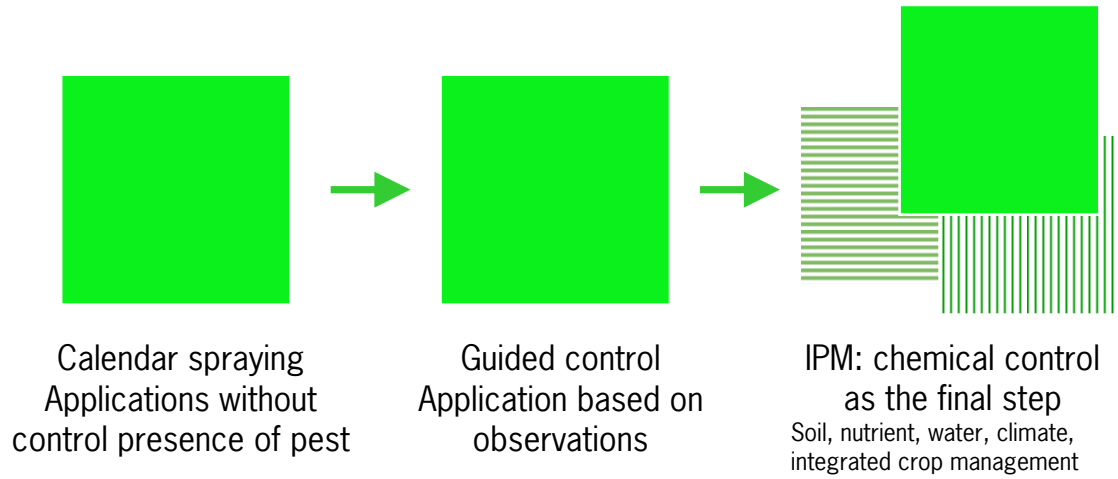


Figure 1. Envisaged steps forward in IPM in chillies and beans.

1.2 Approach

The philosophy behind our approach is a system-approach at field level. System-focused approaches in the Integrated Pest Management programme lead to locally adapted technologies that respond to market needs, and that support a sustainable vegetable production at Equator Products, avoiding pesticide resistance and suboptimal control strategies. The adoption of IPM requires decision-making at different stages in the production (seed, transplanting, crop growth, spatial planning) and a knowledge-based technology development. Therefore, on-farm experimentation with regards to technology development is important. An advantage of using a participatory approach is that the joint learning process for scouts and growers/smallholder farmers provides immediate feedback and faster implementation by growers.

Central in this approach is "learning by doing". The approach relies on intensive observations and monitoring of the state of the crop, the pests and diseases, and the beneficial insects (natural enemies). Regular field observation and measurement are the basis for decision-making the following activities are important:

- Record-keeping to follow the pest densities and the effect of the control strategy.
- Record-keeping to make economic results transparent.
- Exchange of information and experience among farm workers (scouts).
- Through record-keeping in the field book, farm workers and farmers develop skills that allow them to analyze their own situation and progress.

All parties involved (scouts, farmers and facilitators) should strengthen similar skills and apply similar routines to work more effectively. In this context, Equator Products could consider the establishment of an IPM group and organize:

- Parallel training of scouts/facilitators/farmers in ecology and methods for chillies/beans crop stage learning.
- Research on use of local or imported beneficial insects to control key pests in which Plant Research International can give guidance.

1.3 Terms of Reference

The mission's Terms of Reference were as follows:

1. Identify key pest and diseases in hot pepper/beans.
2. Stimulate monitoring of pests and diseases through two training sessions. Develop recommendations for improvement of monitoring methods and formation of scouting team.
3. Planning project 2008.

2. Visits and Discussions

2.1 Koppert Kenya, Nairobi

Day 1, Monday Morning.

Meeting with:

- Mr. Jan Willem van Casteren
- Mrs. Almut Bayerkoehler
- Thijs Gerlagh
- Charles Machaveria (Koppert, is the international market leader in the field of crop protection using alternative strategies to chemicals)

1. Discussion on pest presence and possible control strategies

2. Discussion on permits and the accredited institution KARI

We discussed the need to extend the number of permits and the possibility to test a predatory mite *Swirskii* in the field.

Experiences with control of pests in rose in Kenya are very good. If we want to test *Swirskii* (predator of red-spotted spider mite as well as thrips and whitefly) we have to organize it in such a way that Dr. Songa from KARI will have the final responsibility. She is very cooperative and willing to test beneficial insects.

Actually, Real IPM only produces *Phytoseiulus persimilis*.

We agreed that:

- Charles Machaveria and Naomi Kahurani from Koppert will visit Equator Products 18th October.
- Naomi Kahurani (Koppert) will organize a series of training sessions on scouting, recognition of pests and beneficials.
- Charles will provide Equator Products with a complete list of fungicides and pesticides which are compatible with beneficial insects (the actual list kindly provided by Charles is not complete).

2.2 Visit smallholder farmers at Kaido S.H.G.

Day 1, Monday Afternoon.

Visit to the office of Equator Products at Matuu.

Meeting with smallholder farmers at Kaido S.H.G.:

- Almut Bayerkoehler
- 18 smallholder farmers at Kaido S.H.G.
- Chairperson Mr. Manyala
- Mr. Mghuti (Equator Products responsible for the development of the farmer field schools, FFS's)

1. Cooperation smallholder farmers Equator Products

Almut explained the cooperation/contract they have planned for chilies production; fixed prices, guaranteed purchase, contract farmer-Equator Products and the technical training on preparation of the nursery, transplanting production and protection. All participants in the meeting want to start as soon as possible.

Only those farmers that have irrigation by gravity (permanent water) can participate.

They agreed that:

Almut and Mghuti will visit all the farms on Saturday 13th October

The next group meeting will be the 15th October
Plot size will be ¼ acre (1000m²)
15 gram chilly seed (thiram treated, imidachloprid and drenched seeds) will be provided for 150 KSH.

Suggestions Eefje:
- Link training for the scouts at Equator Products Farm with scouting at smallholder farms (but e.g. in simplified form, e.g. in stead of 36 plants, 20 plants will be checked for presence of insects).
- Make biobarriers/windbreaks with maize to keep out the pests like whiteflies. Plant the maize before sowing the chilly seeds to reduce infestations with insects and virus infections.

2.3 IPM at Equator Products

Day 2, Tuesday, morning.

Preparation introductory IPM training course for technical staff.
Meeting with the representative Syngenta (Mrs. Agnes Mbugua).
Scouting block 36 with Jan Willem, Thijs and Benjamin (scout).

Eefje has prepared two introductions. "Knowing and recognizing good and bad guys on chilies and beans, life cycles important pests and natural enemies" and "How to scout efficiently". See the annexes I and II.
Within 14 days, Agnes Mbugua from Syngenta will prepare a list (side effect guide) in she indicates the side effects and the way their products are compatible with beneficial insects (e.g. scale 1-4 for side effects).

Suggestion Eefje:
- Compare the Syngenta list with the list made by Koppert.

Discussions on actual situation in IPM
The actual monitoring strategy was discussed. Efficient monitoring is of paramount importance in the management of a successful integrated pest management system. Only when the pest situation is known appropriate decisions can be made. This requires information on:
The location of hot spots (high pest densities).
Number and type of pests present in the crop.
and which naturally enemies are present or being used.

In addition it is important to know which stages of the pests life-cycle is prevalent in the crop and which stage is most effectively tackled by the predators and parasites available. Also compatibility of fungicides and pesticides with beneficial insects has to be checked.

Two production blocks (beans and chilies) were visited to evaluate the actual pest control situation. We found spider mites, aphids, whitefly symptoms, and leaf miners. Actually, few fungal diseases were present (only some rust spots in beans). Similar to wherever chilies are grown viral diseases are a significant constraint.

What we know from other places is that the amount of losses can be up 60% depending on the strain of the virus, the variety, the age of the plant, the time of infection, the temperature during the disease development and the extent that the virus has spread in the planting.

The control of the insects transmitting those viruses is difficult. Poty viruses are spread by aphid vectors in a non-persistent way (virus stay at the mouth parts, stylets) meaning that insecticides cannot prevent the spread. Strategies to delay early infection can be used to enhance yield and reduce the number of cull fruit. Mineral oil sprays have been used to interfere with the transmission of all pepper viruses by aphids.
Experiences in Spain have shown that biological control reduces the mobility of the aphids and reduces virus transmission. Several non-chemical control techniques can be used such as the use of mesh barriers or non

susceptible crops like maize (also for smallholder farmers). Other management strategies involve the removal of infected plants or alternative sources such as weeds in or near the crop. In addition, the development of systemic insecticides such as imidachloprid and resistant varieties through plant breeding have been applied.
However, the insect vectors seem to become resistant to pesticides and the virus become resistant to the varieties (suggestion Eefje check with EWINDO).

Gemini viruses are transmitted by whitefly e.g. *Bemisia tabaci*. Heavy rainfall maintains the whitefly populations depressed. During dry periods I expect much more problems. In literature we have found that whitefly types (biotypes) on fresh beans and chilies are the same.
The parasitoids *Erectmocerus* and *Encarsia* are identified as significant parasitoids of *Bemisia*. The common short coming of both species is their inefficiency to control high densities of the pest populations.

Thrips williamsi, the thrips we have identified in the samples taken from the outdoor chilies can transmit virus also. Thrips are transmitting the severe tomato spotted wilt virus (TSWV, a tospovirus). Once infected at the larval stage, adult thrips usually transmit tospoviruses for life. Transmission to plant hosts occurs when thrips feed.
Actually, virus seems the most serious threat to the chilly production.

Some remarks by Eefje:
- Actually, calendar spraying is used. Frequency of pesticide application increases if pests/diseases are found.
- Actual staggered production in chillies due to virus infections.
- Possibly virus transmission increases due to pesticide use (insects got more active before they die).
- Frequent applications of the same pesticides (e.g. Decis) possibly lead to insecticide resistance problems.
- Thrips, aphids and whitefly all typically show rapid resistance against pesticides.
- Actual scouting is not efficient enough (5 spots with 10 plants in a row). Observations can be improved.

Tomorrow Eefje and Thijs will check actual pesticide application schemes. Thijs will summarize these results.

2.3.1 IPM training “How to recognize the good and the bad guys”

Day 3, Wednesday morning

Training for the whole technical team.
Kick-off by Eefje “how can I recognize the good and the bad guys (see photos). How to use a magnifying glass?
Objective: How do I recognize the main pests (spider mite, thrips, whitefly, aphids) and biological control agents (predatory spider mites, parasitoids.
- Explanation in plenary session.
- Presentation of photographs of several pests and their natural enemies.
- Explanation of benefits of Integrated Pest Management.
- How to grow a healthy crop?
- Explanation of resistance development in spider mite, thrips, and whitefly against pesticides.
- Consequences of mismanagement of pesticides.

Methods used: Direct observations using material collected in the field.

Tasks in the field for small groups (two persons each):
- Find the yellow, black and black with grey thrips species in chillies.
- Find rust in chillies.
- Find leaf miner tunneling and feeding symptoms in chillies.
- Find aphid and aphid mummies in beans.
- Find red-spotted spider mites.
- Find beneficial mites.

Methods used: Observation walk, direct observations, discussions.
Remarks: I was impressed the way farm workers do recognize the pests (and beneficials) in both crops the field.

2.3.2 IPM training “Scouting”

Day 3, Wednesday afternoon

Training for the scouts.
Objectives:

- Understanding population dynamics of pests and beneficials in relation with temperature (average temperature – duration of life cycle).
- Understanding behavior of pest in the crop (spreading, hot spots).
- Evaluation of actual scouting practices in the crop, and the way to record and process the data.
- Exercise scouting practices/recording.
- Understand side effects of chemical pesticides (fungicides and pesticides on biological control agents.

The results of the morning session, were related with “growing a healthy crop” (seed treatment, balanced irrigation, balanced fertilization with pest management). According to the IPM approach I explained that
Success in crop production and protection depends on:

- Understanding of crop, pests and control strategies.
- Growing a healthy crop.
- Combination of control strategies.
- While last step is pesticide use.
- Specific agro-ecological knowledge.
- Change in attitude, tactical and strategic IPM.
- “Learning by doing” and sharing our experiences.

Evaluation of the actual scouting programme by the whole group resulted in a very lively discussion and accurate way to improve the scouting schedule. The observation schedule will be adjusted.

- Thijs will repeat this scouting part and make a new scouting schedule.
- Other topics to be taught next week: irrigation, fertilization, hygiene (sanitation), cost-effectiveness, plant protection, scouting, organigramme.
- Check on the dry bean material used as mulch in the chillies.

2.4 Analyses actual scouting and pesticide application schemes

Day 4, Tuesday morning.

Meeting Eefje and Thijs

Discussion on improving actual scouting

- Application frequency of Decis against thrips is too high (sometimes three times a week. Decis is not ideal and sub-optimal (efficacy class III. My suggestion is to use other products.
- Stickers, adhesives and other adjuvants are expensive. I suggest no to use them. Normally the producer makes the ideal mix of active ingredient/sticker/etc.
- Evaluation of the scouting formats reveals that sometimes the scout finds exactly the same infestations at all locations (to our opinion not possible).
- Avoid long intervals between scouting and action: suggestion is to do the scouting one day before the farm manager decides what to do.
- During harvest there is no need for foliar feeds. This can be counter-productive.

3. IPM Plan for 2008

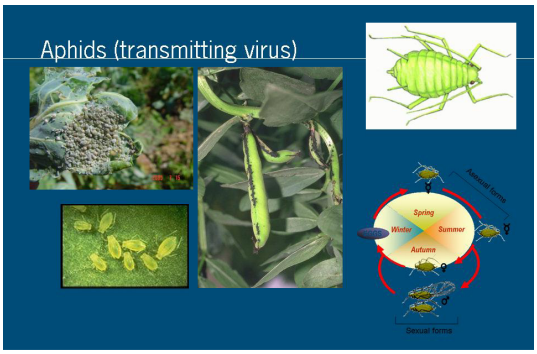
- In January 2008 design of 1 field trial at Equator Products Farm on control of pests by *Ambliseiulus swirskii* eventually in combination with *Phytoseiulus persimilis* (in close cooperation with Koppert and Kari).
- Design of a field trial at Equator Products Farm on control of whitefly by a naturally occurring parasitoid *Erectmocerus.*
- Participation of Jan Willem at training course at Koppert (Business Link PUM).
- Linking IPM training at Equator Products Farm with smallholder farmers (e.g. scouting).

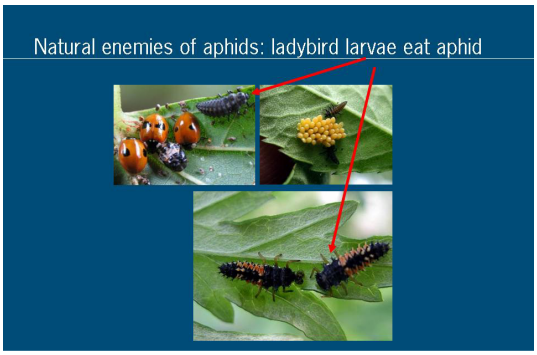
4. Itinerary

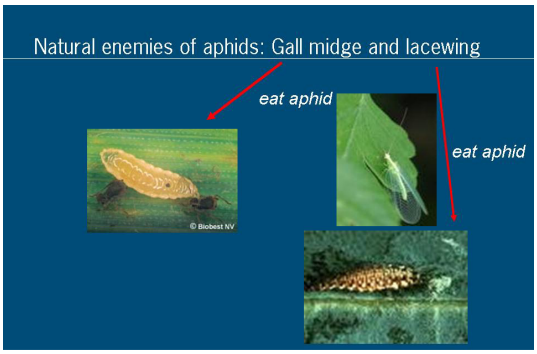
Su 7 Oct	Evening	Flight Amsterdam – Nairobi
Mo 8 Oct	Morning	Arrival to Nairobi Meeting at nearby mall with Jan Willem van Casteren and Almut Bayerkoehler, Thijs Gerlagh (PUM), Charles Macharia (Koppert Kenya)
	Afternoon	Drive Nairobi-office Equator Products Ltd Meeting at Kaindo S.H.G. (Almut, Mr. Mghuti, 18 future FFS participants and chairperson Mr. Manyala)
	Evening	Checking in to hotel Meeting/dinner with Almut, Jan Willem, Thijs
Tue 9 Oct	Morning	Visit to Kabaa Farm, field visit (Jan Willem, Thijs) Meeting with INDU Farm (Siebold de Vries.)
	Afternoon	Discussion on soil analyses from Crop Nutrition Services (Jan Willem, Thijs) Preparation introductory IPM training course Meeting representative Syngenta (Mrs. Agnes Mbugua) Scouting block 36 with Jan Willem, Thijs and Benjamin (scout), preparation IPM training course
	Evening	Meeting/dinner with Almut, Jan Willem and Thijs
Wed 11 Oct	Morning	Preparation IPM training at Kabaa Farm IPM training for field personnel (27 persons, scout, spray, irrigation, crop) Field practice “good and bad guys” in chillies and beans (whole group)
	Afternoon	Lunch (Almut, Jan Willem, Thijs) In depth IPM training scouting for smaller group (15 persons)
	Evening	Meeting/dinner (Almut. Almut, Thijs)
Thu 11 Oct	Morning + afternoon	Discussion with Thijs (follow-up topic next week training, analyses actual scouting and pesticide schemes block 21 and 31)
	Late afternoon	Drive Nairobi with Almut Flight Nairobi – Amsterdam
Fri 12 Oct	Morning	Arrival to Amsterdam Airport

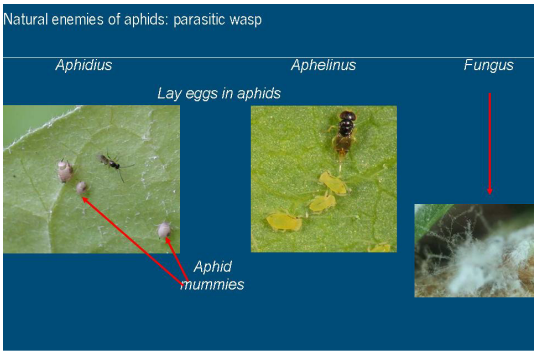
Annex 1.

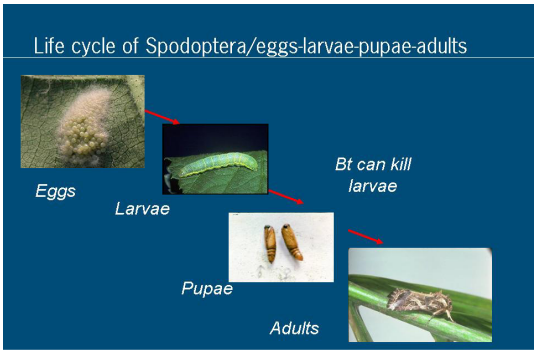
Life cycles important pests and natural enemies



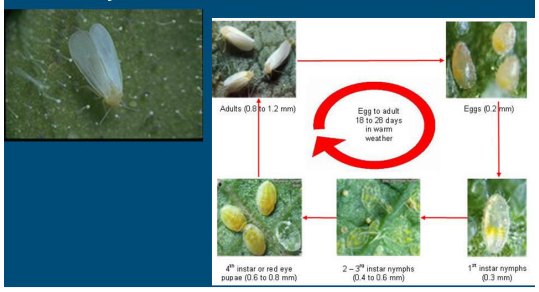








White fly (transmitted virus)



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Leafminer Lyriomyza and natural enemy Diglyphus

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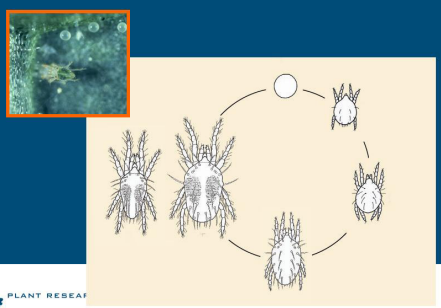
Red spider mite – life cycle



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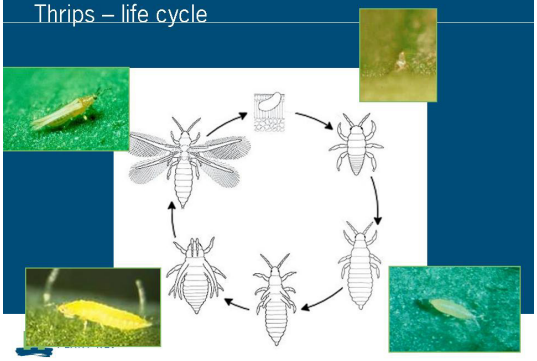
Thrips – life cycle



Amblyseius californicus

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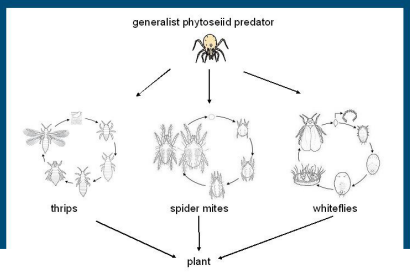
Amblyseius swirskii (SWIRSKI-MITE)



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Annex 2.

Integrated Pest Management in chillies and beans "learning by doing"

Integrated Pest Management in chillies and beans "learning by doing"

Eefje den Belder

Nairobi Kenya
October 2007

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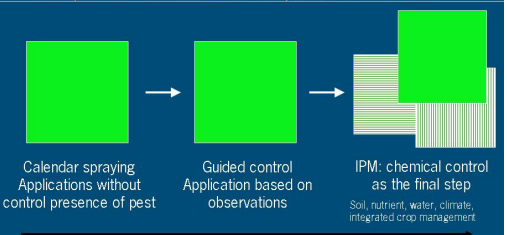
Steps forwards in IPM Equator Products



Calendar spraying Applications without control presence of pest

Guided control Application based on observations

IPM: chemical control as the final step

Soil, nutrient, water, climate, integrated crop management

LEARNING by DOING AND COMMUNICATION

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Introduction – IPM

- Success depends on understanding of crop, pests and control strategies
- Growing a healthy crop
- Combination of control strategies
- **Last step is pesticide use**
- Specific agro-ecological knowledge, technology
- Change in attitude, tactical and strategic IPM
- "Learning by doing"

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Four important steps of this IPM training

- **Knowledge of the pest:** now what pests you have (identification)
- **Decision making:** Know how much you have (monitoring)
- **Pest management practice:** Know what you have to do (e.g. release beneficials)
- **Cost of pest management options:** Use a Field Book

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E.g. compatible acaricides with predacious mites

- Floramite
- Nissorun
- Tedion
- Torque
- Cascade

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NOT COMPATIBLE FUNGICIDES

- Sulphur (i.e. Wetable Sulphur, Dusting Sulphur, etc)
- Benlate
- Bavistin
- Topsin-M
- Fungicides that contain the active ingredient of the mentioned fungicides (Melody Duo, Punch Extra) must not be used.

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Products used in preventive spray programme not compatible with IPM

- Bifenthrin
- Deltamethrin
- Dimethoate
- Lambda cyhalothrin

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Products against most aphids compatible with natural enemies IPM

- Azadirachtin
- Flonicamid
- Potassium salts of fatty acids
- Pymetrozine
- Pyrethrins +piperonylbutoxide
- Triazamate
- Pirimicarb

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Side effects

- When BCA's meet certain pesticides…
- …on the plant or other places in the greenhouse,
- it can have specific effects, related to the active ingredient in the pesticide
- This is expressed in following scale (loss of effectivity)
  - 1 = <25%
  - 2 = 25-50%
  - 3 = 50-75%
  - 4 = >75%
- Persistence is also relevant
  - Calculated in weeks after pesticide application
  - From 0 → 8 weeks!

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Side effects

- Information
- www.koppert.nl
- Booklet side effects
- In case of doubt: always check!

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How incompatible pesticides meet BCA's

- Through normal application (but wrong choice of pesticides)
- Remaining bit of incompatible pesticide on bottom of spray tank or in spray lines
- Drift from spray on neighboring plots

Note: use of incompatible pesticides can ruin a good working biological system!

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Other observations in registration format (field book)

- Record the pesticide sprays IPM/conventional greenhouse,
- to evaluate the effect of IPM on the pesticide inputs.
- For each treatment, record: date of application, pesticide name (active ingredient) , quantity used, target of use.
- Further it is recommended to record the yield of IPM and conventional practice greenhouse, to evaluate the effect of the reduced spraying regime on the crop.

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