



Trip Report June 2009

A Research and Development Plan for the introduction of Integrated Pest Management in the Ethiopian Rose Sector

Eefje den Belder





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Plant Research International B.V.

Address : Droevendaalsesteeg 1, Wageningen, The Netherlands
: P.O. Box 616, 6700 AP Wageningen, The Netherlands
Tel. : +31 317 48 06 21
Fax : +31 317 41 10 47
E-mail : eefje.denbelder@wur.nl
Internet : www.pri.wur.nl

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1. Summary

The mission's Terms of Reference were as follows:

1. Briefing various governmental representatives about IPM progress in rose and up-scaling.
2. Possibilities for IPM in other crops.
3. Multi-stakeholder brainstorm at MoARD with regards to possibilities IPM on-farm trials in other crops.
4. MSc's at Jimma University: the development of 'new professionals' through linking research training with on-farm trials.

IPM on-farm trials in rose and up scaling

1. Actually six rose farmers participate in the on-farm trials: ET Highlands, J.J. Kothari, Herburg, AQ roses, Dream Flowers, Golden Rose, and Oromia Wonder. Those farms represent growing conditions between 1700 and 2600 masl, providing a wide range of climatic conditions.
2. At E.T. Highland spider mite is controlled with predatory mites in 13 Ha rose. Golden Rose and J.J. Kothari have asked permits for up scaling in respectively 1 and 3 Ha rose.
3. Frequent backstopping visit by supplier is of utmost importance.

Possibilities for on-farm trials in other crops

4. At Koka, Almetta (strawberry with key pest red-spider mite), Florensis (herbs with key pest whitefly), and Desa plants PLC-Ethiopia (propagations with key pest Sciaridae) are very keen to start IPM on-farm trials. Eefje will identify the mites and whitefly with help from the PD.

Multi-stakeholder brainstorm at MoARD: possibilities

5. Growers have to apply for the various permits. All parties involved agree upon the good control of red spidermite *Tetranychus urticae* with *Phytoseiulus persimilis* and *Neoseiulus californicus* in rose at the various farms. There is growing confidence of growers involved.
6. Up scaling of the trials at other rose farms and other crops have been discussed with the various stakeholders (EPHEA, MoARD, EIAR, Ethiopian Horticultural Development Agency (EHDA), growers, PPRC AMBO, Embassy, and WUR). Possibilities for up-scaling in rose propagation, strawberries, herbs, and propagations of other crops are discussed and agreed on.
7. The way integrated pest management (IPM) will be adopted will be affected by the level of ecological and socio-technological knowledge among the actors in the innovation system therefore not only depend on farmer's ecological knowledge, but also on the mindsets of those involved in the process, and the establishments of partnerships between the institutions. This has been discussed during the brainstorm.
8. Adoption of IPM relies on several institutional, technical, economic and socio-psychological factors such as a favorable framework, awareness raising, confidence building, interactive extension and. group approach. Consequently a strategic communication approach that includes all those areas could greatly enhance the likelihood of faster elaboration of new methodologies and their sustainable market-oriented diffusion in the country. In order to have real diffusion of IPM techniques, not limited to single projects or the enthusiasm of a few motivated farmers and scientists, the most area of action for communication for development is very likely at the national or sub-national political level.

Linking formal research and on-farm trials

9. Researchers, growers, field workers students hold different sets of ecological knowledge and can learn from each other. Institutional innovations to improve R&D prioritization processes include among others the establishment of partnerships between Universities, producers' organizations, and the development of 'new professionals'.

10. The importance of MSc's performed at farms has been discussed as part of the IPM curriculum development at the College of Agriculture and Veterinary Sciences of, Jimma University. Integrated pest management is one of the crucial topics within sustainable agricultural development in Ethiopia. Fikre Lemessa and Eefje den Belder agreed on a MCs titled 'Population dynamics of whitefly in various herbs before and after the introduction of beneficials (Florensis) and a second MSC 'Population dynamics of red spidermite (*Tetranychus urticae*) Koch in rose before and after the introduction of phytoseiid predators'.

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

Wageningen, June 2009

2. Introduction

2.1 Project rationale

The level at which national economies develop is determined by the efficiency of mechanisms set in place to exchange ideas between the multiple actors operating in the system (van Mele, 2008). Traditional R&D providers are required to become more client-oriented which calls for demand-driven modes of working and establishing linkages with the private sector and society as a whole (Klerkx & Leeuwis, 2007). Guidelines and tools to diagnose linkages and capacity to innovate are presented by Hall and colleagues (2006). With innovation systems thinking applied to agricultural research, rather than research the innovation intermediaries take central stage as match makers between suppliers and users of technologies. Innovation predominantly derives from 'working with and reworking the stock of knowledge' not necessarily the creation of new knowledge, and from brokering networks, learning alliances or innovation platforms.

Public-private partnerships contribute little to sustainable agriculture in developing countries where the agrochemical industry has a quasi monopoly in cashing in on the growing horticultural market. National agricultural scientists, short of research funds, may be more inclined to team up with pesticide companies to test their products in farmers' fields.

The way integrated pest management (IPM) will be adopted will be affected by the level of ecological and socio-technological knowledge among the actors in the innovation system therefore not only depend on farmer's ecological knowledge, but also on the mindsets of those involved in the process, and the establishments of partnerships between the institutions (Van Mele, 2008).

Ethiopian export horticulture is developing at a unique and unexpected high speed. In 2000, 9 ha were under flowers, which had increased to over 600 hectares in 2006. In 2005/2006 the export value was \$26 million, for the year 2008 the export value was slightly less than \$ 130 million.

With the rapid development of the sector public concerns within and outside Ethiopia are growing regarding labour conditions at the farm, the environmental impact (over-exploiting water resources), and human health due to the misuse or overuse of pesticides and fertilizers. The Ethiopian government is introducing a series of measures designed both to promote a long-term shift away from chemical controls where this is practicable and thus moving towards more sustainable forms of pest management. Research programmes are also looking at ways to reduce pesticide use while maintaining agricultural productivity. In response to above mentioned concerns the Ethiopian Horticulture Producers and Exporters Organization has taken the initiative to develop a code of conduct. The development of this code of conduct (including a plan for implementation) is supported by the Royal Netherlands Embassy in Addis Ababa.

The heavy use of pesticides in current Ethiopian rose cultivation has introduced consequences for the market, for resistance development by the pests to pesticides and environmental pollutions.

For these reasons, all stakeholders involved in the development of the code of conduct agree that alternative pest control strategies are needed. Integrated Pest Management (IPM) brings together various control strategies, and can therefore make a big contribution to realizing the code of conduct. Experts both in the commercial as well as from the scientific side see good possibilities for the introduction of IPM, given the successful introductions in Zimbabwe and Kenya. It should be stressed that rose growers in Ethiopia see an urgent need for implementation of Integrated Pest Management. It will create a competitive market advantage. Without IPM, there exists a serious danger of losing market share to growers in countries where certification schemes have realized the use of IPM.

2.2 Approach

The philosophy behind our approach is a system-approach at field level evaluation. System-focused approaches in the Integrated Pest Management R&D programme lead to locally adapted technologies (e.g. in the various climate zones) that respond to growers' needs (bulk or niche market), and that support the sustainable production in Ethiopia. The adoption of IPM requires decision-making at different stages in the production and a knowledge-based technology development. Stakeholders are the key to development. For IPM there are a number of key stakeholders in partnerships which range from:

Growers, who may need to change their management in order to benefit, to extension agents to researchers, the private sector and policy-makers, who can help to bring about the change.

Therefore, linking informal and formal research approaches with regards to technology development on the farm and with regards to growers' participation are important. An advantage of using a participatory approach is that the joint learning process for growers, scouts, students, researchers, provides immediate feedback to researchers. Another advantage is the opportunity for researchers to do more in a very short time span. The advantages of this approach are the immediate feed-back to growers, the immediate results at farm level, and faster implementation by growers.

All parties involved (policy makers, directors, leaders, researchers and field extensionists) should strengthen similar skills and apply similar routines to work more effectively to make IPM effective for growers. After all, it are they who are finally in charge of the pest management strategy that is best suited for their farm.

2.3 Terms of Reference

The mission's Terms of Reference were as follows:

1. Briefing various governmental representatives about IPM progress in rose and possibilities for up scaling.
 2. Possibilities for on-farm trials in other crops.
 3. Multi-stakeholder brainstorm at MoARD with regards to possibilities IPM on-farm trials in other crops.
 4. MSc's at Jimma University: the development of 'new professionals' through linking formal research with on-farm trials.
- Visit to candidate growers for on-farm trials (analyze the on-farm situation). When can we start? At Koka? Can spraying schemes interfere with the development of the beneficials, is the temperature detrimental, are there other factor that can play a role, how do we organize communication with supplier sufficiently?
 - Multi-stakeholder brainstorm with regards to IPM possibilities in other crops. How are the procedures? What is the role of CPRC AMBO? Are there alternative pest control strategies for red spidermite in strawberries, whitefly in herbs, and sciarids in propagations? How can the Agricultural Agency improve adoption of IPM?
 - MSc's at Jimma University: the development of 'new professionals' through linking formal research with on-farm research. Discussion on MSc possibilities at Jimma University with Dr. Fikre Lemessa (dean Jimma University). What is research?

3. Visits to Strawberry and Propagation farms: possibilities for on-farm trials

Because pest management strategies are linked to other farming system components, it will be necessary to study relationships among, pest management, farming practices and plant nutrition. By doing so, we will gain comprehensive data essential for the development of an integrated crop protection strategy in the various sectors in Ethiopia.

Integrating biological and cultural control methods of pests and diseases key to achieving sustainable pest management. Biological control practices must be integrated with normal crop-management practices (e.g. beneficial insects with compatible fungicides and pesticides). Such integration will require a variety of investigations:

- Timing of applications,
- Methods of applications,
- Amount of biological control applied, and
- Whether controls can be applied simultaneously and what would be the outcome.
- Backstopping by supplier is crucial.

An integrated scientific approach can direct research efforts towards practical pest-management solutions.

3.1 Visit to Almetta: Possibilities for spider mite control in strawberries



Figure 1. Strawberry production at Almetta (left) and Mr. Tesfaye G. Mariam (Almetta Farm Manager) in discussion with Yeraswork Yilma (MoARD).

Day 1, Tuesday Morning

- Mr. Tesfaye G. Mariam (Almetta Farm Manager)
- Yeraswork Yilma
- Eefje den Belder

Spidermite control in strawberries

Almetta (Koka area, 1800 masl, 90 ha all outdoor production, strawberry, herbs and grapes) has expressed interest in hosting an IPM on-farm trial in strawberries. There is one manager crop protection manager plus 12 scouts (in

total for 17 ha grapes, 10 ha strawberries and 4 ha herbs). Strawberry production is in tunnels (See Figure 1). Tunnels are opened at 8 h in the morning and close at 5 h in the afternoon. They have drip-irrigation.

The twospotted spidermite (TSSM) *Tetranychus urticae* Koch (Acari: Tetranychidae, (Eefje has collected mites for identification), has been recognized as the most important arthropod pest in strawberries. *Tetranychus urticae* feeds on strawberry leaves and alters their anatomical structure drastically. Feeding results in chlorosis, which leads to a decrease in photosynthetic activity and a subsequent reduction in yield? In the past, TSSM has been controlled with several applications of acaricides. However, due to the high fecundity and problems associated with resistance to acaricides, the management of TSSM has become a major problem for growers.

As an alternative to chemical control, mite control focuses on inoculative releases of species of predatory mites. Cultural practices that favor vigorous plants are key to minimizing damage from spider mites. In addition, choosing insecticides and miticides that are least harmful to beneficials. When treating for mites, the most selective miticides must be chosen and have to be alternated with miticides of a different chemistry or mode of action to avoid the development of resistance.

Predator mites such as *Phytoseiulus persimilis*, and *Neoseiulus californicus*, are commercially available for release. Of the commercially available predatory mites, *Phytoseiulus persimilis* is most commonly used for suppressing spider mite populations. It is an effective feeder, and it multiplies rapidly.

Following releases of predator mites, it is important to monitor spider mite densities closely to evaluate the effectiveness of the predatory mites in maintaining the pest mites below economically injurious levels. Insecticides, miticides, and fungicides that are not selective will kill the predators.

How to continue: discussion with farm manager

Field experiments will be conducted starting in September 2009 to determine the effect of the predatory mites, *Neoseiulus californicus* and *Phytoseiulus persimilis* on the two-spotted spidermite, *Tetranychus urticae* Koch, in Almetta strawberries (*Fragaria × ananassa* Duchesne??).

- Plots (IPM and conventional) must have the same variety and age.
- Measures must be taken to prevent incompatible pesticides to arrive on the IPM plot.
- Use separate spray tank, hose and measuring cylinder for IPM plot.
- Take care of wind direction when spraying adjacent fields to prevent spray drift of incompatible pesticides on IPM plot.
- Make sure the compatible pesticides needed for all relevant pests and diseases are in stock before the program is started. Koppert Holland makes a list (A. Tetteroo) which pesticides must be in stock for eventually outbreak of other pests.
- Application of pesticides during the transition stage will be discussed thoroughly during the visits of Chris in June and July (and backstopped by Koppert Holland by A. Tetteroo).
- Also the selection of the compatible pesticides during the on-farm trial will be discussed with Chris and A. Tetteroo.
- After the arrival at Bole predators must be handled properly and swiftly applied.
- Dedicate one special person to communicate the relevant data on a weekly basis by e-mail to both Wageningen UR and Koppert Biological Systems.
- Koppert Kenya will train 2 scouts in July and later in 2009? (Eefje has contacted Ed Moerman Koppert).
- Koppert in consultation with the farmers develops the release schedules. The schedule is based on experiences in other countries. These schedules typically show a few consecutive weeks of high release volumes. Predators populations are built up the predator populations and diminishes mite populations.
- Climate data (there is a computer measuring Temperature and Relative Humidity) will be send weekly to Koppert, WUR

Releases of the two predatory mites will be conducted conform the release schedule to compare effects of predator release with conventional chemical control. It will be important to have an experimental design in which conventional control and the IPM approach are not interfering. Eefje will contact Alex Tetteroo for his visit in June to Almetta.

3.2 Visit to Florensis: Possibilities for white fly control in herbs



Figure 2. Production of herbs at Florensis.

Day 1, Tuesday Afternoon

Meeting with:

- Mr. Ronald Vijverberg
- Yeraswork Yilma
- Eefje den Belder

Florensis is a Dutch ornamental seed and young plant producer and distributor based in H.I Ambacht. It has production facilities in the Netherlands, Portugal, Kenya and Ethiopia and distributes throughout Europe. Florensis at Koka produces herb grafts, herb plants and garden plants, and some vegetables for export (See Figure 2). It must supply its products without chemical residues to supermarkets and garden shops (zero-tolerance), and is therefore interested in IPM. The main problems are whitefly and thrips. They grow the mother plants on volcanic ash, and use a drip irrigation system. Solar radiation is reduced through the application of chalk, which ensures a better root development.

A request for the on-farm evaluation of beneficials against whitefly will be submitted by Koppert to EIAR, which will send it to MoARD. They plan an IPM on-farm trial in October/November 2009. Nettings avoid aphid problems. It is potentially willing to evaluate also biological agents against soil pathogens, but would also welcome its testing at e.g. CPRC Ambo. Sometimes there are problems with fungus gnats (Sciarids).

White fly control in herbs

Actually whiteflies infest many species of protected herbs. The presence of whiteflies and/or their sticky honeydew and the associated sooty moulds are unacceptable on fresh cut or pot herbs supplied to supermarkets. The most common whitefly species found on protected herbs is the glasshouse whitefly, *Trialeurodes vaporariorum*. The tobacco whitefly *Bemisia tabaci* can also infest herbs. Glasshouse whitefly has a wide host range and commonly-infested herb species include sage, lemon verbena, mint, marjoram, bergamot, basil, balm rosemary, oregano and rue. Table 1 provides an overview of pests and diseases. The main pests and diseases are whiteflies, thrips, aphids and powdery mildew and *Rhizotonia*.

In heavy infestations, the sticky honeydew excreted by the whiteflies allows the growth of sooty moulds on the upper surface of leaves below the infested ones. Both whitefly species can transmit plant viruses. The young (immature)

stages use their piercing-sucking mouthparts to extract plant fluids. Whiteflies can cause plant stunting and wilting, and leaf distortion.

Glasshouse whitefly *Trialeurodes vaporariorum* can occur all year round on herbs under protection. The eggs are the most cold-hardy stage and can survive for a few days at temperatures as low as -6°C. Nurseries growing other whitefly-susceptible edible or ornamental crops are at particular risk from the pest, especially when infested plants are disturbed or removed, when adult whiteflies may disperse to find other host plants. Glasshouse whitefly population growth can occur between 8°C and 35°C with the optimum temperatures for development in the range 20-25°C.

Tobacco whitefly *Bemisia tabaci* is a species less well adapted to cool temperatures than the glasshouse whitefly. *Bemisia* cannot survive below 0°C although it can survive under protection. *Bemisia* population growth can occur between 16°C and 30°C, whilst the optimum temperature range for development is 25-30°C. Tobacco whitefly adults are slightly smaller than those of the glasshouse whitefly, and tend to hold their wings slightly apart and at an angle to the body when at rest, exposing the yellow body.

Integrated Pest Management trial in herbs

Very few pesticides are approved or effective against whiteflies on herbs. Whiteflies are commonly resistant to many pesticides. Several biological control agents are commercially available for the control of whiteflies. Biological control strategies for whiteflies within an IPM programme should be planned carefully.

Sanitation is very important (so keep stock plants in separate structures from those used for propagation or production. Avoid taking cuttings from infested mother plants. Maintain strict weed control in and around glasshouses and tunnels. Dispose of infested plants carefully. Clean bench or floor coverings between crops, as whitefly adults can disperse when removing plants, and may survive on plant debris).

Encarsia formosa gives successful control of glasshouse whitefly on many protected crops, including cucumber, tomato and various ornamentals. However, use of *Encarsia* on protected herbs has given variable results. Possible reasons for this included low early season temperatures preventing *Encarsia* flight and establishment; hairy or strongly scented herbs repelling or impeding *Encarsia*; short herb production periods preventing *Encarsia* from completing its life cycle on the crop.

Eretmocerus spp.

This parasitic wasp is similar to *Encarsia* but is yellow in color. It is more effective against the tobacco whitefly than *Encarsia*, and is less susceptible to pesticides. *Eretmocerus spp.* (*E. emeritus* and *E. minds*) will also kill glasshouse whitefly, both by host-feeding and by parasitism. Optimum temperatures for *Eretmocerus* are above 20°C. If only glasshouse whitefly is present, *Eretmocerus* should not be needed.

Amblyseius swirskii

This predatory mite feeds on whitefly eggs and young scales as well as on thrips larvae. The predator is very similar in appearance to *Amblyseius cucumeris*, which is widely used for thrips control. Optimum temperatures for *A. swirskii* are 25-28°C and the minimum temperature for activity is 15°C. *A. swirskii* on protected herbs e.g. on mint, is successful to both whitefly and thrips.

Amblyseius swirskii may be difficult to find on herb plants, but might be present on the undersides of young leaves infested with whitefly eggs.

Very few pesticides are approved or effective against whiteflies on herbs. A pesticide should only be used if necessary. Whiteflies are commonly resistant to many pesticides and it is very important to follow resistance management guidelines when using a pesticide.

Monitoring within IPM will be planned and supervised by the supplier Koppert and discussed with Eefje den Belder WUR.

Table1. Overview from literature of pests and diseases in herbs.

Crop*	Latin name	Dutch name	Pests	Diseases
Basil	<i>Basilicum spp.</i>	Basilicum	Primarily thrips, also aphids, whiteflies	Powdery mildew <i>Fusarium</i>
Helichrysum*	<i>Helichrysum spp.</i>	Helichrysum		
Lavender*	<i>Lavendula spp.</i>	Lavendel	Aphids, whitefly, mites, mealybugs	<i>Septoria</i> leaf spot, <i>Botrytis</i>
Lemon Balm	<i>Melissa officinalis</i>	Melissa	Primarily mites also aphids, whiteflies	<i>Botrytis</i>
Lemon Grass	<i>Cymbopogon citratus</i>	citroengras	Mites, thrips	Rust
Lemon Verbena	<i>Verbena officinalis</i>	ijzerhart	Aphids, mites, whiteflies	
Marjoram	<i>Origanum majorana</i>	Marjorein	Whiteflies	<i>Botrytis</i> , Powdery mildew, Rust, <i>Verticillium</i>
Mint* (3)	<i>Mentha spp.</i>	Munt	Primarily whiteflies, mites, also aphids, thrips	Crown and root rots, <i>Rhizotonia</i> , powdery mildew, rust (peppermint and spearmint)
Oreganum*(2)	<i>Oreganum sp.</i>			
Parsley*	<i>Petroselinum crispum</i>	Peterselie		Primarily root rots, also <i>Botrytis</i> blight, <i>Rhizotonia</i> , <i>Pythium</i> , <i>Alternaria</i> , virus
Rosemary*(2)	<i>Rosmarinus officinalis</i>	Rozemarijn	Whiteflies, aphids, and thrips	Primarily, Powdery mildew also <i>Pithium</i> , <i>Rhizotonia</i>
Rue	<i>Ruta graveolens</i>	Wijnruit	Aphids, whiteflies	Aphids, whiteflies
Sage*(4)	<i>Salvia officinalis</i>	Salvia	Primarily whiteflies, also mites and aphids.	Powdery mildew
Scented Geranium	<i>Pelargonium spp.</i>	Perlagonium	Primarily whiteflies	Bacterial blight (<i>Xanthomonas</i>), Bacterial fasciation
St. Jonswort	<i>Hypericum perforatum</i>	Kale jonker?		Antracnose, powdery mildew
Thyme*(7)	<i>Thymus vulgaris</i>	Tijm	Aphids, thrips	Crown and root rots, <i>Rhizotonia</i> web blight, <i>Botrytis</i>

* crops present at Florensis () = number of varieties.

How to continue

The on-farm trial will be conducted starting in October 2009 to determine the effect of *Amblyseius swirskii* and *Eretmocerus spp.*.

Ronald's plan is to have a new crop (2x400 square meters) one IPM plot, one control (conventional) plot with the same herbs.

- Measures must be taken to prevent incompatible pesticides to arrive on the IPM plot
- Use separate spray tank, hose and measuring cylinder for IPM plot
- Koppert Holland makes a list (A. Tetteroo) which pesticides must be in stock for eventually outbreak of other pests
- Application of pesticides during the transition stage will be discussed thoroughly during the visits of Chris in June and July (and backstopped by Koppert Holland A. Tetteroo)
- Dedicate one special person to communicate the relevant data on a weekly basis by email to both Wageningen UR and Koppert Biological Systems
- Also the selection of the compatible pesticides during the on-farm trial will be discussed with Chris and A. Tetteroo
- After the arrival at Bole predators must be handled properly and swiftly applied
- Koppert Kenya will train 2-3 scouts in Sept-October
- Koppert in consultation with the farmers develops the release schedules. The schedule is based on experiences in other countries. These schedules typically show a few consecutive weeks of high release volumes. Predators populations are built up the predator populations and diminishes mite populations
- Climate data (greenhouse temperature per hour indoor/outdoor, Relative air humidity indoor, Radiation indoor/outdoor) will be send weekly to Koppert and WUR.

3.3 Visit Desa plants: Possibilities for Sciarid flies control in propagations

Day 1, Tuesday Afternoon

Meeting with:

- Mr. Frans Diedens
- Mr. Ben Depreatere
- Yeraswork Yilma
- Eefje den Belder

Desa Plants, a producer of cuttings, produces mainly *Perlagonium* cuttings for export. Intensive use of agrochemicals in no more sufficiently effective. Mr. Diedens and Mr. Depreatere are very interested in an IPM on-farm trial with beneficials against sciarid flies (fungus gnats) in motherplants. At the moment we visited Desa Plants the greenhouses were totally cleaned so it was impossible to collect some pest individuals for identification. Eefje suggests that Alex and Chris discuss candidate beneficials during their visit during the second week of June 2009.

Sciarids control

Sciarid flies (Sciaridae) are a difficult pest, particularly in young plant material. They can cause damage to seedlings, rootstock and cuttings of many plant species. Sciarid flies go through several stages, from egg, four larval stages, pupa to adult fly. Adults are noticed when they appear in large numbers. Eggs are deposited in the soil. Larvae generally eat rotting plant material, algae and fungi that are present in or on the soil. Pupation takes place in the soil as well.

Direct damage can occur to young and/or weak plants in a moist, organic environment, when larvae chew the plant's roots. This reduces the uptake of water and nutrients, causing the plants to die. Strong plants are only affected at very high level of infection. Very serious damage can be caused Indirectly when larvae transmit mites, nematodes, viruses and fungal spores. Also adult sciarid flies can transmit various fungal spores. Scarids flies carries spores of *Pythium*, *Botrytis*, *Verticillium*, *Fusarium*, and *Thielaviopsis*. The places where larvae have chewed are also potential entries for fungi. All things together can be lethal to the plant.

Steinernema feltiae

Some nematode species such as *Steinernema feltiae* have adapted a strategy to attack both the mobile and sedentary/less mobile insects at the surface or deeper in the soil. *Steinernema feltiae* is highly effective against fungus gnats, sciarid flies and mushroom flies.

Steinernema feltiae is an entomopathogenic nematode applied for the larval control of several flies species (sciaridae, phoridae, leaf miners, house fly) and also of some moth larvae. Once in the soil the infective stage of the nematode waits for its host and penetrate actively its body through the cuticle. A pathogenic symbiotic bacterium (*Xenorhabdus*) is responsible for the rapid host killing (24-72 hours). In this way perfect condition for reproduction and development of a huge population of nematodes are created and thousand of them will be able to escape and search for new hosts.

Soil application against Sciarid flies in rates between 0.25-1 million nematodes per m², amount of spray solution depends on application method, water the crop before and after application keeping the soil moist for the first 2 weeks after application.

Hypoaspis aculeifer (predatory mite)

Hypoaspis aculeifer (Canestrini) (Acarina: Laelapidae) is a soil-dwelling predatory mite. *Hypoaspis aculeifer* feeds on sciarid fly larvae, bulb mites, thrips pupae, root aphids, mites and other harmful soil insects. Soil must be moist but not too wet, preferably rich in organic matter, with an open structure and minimum temperature of 15°C.

3.4 Suggestions for improvement of spider mite control in rose

Early control approach in rose

Red spider mites are a major threat to the production of quality roses as they pierce leaf cells and withdraw sap, leading to lethal cell collapse and visible spotting on the upper leaf surfaces. Heavy infestation can cause hyper-necrosis with significant desiccation and leaf fall. As cut flowers are grown for their appearance and aesthetic value the commercial tolerance of such damage is low and, typically, very close to zero in export markets.

Possibly, costs on control of red spotted spider mites can be reduced with an early start of the mite suppression in the rose propagations. *P. persimilis* can give good control of two-spotted spider mite on rose, particularly if the predators are introduced early in the cropping season when numbers of TSSM are still fairly small.

Many farms do have their own propagations (e.g. J.J. Kothari, Golden Rose, Holetta Roses)

Koppert (Alex Tetterroo/E. Moerman) will identify a farm to test on a small a scale this early control approach.

T. urticae mites are vigorous, multiplying both sexually and asexually and completing their life cycle within 4–24 days. They overwinter successfully in protected environments, thrive in the conditions that commercial rose growers strive for (25–28 °C, 60–70% RH) and are reported as acquiring resistance to many broad-spectrum, synthetic miticides. Miticides account for more than 40% of the pesticide volume applied to rose crops and 25–50% of the total cost of pest control depending on the rose variety, season and region. Eefje has informed Alex that Holetta roses is interested.

3.5 Visit to E.T. Highland roses

Day 3, Thursday morning

Meeting with:

- Ms. Emebet Tesfays, Farm Manager
- Mr. Wondwossen Legesse, Crop Protection Manager
- Mr. Santhosh Kulkarni
- Yerawork Yilma
- Eefje den Belder

E.T. Highland do not propagate their roses. So early control in rose propagations is not opportune. Actually in one greenhouse mealybugs are a problem. Eefje has collected some individuals and immediately send for identification. Eefje has collected mealybug at E.T. Highland and at the moment material will be identified.

The citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), is the most common mealybug associated with cut roses. In greenhouse cut roses, citrus mealybug is often by far the predominant species. However, various species of mealy bug can cause problems. Beside the citrus mealy bug (*Planococcus citri*), these include the long-tailed mealy bug (*Pseudococcus longispinus*) and the obscure mealy bug (*Pseudococcus viburni*). The citrus mealy bug is one of the most common species and is also the only species which can be parasitised by parasitic wasp. In IPM systems reducing the use of broad-spectrum insecticides mealybug populations can increase, threatening the success of this integrated pest management (IPM) programme. The lower developmental threshold observed is between 9 and 11°C. Even lower developmental thresholds of the citrus mealybug have been found. Golan can be applied. Eefje suggests Koppert to visit E.T. Highland in week 26. Eefje has collected mealybugs which will be identified.

3.6 Visit to Holetta Alliance Flowers Plc

Day 3, Thursday morning

Meeting with:

- Mr Navale, Production Manager
- Mr. Ravi , Production Manager
- Yerawork Yilma
- Eefje den Belder

Alliance Flowers Plc,. Is a 22 ha farm locate at an altitude of 2640 masl. They grow hybrids that are almost on par with those grown in Ecuador. The flowers from Alliance are sold at FloraHolland. Eefje has collected some aphids (very problematic) and immediately send for identification. They participate in the on-farm trials in which red spidermite is controlled by predacious mites. At Holetta initial releases were about 50 individuals per square meter and actual releases are only 2 individuals per square meter. They are interested in an on-farm trial in their propagations. Eefje will inform Koppert about their interest.

4. Extension of EPHEA team

The development of sustainable approaches for managing pests and diseases in the various horticultural crops requires accurate training in specific topics.

Glenn and Eefje consider it as utmost importance that for 2 team members of the EPHEA team a tailor-made training will be organized at Koppert Netherland.

Eefje has spoken to Koppert Nederland (Alex Tetteroo) and discussed the possibilities for a more focused training for the team members and Glenn will list the topics to be taught. Unfortunately the 2009 course just started in week 25.

Also a visit to Koppert Kenya and various farmers in Kenya will broaden the horizon. Eefje has discussed this also with Geert.

It is expected that with the training of two team members the whole team will have better access to, and use of IPM knowledge and technologies, which through sustained partnership with various stakeholders in the chain, contribute to higher quality, productivity and profitability in the horticultural sector.

The overall objective of this component is to support the Government to implement the IPM approach, focusing on empowering the extension clientele through sharing of information, imparting knowledge, skills and changing attitudes, so that they can efficiently manage their resources for increased productivity, improved incomes and standard of living.

5. Multi-stakeholder brainstorm with regards to IPM possibilities in other crops at Ministry of Agriculture and Rural Development (MoARD)

Day 2, Wednesday, morning

Meeting with: See Annex 1.

1. Presentation IPM on-farm results by Eefje den Belder: Briefing/How to continue/Communication

Upscaling of the on-farm trials at rose farms has been discussed with the various stakeholders (MoARD, EIAR, Ethiopian Horticultural Development Agency (EHDA), growers, PPRC AMBO, WUR). The control of red spidermite in rose with predacious mites is successful. Various growers want to extend the on-farm trials in which red spidermites are controlled by *Phytoseiulus persimilis* and *Neoseiulus californicus*. Possibilities for up-scaling in rose propagations, strawberries, herbs, and propagations of other crops as *Perlagonium* propagations were discussed also. We agreed that in the other crops the same procedures will be followed as in the on-farm trials in rose. The growers have to ask for the permits.

However various rose growers are interested in up-scaling (Golden Rose, J.J. Kothari, Holetta Rose), growers hesitate because of the difficult financial situation at this moment.

Navale Bausaheb will analyse the cost benefits from the IPM on-trial at Holleta.

Eefje will ask Emebet (E.T.Highland) to do the same.

Yeraswork Yilma has suggested to include a table in the last report (written by Eefje, Anne and Mohammed) including the pesticides used in the IPM trial and in the conventional greenhouse.



Figure 3. Multi-stakeholder brainstorm at MoARD.

The way integrated pest management (IPM) will be adopted will be affected by the level of ecological and socio-technological knowledge among the actors in the innovation system therefore not only depend on farmer's ecological knowledge, but also on the mindsets of those involved in the process, and the establishments of partnerships between the institutions. This has been discussed during the brainstorm.

- We agreed that the Ethiopian Horticultural Development Agency (EHDA) will encourage and support the development of channels for IPM communication and seek out opportunities for joint working with organizations that have specific areas of expertise.
- Mohammed Dawn expressed PPRC Ambo interest to start a trial with Trianum against soil-borne fungal diseases.
- For the next IPM study group meeting (organized by Mr. Yeraswork Yilma) representatives from other farms (e.g. Almetta) will be invited also.

IPM and risk assessment must not only be addressed from the economic, environmental and public health perspectives but also from a communication and consensus-building point of view.

2. Discussion at the Horticultural Agency about IPM and their role

Day 2, Wednesday, afternoon

Meeting with:

- Mr Zenebe Woldu, Deputy Director of the Agricultural Agency
- Yeraswork Yilma
- Eefje den Belder

The Agency was established 10 months ago and started with twelve employees. Actually there are almost thirty staff members. One of the objectives is to facilitate the horticultural sector e.g. code of practice, capacity building. Visits have been organized to Staff of the Ethiopian Horticultural Development Agency (EHDA) to all IPM on-farm trials at the various locations. Those visits were well-planned, focused and were recorded and debriefed to the various levels within the Horticultural Agency. We have discussed how to strengthen the ecological and socio-technological knowledge related to Integrated Pest Management.

We discussed also the possibilities how to encourage the up-scaling of red spider mite control in rose. Growers are very interested to extend the acreage under IPM control, however the financial situation at the farms make up-scaling actually very difficult. Mr. Zenebe will investigate the possibilities to support the growers in the transition from chemical control to an IPM approach.

Eefje and Yeraswork met Mr. Haileselassie Tekie (Director Ethiopian Horticultural Development Agency (EHDA)).

Adoption of IPM relies on several institutional, technical, economic and socio-psychological factors such as a favorable framework, awareness raising, confidence building, interactive extension and group approach. Consequently a strategic communication approach that includes all those areas could greatly enhance the likelihood of faster elaboration of new methodologies and their sustainable market-oriented diffusion in the country. In order to have real diffusion of IPM techniques, not limited to single projects or the enthusiasm of a few motivated farmers and scientists, the most area of action for communication for development is very likely at the national or sub-national political level.

6. MSc's at Jimma University: the development of 'new professionals' through linking formal research with on-farm research proposals

Day 2, Wednesday, afternoon

Meeting with:

- Dr. Fikre Lemessa (Dean of the College of Agriculture and Veterinary Sciences of, Jimma University)

1. What is research?

The importance MSc's performed at farms has been discussed as part of the IPM curriculum development at the College of Agriculture and Veterinary Sciences of, Jimma University. Integrated pest management is one of the crucial topics within sustainable agricultural development in Ethiopia. Actually funds have been allocated for five MSc's.

Fikre Lemessa and Eefje den Belder agreed on two MSc topics:

- Description of population dynamics of whitefly/beneficials in various herbs before and after the introduction of beneficials (at Florensis).
- Description of population dynamics of red spidermite (*Tetranychus urticae*) Koch in rose before and after the introduction of phytoseiid predators.

The criteria that a MSc research should meet, were already briefly discussed during a meeting in Jimma. The following criteria were identified:

- The research must be do-able. Students will receive funding for a restricted period, in which the entire research, including the write-up must be finished.
- The research must be demand-driven, and related to problems in the Ethiopian rose industry/agriculture, in the sense that it must contribute to the solution of current problems.
- The professor at Wageningen UR must be known on beforehand. The Wageningen professor will be involved in the writing of the final proposal, and will have to agree on all other aspects of the PhD research before it starts.
- MSc's can be an element within a PhD.

Global experiences now show that the changing agenda requires new ways of thinking about doing research and development. Fundamental to this emerging paradigm shift is reassessing the traditional notion of research and development as a process primarily concerned with generating and transferring modern technology to passive end-users. Instead, research and development is now widely seen as a learning process that:

- Encompasses a diverse set of activities for generating, sharing, exchanging, utilizing.
- Results in a wide range of knowledge products, from technological to socio-institutional.
- Build synergy between local capacities, resources and innovations.
- Draws upon diverse sources of knowledge, from local systems to global science.
- Provides decision-support tools and information that enable various types of users to make strategic choices and actions.
- Requires a holistic perspective of both the biophysical and social spheres in agriculture and natural resource management.

It is important to bear in mind that many technologies available in the toolbox for IPM are derived from research, and that project proposals have to include research components to gain additional information to optimize and increase implementation. The IPM project (sub-project #5) is meant to develop comprehensive research and implementation for a systematic and responsible introduction of IPM. The setting of the research agenda and process of development of new technologies will be undertaken with the full participation of major stakeholders involving the intended beneficiaries (growers through EPHEA, and institutions).

7. Netherlands Embassy

Day 1, Tuesday afternoon wrap up with Geert Westenbrink (Agricultural Counsellor)

Day 1: Tuesday evening Dinner with Geert, Glenn, Piet, Erik, Milko and Jeroen

Discussions on the following items:

- Results of on field-trials
- Up-scaling of the on-field trials: possibilities in other crops: early red spidermite control in rose propagations, red spidermite control in strawberry, whitefly control in herbs, sciarid control in propagations
- Brainstorm at Moard
- Project activities 2009
- Finances PRI-project: funds are very limited
- PhD: Yosef Kebede [josekebe@yahoo.com]
- MSc proposals
- IPM training EPHEA members in the Netherlands at Koppert and visit to Kenya.

8. ANNEX 1: Participants at multi-stakeholder brainstorm

No.	Name	Institution	Position	Telephone	e-mail
1	Fikre Lemessa (dr.)	Jimma University	Dean	0917550038	emessaf@yahoo.com
2	Sunil Chaudhari	Golden Roses PLC	Manager	0911684237	gomba@ethionet.et
3	Getaneh Belete	MoARD	Pathologist	0911371278	Geta2000@ethionet.et
4	Rohidas Sable	J. J. Kothari	Manager	0911214459	ljayprakash@msn.com
5	Eefje den Belder	WUR	IPM specialist	+31-317-476105	eefje.denbelder@wur.nl
6	Gossaye Dechasa	EHDA	Horticulturalist	0911813058	ehdadg@ethionet.et
7	Mohammed Dawd	EIAR -PPRC	Researcher	0911881471	mdawd2000@yahoo.com
8	Kongit Feleke	MoARD	Entomologist	0911044597	konjit..feleke@yahoo.com
9	Navale	Holeta Roses	Manager	0911677919	bkn_akole@rediffmail.com
10	Yearswork Yilma	APHRD-MoARD	Entomologist	+251911000286	yeraset@yahoo.com
11	Eefje den Belder	WUR	IPM specialist	+31651697287	Eefje.denbelder@wur.nl

Dr Mohammed was there on behalf of EIAR.

9. Itinerary

Mo 8 June	Evening	Flight Amsterdam – Nairobi – Addis Ababa
Tu 9 June	Morning	Arrival Addis, departure to KoKa
	Afternoon	Visit to Almetta (with YY, meeting with Mr. Tesfaye G. Mariam) Visit to Florensis (with YY, meeting with Mr. Ronald Vijverberg) Visit to Desa Plants (with YY, meeting with Mr. Frans Diedens, Ben Depraetere)
	Evening	Check in Beer Garden Hotel Dinner with Glenn Humpries (EPHEA)
Wed 10 June	Morning	Multi-stakeholder brainstorm at MoARD see annex
	Afternoon	Discussion Dr. Fikre Lemessa, Dean College of Agriculture and Veterinary Medicine, Jimma University Visit Horticultural Agency (with YY, meeting with Zenebe Woldu Deputy Director)
	Evening	Report writing
Tu 11 June	Morning	Visit Holetta Roses (with YY, meeting Navale Bhausahab farm manager, Mr Riva) Visit E.T. Highland (with YY, meeting with Ms. Emebet Tesfaye, Mr. Wondwossen Legesse, Mr. Santhosh Kulkarni)
	Afternoon	Visit Dutch Embassy meeting with Geert Westenbrink (agricultural counselor)
	Evening	Dinner with Geert, Glenn, Peter Pardoen (DLV), Eric Kerklaan (DLV), Milco Rikken, Jeroen Flight Addis Ababa– Karthoum - Amsterdam
Fri 12 June	Morning	Arrival at Schiphol A'dam

10. Persons met with:

Name	Function	Organization	Address	Phone	Email/web/fax
Mr. Geert Westenbrink	Agricultural Counsellor	Netherlands Embassy	Addis Ababa	+251-11-3711100 +251-911-306586 (m)+251.(0)11. 3711577	Geert.westenbrink@minbuza.nl
Mr. Fikre Markos	Deputy Head	Animal and Plant Health Regulatory Directorate, MoARD	P.O.Box 2531 Addis Ababa	+251-911-250651 (m)	fikrem2001@yahoo.com +251-116463686 (f)
Yeraswork Yilma	Entomologist and Project Coordinator	APHRD/ MoARD		+251911000286	yerasget@yahoo.com
Hiwot Lemma Belitu	APHRD/ MoARD	Entomologist	P.O.Box 2531 Addis Ababa	091116231770	gfikirbh@yahoo.com
Getaneh Belete	APHRD/ MoARD	Pathlogist	P.O.Box 2531 Addis Ababa	0911371278	Geta2000@ethionet.et
Dr. Fikre Lemessa	Dean	College of Agric. Veterin.Medicine, Jimma University		+251 917 550038 +251 471110019	Fikre.lemessa@ju.edu.et
Mrs. Glenn Humphries	Head (tentative)	Horticultural Training Centre		+251 912136429	Grd.josland@tiscali.co.uk
Mr. Hailelassie Tekie	Director	EHDA		0913 946576 +251 011 550 2483	Haileselassie@yahoo.com
Mr. Zenebe Woldu	Deputy Director	EHDA		+251 911 - 118825	Zenebe12@yahoo.com
Mr. Rohidas Sable	Farm Manager	J.J. Kothari & Co., (Eth.) Ltd.		+251 911 - 218602	ljayprakash@msn.com
Ms. Emebet Tesfaye	Farm Manager	ET Highland		+251 911 -502147	etland@ethionet.et
Mr. Wondwossen Legesse	Crop Protection Manager	ET Highland		+251 911 - 393421	etland@ethionet.et
Mr. Anthosh Kulkarni	Production Manager	ET Highland		+251 911 - 684296	santhoshkul@recliffmail.com
Mr. Tesfaye G. Mariam	Farm Manager	Almetta		+251 910-298469	Tesfayeg.mariam@yahoo.com
Ben Depraetere	Farm Manager	Desa Plants			bendepaetere@perlagoniumdecock.be
Mr. Frans Diedens	Farm Manager	Desa Plants			Diedens.frans@ethionet.et
Mr. Navale	Farm Manager	Holetta Roses		+251 911c677919	navale@nehainternational.com
Mr. Ravi	Production Manager	Holetta Roses		+251 911 - 414127	Pushpamt4@Yahoo.co.in
Mr. Peter Pardoën		Consultancy for DLV		00251910498011	
Mr. Milco Rikken	Director	Proverde		+31 625028939	m.rikken@proverde.nl
Mr. Erik Kerklaan		DLV PLANT		+31 653427249	e.kerklaan@dlvplant.nl
Mr. Jeroen van der Hulst		CBI		??	??

11. ANNEX 2: Presentation Eefje den Belder

Ethiopian-Dutch Horticulture Partnership: IPM Alliance Meeting at MoARD

Eefje den Belder, Yeraswork Yilma, Anne Elings
Addis Ababa, 10 June 2009




Pesticide use Ethiopia: actual situation at many farms

- Medium size rose farm uses about 1000 L/ha
- 23 different chemical compounds
- At a cost of 100,000 ETB/ha, 9000 €




Pesticide use: must go down

- Market**
 - 25% expenditures
 - 15% yield reduction
 - S → longevity plastic cover
 - Demand low residues
- Control**
 - Resistance development to chemicals
- Image sector workers' health**
 - Bad image for consumers/retailers/supermarkets
 - Complaints from workers and neighbouring farms





IPM = knowledge-based and grower-driven



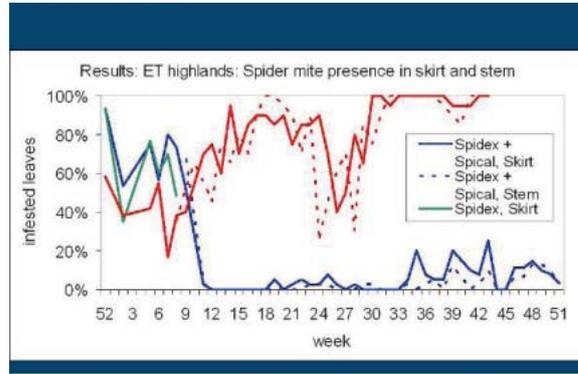

Rose: Key pest red spider mite

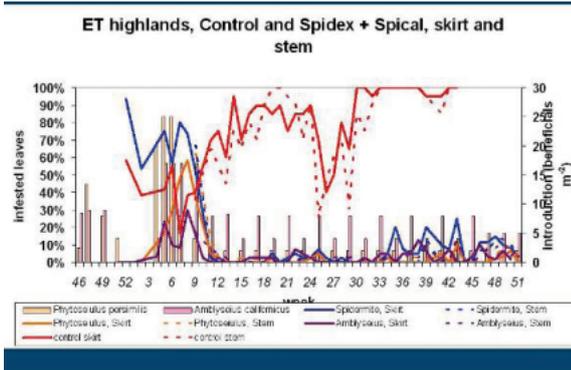



Training of scouts



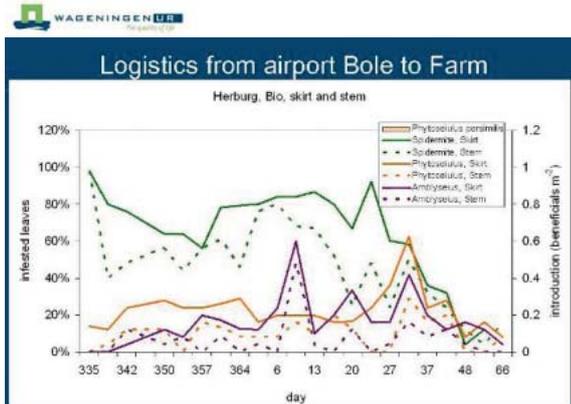
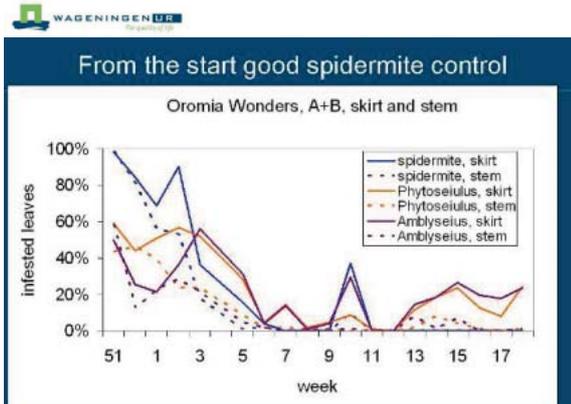

Rose: Release *Amblyseius californicus*, *Phytoseiulus persimilis*



Communication very important:

- Also during the transition stage weekly contact
- Chemical → IPM
- Grower-supplier on fixed day



Conclusions

- Spider mite level lower in integrated pest management, than in full chemical control
- combination predacious mites *P. persimilis* and *A. californicus* is effective tool to control spider mite
- Careful monitoring and intensive communication is essential
- If conditions are met biological control can form a pillar in IPM

Implementation of IPM needs:

- An enabling environment
 - e.g., rules and legislation, institutional setting
- Knowledge exchange
 - e.g. training, on-farm trials, study groups
- Training programme "new professionals"
 - 5 MSc's and 5 PhD's financed by NUFFIC



Up-scaling R&D IPM Ethiopia

- Pests and diseases & biological control agents
- Acreage = number of rose farms
- Rose propagations, strawberries, herbs, vegetables, food crops ?)

Early control approach of red spider mite (*Tetranychus urticae*) in rose propagations

- Phytoseiulus persimilis* and *Amblyseius californicus*

Red spider mite control in strawberries (*Tetranychus urticae*)

- *Phytoseiulus persimilis* and *Amblyseius californicus*




White fly control in herb propagations (resistance against imidacloprid)

- *Amblyseius swirskii* against whitefly (*Trialeurodes & Bemisia*) and larvae of thrips (*Frankliniella occidentalis*, *Thrips tabaci*)
- Parasitoid *Eretmocerus eremicus* against larvae of whitefly
- Trianum against *Fusarium* and *Pythium*




Propagations: Sciaridae control

- *Steinernema feltia* (nematode)
- *Hypoaspis aculeifer* (predacious mite)



Institutional context - National policy

IPM successful if policy makers:

- Assess the way institutions are organized
- Take part in platforms
- Create strong partnerships




Thanks

- Owners, growers, managers, scouts
- EPHEA
- EIAR (PPRC)
- MoARD
- Jimma University (College of Agriculture and Veterinary Sciences)
- Horticultural Agency
- Dutch Embassy
- Koppert



Sustainable crop production in Ethiopia




Management possibilities

1. application
2. not established, but with strong dissemination status
3. not relevant by
4. invasion
5. not relevant

	Spain	Chrysanthemum	France	Germany	Netherlands	Leafy vegetables	Fruit vegetables
Spider mite	1	1	1	1	1	1	1
White fly	1	1	1	1	1	1	1
Thrips	1	1	1	1	1	1	1
Trialeurodes	1	1	1	1	1	1	1
Bemisia	1	1	1	1	1	1	1
Frankliniella	1	1	1	1	1	1	1
Thrips tabaci	1	1	1	1	1	1	1



Pest possibilities

Problems

1. already a problem
2. emerging problem due to IPM implementation
3. not expected to become a problem

	Spain	Chrysanthemum	France	Germany	Netherlands	Leafy vegetables	Fruit vegetables
Spider mite	1	1	1	1	1	1	1
White fly	1	1	1	1	1	1	1
Thrips	1	1	1	1	1	1	1
Trialeurodes	1	1	1	1	1	1	1
Bemisia	1	1	1	1	1	1	1
Frankliniella	1	1	1	1	1	1	1
Thrips tabaci	1	1	1	1	1	1	1



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