PLANT RESEARCH INTERNATIONAL
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Trip Report March 2010

The introduction of Integrated Pest Management in the Ethiopian Horticultural Sector

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Note ??

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1. Summary

The mission's Terms of Reference were as follows:
1. Visit farms at which IPM trials are running.
2. Stimulate further up-scaling in other crops: visit farms that are interested in conducting IPM trials, and discuss activities.
3. Plan training programme PUM.
4. Meet with various stakeholders.
5. Workshop with EIAR researchers on IPM trials.

Visit farms at which IPM trials are running

1. **Upscaling IPM in rose.** IPM evaluation at AQ Roses is still going on. Results were not yet fully satisfactory, most likely due to residue problems. Measures have been taken, and recent results show improvements. Telephone calls were made with a number of rose farms to discuss the status of the red-spider mite IPM trials. On the whole, farm managers were satisfied. Oromia Wonder and Dream Flower have stopped recently because of financial problems.
2. Diversification IPM crops. IPM evaluation at herb farm Florensis is progressing well. Soon, extension for a further 6 months IPM trial will be requested and will be backstopped by WUR. Results are discussed with farm managers and EIAR.

Stimulate further up-scaling: visit farms that are interested in conducting IPM trials, and discuss activities

3. Desa plants at Koka would like to evaluate IPM management of shore flies in propagations. It is planned to start the evaluation from week 25 onwards. WUR has collected pest individuals for identification.
4. Jittu – Debre Zeit: the farm would like to evaluate IPM in outdoor vegetables, for the control of Phytophtera and Fusarium.. It is planned that the evaluation starts in a few weeks time. WUR has discussed the design of the IPM trial.
5. Jittu – Awassa: the farms would like to evaluate IPM in tomatoes, for the control of Whitefly. It is planned that the evaluation starts in April / May 2010. WUR is involved in the design of the trial.

Plan training programme

6. A training programme will be organized in which the approaches of various stakeholders (Ehpea, Koppert, Agency, DLV, and possibly others) is offered in a standardized manner. A PUM-subsidy will be requested for this. The training is scheduled to take place after the rainy season.

Meet with various stakeholders

7. The 2010 work plan and budget were discussed. They have to be submitted fairly soon, before the coming meeting of the WSSD Programme Committee.
8. In consultation with Dr. Melaku it was decided to cancel the meeting with EIAR staff on IPM. One of the issues to be discussed was the question whether th on-farm trials evaluate established IPM technology, or whether the efficiacy of a particular biological agent is tested. We support the view that established IPM technology is evaluated, which allows for the combination of biological control agents with other means of pest control when necessary, and which also involves the optimization of other farm management aspects. Testing of biological control agents is more an on-station activity that requires carefully controlled environmental conditions, insect cages, etc.
    a. We feel that this issue should be resolved, as it hampers the progress in on-farm research.
    b. We also propose to carefully review the official documents, in order to prevent confusion.

9. In the participatory planning workshop held October 2009 EDHA had accepted a leading role in the formulation of a communication plan. In the EHDA/MoARD action plan that we saw, this activity has been omitted. We believe that the project would benefit from one single project plan in which all activities are presented in an integrated form.
10. Operational agreements were made with the Ethiopian Horticulture Development Agency and other stakeholders.
    a. If new initiatives are developed by the private sector in relation to IPM trials, the IPM alliance will be flexible in the acceptation of these initiatives. However, plans and reporting should be as specific as possible.
    b. MoARD and EIAR will discuss the coordination of the IPM Alliance for the coming time.
    c. MoARD and EHDA expressed their concern that the funds are available after activities are performed.
    d. The activities of WUR are reported in trip and research reports.
    e. It was suggested that IPM alliance meetings can be held independently of WUR visits. This would enable a better progress monitoring, and intensify exchange of thougths.
11. With the agricultural councellor, Mr. Westenbrink, it was agreed that WUR will write a small report on BN3.

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Wageningen, March 2010

2. Introduction

2.1 Project rationale

A large number of growers in Ethiopia acknowledge the need for adoption of Integrated Pest Management. With the endorsement of a wide range of stakeholders (growers, the Ministry of Agriculture and Rural Development, the Ethiopian Institute for Agricultural Research, the Ministry of Trade and Industry, the Ethiopian Horticulture Producers and Exporters Organization, The Ethiopian Horticulture Development Agency), it was decided in the course of 2007 to conduct on-farm trials to evaluate IPM systems (of which biological control is an important element) under Ethiopian conditions, starting in rose. Up-scaling in terms of acreage, crops and pests/diseases was anticipated a future development.

So far, on-farm trials at Ethiopian rose farms and at an herb farm have been set up to evaluate IPM systems under Ethiopian conditions, and to gain grower's acceptance of IPM. Trials in other crops as tomato and Pelargonium will be started within few months.

In integrated pest management innovation systems 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. 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.

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.

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.

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 but also other ornamental and vegetable 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

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. Visit farms at which IPM trials are running.
2. Stimulate further up-scaling: visit farms that are interested in conducting IPM trials, and discuss activities.
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4. Meet with various stakeholders
5. Workshop with EIAR researchers on IPM trials.

3. Visits to Vegetable 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 Jittu Horticulture PLC farm Awassa: Possibilities for whitefly control in tomato

Figure 1. Vegetable production at Jittu Awassa (left) and Mr. Gashu (middel, Jittu deputy managing director) and Mr. Gelatu (Farm Manager) in discussion Eefje den Belder.

Day 2, Monday Morning/Afternoon

- Mr. Gashu, Jittu deputy managing director and specialist in crop protection
- Mr. Gelatu, Farm manager Awassa
- Eefje den Belder
- Anne Elings

Whitefly control in tomato

Specific situation at Jittu Horticulture PLC
Jittu Horticulture PLC has several production locations. One of them is situated in Awassa, altitude approximately 1840 meter above sea level, where amongst others tomatoes (various types), sweet pepper, hot pepper, cucumber, and aubergine is produced. The total compound acreage is 1000 ha. At this location, tomatoes for fresh market are produced in greenhouses on a total area of approximately 5 ha. Sweet pepper also occupies some 5 ha, and plans are to expand the greenhouse farm to 20 ha. In the future, also outdoor vegetables will be grown. Plans exist to, in addition, purchase vegetables from small surrounding growers, and market these as well. Products are exported to Dubai, and hot peppers to Europe. The IPM trial will take place in a greenhouse of 25000 m^2 where an area of 5000 m^2 will be separated by a screen to prevent drift of pesticides landing on the trial plot.

Irrigation is supplied with a pressure-compensated system. Water is obtained from a bore hole of 170 m depth. A substrate trial will start soon, to investigate options to deal with the nematode problem.

Greenhouse pests and diseases are: white fly, thrips, aphids, leaf miner, Fusarium, Verticillium, Phytophtera and Alternaria blight, and root-knot nematodes.

Whitefly feeding damage can cause economic losses, it is the ability of whiteflies to transmit or spread viruses that has had the widest impact on global food production. In the tropics and subtropics, whiteflies (Hemiptera: Aleyrodidae) have become one of the most serious crop protection problems.
Whitefly is a mayor pest in the production of tomatoes in greenhouse. Chemical control is still effective, but intensive use of agrochemicals has a negative influence on plant growth and production. More over, the fruits have to meet market requirements with respect of residue levels of agrochemicals.

Biological control of whitefly is a potential solution for this problem. For this situation a combination of the following measures is most likely to be successful:
- the predatory bug *Macrolophus caliginosus* against:
  - eggs and larvae of whitefly (*Trialeurodes vaporariorum* and *Bemisia tabaci*)
- the parasitoid *Eretmocerus eremicus* against:
  - larvae of whitefly (*Trialeurodes vaporariorum* and *Bemisia tabaci*)
- the parasitoid *Encarsia formosa* against:
  - larvae of whitefly (*Trialeurodes vaporariorum* and *Bemisia tabaci*)

The parasites *Eretmocerus* and *Encarsia* will be supplied as a mixed product, trade name Enermix: cards with equal portions of pupae of both parasitoids.

Jittu Horticulture PLC in Awassa has expressed interest to work on these problems through a trial with biological control agents, hence wants to request the Ministry of Agriculture and Rural Development to grant permits for the import of the following beneficials:
- *Macrolophus caliginosus* (Mirical)
- *Eretmocerus eremicus* (in Enermix)
- *Encarsia Formosa* (in Enermix)

to perform a trial in greenhouse tomatoes.
The mode of action of these biological control agents:

Macrolophus caliginosus
Macrolophus caliginosus Wagner (Heteroptera: Miridae) is a predatory bug, which has proven to be effective in controlling insect pests of greenhouse vegetables (eggplant, tomato, and cucumber) especially whiteflies. Adult predatory bugs and nymphs search actively for their prey, insert their sucking mouthparts and suck out the contents. Visual effect: If whitefly eggs, larvae or pupae are eaten by a predatory bug, only the skin remains usually in its original form with a tiny hole where the mouthpart of the predatory bug have been inserted. The developmental period of this predator varies due to factors such as host plants, temperature,

relative humidity (RH), habitat and most importantly the predators' species. The temperature for example, can influence the growth rate of an insect significantly.

Encarsia formosa
Female adult parasitic wasp parasitizes the larva of the whitefly. Host feeding also takes place. Visual effect: After 2-3 weeks, the first parasitized pupae can be seen in the crop. Parasitized pupae of *Trialeurodes vaporariorum* and *Bemisia tabaci* turn black and light brown in colour respectively. The adult parasitic wasp emerges from the pupa through a round hole.

Eretmocerus eremicus
E. eremicus attacks whiteflies (Homoptera: Aleyrodidae) including greenhouse whitefly (*Trialeurodes vaporarium*), sweetpotato whitefly (*B. tabaci*), silverleaf whitefly (*Bemisia argentifolii*), and bandedwinged whitefly (*T. abutlonea*).
female adult parasitic wasp parasitizes the larva of the whitefly. Host feeding also takes place. Visual effect: after about 2 weeks, the first parasitized pupae can be seen in the crop. The parasitized whitefly pupa turns yellow in color and is independent of species. The adult parasitic wasp emerges from the pupa through a round hole. This wasp thrives at higher temperatures than *Encarsia*.
Advantages:
Eretmocerus is *Encarsia formosa's* welcome assistant in whitefly control because of the following advantages:

- If the whitefly population is big (high insect pressure), *Eretmocerus* will perform more host feeding.
- At high temperatures, *Eretmocerus eremicus* lives longer than Encarsia, and works better.
- *Eretmocerus californicus* is more resistant to pesticides than *Encarsia*, which is more compatible with integrated pest management
- Both greenhouse whitefly and sweetpotato whitefly can be parasitised by *Eretmocerus eremicus*.
- Parasitised pupae are very easy to recognize due to their yellow colour.

The trial will demonstrate the practical feasibility and effectiveness of biological control of whitefly in greenhouse tomato production in comparison with the previously applied chemicals-only approach.
Through visits by colleague farmers and study groups the results and experiences of the demonstration trials during the first phase will be disseminated.
Following releases of predator bug and parasitoids, it is important to monitor whitefly densities closely to evaluate the effectiveness of the beneficials in maintaining the pest whitefly below economically injurious levels. Insecticides, miticides, and fungicides that are not selective will kill the predators.

How to continue: discussion with deputy managing director and farm manager

Field experiments will be conducted starting in April 2010 to determine the effects of the beneficials. Sowing will take place this week (week 10), and planting in two weeks from now (week 12).

The IPM trial will take place in a greenhouse of 2.5 ha where an area of 0.5 ha will be separated by a screen to prevent drift of pesticides landing on the trial plot.

A compartment of the greenhouse field has been selected that meets the technical requirements to start biological control of whitefly. Training of staff will be performed by qualified consultants of the supplier, frequently visiting the site.

- In the trial the following climate data will be collected (outdoor radiation, indoor air temperature, indoor relative air humidity). Climate data that have been gathered so far, will be sent to Wageningen.
- Supplier will check the "chemical stock" for "soft chemicals compatible with beneficials".

- Supplier will discuss which kind of nematode control is the best strategy compatible with the release of beneficials.
- The supplier discuss the starting date of the trial. This will be delayed untill May (because the greenhouse is actually under construction) when the highest temperatures are expected.
- Eefje will check what the reason can be that root-knot nematodes are spread so quickly all over the farm area.

The experiments will be supervised and reported to MoARD by Dr Firdu Azerefegn from the University of Awassa. Unfortunately, we could not meet with Dr. Firdu as he was on a foreign trip.

It should be realized that the hot month of May is approaching, followed by the rainy season. Both are relatively unfavourable for the establishement of biological control agents. Therefore, it might be necessary to introduce relatively high amounts of bca's.

Day 7, Friday morning

- Mr. Jan Prins Jittu general manager
- Eefje den Belder
- Anne Elings

Various aspects of the trail at Jittu-Awassa were discussed with Mr. Jan Prins, Jittu general manager:

- Good logistics between airport and Awassa for a fast transport of beneficials.
- Check custom procedures with Thomas of Koppert.
- Nematodes in Awassa
  - Analyses before planting were negative. Source of nematodes difficult to identify.
  - Control measures are needed. Soil steaming, substrate + reverse osmosis.
- A PhD in Awassa would in principle be OK.
- Preventive spraying against Phytophtera required.
- The insect pressure is not very high, so confidence in the IPM approach for Awassa is high.

3.2 Visit to AQ Roses: On farm trial of spidermite control in rose

Day 3, Tuesday Morning

Meeting with:

- Wim Ammerlaan
- Anne Eling
- Eefje den Belder

At AQ Roses the control of the red spidermites is hampering, and population densities are fluctuating. We discussed with Wim several reasons for the failure in the build-up of the predator mite populations.

- The presence of residues of chemicals in the plants (check through chemical analyses) probably has affected the beneficials. This may have been due to drift from the rest of the large greenhouse. The separating plastic sheet has been heightened.
- Problems with logistics from Bole to Ziway so predators face high temperatures during transport and are in suboptimal conditions.
- Probably history of location (residues nematicides). Previously, maize, vegetables and potatoes were cultivated.

Further remarks:

- The data originate from the crop in the new greenhouse that was planted approximately one year ago. Starting IPM in a young crop is not perfect, due to the low crop transpiration, low air humidity and high temperatures.
- Most beneficials introduced is Phytosieulus; Amblyseius is supplied in lower quantities.
- Months with high temperatures and low relative air humidities are apporaching. Close attention is required.
- Nematodes is an increasing problem.

How to continue

- Supplier will visit AQ roses and check release schedule, and compatible chemicals.
- A re-start of the growers meetings would be highly appreciated.

3.3 Visit to Florensis: On farm trial of white fly control in herbs

Figure 2. Production of herbs at Florensis.

Day 3, Tuesday Afternoon

Meeting with:

- Gashawbeza Ayalew
- Ronald Vijverberg
- Annemarie de Theije
- Anne Elings
- Eefje den Belder

Florensis is a ornamental seed and young plant producer and distributor based in H.I Ambacht. 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 started an IPM on-farm trial in November 2009. The main problems are whitefly and thrips. Sometimes there are problems with fungus gnats (Sciarids).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. Nettings avoid aphid problems.

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 d 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 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 is 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

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.

Results so far and how to continue

The on-farm trial has started in October 2009 to determine the effect of *Amblyseius swirskii* and *Eretmocerus spp.*.
So far the managers consider the results as quite successful, with a good balance between pest and predator. In contrast to the conventional chemical control (strong chemicals were used) in previous years, during which more than 500 whitefly adults could be found per yellow sticky traps, actually these numbers vary in the IPM trial between 10 and 50 whiteflies per trap.

- Application of pesticides during the transition stage was not nessesary.
- Still it is very difficult for the scouts to find the parasitized pupae of the whiteflies. Annemarie will spend a day with her team to find more pupae. It is an option, if necessary, to stop with the application of parasioids towards the end of the season, in an effort to detect the isoloated effect of the predator.
- Transport of the beneficials after the arrival at Bole are handled properly and can be applied swiftly.
- Data are sent weekly to Koppert and WUR.
- Annemarie de Heije and Ronald Vijverberg will ask the permit for another six months to complete the year round seasons.
- Mr Gashaw will support this permit and will help were possible.
- In November Eefje and Anne will write a draft report on the results.

Table 1. Overview from literature of pests and diseases in herbs.

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

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

3.4 Visit Desa plants: Possibilities for shore flies control in propagations

Day 2, Tuesday Afternoon

Meeting with:

- Dr Gashawbeza Ayalew
- Mr. Ben Depreatere

- Anne Elings
- Eefje den Belder

Desa Plants, a producer of cuttings, produces mainly Perlagonium cuttings for export. Intensive use of agrochemicals in no more sufficiently effective. Sometimes they lose 50% of the production batch (50.000 Euro). It is not the intention to rely fully on IPM.
The production schedule is as follows:

- week 15-20 planting of elite material
- week 25-30 planting of mother plants
- week 5-10 planting of export cuttings

An IPM experiment is only possible in mohter plants or export cuttings, but elite material is too valuable to run any risk. The planting of export cuttings is coming to an end, therefore the next opportunity is an IPM experiment on the mother plants starging week 25-30.

- Mr. Depreatere is still very interested in an IPM on-farm trial with beneficials against shore flies in **motherplants**.
- He wants to in between week 25 and 30..
- Eefje has collected flies for the best indentification possible. In cooperation with the Plant Protection Service of The Ministery of Agriculture, Nature and Food Quality this material has been identified as Diptera: Ephydridae, Scatella sp. Steinernema can control this species.
- She will send this information to all parties.
- If the experiment is positive, it can be repeated early next year on the export cuttings.

Shore fly control in greenhouses

Shore flies, moth flies, and March flies occur around damp, decaying vegetation, algae, and fungi. These flies can appear in large numbers in or around buildingsand also can be a problem in greenhouses, nurseries, and interior plantscapes.

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 effective against shore 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 shore flies in rates between 0.25-1 million nematodes per m^2, 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 spp. (Canestrini) (Acarina: Laelapidae) are a soil-dwelling predatory mites. *Hypoaspis spp.*feeds on 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.

3.5 Actual situation 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.
Actually, spidermite control through the IPM approach is at ET Highland (12.2 Ha), JJ Kothari 2 Ha, Menaye 2 Ha, Dukta 1.5 Ha (in process), Golden Rose 2 Ha (in process). Oromia Wonder and Dream Flower have stopped because of financial problems.
Possibly, costs on control of red spotted spider mites can be reduced with an early start of the mite suppression in the rose propagations.

3.6 Visit to Jittu Debre Zeit, possibilities for control of Phytophtera and Fusarium

Day 7, Friday morning

Meeting with:

- Mr. Gashu, Jittu deputy managing director and specialist in crop protection
- Mr. Tebetu, farm manager Debre Zeit
- Mr. Retta, Chief Agronomist Debre Zeit
- Mr Eshetu Dersa, Senior Scientist plant pathology EIAR
- Yerawork Yilma
- Anne Elings
- Eefje den Belder

The Jittu Farm at Debre Zeit grows outdoor vegetables: brassica, lettuce, celery, parsley onions in a 1 ½ year rotation. The farm measures 70 ha, of which 56 ha is under cultivation.
Water is obtained from a bore hole. Water quality is good on the whole, although the sodium level is high. Tubes are not pressure compensated.
The level of aphids is low, and is controlled with moderate spraying. As the soil is very heavy, the level of nematodes is also low.
The major diseases are Phytophtera (> 10%) and Fusarium (10%). Pytium occurs in approximately 2% of the plants.

Trianum

Trianum, containing the beneficial fungus Trichoderma harzianum T22. This fungus increases the resistance of plants to stress caused by diseases, sub-optimal feeding and watering regimes or climatic conditions, and increases nutrient uptake. This enhances the growth and development of roots and above-ground plant parts. Fusarium, Pythium, Sclerotinia and Rhizotonia, Thielaviopsis and Cylindrocladium from occupying space on or near the root zone. TRIANUM also protects against secondary infections resulting from insect damage to the roots. It has no adverse effects on humans, animals, or plants, and is listed by the Organic Materials Review Institute in the USA and the Soil Association in the UK as suitable for use in organic production.. The mode of action of Trichoderma harzianum Rifai T-22 is as a plant strengthener. The defensibility of the plant against stress due to disease pressure and suboptimal fertilization, watering and climatological conditions is increased and also the uptake of nutrients by the plant is enhanced. The root system and the upper parts of the plant will be developed stronger.

After treatment with Trichoderma harzianum Strain T-22 the spores germinate and the mycelium colonises the roots of the plant. The mode of action is based on several mechanisms e.g. the induction of a strengthened root growth of the plant, competition on nutrients and space between T. harzianum and other organisms living in the soil and mycopasasitism.

Trichoderma harzianum strain T-22 grows on the developing underground plant parts. And grows between 10 and 34 ^{0}C. TRIANUM grows best at a pH of 4 – 8.

A single application provides up to 3 months protection.

TRIANUM has a shelf life of up to 6 months when stored at room temperature, or 12 months in cold storage. It can be used in conjunction with all insecticides, fertilisers, rooting compounds, growth regulators, non-ionic surfactants, and most fungicides.

Verification trial

The idea of the verification trial is to evaluate whether Trianum increases production of the crops in the rotation system.
The effect of Trianum on production will be evaluated in a verification trial without replicates. Both control and trianum-part will measure 0.5 ha. It is assumed that the soil is uniform, just as the occurrence of diseases. After the treatment of the cocopeat percentage of survival of the germinating plants will be counted in five trays with and without Trianum treatment and weight of the plants will be measured in the control (zero Trianum) and the treatments with and without Trianum after transplanting.

Figure 3. Vegetable production at Jittu Debre Zeit. From left to the right: Tebetu, ?, Dersa, Thomas, Gashu, Eefje, Retta, Yeraswork

[Gashu gevraagd naar naam]

3.7 Phone calls with farms

Phone calls were made with the following farms:

- ET Highland: Ms. Emebet
- JJ Kothari: Mr. Sable
- Neha - Holetta Roses PLC: Mr. Navale

Growers were requested to make available environmental data to WUR for a scientific analysis of red spider mite management in rose.

4. Other meetings

4.1 EHPEA

Day 3, Wednesday Morning

Meeting with:
- Ms. Glenn Humphries, training specialist
- Anne Elings
- Eefje den Belder

Research proposals, budgets, and claimed budgets were clarified:
- Beginning 2007 – mid 2008
- Mid 2008 – end 2008
- 2009

An invoice for 2009 has to be submitted soon. A research proposal for 2010 has to be submitted soon as well, as the Programme Committee will meet one of these weeks.

Plans for an IPM training course were discussed:
- A request for PUM assistance is prepared. Anne will finalize.
- Good locations:
  - Holeta / Sebeta: rose (or split these two?)
  - Debre Zeit: rose
  - Ziway: vegetables
- Standardization of forms and records between Ehpea, Koppert, Agency, DLV, and possibly others. Reach a common understanding. Towards simple decision making.
- Rough programme:
  - How to scout
  - How to report the scouting
  - How to use records
  - How to develop a release/spray programme from the results
- Scouting should be the only basis for a release/spray programme, and not serve as an addition to a default programme.
- One very good expert on both roses and vegetables, or two experts.
- Timing: after rainy season.

4.2 Ministry of Agriculture and Rural Development

Day 3, Wednesday Afternoon

Meeting with:
- Mr. Yeraswork Yilma, Senior Entomologist & Flower IPM Project Coordinator
- Anne Elings
- Eefje den Belder

- Mr. Yeraswork had just returned from a study mission to Japan, which had caused some interruption in the communication.
- The government want to continue with up-scaling.
- Extension at Florensis is OK for MoARD, which in principle follows the desire of the grower in this.

- The design of the trial is the responsibility of EIAR. MoARD merely wants to know whether the IPM approach is succesful.
- Pest identification at the species level has been standard so far, and was requested because identification was possible. However, for MoARD, this is not standard. It is recommended to evaluate how for example the sciarid pest is managed world-wide, without identification at the species level.

MoARD agrees with the 2010 plan.

4.3 Netherlands Embassy

Day 6, Thursday afternoon wrap up with Geert Westenbrink (Agricultural Counsellor)

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, whitefly control in tomato, Fusarium and Pythium control in lettuce and cabbage.
- Visits to farms
- WSSD budget has been clarified with Glenn Humpries
- Project activities 2010. Plans will be submitted soon, before the coming meeting of the WSSD committee.
- Yosef Kebede., PhD candidate from Jimma, who has disappeared in illegality end of December 2009 in Wageningen. Nuffic has terminated funding, which implies that a successor can not be sought. It will be considered to request alternative funding from WSSD and to advertise broadly within Ethiopia. Mr. Jan Prins of Jittu in principle welcomes a PhD at Jittu in Awassa

4.4 Ethiopian Institute for Agricultural Research

Eefje has debrieved Mr Melaku on the good results so far and on the discussion with Dr. Gahaw on the IPM trial - whitefly/beneficals/herbs trial- at Florensis, Koka and the possible IPM trial at Desa Plants, Koka.

In consultation with Dr. Melaku it was decided to cancel the meeting with EIAR staff on IPM. One of the issues to be discussed was the question whether the on-farm trials evaluate established IPM technology, or whether the efficiacy of a particular biological agent is tested. We support the view that established IPM technology is evaluated, which allows for the combination of biological control agents with other means of pest control when necessary, and which also involves the optimization of other farm management aspects. Testing of biological control agents is more an on-station activity that requires carefully controlled environmental conditions, insect cages, etc. We feel that this issue should be resolved, as it hampers the progress in on-farm research.

a. We feel that this issue should be resolved, as it hampers the progress in on-farm research.
b. We also propose to carefully review the official documents, in order to prevent confusion.

Eefje has collected shore flies in the pointsettia propagations for identification by a Diptera expert of the Plant Protection Service, and Agency related to the Ministry of Agriculture, Nature and Food Quality.

4.5 Ethiopian Horticulture Development Agency

Day 8, Saterday, morning

Meeting with:

- Mr Gosfaye
- Mr Ato Johannes
- Yeraswork Yilma
- Anne Elings
- Eefje den Belder

- In October 2009 the IPM alliance has elaborated a workplan for 2009 and 2010 which was accepted by all stakeholders during the participative planning workshop at MoARD . In January and February 2010 Anne has asked all stakeholders to respond on these workplans (plus related funds) to enable an early submission. Dr Melaku of EIAR had approved, just as Mr. Yeraswork of MoARD earlier the week of the visit. In the meeting of today Yeraswork and Gosfaye presented an action plan for 2010 with a timetable. In this action plan not all activities that were agreed upon last October were included. Various essential activities have been left out (e.g. communication strategy and leaflets developed by EDHA), activities in which EIAR and Jimma do have the lead, and WUR was not included at all. So far the status of this action plan is not clear. We were surprised to see this action plan, and believe that the project would benefit from one single project plan in which all activities are presented in an integrated form.
- We all agreed that if new initiatives are developed by the private sector in relation to IPM trials (e.g. Jittu Awassa wants an IPM trial on whitefly in tomato, and Jittu Debre Zeit want an IPM trial on fungi control in lettuce and cabbage) the IPM alliance will be flexible in the acceptation of these initiatives. However, plans and reporting should be as specific as possible.
- So far MoARD has the coordination of the IPM Alliance. MoARD and EIAR will discuss the coordination of the IPM Alliance for the coming time.
- MoARD and EHDA expressed their concern that the funds are available after activities are performed.
- The activities of WUR are reported in trip and research reports.
- It was suggested that IPM alliance meetings can be held independently of WUR visits. This would enable a better progress monitoring, and intensify exchange of thougths.

4.5 Ethiopian Horticulture Development Agency: Communication

In the participatory planning workshop held October 2009 EDHA had accepted a leading role in the formulation of a communication plan. In the EHDA/MoARD action plan that we saw, this activity has been omitted.

Eefje had prepared a draft for methods and media used for the diffusion of IPM. In Ethiopia the IPM project succeeds in developing environmentally sound practices, but struggle to communicate the value of information on the risks and benefits of IPM. Communicating about IPM, pesticides and associated risks hings on the ability to earn the public's confidence, raise its awareness and understandig and addressing the various perceptions.

In order to have real diffusion of IPM techniques, not limited to single projects or the enthousiasm 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. This included coherent legislation with meassures favoring IPM and eliminating conflicting measures supporting hard conventional agriculture. Clearly, since the introduction Of IPM techniques very often collides with the supporters of hard technologies and there will be lobbies resisting this changer there will be debates and opposing information that must be foreseen and neutralized with data about the positive and environmental and socio-economic impact of IPM techniques.

So far we have focussed on one aspect: 1) communication for the generation of IPM techniques. Action is needed at least three other areas of action regarding communication, 2) speeding up techniques amongst more farmers, 3) communication for policy design, 4) communication for market development.
In this draft communication plan the five – steps adoption model of Rogers (1983) (awaremess - knowledge – persuation – decision – implementation – confirmation) is used.

Table 2: Suggested use of methods and media for the diffusion of IPM

Purpose	Necessary information	Individual methods	Group methods	Mass methods	Leaflets posters	Manuals	Radio	TV	Web
Awareness raising	**General and stimulating**	x	x	xxx	xxxxx		xxxxx	xxxxx	x
		x	x	xxx	xxxxx		xxxxx	xxxxx	x
Knowledge		x	x	xxx	xxxxx	x	xxxxx	xxxxx	x
Interest raising		x	x	xxx	xxxxx	x	xxxxx	x	
Appraisal	**Specific and detailed**	x	xxxx	xx	xx	xx	x	x	
Trial		xx	xxxx	xx		xx		x	
		xx	xxxx	xx		xx		x	
Persuasion	**Specific and practical**	xxxx	xxxx	x	x	xx		x	x
		xxxx	xxxx	x	x	xx			x
Decision		xxxx	xxxx	x		xx			x
		xxxx	xxxx			xx			
Implementation		xxxx	xxxx			xx			
		xxxx	xxxx						
Confirmation		x	x						

5. Itinerary

Sat 6 March	Day	Flight Amsterdam –Addis Abeba
		Check in Harmony hotel, Addis Abeba
Sun 7 March	Morning	Departure to Awassa
	Afternoon	Arrival in Sabana Lodge near Lake Langano
	Evening	Preparation visit Jittu Horticulture PCL
Mon 8 March	Morning	Visit Jittu Horticulture PCL, Awassa
	Afternoon	Visit Jittu Horticulture PCL, Awassa
	Evening	Langano
Tues 9 March	Morning	To Ziway: visit AQ Roses
	Afternoon	To Koka: visit to Florensis and Desa Plants
	Evening	To Addis: meeting with Mr Thomas Assefa Jima (Koppert)
Wed 10 March	Morning	Meeting Glenn Humphries (EHPEA)
	Afternoon	Meeting MoARD Yeraswork Yilma
	Evening	Wrap up discussion MoARD
Thurs 11 March	Morning	Draft communication plan
	Afternoon	Meeting Geert Westenbrink (Netherlands Embassy)
	Evening	Report writing
Fri 12 March	Morning	Meeting Jittu Jan Prins
	Afternoon	Visit Jittu Farm, Debre Zeit, meeting with Gashu, Tebebu,
	Evening	Back to Addis Abeba
Sat 13 March	Morning	Meeting Mr Gosaye (EHDA)
	Afternoon	Report writing
	Evening	Departure Addis Abeba
Sunday	Morning	Arrival Amsterdam – Wageningen

6. Persons met with:

Name	Function	Organization	Address	Phone	Email/web/fax
Gossaye Dechasa	Horticulture specialist	Ethiopian Horticulture Development Agency	PO Box 43450, Addis Abeba	+251-911-813058	ehda@ethionet.et
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Hiwot Lemma Belitu	Entomologist	APHRD/ MoARD	P.O.Box 2531 Addis Ababa	091116231770	gfikirbh@yahoo.com
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Mr. Ravi	Production Manager	Holetta Roses		+251 911 - 414127	Pushpamt4@Yahoo.co.in
Mr. Jan Prins	Managing Director	Jittu Horticulture		+251-911-231160	jan@jittuhorticulture.com
Mr Gashu	Deputy managing director & specialist crop protection	Jittu		0911502151	Gashu@jittuhorticulture.com
Mr Geleta	Farm Manager	Jittu Awassa		0911362238	awassa@jittuhorticulture.com
Thomas Assefe	Addis Abeba	Koppert			Tassefa@koppert.com
Mr Tibebu	Farm Manager	Jittu Debre Zeit		0911362238	

7. Literature

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8. Annex 1: Crown gall in rose

Epidemiology

Bacteria (*Agrobacterium tumefaciens*) in the ground, may stay there for years without host. Not all the strains of *A.t.* are violent.

Many hostplants may be infected, both herbacious or woody: Aster, Chaenomeles, Dendranthema, Chamaecyparis, Dahlia, Gypsophyla, Malus, Prunus, Pyrus, Rhododendron, Rose, Rubus,Vitis etc.

Infection takes place in fresh wounds of the plant, often below ground. Not only the formed gall is infectious, systemic movement of the pathogen in plants occurs.

Optimal temp 28ºC.

Symptoms

Early symptoms include soft white swellings on the stems or roots which eventually enlarge, harden, and darken in color to form tumor growths on roots and stems. Plants may also be stunted.

Prevention

- Start with healthy plants
- Don't plant susceptible plants into infested soil (any resistant cultivar available??)
- Use budding instead of grafting stock-not as prone to infection
- Disinfect ground or substrate with steam
- Disinfect recirculated drain water
- Hygiene measurements: sterilize knives and scissors after use.
- Optimal growing conditions for young plants –balanced fertilizer -temperature -R.H. –light
- Raised copper levels in nutrition solution (+ 50%)
- Pest contol (insects and nematodes) prevents weak plants and fresh wounds.

Scouting

- Regular inspection of the plants.
- Remove infected plant immediately with surrounding soil or substrate, in a closed bag.
- (A test for detection of violent strains of *A. t.* in ground or sustrate is being developed by NAKtuinbouw and Bioclear)

Control with products (mainly in fruit and ornamental trees)

- Use of antagonistic, non-violent strains of *Agrobacterium radiobacter*.
  1. prevents infection by blocking attachment sites for the pathogen.
  2. produces antibiotics toxic to the pathogen.

  Application to the roots prior to planting is recommended

  - **Galltrol** (AgBioChem, Inc, USA) : *A.t.* strain K84
  - **Nogall** (New BioProducts, Inc., USA) : *A.t.* strain K1026

- Use of curative product, mixture of xylenol and cresol.

  - **Gallex** (AgBioChem, Inc, USA)

Non of these products are available on the Dutch market.

producers:

AgBioChem, Inc **:** www.crowngall.com

New BioProducts, Inc: **:** www.newbioproducts.com