Feed the Future: Innovation Lab for Integrated Pest Management Trip Report

CountryVisited: Tanzania

Dates of Travel: 10 February – 18 February 2017

Travelers' Names and Affiliations: John Cardina and Matthew Kleinhenz, Department of Horticulture and Crop Science, Ohio State University

Purpose of Trip: To participate in a Seedling Health Workshop

Sites Visited: Sokoine University of Agriculture

Description of Activities/Observations:

10 Feb: Depart US for Tanzania.
11 Feb: Arrive Dar es Salaam
12 Feb: travel to Morogoro

13: Feb: Morogoro – Met in morning with the steering committee for the workshop, including Amon Maerere, Kalunde Sibuga, Ramadhani Majubwa, Elias Mgembe, Delphina Mamiro, and Gration Rwegrasira. We previewed preparations for the workshop, inspecting the lecture room and field sites, with attention to physical arrangements, and made suggestions for adjustments. At the Hort Farm, we discussed arrangements for hands-on demonstration stations. On campus, we met with department chair, Dr. Theodosa Msegoya, to thank him for allowing the staff to devote time and effort to this workshop. We visited the lab where the workshop handouts were being assembled and helped organize the program evaluation documents.

14 Feb: Day 1 of the workshop: We welcomed 47 participants to the workshop. Notebooks with handouts were made available to all participants. Then we went around the lecture room for personal introductions. The participants included people of different backgrounds, farmers, agronomists, extension agents, researchers, lecturers and masters students. Organizations like Real IPM, TAHA, AtoZ Textile, the World Vegetable Centre, the Ministry of Agriculture, MARI, KALRO, Ohio State University, and Sokoine University of Agriculture were represented. The instructors of the workshop included Drs. Kleinhenz, Maimiro,. Mgembe, Majubwa, Tibanyedera, Maerere and Sibuga.

The objectives of the workshop were explained as follows: The first step in Integrated Pest Management is production of healthy seedlings that are free from disease, insects, and nematodes. Healthy seedlings are necessary so farmers can begin the season with the best opportunity to produce a good crop while reducing health and environmental effects of pesticides. The workshop focused on increasing efficiency of technologies to control pests and to reduce the use of pesticides by starting with healthy seedlings as the beginning of IPM-based vegetable production. The main crops of interest for this workshop are tomatoes, cabbage, peppers, and cucurbits.

At the beginning and end of each day, participants completed a self-evaluation to scale their understanding of that day's topics. The morning sessions were lectures with active discussions from the participants while the evening sessions were spent at the SUA Horticulture Farm.

Features of the workshop:
Integration of classroom and hands-on sessions;
Attract participants – mostly trainers - representing various countries, career stages and professions;
Emphasis on connections between seedling and overall crop health;
Integrate current local to global science on seedling health and adoption of technologies to advance it, especially in East Africa;
Relevance of organic, sustainable and conventional approaches to crop production;
Encourage vegetable seedling production as a business and provide useful input on how to succeed at commercial production;
Encourage use of proven IPM technologies, including biocontrols, netting etc, and experimentation;
Develop a list of 'Next Steps' to serve as an action plan for enhancing vegetable seedling health management as part of overall IPM programs in East Africa.

The lectures started with an overview of seedling health management. We identified characteristics of a healthy seedling:
Vigor: a short and strong seedling is healthy.
Roots: a healthy seedling with many white branched roots.
Foliage color: no yellowing, browning or purpling on the leaves.
True to type: when planted it exhibits the expected characteristics and not mixed with other varieties.
Uniformity of the seedlings.
No abnormalities that may be caused by either nutrient deficiencies or mutations.
Free of pests and diseases.
Age of the seedling: appropriate for the particular crop, not over-grown.

Discussion highlighted how producing a healthy seedling means that light, nutrients and pest and disease free conditions are required. Healthy seedlings can provide high tolerance for biotic and abiotic stress, high yields, vigorous crop growth, and good and uniform stand establishment. In the discussions, we also noted that the limiting factors to producing healthy, high quality vegetable seedlings are lack of awareness and knowledge of technical skills. Commercializing the seedlings, that is producing seedlings as a business was one of the ways identified to reduce unhealthy seedlings used in vegetable crop production in most parts of East Africa.

The discussion turned to the connection between seeds, growing media, and container (Seed-Medium-Crop-Container (SMCC)). A seed can germinate in any media (even sand) in the presence of warmth, air and moisture. The SMCC combination becomes important when the roots and leaves form.
Characteristics of a good rooting media:
Free of pathogens,
Well aerated or 'fluffy',
Firm in-order to hold the roots,
Retain water and nutrients to give good proportions of air, water and solid around the root zone,
Stable characteristics,
A source of organic material.

It was agreed that plain soil is bulky, not uniform, not stable and can-not be fully sterilized hence it is not a good rooting media. The best rooting media were also noted to have organic matter, mined materials and inoculants (for example Trichoderma and Bacillus). It was emphasized that since the goal is to produce a seedling only – not a mature crop – the nutrient needs are relatively modest at this stage and over-fertilization can lead to problems in seedlings.

The choice of the container depends on the crop root and shoot size. Cucurbits are generally put in larger containers and solanum in smaller containers. The time of production is important – the longer seedlings remain in the container, the larger container required. Soil blocks were also demonstrated. These help to reduce on transplant shock and improve the health of the seedling, because when the roots reach air, they die and branch.

In the afternoon we went to the SUA Horticulture Farm to observe four stations: Seed quality; Media preparation; Container issues; Evaluation and diagnosis of seedling quality. This gave participants an opportunity for hands-on demonstration of techniques that many were not familiar with, including the use of sol blocks, soil sterilization and the problems of sterile technique; dilemmas in diagnosing seedling quality problems such as over- or under-watering, nutrient deficiencies etc. There was also a small poster session.

Considerations of media-container combination:
Can the container accommodate the media?
How long is the seedling going to stay in the nursery?
How much media are you willing to accommodate?


Fig 1: Types and sizes of containers demonstrated and discussed.


Fig 2: Equipment used to make soil blocks.


Fig 3: Soil sterilization using the drum and steam method.

The afternoon program concluded with a general session with a facilitated discussion to identify learnings from the day and to discuss gaps in information that participants wished to fill. From this it was determined that there was a need for information on seed quality and production of disease-free seeds. An after-program evaluation was completed to be paired with the pre-evaluations completed in the morning session.

Feb 15: Day 2 of the Workshop. The moderator was Dr. Mbaka from KALRO, Kenya. The program began with a review of key points from the previous day, this discussion led by Dr. Rwegasira.

To meet the needs of participants, the program was modified to allow Dr. Mamiro to discuss seed quality and production of disease-free seeds. She drew from her experience in the seed testing industry to discuss seed laws and labeling of seeds.

The program continued with discussion on irrigation, nutrient management, protection, and grafting. Emphasis was put on the amount, timing, method, and placement of irrigation water and their effects on possible promotion of disease. For nutrient management we discussed how different media retain nutrients and affect pH of the solution and therefore availability of some nutrients. In the session on seedling protection, we gave Hubert Coffi from AtoZ Textiles an opportunity to explain the use of netting for seedling protection, especially with reference to *Tuta absoluta* exclusion. Also discussed was the impact of netting on the microenvironment and proper site selection for setting up netting if used at a large scale. For vegetable grafting, Dr. Kleinhenz gave an overview of the rationale and different approaches for grafting. He showed video from two farms that take very different approaches to seedling production and emphasized that the level of technology adopted must fit the size and objectives of the farm operation. There was particular interest in the low-tech approach to precision planting in one of the videos. In the group discussion the idea was raise of a pilot project to demonstrate proper seedling production as a commercial venture as a way to make healthy seedlings available regionally.

We gave Patrick Mathenge and Gideon Ringo from Real IPM an opportunity to address the group to introduce the idea of biocontrols and to discuss the WhatsApp

network. At this point all participants with such interest were added to the network for discussion of IPM topics and especially seedling health.

In the afternoon we were again transported to the SUA Horticulture Farm to participate in four hands-on demonstrations: Netting for seedling protection (AtoZ Textiles), Bicontrol products for seedling health (Real IPM), Irrigation; and Grafting.

Netting: The netting demo showed how seedlings can be raised in nurseries with nets to protect them from insects. See Fig 4: Nursery nets.

Irrigation: The method used to irrigate the seedlings is very important as it affects their health. Overhead irrigation methods like a watering can or a knap sprayer can increase incidence of diseases like damping off and mildews. It was demonstrated that the best method for irrigation seedlings is capillary irrigation. This is where seedling trays are placed on a water soaked sponge allowing water to raise by capillary force towards the roots. This method reduces the incidence of damping-off and there is no moisture held in the canopy. The trays are removed after 15minutes or after the media at the top of the tray are wet.

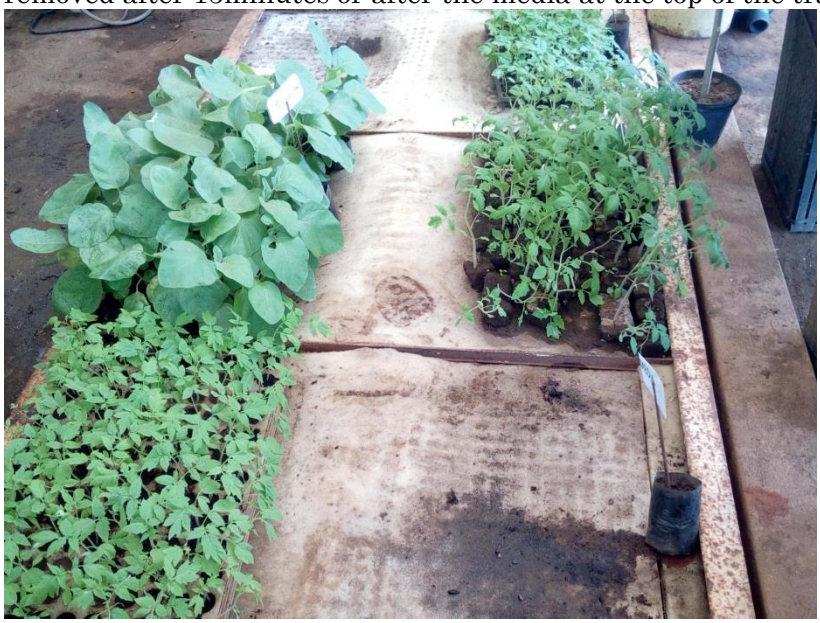

Fig 5: Capillary irrigation

Bio-controls: Seedlings can be protected from pests and diseases using bio-pesticides like Metarhizium, a fungus that can be used to help control aphids and mealy bugs; and Bacillus for mildews and botrytis. Representatives from Real IPM showed their examples of their products and discussed potential uses and label restrictions. There was considerable discussion of how to use these in combination with conventional pesticides, where and when this might be appropriate or when it must be avoided.

Grafting: An excellent demonstration of grafting was done from the actual cutting and splicing to hardening off of plants in a controlled environment. It was

emphasized that one must first identify the problem you want to solve, then to look at grafting like surgery, where cleanness and compatibility are essential. Emphasis was also put on the use of very healthy seedlings. In vegetable grafting, wedge and splice (top) grafting methods are used. Splice grafting involves cutting the scion and rootstock at the same angle and putting the union in a grafting tube. The sizes of the stems must be the same and the tube size must also be the same as the rootstock and scion stems. Wedge grafting involves removing the shoot of the rootstock and cutting stem in the middle, 1cm deep. The scion stem end is then cut in to a wedge which is then inserted in the rootstock and the union held by a peg or grafting tape. In wedge grafting, the scion stem can be smaller than the rootstock stem. The rootstock should be in large containers to grow for long duration in the nursery. The scion leaves should be trimmed to reduce their weight and avoid breakage and excessive water loss by transpiration after grafting. The grafted seedlings are put in a dark room for 3 days and then a room with lighter polyethylene until time to transplant.

In tomato grafting where resistance to wilt and nematodes is the aim for grafting, the union between the scion and the rootstock should be made 2-3 nodes up the rootstock stem to avoid union connect with the soil. The rootstock can also be exposed to low light after germination, to elongate the stem, and then more little just before grafting to strengthen it.

Fig 6: Wedge grafted seedling, tomato scion and eggplant rootstock.

Fig 7: Model of the healing chamber

The afternoon concluded with a group session to discuss learnings from the day and to seek input on issues that still needed to be covered or further clarification. Participants then completed an evaluation of the second day program.

February 16: Day 3 of the workshop: This session began with a review of material from the previous day, including both lecture and demonstration information. The new lessons learned were identified by participants as follows:
Sterilization of seeds using sodium hypochlorite; soaking seeds in a solution of 200ml of jik (Sodium hypochlorite) and 350ml of water. This should be done when about to plant as the soaking in moisture initiates germination.
Making soil blocks as an alternative to trays.
Bending of overgrown tomato stems towards soil or planting most of the stem in the soil during transplanting to encourage root formation.
IPM starts from seed selection; producing healthy seedlings is part of IPM.
Germination test is good to avoid time and labor wastage if seed with a low germination percentage are planted.
Wedge grafting of tomatoes.
Irrigation of seedlings using the capillary method.
Seedling production as a business.

We then gave Mr. Joseph Mbuji, a farmer and a business man from Bagamoyo, an opportunity to describe his farm. He produces seedlings for sale and makes seedling quality a primary interest. In translation from Kiswahili, he made the following points: He uses a mixture of forest soil, chicken and cow manure as his media in the trays. He also treats his own seeds and sprays the seedlings at an interval of 4 days. Joseph, who has over 200 farmer clients with over 30,000 seedling orders a month, transports the seedlings to other farmers using a boda-boda (motorcycle) and a car. His high quality seedlings enable him to get high yields from the small area he farms (both open fields and greenhouses). This improves his business and family status. This has also increased the demand for healthy seedlings from other farmers in his area. Mr. Mbuji also sells his products to Capital shoppers and Nakumatt (a supermarket) including other districts like Arusha and Dar es Salaam. He that his tomatoes have a longer shelf life (2 weeks) if he starts with a healthy seedling. Mr. Mbuji produces seedlings of many vegetables including tomatoes, cabbage, cucumber and 'sikumawiki'. When asked about the challenges he faces, he said "Challenges are there, but the profit is bigger than the challenges."

Fig 8: Mr. Joseph Mbuji describing his seedling production methods.0

Mr. Mbuji summarized his experience in this way:
Constant learning and improving on what know will take me far.
Learning from anywhere and respecting what has worked for me and others before.
Learning to give up traditional methods and adopt improved technologies.
Seedling production as a business is real and profitable.

Be a role model in my area so that other farmers can learn from me.
Quality process gives you a quality product.
Record keeping is essential for future purposes.

At the end of the Workshop with Dr. Kleinhenz as the instructor, participants discussed the next possible steps in IPM- oriented seedling health management. These were captured by one of the participants, Joselyn Nabweteme, a post-graduate student at IITA Kenya. Her list included the following:
Identify 'early adopters' or interested growers in your area who can take up seedling production as a business.
Combine resources to ease production costs.
Set up demonstrations farms and on-farm trails using healthy seedlings so that other farmers can learn from these.
Make a survey on the usage and costs of seed –vs.- seedling as the beginning of a growing season in the area.
Showcase the seedling production skills at farmer shows and filed days.
Print language appropriate publications for the growers on how to raise healthy seedlings.
Raise awareness among general farmers and connect progressive framers to form groups.
Solutions to production problems should be farmer-specific and problem specific.
The main message from the workshop was "Healthy seedlings give quality products."

Ms. Joselyn Nabweteme assisted greatly in the preparation of these notes from the Workshop.

Training Activities Conducted:

Program type (workshop, seminar, field day, short course, etc.)	**Date**	**Audience**	**Number of Participants**		**Training Provider (US university, host country institution, etc.)**	**Training Objective**
			Men	**Women**		
Workshop – Train the trainer	14-16 Feb. 2017	Extension, Ministry of Ag, consultants, horticulturists, farmers, students	37	14	Ohio State, Sokoine Univ. of Agriculture	To provide training in practical methods to produce healthy seedlings, free of insects, viruses, and root pathogens, as a first step in IPM.

Suggestions, Recommendations, and/or Follow-up Items:

The SUA staff did an excellent job in organizing and facilitating this Workshop, setting a model for future workshops. The program ran on time, the facilities were appropriate, handouts were available to all, and they adapted the material to meet the needs of the participants.

In post-program discussions, the following points were raised:
More hands-on demonstration and discussion is always of interest. For example, some were interested in seeing how bio-control products are actually applied and images or demonstrations of how they work in comparison with conventional pesticides. Some were interested in more information on row covers and other protection methods. A visit to a seedling production facility – if one exists – would have been especially interesting. More information on sterile technique would have been useful.

An idea that was raised was to develop a facility for seedling production where "everything is done right" to demonstrate the value of healthy seedlings and to make them available to farmers. Information on business development would have been helpful at this point as there was awareness that this is an opportunity that has not been captured in Tanzania.

There was some lack of enthusiasm for the lecture format for most of the morning sessions. Some of the material was delivered at the undergraduate level to a group that was ready for more advanced information. Reliance on powerpoint as a medium always makes for boring presentations, and there is abundant information available on the internet to include more videos and demonstrations rather than lists of points. Even though participants were invited to use Kiswahili whenever they preferred, the use of English, especially the U.S. vernacular, was difficult for some participants.

The Workshop generated considerable enthusiasm for the idea that horticultural practices are part of IPM; therefore, there appears to be a need for further training on other production phases and practices that contribute to IPM. For example, post-harvest management was an area that is often neglected. Another example is weed management, an aspect of production that is essential but mostly ignored as part of IPM because it is taken for granted.

List of Contacts Made:

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