

# Regional IPM Programs in East Africa: Kenya, Tanzania and Uganda

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## Summary

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The East Africa project is conducting research on development of IPM packages for tomato, pepper, passion fruit and coffee in Uganda; tomato, passion fruit and onion in Kenya; and tomato, coffee and onion in Tanzania. Several components of the IPM packages developed were transferred to farmers by organizing farmers' field days, workshops and meetings. Some of the notable achievements are identification of bacterial wilt tolerant varieties, introduction of grafting and high tunnel cultivation, and screen house production of seedlings to reduce virus disease incidence in tomatoes, screening for virus disease resistance in passion fruit, and use of arbuscular mycorrhiza fungus, *Trichoderma* sp. and

*Bacillus* sp. for control fungal and bacterial diseases fruit and vegetable crops. East Africa project has been closely working the global theme projects on Gender, Impact Assessment and International Plant Diagnostic Network.

## Uganda

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### Tomato

#### Evaluation of Improved Tomato Germplasm for the Management of Pests of Tomato

*Jeninah Karungi, Joe Kovach, Sally Miller, Kyamanywa, Tusime*

In collaboration with AVRDC improved tomato germplasm was acquired and selected the following for screening against key pests and diseases of tomato in Uganda:

- CLN3022C (resistant to viruses)
- CLN3008A (resistant to bacterial wilt, Ty1 and Ty2)
- CLN3022H (resistant to bacterial wilt, Ty1 and Ty3, TMV, fusarium wilt)
- LBR16 (resistant to blight, fusarium wilt, gray leaf spot)
- LBR17 (resistant to blight, fusarium wilt, gray leaf spot (GLS))
- CLN1466EA (resistant to bacterial wilt, TMV, fusarium wilt, GLS)
- CLN2413L (resistant to bacterial wilt, TMV, fusarium wilt)
- MT56 (local, resistant to bacterial wilt)

The germplasm was screened in pot and field trials. Pot trial results indicated that all the lines have succumbed to viral infection with 3008A and LBR 17 being the most severely affected and MT56 the least affected. Line

3008A still had the highest fungal infection while lines 2413L and MT56 were least affected. Scores of bacterial wilt severity indicated that line 1466E was most affected, followed by LBR 16 and 3008A. The remaining lines did not show symptoms. With regards to insect pest infestation, MT56 sustained the highest aphid counts whereas 3008A had the least. Thrips were highest on LBR 16 whereas 1466EA did not have any thrips. 3008A and 3022C had the highest counts of white flies whereas 3022H had the least. Analysis of field trial data is on-going.

### **Variety MT56 for Management of Bacterial Wilt in Uganda**

*Didas Asimwe, Sally Miller, P.R. Rubaihayo, Tusiime, Steven Guwa, Francis Okello*

Studies were carried out to determine the mode of inheritance of bacterial wilt resistance in MT56, interaction of its resistance genes with characterized *Ralstonia solanacearum* biotype(s), and evaluation of its performance in six different agro-ecological zones. BW tolerant varieties, MT56 and Tengeru 97; and susceptible varieties, Moneymaker, Marglobe and Roma were planted and the scoring for disease load is on-going. To identify *R. solanacearum* biovars currently existing in major tomato growing areas of Uganda, bacterial suspensions were collected from infested tomato plants from hotspots for BW disease in the country (central: Wakiso, Masaka, & Mukono; Eastern: Jinja; Western: Mbarara & Kasese; Northern: Lira). Bacterial isolation and biochemical identification of biovars of *R. solanacearum* were done using specific carbohydrates. Results indicated that all the isolates (except one of the three from Jinja and one of the three from Mbarara) were characterized as biovar 3. This study showed that there is little variation in the *R. solanacearum* affecting tomato in Uganda.

### **Development of Techniques for Management of Arthropod Pests of Tomato**

*Michael Otim, S. Kyamanywa, Matt Kleinhenz, J. Kovach, Z. Muwanga*

Two experiments, one on-station and one on-farm (Wakiso district), were conducted to evaluate the effect of reduced pesticide application on the incidence of bollworm, spider mites, aphids, thrips, whiteflies, and natural enemies. The treatments included: i) spraying once a week [a tank mix of dimethoate (insecticide) and agrolaxyl (fungicide)]; ii) spraying once in vegetative growth and once during flowering; iii) spraying twice during flowering and twice during fruiting; iv) weekly sprays with agrolaxyl (fungicide); and v) an untreated control. Results indicated that pesticide application reduced bollworm infestation levels as well as the number of natural enemies (spiders). The results showed no differences in bollworm infestation in plots that were sprayed weekly and those that were sprayed once at the vegetative stage and once at flowering, and those sprayed twice at flowering and twice at fruiting. Analysis of the data for other parameters is still on-going.

### **Seed/Soil Treatments with Biological Preparations in the Management of Fungal, Bacterial and Nematode Problems of Tomato**

*Mary Silver Rwakikara, Samuel Muwanga, Peter Senyonga*

Arbuscular mycorrhiza fungi (AMF) are among the most abundant soil organisms and form symbiotic (often obligate) associations with over 80% of terrestrial plants. Subsequently, they confer a number of advantages to the hosts, including increased nutrient uptake especially for relatively immobile nutrients, e.g. phosphorus and some micronutrients, improved water uptake and use efficiency, and improved disease resistance. The research was set out to develop and evaluate AMF as an IPM

component to be used alongside already developed technologies. Soil was collected from Central Uganda from a tea plantation that was formerly part of the equatorial forest of Mabira, a site previously characterized as highly mycorrhizal. Soil samples were analyzed in the laboratory and found to have high levels of AMF. After that, screen house trials with sorghum and onions plants (documented trap/multiplication hosts for the AMF) were planted in pots inoculated with the fungus. Colonization measures are on-going to establish the colonization capacity of AMF after which further multiplication of the AMF will be carried out to get enough inocula to use in screening on MT56 and other varieties. Samples of the isolated AMF were sent to colleagues in Brazil for identification, and we are waiting for feedback.

## **Hot Pepper cv. Scotch Bonnet**

### **Exploiting Host Resistance to Manage Hot Pepper Root Rot/Wilt Disease in Mubuku Irrigation and Settlement Scheme**

*G. Tusiime, S. Miller, J. Karungi, J. Bonabana, S. Kyamanywa, D. Munyazikwiye*

*Establishment of the range of fungal root rot and wilt pathogens on scotch bonnet in Mubuku irrigation scheme.* Pepper production in Mubuku Irrigation is constrained by the root rot and wilt disease. It is known that pepper rot and wilt could be incited by a complex of pathogens. Of the pathogens in the complex, it is only *Phytophthora capsici* that has been isolated from infected pepper. However, it is important to determine all possible pathogens involved in this disease. Effective management approaches are those that target the whole range of pathogens in the complex. The objective of this component of the study is to survey pepper for the root/wilt causing pathogens. Pepper samples with root rot/wilt disease were brought to the laboratory at Makerere University. Root and crown sections were obtained from the samples and plated on isolation media targeting *Phytophthora*,

*Fusarium* and *Verticillium* spp. So far, only *Phytophthora capsici* has been isolated from the samples. It appears likely that it is the most significant pathogen responsible for the root rot/wilt disease in Mubuku irrigation Scheme.

*Screening hot pepper germplasm for resistance to root rot/wilt disease:* Host resistance is known to be the most reliable means to manage plant diseases. In Mubuku irrigation scheme, the two hot pepper varieties grown are all susceptible to the root rot/wilt disease. In an effort to find and deploy root rot resistant pepper varieties, we obtained One hundred ten (110) F3 lines from Habanero - IP 59234 (said to be resistant to root rot/wilt disease) cross and planted them in Mubuku Irrigation Scheme to evaluate them against the disease. From these, it is hoped that lines with good levels of resistance can be identified and deployed in our efforts to develop hot pepper varieties resistant to the rot/wilt disease. Fifty (50) F3 lines of a cross between Habanero and IP 159234 (were established in a field trial in Mubuku on 20<sup>th</sup> July 2010). These materials have currently not wilted (about 2 months after transplanting), although they seem to be susceptible to viruses. For this reason, about 110 F3 lines (including the 50 planted in Mubuku) have been planted in a field at the Makerere University Agricultural Research Institute (Kabanyolo) to increase seed and reduce the risk of losing seed to unforeseen pests such as the viruses in Mubuku, as we do more evaluations.

### **Establishment of the Optimum Irrigation Frequency and Ridge Size on Hot Pepper Wilt Incidence and Severity in Mubuku Irrigation Scheme**

*G. Tusiime, Sally Miller, Karungi J., Bonabana J., Kyamanywa S., Munyazikwiye D., Mubuku*

*Optimum irrigation frequency to manage pepper root rot/wilt diseases:* It is established that pepper production in Mubuku Irrigation is constrained by the root rot and wilt disease

predominantly caused by the oomycete *Phytophthora capsici*. This pathogen, like all oomycetes, is favored by water logged conditions in the field. Pepper in Mubuku is produced under irrigation. Our interaction with farmers indicates that they apply unnecessarily too much water in their fields. This favors the growth of the pathogen and hence the damage it causes on the crop. The objective of this component of the study is to demonstrate that reduced water in the field by reducing the frequency of irrigation lowers disease severity. A trial to investigate the effects of irrigation frequency on occurrence of root rot/wilt disease on pepper was established in June 2010 in Mubuku Irrigation Scheme. Three irrigation frequencies are being investigated: (i) after every 8 days, (ii) after every 6 days, and (iii) after every 4 days. The farmers' usual ridge size (i.e., 6 cm high ridges) was adopted for this trial. To date, no wilt has developed in the trial.

*Optimum ridge size for managing pepper root rot/wilt disease.* In order to limit the amount of water in the root zone of the pepper crop, ridges on which pepper is planted can be manipulated which in turn limits damage caused to the crop by *Phytophthora capsici*. Farmers currently employ ridges of up to 6cm high. These are too small; they get over logged with water even with a slight irrigation. This encourages development of the disease. The objective of this component of the study is to evaluate different ridge sizes on occurrence and severity of root rot/wilt disease on pepper. A trial to evaluate the effect of ridge size on occurrence and severity of hot pepper root rot/wilt disease was conducted with three ridge heights of (i) 30 cm, (ii) 20 cm, and (iii) 15 cm. Hot pepper was transplanted onto these ridges at a spacing of 1 x 1 m for the 30cm and 20 cm ridges, and 1 x 0.8 m for the 15 cm high ridges. These ridges were irrigated following the farmers' usual practice. The trial is being monitored for disease development. To date, no wilt has developed yet in the trial.

## **Diversity of Hot Pepper Seed-borne Viruses and Development of a System for Small-holder Virus-free Seed Production**

*P. Sseruwagi, S. B. Mukasa, Sally Miller, J.Karungi, J. Bonabana, S. Kyamanywa, D. Munyazikwiye*

The damage caused by viral infections is, among others, dependent on the age when the crop is infected. It is therefore desirable that the crop remains virus free for as long as possible. One of the strategies to ensure this is the provision of virus-free seed. Outdoor pepper seed production is constrained by not being able to keep away the viruses from seed. Seedlings from such seed are transplanted with disease and are weakened so early in their growth. The objective of this component of the study is to evaluate the suitability of a tunnel to produce virus-free pepper seed. A tunnel for in-door establishment of the crop has been constructed at the Makerere University Agricultural Research Institute, Kabanyolo.

## **Passion fruit**

### **Grafting, Soil Amendments and Host Resistance for the Management of Key Diseases of Passion Fruit**

*P. Sseruwagi, M. Ochwo-Ssemakula, M. Otim, S. Kyamanywa, D. Kirunda, S. Miller, S. Nyanzi*

Two passion fruit species namely, sweet calabash (*Passiflora maliformis*) and yellow (*P. edulis* fsp. *flavicarpa*), were previously reported as tolerant to diseases. Physiologically mature fruits of these two species were collected from eight major passion fruit growing districts including: Mbale, Mubende, Mityana, Nakasongola, Lira, Tororo Kaberamaido and Masaka for propagation as root stock in the screen house at the National Agricultural Research Laboratories Institute. Seedlings were then artificially-inoculated with isolates of the virulent collar rot pathogen (*Fusarium solani*) accessed from the disease

hot spot in Wakiso district. These fungal isolates were cultured from single spores in chepadox nutrient media after plating of diseased stem tissue on Potato Dextrose Agar (PDA) media. Data on disease incidence and severity would be collected, starting two weeks after inoculation, for a period of four months. Resistant accessions would be selected for grafting to scions of commercial varieties such as the Kawanda hybrid and the small purple. These seedlings will be raised in the screen house and evaluated in field trials for agronomic performance and tolerance to prevalent pests/diseases at the National Crops Resources Research Institute in Namulonge for 2 years.

Promising passion fruit lines KPF4, KPF11 and KPF12 from Kenya will be evaluated alongside the local root stock in Uganda for tolerance to collar rot and *Fusarium* wilt. In addition, different soil fertility amendments (cow manure and NPK fertilizer) as well as antagonistic *Trichoderma* species found effective in Kenya will be used as a potential IPM strategy. The process for acquisition of the promising lines and *Trichoderma* from Kenya has been initiated.

### **Environmentally-Friendly Management Options for Viral Diseases of Passion Fruit**

*M. Otim, M. Ochwo-Ssemakula, P. Sseruwagi, S. Kyamanywa, R. Natukunda, J. Kovach*

Potential vectors of passion fruit viruses were determined in earlier trials. Subsequent trials will investigate potential environment friendly options, notably bio-control agents and cultural practices, such as use of cover crops/intercrops in management of the vectors and associated viral diseases. An on-station field trial has been completed that determined the temporal and spatial spread patterns of the viral disease.

## **Coffee**

### **Effect of Conventional vs. IPM Management Systems on Priority Insect Pests of Coffee**

*S. Kyamanywa, P. Kucel, J. Kovach, I. Rwomushana, M. Erbaugh*

*Key pests and diseases:* The key pests are: Antestia bugs (*Antestiopsis* spp.), Stem borers (*Bixadus sierricola*), Root mealybugs (*Planococcus ireneus*), Leaf miners (*Leucoptera* spp.), Coffee berry borer (*Hypothenemus hampei*), Coffee lacebugs (*Habrochila* spp.), tailed caterpillars (*Epicampoptera andersoni*), Leaf skeletoniser (*Leucoprema dohertyi*), Common coffee mealybug (*Planococcus kenya*) and Soft green scales (*Coccus alpinus*). The key diseases are: Coffee leaf rust (*Hemileia vastatrix*) and Coffee berry disease (*Colletitrichum kahawae*).

On-farm demonstration trials were set up to verify management options that had been found effective against key pests of coffee on station. These included utilisation of organic manure, mineral fertilizer, and/or bean intercrop on coffee root mealybug infestation; stem wrapping and stem smoothening were the options found effective against the coffee stem borers. Farmers groups were mobilized and three demonstration sites were set up in Bugusege, Sironko district for the period May to September, 2010. Farmer participatory data collection was conducted monthly. This activity hosted a Field Trip to Bugusege Mt. Elgon region to visit on-farm trials and interact with coffee farmers. The trip was for IPM CRSP East Africa Region members (14) and American collaborators (3) who were holding a regional meeting in Mbale, Uganda (10F : 7M). The trip was to two on-farm sites where IPM packages for coffee are being demonstrated after which there was a session with farmers (10F : 4M). The farmers expressed gratitude that Makerere University, through IPM CRSP, was coming out to the communities to assist in improving coffee yields. Amongst their key

problems with coffee production were stem borers, coffee rust, poor quality seedlings, and soil nutrient depletion.

### Action Threshold and Disease Curves for Major Insect Pests and Diseases of Arabica Coffee

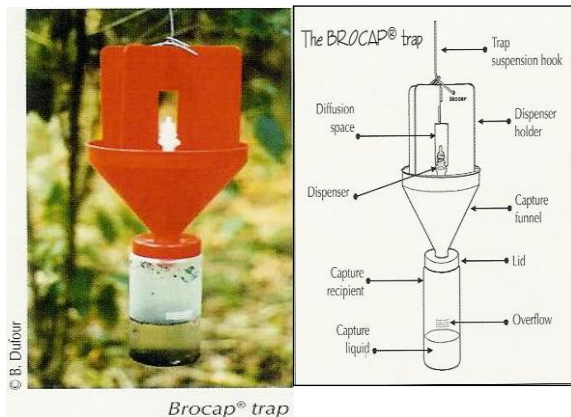
*I. Rwomushana, P. Kucel, J. Kovach, S. Kyamanywa, M. Erbaugh, C. Ssemwogerere*

To reduce pesticide usage while improving coffee yields, studies to determine action thresholds and disease curves as decision tools in IPM on coffee are undergoing in the Mt. Elgon region and on-station in Mukono district. Data on the key insect pest of coffee has been collected for one coffee growth cycle and is being analysed.

### Evaluation of IPM Options for Managing the Coffee Twig Borer in Uganda

*S. Kyamanywa, P. Kucel, J. Kovach, I. Rwomushana, M. Erbaugh*

The study was initiated on-farm at two sites in Ntenjeru and Nakanyonyi Sub-Counties in Mukono district in May, 2010. Community based participatory implementation of the test phyto-sanitary control measures (pruning, stumping and burning) are being carried-out. On-station trials assessing the effect of (BROCARP) traps that use ethyl-alcohol as single attractant are also on-going. Farmer participatory search for alternate hosts has also been initiated. Data collection is on-going.



The BROCARP® Trap (Picture and sketch above) was jointly developed by CIRAD and PROCAFE. Details are available at CIRAD-CP Export service (brocarp@cirad.fr). They were imported in Uganda by Kaweri Coffee Ltd for coffee berry borer control.

## Kenya

### Tomato

#### Grafting and High Tunnel Tomato IPM Workshop

*Waiganjo, M, R. Amata, Z. Kinyua, S. Kuria, M. Menza, C.M. Kambo, C. Njeru, M. Erbaugh, J. Kovach, S. Miller, S. Kyamanywa, R. Ssonko*

A two-day workshop was conducted at KARI/Thika and KARI/Mwea on grafting and using high tunnels as integrated pest management (IPM) strategies for tomato production on April 12 and 13, 2010. In addition, the workshop participants were updated on pest identification and various IPM options to address the major tomato production constraints. There were a total of 44 participants of which 26 were men and 18 were women. The lead trainers were Drs. Waiganjo, Amata, Kinyua, Ssonko, Kyamanywa, Kleinhenz, Miller and Erbaugh, all of whom are PIs with the IPM CRSP Regional Program in East Africa. The training involved presentations, participatory discussions, and practical grafting exercises at KARI-Thika during the first day. On the second day, presentations and discussions were conducted on pesticide handling, pests' natural enemies and beneficial arthropods, and high tunnel technology benefits. The participants were thereafter taken through a demonstration of screen house seedlings protection at the KARI-Mwea centre and a field visit at a small-holder high tunnel structure for tomato production. Use of affordable clear polythene soil solarization was demonstrated.

**Table 1. The effects of treatments on virus disease incidence, insect pests and yield of tomato crop grown at KARI-Mwea**

Treatment	Virus (TYLCV)	Whiteflies	Aphids	Leaf miner	Yield in tons/ha
Screenhouse-IPM	0.13±0.03a	0.95±0.03c	0.21±0.04a	0.27±0.04a	3.01±1.80a
Farmer practice	0.14±0.03a	1.97±0.02bc	0.25±0.04a	0.23±0.04a	1.06±0.20a
Screenhouse +no insecticide	0.14±0.03a	2.99±0.03ab	0.19±0.03a	0.29±0.05a	1.43±0.36a
Outdoor +no insecticide	0.22±0.04a	3.99±0.02a	0.25±0.04a	0.25±0.04a	1.02±0.19a
Cv	23.52	10.30	25.08	22.32	36.15
p-value	0.29	0.0162	0.63	0.73	0.29

Means within a column marked with the same letter are not significantly different at p=0.05 by SAS SNK test.

### Evaluation of effects of screen-house produced seedlings to insect transmitted viruses

*Waiganjo, M., S. Kuria, C.M. Kambo, C.Njeru, M. Erbaugh, J. Kovach, S.Miller*

The second season tomato screen house trials were conducted on-station at KARI-Mwea to test IPM practice involving nursery protection using insect proof screen house and need based pesticide application of bio-pesticides. The IPM option was compared with farmer practice using outdoor nursery and routine insecticide application and untreated control. A commercial variety (Onyx) was used. The treatments included:

1. Screenhouse-IPM- Pest scouting and need based pesticide application of Bio-pesticides namely, B.t, Dipel® alternated with neem, Nimbecidine®
2. Outdoor-Farmer practice involving weekly application of fungicide (Mancozeb®) and fortnightly insecticide application (Dimethoate alternated with Deltamethrin (Decis®))
3. Screenhouse alone-No insecticide application

4. Outdoor -no insecticide application (control)

Data sampling was conducted fortnightly from five plants per plot to assess arthropod pests and disease (tomato yellow leaf curl virus) incidence. Yield/hectare was assessed during harvest.

Tomato seedlings production in the screen house followed by need based pesticide application resulted in significantly lowest whitefly infestation and the highest yield, but the yield was not significantly higher than other treatments (Table 1). The incidence of the viral disease (tomato yellow leaf curl), however, was low in all the plots with no significant difference among the treatments.

### Tomato varietal testing for resistance/tolerance to bacterial wilt (*Ralstonia solanacearum*):

The objective of this study was to test the developed and introduced tomato lines for resistance/tolerance to bacterial wilt on-station at KARI-Mwea and validate the trial on-farm at the farmers' fields in Kirinyaga District.

**Table 2: Effect of introduced and conventional tomato varieties on bacterial wilt incidence and fruit yield**

<u>Season one field trial</u>			<u>Season two field trial</u>		
Tomato Varieties	Mean ± s.e Bacterial wilt infected plants	Mean±s.e yield in tons /ha	Tomato Variety	Mean ± s.e Bacterial wilt infected plants	Mean±s.e yield in tons /ha
155-18	1.14±0.22ab	1.6±0.15a	155-18	0.83±0.12a	1.3±0.14a
193-2	1.64±0.30ab	1.5±0.12a	193-2	0.83±0.12a	1.3 ±0.13a
193-31	1.39±0.22ab	1.7±0.16a	193-31	1.50±0.42a	1.1±0.19a
81-1	1.14±0.21ab	1.6±0.17a	81-1	1.09±0.52a	1.1±0.25a
MT56	0.79±0.08b	1.7±0.19a	MT56	0.94±0.16a	1.3±0.16a
Onyx	1.79±0.25ab	1.6±0.17a	Onyx	1.06±0.19a	1.0±0.11a
CALJ	1.76±0.29a	1.7±0.17a	Valoria	1.13±0.23a	1.2±0.22a
%CV	72	32.59	CV	86.59	33.07
P Value	0.043	0.96	P Value	0.228	0.341

Means within a column marked with the same letter are not significantly different at  $p=0.05$  by SAS SNK test.

During the first season, five KARI-Thika developed tomato lines (TKA 155-18, TKA 193-2, TKA 155-82, TKA 81-1, TKA 193-31), and one introduced line MT56 (UG) and two commercial varieties, Cal J and Onyx, were planted on-station at a spacing of 50cm within the rows and 100cm between the rows in 5x3m plots. The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of seven treatments, replicated three times. Weekly observation of the plants to assess the plant growth in all the treatments was done, and the wilted plants were taken as a percentage of the total number of plants per replicate (25 plants). The trial was repeated on-station for a second crop season and variety Calj replaced with var. Valoria.

There was significant difference between the treatments ( $P=0.043$ ) for bacterial wilt with the introduced line MT56 having the lowest mean number of wilted plants (0.79). The variety CALJ had the highest mean number of wilted plants (1.76). The developed lines 155-18, 81-1

and 193-31 performed better than the commercial variety, Onyx with a mean of wilted plants of 1.14 and 1.39, though there was no significant difference between them (Table 2). During the second season, two of the developed lines (TKA 155-18 and TKA 193-2) proved superior with the least mean number of wilted plants (0.83) lower than the introduced line MT56 (0.94), while 193-31 and 81-1 had the highest mean number of wilted plants (1.50 and 1.69) higher than the commercial varieties, Valoria (1.13) and Onyx (1.06) though they were not significantly different from one another.

During the first tomato crop season, the yields ranged from 1.5 to 1.7 tons. The developed line 193-31, CALJ and the introduced variety MT56 had the highest yields but not significantly different from the others. During the second season, yields ranged from 1.0 to 1.3tons/ha. Developed lines 155-18 and 193-2, and the introduced MT56 had the highest yields (1.3



tons) but not significantly different from each other.

- KARI-Thika lines (TKA155-18, 193-2, 193-31 81-1) showed a high degree of tolerance to bacterial wilt and maintained the preferred market oval shape during both trials.
- The introduced line MT56 was the most bacterial wilt tolerant among the test varieties and recorded high yields. However, the variety was not preferred for marketing due to its poor shelf life.
- The variety MT56 is therefore recommended as root stock for the tomato grafting program.

### **High tunnel and grafting of tomato plant development and crop yield, fruit quality and shelf life**

*Menza, M; Waiganjo, M; Sylvia K; Gitonga, J; Amata, R; Erbaugh, M. Miller, M. Kleinhenz, M..Kovach, J. Pauline Mueke, Charity Gathambiri*

Grafting susceptible varieties onto resistant ones is an effective approach to control of bacterial wilt in tomato. This technology has been employed successfully in various countries including Uganda. The technology has not been explored in tomato production in Kenya. High tunnel production is rapidly gaining importance among smallholder tomato growers in Kenya owing to its many benefits. The technology enables continuous or prolonged higher and better quality yield in a relatively small area regardless of weather changes and enables better pest management. However, limited technical knowledge on high tunnel production among resource poor small holder farmers is a major challenge.

Trials involving high tunnel and open field production were set up at a farmers' field in Mwea. The trial involved use of seedlings from the training workshop. Onyx variety grafted onto MT56 rootstock un-grafted Onyx and Anna F1 varieties were used in randomized

complete blocks replicated 4 times in both high tunnel and open field production system. Seedlings were planted at 30 x 60cm spacing in the high tunnel and 50 x 100 cm in the open field respectively. Fertilizer application, pruning, weeding, irrigation and other cultural practices were carried out by the farmer under his management practices.

Three (3) weeks old scion and root stock seedlings raised under a protected screen house at KARI-Thika were used. Proper hygiene and sanitation was observed in the work. Grafting blades (surgical blades) mounted on stainless steel handles, clips, grafting tapes, gloves, disinfectant (Jik®) and clean water was used. The work was carried out in a grafting shed at KARI-Thika. Wedge grafting method was employed. After grafting, seedlings were kept under acclimatization tunnels properly covered with clear polythene for the grafts to take.

Data collection was carried out biweekly on growth and yield parameters, and pests and diseases infection. Yield data was taken by harvesting from all plants per plot and calculated per hectare basis. Data on growth rate (mean height increase in cm) was taken. Heights of a random sample of four plants per plot were measured biweekly and averaged. Data was analyzed using Genstat and separated by Student-Newman-Keuls test at  $p \leq 0.05$ .

Anna F1 is an indeterminate hybrid variety bred for high tunnel production out yielded Onyx, an open pollinated variety adapted for open field production.

Results of yield from 6 harvests obtained in two months show the following:

- Grafting had no significant reduction on yields in both production systems.
- Both varieties gave higher yields under high tunnel than under open field production.
- Anna F1 out-yielded Onyx in total yield under high tunnel, while under open

field production Onyx gave higher yields than Anna F1.

- There was a sharper decrease in Onyx yield after peak harvest than for Anna F1
- Grafting did not reduce the growth rate in both production systems.
- There were no significant differences in crop growth rate except by the 12<sup>th</sup> week where Anna F1's growth in the open field was significantly higher (66.5 cm) with onyx having the lowest (28.19 cm)

## Passion Fruit

### Diagnostic protocols for passion fruit virus population

*Miriam Otipa, Feng, R. Amata, M. Waiganjo, J. Gitonga, E. Wakoli, M. Erbaugh, S. Miller*

The presence of passion fruit woodiness virus in Kenyan passion fruit samples with virus symptoms is under determination using primers that were designed from the Australian and East Asian strains of passion fruit woodiness viruses. Rt PCR primers are being developed from the Kenyan strains with the help of the Australian, East Asian and Kenyan strains. Molecular Variability of virus strains from diseased passion fruit samples from Kenya will be done through DNA sequencing of the Kenyan strains.

From the preliminary sequence data, it is understood that for one of the new viruses at least two different strains exist. These two strains can be differentiated by using restriction enzymes that digest the cDNA of one strain but not the other. We used the partial sequence information to design a pair of primers that are expected to amplify a PCR product from the cDNAs of both strains. The primers were used to amplify the expected PCR product from RNA samples collected from different fields. The PCR fragments were digested with two different enzymes (MluI and EcoRV) to classify the strains of the virus in

each field. Currently 25 samples were analyzed, 8 samples belong to one strain, and 6 to the other.

Sequences of Initial Kenya passion fruit virus (KPFV) particle, sequences of the 3'-End, first and second sequences of the 5'-End of the KPFV have been determined. Two KPFV different sequences were identified and it is suspected that there are 2 viral strains. Fourteen out of the 25 diseased Kenyan passion fruit isolates tested positive to KPFV virus.

Fifty percent of the genome of one strain of the KPFV has been sequenced. Two additional strains of viruses have also been characterized to a lesser extent (30%). Sequences of eight strains of the KPFV particles have been determined. Sequencing of more samples is ongoing. Primers are being designed based on the information being generated. These primers will be useful in diagnostics of viruses affecting passion fruit in Kenya.

The data collected indicates similarities between KPFV and the virus infecting passion fruit plants in Uganda. The results also indicate that in most of the infected trees, KPFV is present as a mixed population of multiple strains, and is likely to be part of a virus complex.

### Screening and grafting germplasm and rootstocks for passion fruit disease resistance

Passion fruit lines KPF11, KPF4, MKY2 and KPF12 were evaluated for rootstock scion compatibility with the following scion material lines: Purple, MKY2, KPF4, and KPF12. Fifteen plants of each line were grafted with the different scion materials and time taken for shoot development on the scions recorded. Data on yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test. Virulent strains of *F. oxysporum* fsp. *passiflorae* and *F. solani* were

**Table 3. Effect of *Fusarium oxysporum* on mean growth rate (mean height increase in cm) of passion fruit lines**

Line	June 2009	July 2009	August 2009	Sept. 2009	October 2009
KPF11	9.333 a	8.833 a	17.33 a	19.83 a	21.42 a
KPF12	7.667 ab	10.917 a	13.50 ab	17.17 a	17.83 a
KW	7.417 ab	13.667 a	22.42 a	26.83 a	24.17 a
KPF4	7.083 ab	10.800 a	16.00 a	18.75 a	19.33 a
PURPLE	2.667 b	2.500 a	2.92 b	6.00 b	3.58 b
P	0.05	0.140	0.017	0.007	0.015
Cv	52.5	78.1	61.1	46.3	55.7

Means followed by the same letter in one column are not significantly different. Mean separation by Student-Newman-Keuls test at  $p \leq 0.05$

grown on separate plates of carnation leaf agar and spores harvested at 14 days of growth. Fifty milliliters of water with an inoculum concentration level of  $10^6$  per ml each for the two species was introduced to the sterilized soil of each of the four lines (KPF12, KPF11, KW, and KPF4). The lines were replicated four times. The lines were monitored for wilt and stem canker symptoms and growth characteristics recorded. The lines used in production characteristics trial were KPF12, MKY2, C5, KPF4 and purple (as the control). The plants were spaced at 3 meters X 2 meters. Each line was replicated six times. Data on

yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test.

Under the insect proof screen house environment, KPF4, KPF12, and purple passion fruit exhibited self-compatibility. Line KPF12 fruited heavily, followed by KPF4, and purple. MKY2, C-5 and KPF21 performed poorly yield-wise. MKY2 was ever green and vigorous.

Evaluation of passion fruit lines for tolerance to major diseases (*Fusarium* wilt and collar rot

**Table 4. Effect of *Fusarium solani* on mean growth rate (mean height increase in cm) of passion fruit lines**

Line	July 2009	August 2009	Sept. 2009	October 2009	January 2010
KPF11	22.00 a	23.50 b	13.917 a	1.417 a	40.17 a
KPF12	8.75 ab	14.33 b	11.083 a	1.500 a	23.00 b
KW	17.65 a	34.17 a	12.000 a	3.333 a	23.00 b
KPF4	14.58 a	16.33 b	9.667 a	2.083 a	20.00 b
PURPLE	0.50 b	0.25 c	1.333 b	0.417 a	9.83 b
p	0.003	<.001	0.002	0.299	0.001
cv %	65.6	47.6	48.7	130.0	42.9

Means followed by the same letter in one column are not significantly different. Mean separation by Student-Newman-Keuls test at  $p \leq 0.05$

disease) and yield performance is illustrated in Tables below. Lines KPF4, KPF11, and KPF12 did not show any signs of collar rot and grew normally compared to their controls, while the purple showed stunted growth, yellowing and collar rot compared to the controlled and the other cultivars also badly damaged by collar rot in the *F. solani* and *F. oxysporum* var. *passiflorae* trials (Table 3).

Passion fruit lines KPF4, KPF11, and KPF12 tolerated the pathogens well at KARI Thika and could be recommended for straight sowing in the soil. There was no significant difference in mean growth rate between KPF 4, KPF11, KPF12, and KW. There was a significant difference between the purple passion fruit variety and all the rest of the passion fruit lines. There was no significant difference in mean growth rate between KPF 4, KPF12, KW and purple when planted in soil infested with the collar rot pathogen (Table 4).

### **IPM technologies for managing leafminer, *Liriomyza* spp, new pest of passion fruit and spider mites, *Tetranychus* spp**

*Evaluation of passion fruit breeding lines for spider mite tolerance:* Seven breeding lines: KPF4, C5, KPF11, KPF12, PURPLE, MKY2 and KW1 were evaluated for mite infestation. The treatments were replicated three times. Each replicate had four plants. Fifty yellow mite cultures were collected from susceptible species and introduced to the fifth leaf, from the growing tip of the eight plants of each line. There were no introductions on the controls. Data on yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test.

While the purple passion fruit was completely destroyed by the spider mites by the sixth month, KW1 appeared to be untouched by the pest. Lines C5 and MKY2 showed slight damage, while KPF4, KPF11, and KPF12 outgrew the slight damage and performed normally.

### **Evaluation of biologicals, *Trichoderma* spp and *Bacillus* spp, chemical fungicides and cultural practices to manage major fungal diseases of passion fruit**

*Management of Fusarium Wilt:* There was a significant difference between biological control agents and fungicide treatments applied for the control of Fusarium wilt disease when applied after disease set in or curatively. *Trichoderma asperellum* was significantly different from the control and fungicide treatments when applied as curatively but was not significantly different to *T. harzianum*. The two bio control agents (*T. asperellum* and *T. harzianum*) were not significantly different from fungicidal drenches including carbendazim, ridomil and ortiva, when used as protectant treatments.

*Management of Die-back Disease:* There was a significant difference between control and all fungicides and biocontrol agents used irrespective of application method. Carbendazim and Cotaf were effective in controlling dieback irrespective of the application method (i.e., spray, paste, pruning coupled with sprays, and pruning coupled with the paste).

## **Onion**

### **Baseline survey of farmer production practices and marketing of onion**

*Waiganjo M, R. Amata, M. Menza, K. Sylvia J. Gitonga, M. Erbaugh, S. Miller, D. Taylor, Mtui, J. Kovach*

To carry out the onion baseline survey, two structured questionnaires were developed including one for market survey of onion traders and a farmer production practices questionnaire. The dry onions market survey questionnaire had five sections, including general information, background information included trader, supply and demand of onions, gender aggregated control over resources, and other useful information concerning the trader

perceived profitability of onion marketing, business and its constraints.

The questionnaire was pre-tested using four (4) respondents at Nyeri market and adjustments made accordingly. The final adjusted questionnaire administration was initiated to onion traders at Karatina market (Plate 4), and will be continued at Nairobi (Wakulima market), Nakuru, and Bungoma as proposed. In addition, disease infected onion bulbs were collected from Karatina market to KARI-NARL for determination of the disease in the laboratory.

The biological and production baseline survey questionnaire was pre-tested to onion farmers in Kirinyaga District. The questionnaire consisted of basic data, respondents personal data, land details, labor on production, inputs used in onion production and output got from the farm, management experience, knowledge of pests, their control practices, pesticide handling and storage, and required information by the onion farmer and farmer income. Four respondents were interviewed, after which review of the responses and adjustments were carried out and a final questionnaire developed.

## Technology Transfer

### Tomato grafting and high tunnel demonstration

Farmer follow-up tomato grafting and high tunnel training was carried out at Mwea on 2<sup>nd</sup> July, 2010. The field day was attended by 56 farmers (41M, 15F), some of whom had attended the tomato grafting and IPM workshop on April 12<sup>th</sup> & 13<sup>th</sup>, 2010. The one day field day took place at Simon Ndambiris farm, the contact farmer for tomato grafting and high tunnel activities. The objectives of the field day were to demonstrate tomato grafting and use of high tunnel farming in the area, its benefits and importance of good seed selection, and proper crop nutrition as a component of integrated pest management. The resource

persons included research officers from KARI and two production managers from Scotts Limited.

### Transfer IPM knowledge and packages to growers of passion fruit

Members of the Juja farmers group, comprising 15 members (8 women and 7 men), participated in evaluation of passion fruit lines for tolerance to Fusarium wilt and brown spot diseases and evaluation of biocontrol agents for their effectiveness in controlling the 2 diseases.

## Tanzania

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### Tomato

#### Dissemination of IPM Packages

*A.P. Maerere, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro*

The objective of the activity was to demonstrate to farmers the effect of IPM practices on tomato insect pests and diseases. IPM practices that were validated and farmers trained on were seed treatment + mulch + pesticide application based on pest scouting. Mulch was applied at a thickness of 10 and 15 cm using dry rice straws and dry grasses (predominantly *Panicum* spp.). An un-mulched plot was used for comparison. The tomato variety used in the demonstration was Tanya VF. The demonstration plots were established at Mlali village. Farmers from Mlali, Kipera, Misegese were invited to visit the plot for training on seed treatment, nursery establishment, transplanting, mulching, fertilizer application, scouting for insects and diseases as basis for deciding whether to apply pesticide or not, and on appropriate methods/practices of pesticide application.

As was undertaken during phase 1, the Ward Agricultural Extension worker met with the farmers on site on a designated day, once a week for pest scouting and pesticide application, as needed. Researchers visited demonstration plots and interacted with

farmers at least once every two weeks to monitor and evaluate, conduct training, and discuss the development of the crop.

A total of 40 farmers were trained (18F:22M) on farm using the demonstration plot.

Observations/comments made by farmers were:

- (a) Application of mulch reduced the effect of drought that was experienced this year on the tomato crop. This was demonstrated by the fact that plants in the mulched plots were more vigorous and had remained green without signs of wilting at 4 weeks from when irrigation had been stopped. Thus mulch had positive effect on soil moisture conservation.
- (b) Mulch reduced weed populations and therefore the need for frequent weeding that is usually done up to 3 times per crop cycle.
- (c) The thicker mulch of 15 cm using rice straws was most effective both on weed suppression and soil moisture conservation.
- (d) Tomato fruits in the mulched plots were more colorful and with lower incidence of blossom end rot.
- (e) Farmers recognized the need to stop the practice of burning rice straws, and instead to collect them for use in tomato mulching.

The final training session for the season was recorded on video. This is being processed to produce a video film that will be used for training other farmers.

### **Impact of Management Practices on Post-Harvest Physiology and shelf Life**

*A.P. Maerere and H.D. Mtui, M. Bennett*

On station field experiments to test the impact of management practices on postharvest physiology and shelf life of tomato were conducted at SUA. Treatments consisted of two tomato cultivars (Tanya VF (Ta) and Tengeru

97 (T)), two mulch ((M) at 15 cm thickness) and no mulch (M0)) and four spray regimes (No spray (F0 =control)), spray with pesticides (fungicide and insecticide) according to recommended dosage rates and intervals (Fs), spray weekly (Fp) and spray as needed (Fi).

The two cultivars used showed difference in time to maturity. Cultivar Tanya VF was early maturing by producing fruits which ripened a week earlier compared to cultivar Tengeru 97. The last harvest for Tengeru 97 was also one week later. This phenomenon has positive implication on marketing. Since the two varieties are grown concurrently, it means that the season is extended.

On the overall, there was a higher incidence of fruits with blossom end rot and sunscald (SS) disorders as well as higher rates of fruit rot on non-mulched plots. The incidence of fruit decay was minimal in mulched plots compared to non-mulched plots. BER occurred at a lower rate in Tanya VF than in Tengeru 97. Cultivar wise, mulching seems not to have effect on BER fruit disorder as well as fruit rot in Tengeru 97, while it had pronounced effect in preventing fruit rot in Tanya VF (Table 5)

Observed fruit damages were mainly due to Blossom End Rot, American boll worm and birds. Tengeru 97 was highly susceptible to bird attack and to damage by American bollworm compared to Tanya VF (Table 5). Birds seemed to prefer Tengeru 97 which is semi-indeterminate (growing upright) as the fruits were more exposed, compared to Tanya VF which is determinate with relatively dense canopy. The fruits lying on the ground were possibly more protected from the birds. Other important pests observed included aphids and whiteflies.

There were yield differences between the different treatments. Tanya VF was found to be higher yielding than Tengeru 97. Pesticide sprays at recommended dosage rates and intervals (Fs), Weekly Pesticide sprays (Fp) and spray as needed (Fi) gave higher yields

**Table 5: Yield and yield components obtained from different treatments**

TREATMENT	Average marketable Fruit number plant <sup>-1</sup>		Average fruit weight (g)		Yield (t/acre)	
	Tengeru 97	Tanya VF	Tengeru 97	Tanya VF	Tengeru 97	Tanya VF
M-F0	12	25	94	51	10.9	12.5
MF0	11	30	113	59	11.8	17.4
M-Fi	12	39	130	87	15.5	35.8
MFi	10	52	140	91	14.4	45.0
M-Fp	12	31	130	78	15.8	24.4
MFp	13	43	139	88	18.5	37.6
M-Fs	11	35	123	77	13.6	26.9
MFs	12	42	150	94	17.8	39.3

compared to the control (F0) (Table 1). Mulched plots gave higher yields compared to non-mulched plots. For Tanya VF cultivar, the highest marketable yield was obtained when spraying was done as needed (IPM) and mulched (MFi) though may not be statistically different from those using mulch and sprayed weekly (MFp) and using recommended dosage rates and intervals (MFs).

The average fruit number per plant and fruit weight was higher in sprayed treatments than control. In all treatments, the average marketable fruit number per plant, average fruit weight and consequently yields obtained from mulched plots were high compared to non-mulched plots. Although Tengeru 97 had higher fruit weight, it had fewer marketable fruits per plant which resulted into lower yield compared to Tanya VF.

## Coffee

### Effect of Existing Shade and Open-Grown Coffee on Key Pests

*J.M. Teri, G. Maro, F. Magina*

The objective was to conduct comparative study of effects of shaded and open grown coffee on the behavior of key coffee pests and the

damage levels, yield and quality of coffee under natural shade or open field.

Preliminary results show that white coffee stem borer (*Anthores leuconotus*) is more prevalent in sparse than in dense shade. Rains or high humidity has the effect of increasing the pest population. However, the Antestia bug (*Antestiopsis* spp) was more abundant in dense shade and increased in the field during the flowering and fruiting period. The Coffee Berry Borer (*Hypothenemus hampei*) is slightly more prevalent under dense shade and observed in the field particularly during the period of fruiting (young cherries to ripe fruits).

These initial results tend to indicate that management strategies for WCSB should encourage proper shading by planting more shade trees in sparsely shaded farms to attain a light intensity of between 20 to 40 lux. For Antestia bug, the proper management would be to prune the coffee and trees so as to improve the aeration within the plant canopy. Proper pruning will deny the *Antestia* bug and CBB hiding sites.

## Coffee Berry Borer Management Using Traps

*J.M. Teri, G. Maro, F. Magina*

Traps based on the use of attractants identified during the baseline survey as being used by farmers were set in a trial. These included alcohols/spirits (wine, methanol, ethanol and methylated spirit). Local brews made from fermented ripe banana juice mixed with porridge of malted finger millet is considered to be a cheap alternative to industrial alcohols, which is readily available in coffee growing areas. Local made recipient materials have also been identified. Alcohol based attractants have appears to be effective in trapping the CBB.

## Onion

### Baseline Socio-Economic Survey on Onion Production

*C. Msuya-Benges, K. Mwanjombe, A.P. Maerere, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro*

The survey questionnaire was developed and pre-tested during the month of August 2010, in 4 villages (Msosa, Nyanzwa (in Kilolo district), in Iringa region, Malolo B and Chabi (in Kilosa district) Morogoro region). Out of the four villages, three namely - Msosa, Malolo B, and Chabi - were selected for the actual survey. A total of 100 farmers (46 Female, 54 Male) were interviewed. The survey was completed in September 2010.

Farmers in the study area grow maize, rice, beans and onion as major crops. Onion is the major cash crop. Production system is based on both rainy fed and irrigation. Due to the possibility to irrigate, onion is grown almost throughout the year, although the main production season is March – July. Seed sowing in nursery is done in December – January, followed by transplanting in the field from February to April. Thus harvesting is mainly from July to August. The same plots are used for all crops, and therefore, most farmers

practice mixed cropping and crop rotation. Crop rotations are, however, of relatively short period of time before the same crop comes again on the same piece of land.

Although many farmers in the study area consider onion production to be under a monoculture cropping system, most plots planted with onion were observed to be intercropped with maize. Onion is always grown at a very close spacing ( $\approx 10\text{cm}$ ), while maize is grown at a very wide spacing and mainly on the edges of beds as is indicated.

At least three varieties of onion were found to be grown in the villages. The varieties are Red Bombay, Khaki, and Red Creole Khaki (Texas Grano type). Red Bombay is the most important. It is considered to be the most high yielding and very attractive to buyers due to its bright red color. Red Creole is preferred by farmers on grounds that it has good market and produces fewer splits. Khaki variety was said to have relatively better storage shelf life compared to other varieties, however, it is less cultivated due to low yield and poor market attributes.

Weeds and insect pests were considered to be more problematic in all surveyed areas. The most common troublesome weed species is Mexican poppy (*Argemone mexicana*). Other weeds are Blackjack (*Bidens pilosa*), wild amaranth, annual and perennial grasses. Weed control in onion production is done by using herbicide followed by hand pulling. The most common herbicides used are Volmethalin® (Pendimethalin 500) and Galigan® (Oxyfluorfen 240 EC). The very close spacing used in onion production does not allow the use of the hand hoe in weeding, and therefore use of herbicide has become more popular.

Insect pests known to be important in the area include; onion thrips (*Thrips tabaci*), elegant grass hopper and onion grub. Onion thrips was mentioned to be an important pest in all study areas, while white or Onion grubs (*Phyllophaga* spp.) are said to be new and is



more serious in Chabi village. Farmers use insecticides such as selegon® to control onion thrips and the elegant grass hopper. Currently, there is no known method for the control of grubs. Farmers practice hand picking of the grubs when observed (unearthed), but found that the method is laborious and not effective enough.

*Gender Distribution of Labor:* All tasks of onion production from nursery preparation to harvesting are done by all. However, land preparation activities are considered as men's activities. After harvesting, men are also responsible for the transportation of the produce, i.e., carrying of onions from the field to the homestead. Grading is done by men, while drying, threshing and winnowing of seeds are tasks reserved to women.

## **Gender Baseline Survey for Scotch Bonnet in Mubuku Irrigation Scheme, Uganda**

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*Margaret Najjingo Mangheni (Gender),  
Jackline Bonabana (Impact Assessment)*

*M. E. Christie, (GK), M. Erbaugh, (GK), G.  
Norton (IA), D. Taylor, (IA), D. Kraybill (IA),  
Justar Gitonga*

Hot Pepper (Scotch bonnet) production in Mubuku Irrigation scheme is constrained by the root rot and wilt disease. IPM is implementing 3 studies aimed at testing various tactics for managing these diseases, namely, resistant varieties, optimum irrigation frequency and ridge size. A survey was conducted to collect gender disaggregated baseline information on the socio economic characteristics, production, and prevalence of insect pests and diseases affecting pepper, current pest and disease control measures, enterprise characteristics, operational constraints, and the current application level of the code of practices.

The baseline survey questionnaire was developed in June 2010 with input from a multidisciplinary team of social scientists including a gender specialist. It was pre-tested in the field in the first week of July 2010. Data was collected in July by five enumerators assisted by the District Agricultural Officer, the Sub-county Extension officer attached to Mubuku Irrigation Scheme, and the Scheme's records officer. The data was entered and preliminary analysis done using SPSS computer program.

The basic demographic profile of the respondents is as follows: Responses were obtained from a total of 112 farmers (73 males, 39 females). Sixty-six percent of the respondents were married, while the rest were single, widowed, or divorced. The major occupation of respondents was farming (94%). A small number of respondents were people in private service and business (<1% each). Labor for farm operations was mainly provided by family members. About 30% of the respondents employed mainly hired labor on the farms. The average amount of land owned was 11 acres of which about 7.5% was under pepper production. About 60% of the respondents considered Hot Pepper a family crop (grown by both husband and wife), while <4% considered it a wife's crop. Ninety-nine percent of farmers grew hot pepper on raised land (ridges). Access to credit was generally not considered a constraint. Ninety-one percent had easy access although only about 51% had actually obtained credit ranging from fifteen thousand to seven million shillings. The major source of credit was a local bank in the district.

## **Economic Impacts of Integrated Pest Management in Tomato production in Kenya**

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*Muthoka, N.M., M.M. Waiganjo, and S. Kuria*

## **Evaluation of Tomato Pest Management Options – on station experiment 1**

Tomato trials were conducted at KARI-Thika to assess the comparative efficacy of various tomato pest management options and their economic benefits. Five treatments included grass mulch application without insecticide application, untreated control without insecticide application, grass mulch application at two weeks from transplanting and need-based pest control using bio-pesticides, farmers' practice involving staking and bi-weekly insecticide application, and fifth option was tomato staking and need-based insecticide application using bio-pesticides. Using a commonly grown tomato variety Cal J, the five treatments were laid out in randomized complete blocks, replicated four times.

## **Evaluation of Tomato Pest Management Options – on station experiment 2**

Trials were conducted on-station at KARI-Thika to test IPM practice involving nursery protection using insect proof screen house and need based pesticide application of bio-pesticides. Four reportedly wilt tolerant tomato varieties developed at KARI-Thika (TKA 81-1, TKA 193-31, TKA 155-18, TKA 193-2) were compared with a commercial variety Cal.J as the sub-plots and three pest management options as the main plots.

The three treatments included:

1. IPM practice-Pest scouting and need based pesticide application of Bio-

pesticides namely, B.t, Dipel® alternated with neem, Nimbecidine®

2. Farmer practice involving weekly application of fungicide (Mancozeb®) and fortnightly insecticide application (Dimethoate alternated with Deltamethrin (Decis®) )
3. An untreated control with no insecticide application.

The IPM practice with need-based pest control using bio pesticides had highest mean marketable yield (3,137.20kg/ha and 2,988.12kg/ha respectively) while the untreated control had the lowest mean marketable yield (1,667.23kg/ha). The highest economic benefits were recorded from the IPM practice while the farmer practice incurred highest costs attributed to routine pesticide use.

## **Aggregate economic benefits of the project**

The economic surplus approach is used in measuring the aggregate economic benefits of agricultural research and calculates two measures of project worth, the net present value (NPV) and the internal rate of return (IRR). The focus is primarily on the research-induced supply shift. The NPV and IRR values are estimated for the period 1995-2016. Research costs have been estimated using the IPM-CRSP tomato allocation for KARI-THIKA and are assumed to continue to 2016. Data on price and quantity was obtained from Ministry of Agriculture annual reports.

**Table 6: Economic benefits of the management options evaluated in the tomato trial at KARI-Thika, Kenya**

Treatment	Marketable yield (kg/ha)	Yield value (Ksh/ha)	Other costs	Pest management cost (Ksh/ha)	Economic benefit (Ksh)
Untreated control	258	15,480.00	20,150	0	-4,670
Mulching and no insecticide	850.00	51,000.00	20,150	25,000	5,850
Mulching, need-based pest control using bio-pesticides	1,379.73	82,783.80	20,150	42,000	20,634
Farmers' practice	2,527.69	151,66	20,150	116,000	15,511
Staking, need-based pest control using bio-pesticides	1,993.32	119,599.20	20,150	78,000	21,449

1. Need based bio-pesticide application and staking yielded higher returns, though not significantly different from need based bio-pesticide application and mulching.
2. Mulching although not usually applied by tomato farmers greatly reduced occurrence of weeds and pest infestation in the tomato plots.

The scientists involved in the project gave responses to a scientist questionnaire for the different IPM practices, (stalking, need based use of bio-pesticides, solarization, scouting and use of suitable varieties). Then a focus group was held with 11 farmers who were trained and grow tomatoes in Kirinyaga south District, in addition, statistical data was used from the Ministry of Agriculture.

According to the scientists, a yield improvement of 50-100% occurs with IPM use compared to the untreated control, with a 50% yield change assumed in the economic surplus analysis. The cost change was estimated to be – 0.40%. The scientists suggested that maximum adoption rate of 70-100% will be achieved by year 2016. The elasticity of supply was

assumed to be 1, due to the fact that producers are able to alternate their production between french bean, sweet corn, water melon, and butter nut with relative ease. An elasticity of demand for tomatoes was estimated of 0.5.

The consumer and producer surplus analysis yielded positive values for all years. For the conservative scenario (maximum adoption 25%), the benefits and costs of the IPM practice were discounted at 15% giving a net present value (NPV) of approximately Ksh 268,475,172 the IRR was 106% over 20years. For the robust scenario (maximum adoption 70%), the benefits and costs of the IPM practice were discounted at 15% giving a net present value (NPV) of approximately Ksh 2,113,384,505 the IRR was 517% over 20years. (Tables 6 & 7)

**Table 7: Summary of the results from the economics surplus analysis**

	NPV	IRR
<b>Conservative scenario, max adoption rate = 25%</b>	Ksh 268,475,172	106%
<b>Robust scenario, Max adoption rate= 70%</b>	Ksh 2,113,384,505	517%

**Gender:** According to the focus group discussion, men are involved in more activities than their female counterparts in tomato production activities, a factor that could be explained by the fact that tomato production is a commercial activity. Resources from the sales of tomatoes are mainly controlled by men.

## Review of All Project Work Plans for Integration of Gender and Impact Assessment Components

Integration of gender and impact assessment into IPM research projects is feasible when they are on farm interfacing with male and female farmers. Therefore, the work plans of projects in all countries were reviewed so as to determine the time when gender and impact assessment integration would be done. It was found in Uganda that only 3 projects (hot pepper and coffee) were on farm in year 1, and in Kenya, only 1 project on passion fruit. All other projects were still on station in year 1 and would go on farm in year 2. Based on these findings, it was decided that a gender disaggregated baseline survey be conducted for hot pepper in Uganda in year 1. A similar study was also planned for coffee.

**Presentations:** A presentation on the status and progress of the impact assessment activities was made at the IPM Annual Technical Committee meeting held in Mbale, Uganda, June 2010. The meeting was attended by country coordinators and scientists from Kenya, Uganda, Tanzania; collaborators from US partner institutions; and a regional collaborator from KARI, Kenya. At the planning meeting, Year II activity plans were drawn. 7 male and 9 female scientists attended the meeting.

Another presentation titled “How, why, and when to assess impact of an introduced technology” was delivered to undergraduate students taking the course ABM 1205 Farm management and accounts at Makerere University. In this presentation, students were

exposed to methodologies for impact assessment being used by the IPM team. 20 female and 39 male students attended this presentation.

Under the Millenium Science Initiative project, a tour of potato farmers in Muko, Rubaya and Hamurwa subcounties (Kabale district) and Kambuga Subcounty (Kanungu district) was done during the 4<sup>th</sup> week of May 2010. During this tour, informal presentations were made on the benefits of reducing pesticides, and on alternative methods of controlling major pests in potato production in the two southwestern districts of Uganda. 151 male and 94 female farmers benefited from the presentations.

## IPDN in East Africa

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### Assessment of Tomato, Onion and Passion Fruit Diseases (Kenya)

*Kinyua, Z.M., R.L. Amata, B.C. Langat, S.M. Ndirangu, S. Miller, Waiganjo M. and M. Erbaugh*

Field appraisal and sampling was carried out to assess the range of diseases affecting tomato, onion and passion fruit. Field visits were undertaken in selected parts of Kirinyaga and Murang'a. Samples were also taken for analysis to the Plant Pathology Laboratories at KARI NARL-Kabete, where fungal, bacterial, viral and nematode diseases and their causal agents were determined. Laboratory work involved direct visual examination, direct microscopy or culturing/isolation followed by microscopy or biochemical analyses, depending on the nature of the sample and the anticipated pest problem.

A wide range of diseases was recorded in the assessed crop fields (Table 8). Viral infections on tomatoes appeared to be combinations of at least two viruses, which were not resolved as symptoms of many virus diseases are known to

over-lap. On the other hand, analysis of soil and root samples where nematode infestation was suspected revealed a number of nematode species, particularly in tomatoes.

**Table 8. Diseases and pests identified in selected crop fields in central Kenya during the period July to September 2010**

Area/Locality	Crop name	Problem description/disease	Causal agent and other pests	Disease severity indication*
Kariguini	Tomato	Leaf spots & blighting	<i>Alternaria solani</i>	Moderate
		Bacterial wilt	<i>Ralstonia solanacearum</i>	Very low
		Bacterial specks	<i>Pseudomonas</i> sp.	Very low
		Insect damage	<i>Thrips</i>	Moderate
Makuyu	Tomato	Powdery mildew	<i>Leveillula taurica</i>	Low
		Leaf spots & blighting	<i>Alternaria</i> sp.	Very low
		Late blight	<i>Phytophthora infestans</i>	Very low
	Onions	Insect infestation	<i>Thrips</i>	Very severe
		White tip	<i>Alternaria</i> sp.	Very low
	Passion fruit	Fruit stalk rot	<i>Alternaria</i> sp.	Very low
Dieback, viral symptoms		<i>Colletotrichum</i> sp. Woodiness virus	Very severe	
Punda milia Bombo	Tomato	Wilting	<i>Ralstonia solanacearum</i>	Mild
		Leaf Mosaic	viral infection	Mild
	Onions	Insect damage	<i>Thrips</i>	Very severe
		White tip	<i>Alternaria</i> sp & <i>Botrytis</i> sp	Very low
Mungania/Kandara	Passion fruit	Stem necrosis	<i>Ascochyta</i> sp.	Low
Rukenya Kutus	Tomato	Wilting & bacterial speck	<i>Ralstonia solanacearum</i> <i>Pseudomonas</i> sp.	Low
		Early blight	<i>Alternaria</i> sp	Low
		Bacterial specks	<i>Pseudomonas</i> sp.	Low
		Wilting	<i>Ralstonia solanacearum</i> <i>Pratylenchus</i> sp.	Low

Kagumo/Kerug oya	Tomato	Stunting/nematode infestation	<i>Tylenchorynchus</i> sp	Low
		Crown rot	<i>Phoma</i> sp	Low
	Passion fruit	Brown necrotic spots	<i>Colletotrichum</i> sp	Moderate
		Woodiness	Woodiness virus	Low
		Dieback of twigs	<i>Colletotrichum</i> sp., <i>Meloidogyne</i> sp, <i>Helicotylenchus</i> sp. & viral infections	Very low
Kagio	Tomato	Bacterial specks	<i>Pseudomonas</i> sp.	Low
		Stem rot	<i>Erwinia carotovora</i> ; presence of <i>Helicotylenchus</i> sp., <i>Pratylenchus</i> sp., <i>Hemicyclophora</i> sp.	Low
		Viral symptom	Viral infection, presence of <i>Meloidogyne</i> sp. & <i>Pratylenchus</i> sp.	Low
Ritaya Kakuzi	Passion fruit	Woodiness of fruits & wrinkled leaves	Woodiness virus	Very severe

**\*Severity indications**

- **Very severe** if 76 to 100% portions of most symptomatic plants in the crop field are affected;
- **Severe** if 51 to 75% portions of most symptomatic plants in the crop field are affected;
- **Moderate** if 26 to 50% portions of most symptomatic plants in the crop field are affected;
- **Mild** if 11 to 25% portions of most symptomatic plants in the crop field are affected;
- **Low** if 5 to 10% portions of most symptomatic plants in the crop field are affected;
- **Very low** if less than 5% portions of most symptomatic plants in the crop field are affected.