

Tuta absoluta

*Meeting
the
challenge
of the
tomato
leafminer*



*Nov. 26-28, 2013
Intercontinental
Hotel,
Addis Ababa,
Ethiopia*



Dear Participants,

It is with great pleasure that I welcome you all to this international workshop on *Tuta absoluta*: Meeting the Challenge of the Tomato Leafminer in Addis Ababa, Ethiopia. As you are all aware, *T. absoluta* is of South American origin and was accidentally introduced to Spain in 2006. Since then, it has spread to most of the European and Mediterranean countries. In the last couple of years, it has invaded Senegal in West Africa and Ethiopia in East Africa.

Recognizing the impending possible leafminer invasion into west and central African countries, the Integrated Pest Management Innovation Lab in collaboration with the USAID-West Africa Regional Office, the U.S. Department of Agriculture, and the West and Central African Council for Agricultural Research and Development (CORAF) organized a workshop in Senegal last May to sensitize scientists and administrators in these countries to the threat. The IPM Innovation Lab has again taken a leadership role in organizing this conference to raise awareness about the impending danger and to inform the authorities in countries from East Africa to South Asia.

I welcome participants from an array of institutions—international organizations, private companies, and trade organizations; and from geographically disparate locales—Europe, north, west and East Africa, South Asia, and the host country, Ethiopia.

I hope participants will take advantage of this event to network and to exchange information on the mitigation of the adverse impacts of *T. absoluta* through quarantine regulations, surveys, detection, identification, management, and other activities.

On behalf of Virginia Tech, I wish you all a very productive and fruitful workshop.



Mike Bertelsen
Executive Director
Office of International Research, Education and Development
Virginia Tech

Tuta absoluta:

Meeting the challenge of the tomato leafminer
Intercontinental Hotel, Addis Ababa, Ethiopia

Agenda

Tuesday, November 26, 2013

8:00 – 9:00 a.m.

Registration

9:00 – 10:00 a.m.

Inaugural Session

Chairs: Gashawbeza Ayalew, EIAR and R. Muniappan, IPM Innovation Lab
Kassahun Semachew, USAID Ethiopia Mission
Brhane Gebrekidan, Ethiopian Academy of Sciences
Fentahun Mengistu, Director General, EIAR, Ethiopia

10:00 – 10:30

Coffee break and group photo

10:00 – 12:00

Tuta absoluta, an overview

Chair: Gashawbeza Ayalew
A review of what we know – Shakir Al Zaidi, Russell IPM

12:00 – 1:00

Lunch

1:00 – 3:00

Reports by participating international and regional programs

Chair: Fentahun Mengistu
Integrated Pest Management Innovation Lab – R. Muniappan
FAO – Wondimagegne Shiferaw/Bayeh Mulatu
Switzerland – Sustainable management of arthropods in African vegetable production systems: Fighting old foes and facing the challenge of a new invasive pest – Jana Collatz
Swedish University of Agricultural Sciences – Richard Hopkins
ICIPE – *Tuta absoluta* activities in North and Sub-Saharan Africa: an overview – Samira Mohamed and Sunday Ekese

3:00 – 4:00

Country reports

Chair: Brhane Gebrekidan
Bangladesh – Shahadath Hossain
Burkina Faso – Kambou Georges
Ethiopia – Endale Gebre
India – C. Durairaj
Iraq – Naser Abdulsahib Obaid
Iran – Babak Zahiri
Kenya – Monicah Waiganjo
Tanzania – Maulid Mwatawala
Uganda – S. Kyamanywa



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Ethiopian Institute of Agricultural Research

4:00 – 5:00

***Tuta absoluta* review**

Chair: R. Muniappan

Taxonomy

Origin and distribution

- **Status of *Tuta absoluta* in Senegal** – Dienaba Sall
- **Monitoring *Tuta absoluta* populations using pheromone traps in northern Ethiopia** – Tesfay Belay and Zeray Siyoum

Biology

Confirmation of deuterotokous parthenogenesis in three populations of the tomato leafminer, *Tuta absoluta* in Tunisia – Kaled Abbes, Samira Muhamed Faris, and Brahim Chermiti

Wednesday, November 27, 2013

All day

Field trip to Melkassa/Koka

Thursday, November 28, 2013

8:00 – 10:00 a.m.

***Tuta absoluta* review** – continued

Natural enemies

Quarantine regulations

Monitoring

Control methods:

- Mechanical
- Cultural
- Chemical
 - **Pheromone traps for monitoring tomato leafminer, *Tuta absoluta* in tomato fields in Egypt** – A.S. Abdel-Razek
 - **Efficacy of two mass trapping methods of *Tuta absoluta* in Egypt** – Saad A. Gaffar, A.A. Taman, A.M.M. Abo El-naga, and Maha S. Nada
 - **Evaluation of pheromone lures for mass trapping of the tomato leafminer, *Tuta absoluta* in tomato under open field and greenhouses in Sudan** – Ensaf S.I. Mohamed and Mohammed E.E. Mahmoud
 - **Occurrence and studies on the management of the tomato leafminer, *Tuta absoluta* in the Central Rift Valley of Ethiopia** – Gashawbeza Ayalew and Abiy Fekadu
- Biological
 - **Natural enemies of *Tuta absoluta* in Kassala State, Sudan** – Mohammed E.E. Mahmoud
- Integrated Pest Management
 - **Management of *Tuta absoluta* in Near East and North African countries** – Khaled Alarouchdi

10:00 – 12:00

Working group(s) on preparation of a concept note(s)



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Ethiopian Institute of Agricultural Research

12:00 – 1:00

1:00 – 2:00

2:00 – 3:00

3:00 – 4:00

4:00 – 5:00

7:00 – 9:00

Lunch

Continuation of working group sessions

Working group presentations

General discussion

Closing ceremony

Reception



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Intercontinental Hotel, Addis Ababa, Ethiopia

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***Tuta absoluta*:**

Meeting the challenge of the tomato leafminer
Intercontinental Hotel, Addis Ababa, Ethiopia

Abstracts

Pheromone traps for monitoring tomato leaf miner, *Tuta absoluta* (Lepidoptera: Gelechiidae) in Egypt

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Tuta absoluta is a very challenging pest to control. Application of pheromone to lure and kill by mass trapping has been found to be effective to control *T. absoluta* in Egypt. The effects of trap color, trap direction and trap position on *T. absoluta* captures were evaluated in this study. Each trap was baited with a pheromone capsule type Q lure-TUA. With this trap a high-capture rate is ideal for mass trapping and reducing the *T. absoluta* population. Mass trapping is a technique that involves placing a higher number of traps in the crop field in various strategic positions to remove a sufficiently high proportion of male insects from the pest population. It is widely used in conjunction with other control measures to reduce pest infestation by minimizing the mating incidence and the number of viable eggs laid. White pheromone traps caught more moths than yellow, blue, green and red traps. Significant differences between mean catches by white trap and other colored traps were observed. The trap, when located at south or center of the infested area, caught more moths than when located at west, east or north, although there was no significant difference between mean catches at each location. The collective catch of *T. absoluta* moths by the traps rested on the ground was more than that of the two other positions (50cm and 100cm above the ground) and there was significant difference between 0cm position (rested on the ground) and the other two positions.

Confirmation of deuterotokous parthenogenesis in three populations of the tomato leafminer *Tuta absoluta* (Lepidoptera: Gelechiidae) in Tunisia

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The tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a key pest of tomato crops in Tunisia and the west Palaearctic region. Following its introduction to Spain in 2006 and subsequently to Tunisia, it caused severe yield loss in tomato crops, especially during the first year, ranging from 11 to 43% in greenhouses. In the absence of control, crops were totally destroyed. In the beginning, the management of this invasive pest was extremely problematic due to the lack of knowledge about its biology, its high biotic potential, the resistance to many insecticides and the absence of sufficiently adapted auxiliary fauna in the new dispersion zones. A few years later, efficient IPM programs were developed to control this moth in greenhouses and open field tomato cultivations. In Tunisia, the use of insect proof screens, augmentative and conservative biological control using the mirid bug *Nesidicoris tenuis* (Reuter), biological and plant extract-based insecticides including *Bacillus thuringiensis* (Bt) and Neem oil based products in addition to pheromone mass trapping were successfully integrated to control

the pest. In addition, some autochthonous parasitoids and predators were recently reported to attack and develop on different biological stages of this pest.

Mass trapping of males has been recognized as one of the most important control techniques of *T. absoluta*. Indeed, the biology of this insect supports the potential of male annihilation as an effective control method as its reproduction was considered to be strictly sexual, males emerge earlier than females and females mate and multiply. In Tunisia, pheromone traps are considered to be the first line of defence against this moth both in open fields and greenhouses. Trapping of males is used for monitoring and male annihilation purposes. The use of super-dosed pheromone lures and new types of traps (Delta traps) reduced the density of traps in open field cultivations from 30-40 to 15/ha, which cut back on cost and maintenance charges. However, Caparros Megido *et al.* (2012) reported the propensity of a French population of *T. absoluta* to reproduce parthenogenetically in laboratory conditions for the first time. In this present paper, we present proof of the ability of three Tunisian populations of *T. absoluta* to reproduce asexually in laboratory conditions with regards to the possible implications on IPM programs targeting this pest.

Evaluation of pheromone lures for mass trapping of the tomato leaf miner *Tuta absoluta* in tomato under open field and greenhouses in Sudan

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The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the major tomato pests in Sudan since its detection in 2010. The effectiveness of TUA-Optima, TUTA-CAP Long life and TUA-100N loaded with 0.8, 1.5 and 3 mg of synthetic pheromone was evaluated for mass trapping of *Tuta absoluta* males. These trials were carried out in the season of 2012/2013 in Khartoum and Kassala States, Sudan in commercial open fields and greenhouses treated with insecticides. All tested types showed comparable performance in trapping males under each site of open field and greenhouse trials. In the open field trials, high male population and damage to fruits were observed in sites solely growing tomatoes compared with isolated field surrounded by cereal fodder crops. Moreover, pheromone for mass trapping in insect-proofed greenhouses equipped with double doors significantly reduced the percentage of mined leaves and infested fruits compared with unprotected ones. The mass trapping to control tomato leaf miner in tomato fields could be included in integrated management programs and it has proven to be effective in isolated fields and well-protected greenhouses.

Comparison of mass trapping with delta and pan traps baited with pheromone on population dynamics of tomato leafminer, *Tuta absoluta* in Egypt

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The use of synthetic pheromones that interfere with insect mating for pest control has been demonstrated in lepidopteran and other insects. An experiment was carried out in the summer 2013 season in Biella district – Al-Galallia, namely, section 8, Kafrel-Sheikh Governorate, Egypt, to evaluate the effectiveness of different pheromone traps to capture *Tuta absoluta* males for development of a mass

trapping technique and to incorporate in subsequent control tactics. The study evaluated each trap type individually and in combination with delta and pan traps. The direction of trap set up in the field was also considered. Traps were baited with 0.5 mg of *T. absoluta* pheromone and water-detergent for captures. Results indicated that an average of 75.1 adult males were captured in 4 pan traps plus 1 delta trap and 52.4 captured in 5 pan traps. The direction of placement traps placed west-north were found to hardly reduce the density of tomato leafminer in tomato plantations.

The study also indicated a strong relationship between fluctuations in trap catches irrespective of the type of trap tested. Thus, it is possible that the general trend of moth activity can be assessed using any type of trap. There was a strong relationship between population dynamics of *T. absoluta* male moths captured in pheromone-baited traps and cumulative heat units in degrees-days (DD'S) during summer 2013.

Occurrence and studies on the management of the tomato leaf miner, *Tuta absoluta*, in the central rift valley of Ethiopia

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Occurrence of the tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Ethiopia was confirmed following heavy infestation of the tomato fields in the Central Rift Valley (CRV) region of Ethiopia by the insect in February 2013. However, after its occurrence was declared, different workers engaged in tomato production reported its existence in the last quarter of 2012 in the Tigray region of Northern Ethiopia and the CRV. Initially, photographic pictures on damage symptoms and measurements on the different life stages of the insect enabled tentative identification, which was later confirmed by an Israeli expert using adult specimens.

A survey was conducted to determine the pest distribution and severity of damage during the first week of March 2013 in the major tomato belt of the CRV. Thirteen out of 15 tomato fields were infested with damage levels reaching as high as 100% in some fields. As locally available insecticides did not help to reduce the pest damage during periods of outbreak in early 2013, there was an urgent need to identify and use insecticides as an integral component of the pest management. Ten different insecticides from different insecticide classes including Pyrethroids, Organophosphates, Spinosyns, IGRs, and Diamides were screened using randomized complete block design with three replications at Ethio vegfru and Almeta impex farms of Koka in the CRV between April/May and August/September 2013. Fruit infestation in plots treated with Diamide insecticides was significantly lower (4-5%) followed by Spinosyns (30-35%). The rest of the plots suffered greater fruit damage ranging between 80 and 100%. Because of short generation time and high reproductive potential, the pest is known to develop resistance to insecticides fast. Hence, the study towards its management should focus on integrated management primarily based on the use of biocontrol agents (predators, parasitoids and microbials).

Potential of biological control agents against *Tuta absoluta*: current knowledge in Argentina

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Pest suppression through biocontrol seeks to maximize the action of pests' natural enemies with the goal of reducing pesticide use. We discuss the recent advances on several entomophagous species such as *T. absoluta* biocontrollers in commercial tomato crops in Argentina, with the aim to select species to manipulate through augmentative and/or conservation biological control strategies. Regarding parasitoids, we continue evaluating *Trichogramma* and *Encarsia* species as egg attackers and *Dineulophus phthorimaeae* and *Pseudapanteles dignus* wasps on larvae. Egg parasitoids produce slight levels of parasitism as compared to *T. absoluta*. Reproductive strategies of the koinobiont endoparasitoid *P. dignus* indicate that females are moderately synovigenic and rarely superparasitize hosts in the field, although it occurs in the laboratory. This information along with that available on the egg production strategy are crucial for appropriate breeding conditions in a potential mass rearing of the wasp, as well as to exploit the maximum egg load of the female for releasing time, optimizing *T. absoluta* biocontrol. The search for alternative hosts of *P. dignus* yielded its presence in eggplant crops and other non-cultivated solanaceous species present in horticultural farms. The idiobiont ectoparasitoid *D. phthorimaeae* is extremely synovigenic, has a modest fertility, kills *T. absoluta* larvae by parasitizing and host-feeding, and rarely multiparasitizes *T. absoluta* larvae previously attacked by *P. dignus* in the field, seemingly avoiding direct interspecific competence. Field surveys carried out in extensive areas of Argentina reveal that *P. dignus* and *D. phthorimaeae* coexist in tomato crops, showing both species have density-independent patterns of parasitism regardless of the region. Moreover, studies in progress are determining the ability of a reduviid species of the genus *Zelus*, to consume larvae and adults of the pest.

Natural enemies of *Tuta absoluta* in Kassala State, Sudan

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Chemical control is the only management option applied to control *Tuta absoluta* in Sudan. Other control options are essential to reduce reliance on pesticides especially biological control agents. A survey conducted in Kassala State revealed four parasitoids and two predatory bugs associated with *T. absoluta*. The parasitoids *Bracon (Habrobracon) concolorans* Marshall and *Bracon (Habrobracon) hebetor* (Say) (Hym.: Braconidae), *Ecdamua cadenati* (Risbec) (Hym.: Torymidae) and *Neochrysocharis formosa* (Westwood) (Hym.: Eulophidae); and the predators *Nesidiocoris tenuis* Reuter and *Macrolophus* sp. (Hem.: Miridae) were reported to be effective natural enemies.

Status of *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) in Senegal

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In Senegal, the presence of *Tuta absoluta* (Meyrick) (Lepidoptera.: Gelechiidae) was noted in August/September 2012 on tomatoes (*Solanum lycopersicum*), the second most important cultivated vegetable crop after onions, which accounts for 20% of the cultivated area. Several infested areas were observed in Niayes (Dakar, Thiès, Louga, Saint-Louis), Diourbel, Kaolack and in the southern part of the country (Casamance). The detection of the insect in these areas of tomato production indicated that the insect was well established in the country. Laboratory studies on the biology of *T. absoluta* confirmed four larval instars measuring 1.67, 3.15, 5.45 and 6.97 mm, respectively. The egg-hatching rate was 33.50 %, larval survival rate was 92.18 % and adult emergence rate was 73 %. At the ISRA/CDH research station, the severity of attacks of *T. absoluta* varied according to the plant phenological stage. During the

growth stage of the tomato (variety mongale), the severity of attack was low, at 10 %, whereas during flowering and fruiting stages, the severity was between 15 and 50 % and sometimes reaching up to 75 %. Forty-one days after transplanting, the severity of the attack decreased. During the follow-up on the population dynamics by pheromones traps in three sites of the region of Dakar (Malika, Golf the North and UCAD) at the beginning of the rainy season, 25 to 160 individuals were caught per trap.

ICIPE *Tuta absoluta* activities in North and sub-Saharan Africa: An overview

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The micro lepidopteran, the tomato leafminer *Tuta absoluta*, is a very serious tomato pest. With the recent invasion of this pest in Tunisia and Sudan, where it is currently devastating tomato production, and the threat it poses to the Republic of South Sudan, Uganda and Kenya, the International Center of Insect Physiology and Ecology (ICIPE), in collaboration with the International Potato Center (CIP), the Institute of Biological Control (JKI-BI) of the Federal Research Center for Cultivated Plants and Julius Kühn-Institut (JKI) in Darmstadt, proposed to develop, test and adapt sustainable integrated pest management (IPM) options for *T. absoluta* in order to increase tomato production and improve the income and nutrition of small and medium scale tomato growers in the target countries of Tunisia, Sudan, Kenya, Republic of South Sudan and Uganda.

The proposed strategic research to minimize the impact of *T. absoluta* damage to tomatoes includes biological studies and establishing the potential distribution of the pest using ecological niche and phenological models to assess the risk of *T. absoluta* spread and establishment under a climate change scenario. The project also focuses on research for promising natural enemies in the pest's aboriginal home of Peru and later introduction(s) into Africa. Additionally, the project will test and implement proven IPM technologies as alternatives to synthetic pesticides that are based on mass trapping and the development and use of attract-and-kill, intercropping and bio-pesticides. Because of the rapid spread of *T. absoluta*, the project proposes to strengthen the emergency response and management capability of the National Agricultural Research Systems (NARS) of high-risk countries like Kenya, the Republic of South Sudan and Uganda, by conducting systematic surveillance across these countries for early detection, containment and management in the likely event of invasion. Technology transfer and training programs to enhance NARS and farmer appreciation of non-chemical alternatives to *T. absoluta* management is also built into the project. Capacity building of M.Sc and Ph. D. students is an integral component of the project. Highlights of the project activities are discussed.

Evaluating the effect of seed treatment using plant defense elicitors against tomato leafminer, *Tuta absoluta* (Lepidoptera: Gelechiidae) in tomato crop in Curitiba, Brazil.

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Seeds may be receptive to plant defense activators such as β -amino butyric acid (BABA) and jasmonic acid (JA), conferring protection to the subsequent plant against a wide spectrum of plant pathogens and insects. We examined the effectiveness of Methyl Jasmonate (MeJA) seed treatment on enhancing the plants' resistance against tomato leaf miner, *Tuta absoluta* in the southern part of Brazil. All the experiments were conducted inside a greenhouse during March-April 2013 at Federal University of Parana, Curitiba-Brazil. Our final results suggested that when larvae fed on the plants treated with MeJA,

effects could be seen in the life-cycle of the insects; lengthening larval developmental phase and reducing the final pupal weight thus greatly reduces the overall damage from the pest. On average, larvae feeding on the leaves from tomato plants took 1.3 days more to pupate in comparison with those fed on control plants. Similarly, larvae reared on leaves from the treated plants showed significantly lower pupal weight in comparison with those reared on the leaves from untreated ones. Thus, if successfully integrated with other facets of integrated pest management program, the use of MeJA as elicitors of plants' defense could prove to be an important tool in managing *Tuta absoluta*, without relying heavily on chemical pesticides.

Monitoring *Tuta absoluta* populations using pheromone traps in Northern Ethiopia

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Tomato leafminer, *Tuta absoluta* (Meyrick), was reported by Sudan in 2012. The northern region of Ethiopia borders Sudan, and tomato leafminer is expected to have entered Ethiopia following this route. The insect was also seen in the north western zone of the Tigray region prior to the report of its occurrence in other parts of Tigray. Extension experts observed an increased severity of damage on tomato plants and that farmers were unable to manage the insect with the available insecticides. In November of 2012, the insect was reported from eastern and southern zones of the Tigray region where tomato is grown with irrigation in the off-season. The exchange of crates might have aided the spread of the insect. Losses were huge amounting to 100% on certain farms. The extension department did not recommend insecticides for commercial farms in the Raya-Valley, but they did advise farms not to plant tomato for certain months and clear their fields of the host plants.

In an attempt to monitor leafminer populations, we tried pheromone traps obtained from Russell IPM, UK and put them at the Mekelle agricultural research center. Traps used were *Tuta absoluta* – Optima PH-937-OPT1. This center is located at an altitude of 1970 meters at the outskirts of Mekelle city. The trap was kept in the field from the 26th of April to the 30th of September 2013. The dispenser was replaced every 6 weeks. The numbers of males trapped were recorded every 7-14 days. Average weekly temperature and rainfall were also recorded in a nearby met station, and we tried to relate male catches with the recordings.

The number of males trapped ranged from 11 to 250 per trap. The highest numbers of males were trapped in July and the peak catches were from the 17th of July to the 30th of September 2013. Rain did not affect the number of males trapped and hence the activity of the insect. An average minimum and maximum temperature of 13 and 27 degrees Celsius respectively seems ideal for the spread and development of the insect in the Mekelle area. Pheromone traps, therefore, do have tremendous potential of integration with other control options.

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