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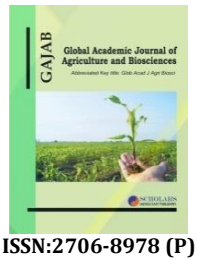

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Original Research Article

Study of the Population Dynamics of the Leafminer, *Tuta Absoluta*, Pests of Tomato (*Lycopersicum esculentum*) in the Municipality of Ouallam in Niger

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Abstract: In Niger, since 2012 a new pest *Tuta absoluta* has appeared on tomato. Tuta absoluta is subservient not only to tomato but also to other solanaceae (potatoes, peppers etc.). All these crops can be attacked by this pest and production losses can reach 100% of the harvest, if none protective measure is taken. The objective assigned to this study is to improve tomato production in Niger through the integrated management of the tomato miner *Tuta absoluta*. To do this, the study focused on monitoring the dynamics of the *Tuta absoluta* population during the wintering period using pheromone traps and also an interview guide addressed to producers. The results showed the effective presence of the tomato leaf miner (Tuta absoluta) on the two sites monitored throughout the rainy season. The results showed that more than half of the tomato plots were attacked by Tuta absoluta and showed attack symptoms. However, the attacked plants regenerated with new organs (leaves and stems) hence the extension of tomato cultivation in Tolkoboye with the use of pheromone traps. The study of the population dynamics of Tuta absoluta shows that the average captures per week oscillate between 53.6 and 1.72 individuals during the capture period on the observation sites while the peak on the control site oscillates between 70.8 and 52 individuals. It therefore emerges from the observations that the catches of butterflies this year are lower than those of last year.

Keywords: Tomato, Tuta absoluta population dynamics, pheromone trap, Tolkoboye.

I. INTRODUCTION

The tomato (*Lycopersicum esculentum*) is produced in the regions of the Niger River, the Ader Doutchi-Magia, the Goulbi de Maradi and around ponds and other water reservoirs. The volume of production practically doubled, rising from 57,685 tons in 1996 to 112,445 tons in 2000). It is certainly far from satisfying domestic demand (IRAM, 2002). Indeed, in recent years this production has experienced many falls due to entomologically important fauna which threaten the solanaceae. Among the pests is the tomato leaf miner which has been threatening this production since 2013 (RECA, 2013). The tomato leaf miner Tuta absoluta (Meyrick, 1917) has for some years been the main threat to tomato (*Lycopersicum esculentum*)

cultivation in several tomato producing countries. It also attacks potatoes, eggplant, peppers and other cultivated nightshades as well as wild nightshades. Originally from Latin America, it appeared in Africa in 2008 in Morocco and Algeria (RECA, 2013). In Niger, it appeared for the first time in October 2013 in Ouallam in the village of Bourboukabé (RECA 2013). The damage is caused by the caterpillar, at all stages of cultivation. All the aerial organs of the plant can be affected (Anne Terrentroy, 2012). The economic losses can be significant up to the destruction of the crop (Anne Terrentroy, 2012) if no protective measures are taken. This leaf miner mainly attacks the leaves, stems and fruits which become highly depreciated on the market thereby reducing their market value. In Niger, tomato cultivation is practiced in the off-season in the regions of the Niger River, Ader Doutchi_Maggia, Goulbi de Maradi and around ponds and other water reservoirs (RECA, 2012). This crop occupies a key place in Niger with a production of 141,500 tons since 2012 (RECA, 2012). Given the importance of tomato cultivation and given the extent of the damage caused by this pest, Niger has deployed several control measures since its appearance in order to be able to limit crop losses as much as possible.

This study is part of the same logic and deals with the dynamics of Tuta absoluta populations in market gardening sites in the commune of Oualam.

II. MATERIAL AND METHOD

2.1 Material

2.1.1 Presentation of Study Sites

The study was carried out in two market gardening sites in the commune of Oualam. The latter is characterized by three types of soil:

- Clay_loamy soils in Sargane, Tolkoboye, Dignassa.
- Sablo_limoneux soils present in Talkadabey, HananTondi, ouallam ville, Dabrey.
- Lateritic soils in the plateaus.

Woody Vegetation Includes

- Eucalyptus camaldulensis which are artificial stands around ponds and restoration perimeters;
- Guiera senegalensis, Combretum micrantum… which are natural stands on the plateaus;
- Acacia albida, Balanites aegyptiaca, Combretum glutinosum… in agroforestry parks on agricultural land.

The two selected (Tolkoboye koira tagui and Fondo bon) are characterized by high production of nightshades and in particular tomatoes. Other speculations were found on the sites: lettuce, garlic, cucumber, moringa, okra, parsley, onion etc. The characteristics of the sites are presented in Table 1 below.

Table 1: Characteristics of investigation sites

Study sites	Commune	Geographical coordinates	Market gardening practice	Main speculations found
municipality of Ouallam	Tolkoboye koira tagui	2°7’3829’’E and 14°12’5976’’ N.	since 1987	Tomato, lettuce, pepper, onion, potato etc.
	Fondo bon	2°8’1900’’E and 14°13’0.98 N	since 1987	lettuce, pepper, tomato, potato, onion etc;

2.1.2 Plant Material Using

The plant material used is tomato. The variety chosen is a Mongal F1 hybrid known for its adaptation to the wintering period and the off-season. The characteristics of this variety are shown in the table below.

Table 2: Characteristics of the chosen variety

Varietie	Period	Cycle	Yield	Resistance
Mongal F1	Winter and off-season	60 and 65 days	Variable according to the production period	Very resistant to humidity

2.2. Methodology Used

To study the dynamics of *Tuta absoluta* populations, phytosanitary maintenance is carried out in order to know the various pests associated with tomato cultivation, pesticides and peasant practices for the use of these pesticides.

Then, a monitoring of *Tuta absoluta* populations in two market gardening sites in the commune of Oualam was carried out. To do this, 30 pheromone traps were installed on the two market gardening sites. The study first consisted in choosing 25 plots of 200 M2 at the Tolkoboye site and five plots on the Fondo Bon site. A total of 30 traps were installed to detect the presence or absence of *Tuta absoluta* populations.

At each phenological stage of the tomato, the traps are placed at canopy level.

Monitoring the population dynamics of *Tuta absoluta* began one week after the installation of the traps. The pheromone capsules were renewed every 4-6 weeks depending on bad weather such as rain, wind, and children. The glues are only renewed when there is a large number of captures (saturation) or when the latter becomes very dusty, thus reducing its effectiveness.

2.3 Parameters Studied

At the end of this system, several parameters were determined:

- Phytosanitary practices before the installation of crops;
- Tomato pests on the sites;
- Phytosanitary products used against tomato pests;
- The parts of the tomato attacked by *Tuta absoluta*;
- The number of adults of *Tuta absoluta* per week on the two sites and
- The yield of the tomato

2.4 Data Analysis

The data was compiled using Excel software. The qualitative data of each person was determined. For quantitative data, means and frequencies were also determined.

III. RESULTS-DISCUSSION

3.1 Diversity of Phytosanitary Practices among Tomato Producers

The results of the survey showed that 100% of the producers cleared and burned the crop residues of their plots before the establishment of the crop and 90% of them did the sowing in line. At the same time, they are setting up nurseries intended to raise young plants for about thirty days which will be ready to be transplanted.

The soil was first amended with nitrogen; phosphorus; potassium (NPK) 15 15 15 and organic manure. Then the seeds were sown in line. The number of rows varies between 3 to 12 per nursery. The size of the nursery varies according to the needs of the producers (marketing of nursery plants or personal use). The seedlings in the nursery are watered once a day before germination and two (2) times after the emergence of the above-ground seedling.

3.2 Diversity of Pesticides and Their Use Practices

The majority of producers used chemicals and products based on neem (aqueous extracts of leaves and seeds).

The data obtained during this survey are recorded in Table 3. In total, four synthetic products are used by the producers. Of these four products, 3 are insecticides and only one is acaricidal even if the latter has insecticidal properties. The survey also reveals that 3 of the 4 products used are approved by the Sahelian Pesticides Council (CSP) (RECA, 2018), i.e. 75%. 26% of the producers sampled use Pacha 25 EC, 28% Lambda super 2.5 EC and 23% Bomec against 23% who used DD Force (Figure 1). The latter is an unregistered organophosphate sold in local markets from Nigeria. It is a pesticide with very high phytotoxicity. Despite the excessive application of pesticides, a significant number of individuals of the tomato leaf miner (T. absoluta) were captured. This shows that the use of pesticides is not enough to control Tuta absoluta.

The results found also reveal that 90% of producers used bio-pesticides based on neem (leaves, seeds), pepper. In Tolkoboye Koira Tagui, the producers are 80% able to perfectly describe the manufacturing process of these products (neem, pepper, garlic, tobacco). However, they claimed to have participated in at least one training session given by the technical services of the State and development partners.

Table 3: Type of pesticides used by producers

Commercial names	Active ingredient	Type of product	Chemical family	Legal status
Pacha25 EC	Lambda_cyhalothrine 15g/acetamipride 10g/l. Emulsion concentrés_EC	Insecticide	Pyétréniodes et néonicotinoides	Approved
Lambda super 2.5 EC	Lambda_cyhalothrine 25 g/l	Insecticide	Pyétréniodes	Approved
Bomec	Abamectine 18 g /l EC	Insecticides-Acaricide	Avermectines	Approved
DD Force	DDVP1000EC (Dichlorvos)	Insecticide	organophosphorus	Not Approved

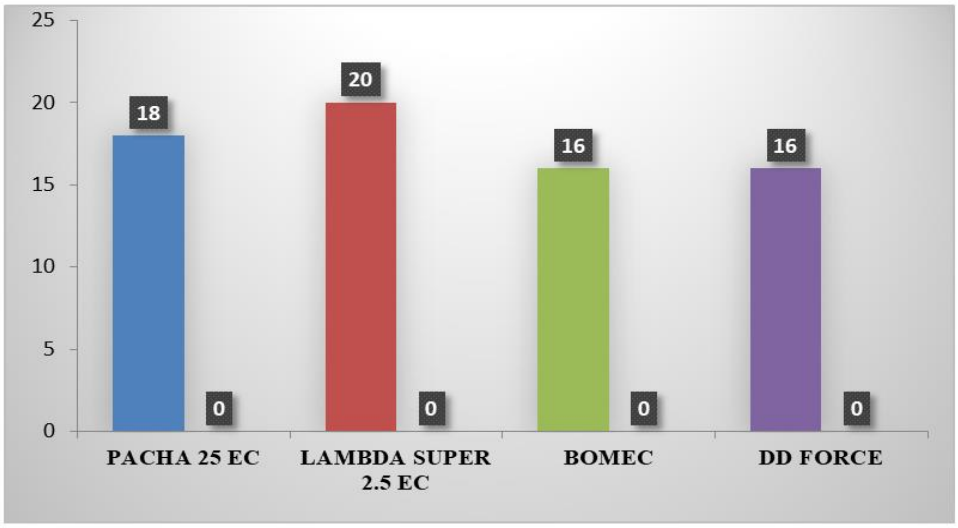

Figure 1: Distribution of pesticides according to their frequency of use by producers

Before the training of the brigadiers, on average 17% of the producers apply the pesticides randomly, 60% approximately, and only 11% respect the recommended dosage. After the densified training sessions, 70% respect the dosage, 12% by estimation and 7% approximation.

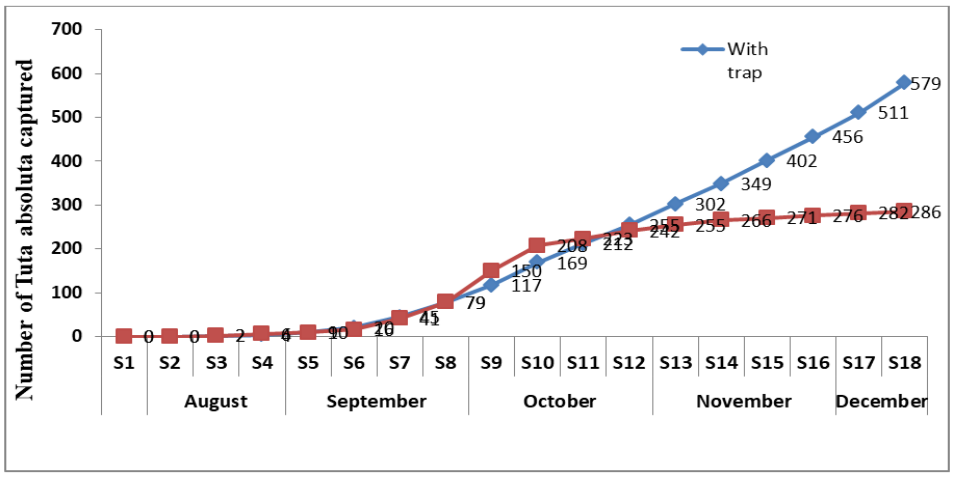

Figure 2: Evolution of the number of *Tuta absoluta* captured on the traps and on the witness

The results in Figure 2 show that the average population densities were low (<5 individuals/trap) at the start of vegetation (first 3 week of August). Then from the end of August, they started to grow steadily until the first week of October when they reached more than 50 ind./trap. From the last week of October, they continued to increase to reach nearly 70 ind./trap.

The pupae have started to give individuals, from the fifth week until the ninth week the number of captures becomes increasingly important with an average capture per week of nearly 55 at the beginning of October After the chrysalis stage the neonate females of *Tuta absoluta* were each able to lay a large number of eggs, the hatching of which released numerous larvae. Indeed, a female Tuta can lay up to 250 eggs during her lifetime (Desneux and *al.*, 2010), which explains the increase in individuals captured and the appearance of symptoms on the leaves in September. This average drops from the tenth to the twelfth week due to phytosanitary treatments and there is also the low longevity of *Tuta absoluta* individuals. For the thirteenth to the eighteenth the average catch only increases. But this situation hides a great disparity within the plots of the same site. Indeed, in some producers the tomato plants completed their cycle very early, which led to a decrease in catches in the latter, while in others, the catches increased in relation to the growth of the plants.

Bat on the witness, *T. absoluta* populations remained low until the 5th week with less than 5 males captured per trap. Then, they progressed almost exponentially until the 9th week, going from less than 10 to 70 males/trap. Then, the populations underwent a free fall which faded at the 11th week.

The regression in captures continued but very slowly, going from 20 individuals (week 12) to less than 5 individuals/trap at the 18th week of capture. This situation is due to the fact that at the beginning of tomato vegetation, *Tuta absoluta* would be in the resting stage, that is to say in the chrysalis stage. Gradually, these give adults able to feed and mate. The peak is obtained in the ninth week after transplanting, i.e. in full tomato production. The fall started in the tenth week. At this stage, the tomato plants should have enough organs (leaves, stem and fruits) on which the caterpillar can develop. This fall is due to a very severe attack of tomato plants by tomato leaf spot disease due to *Xanthomonas campestris* which caused very significant defoliation. To this bacterial attack was added that of the root-knot nematodes of the genus Meloidogyne which led to the death of the attacked plants.

3.4 Monitoring of the Evolution of the Attack of *Tuta Absoluta* on the Organs of the Attacked Plants

According to the results in Figure 1, 5, there are 65% of the plots that had the leaves attacked by *Tuta absoluta* at the maturity stage in the 9th week in (October). 33% of the plots had fruits attacked by this miner at the fruiting stage until the harvest from the 14th week to the 18th week in (December). Symptoms appeared on stems at 2% maturity until harvest.

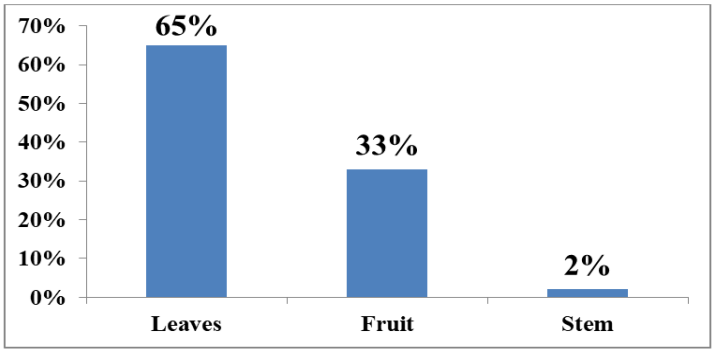

Figure 4: Proportion of plots attacked by Tuta absoluta in different parts of tomato plants

3.5 Tomato Yield

At harvest, the plots of the study site were classified into two groups: those that were moderately attacked by other crop enemies and plots that were severely attacked by pests other than *Tuta absoluta*. The results in Figure 5 show that the yield varied on the two types of plots selected from 16.41 to 22.55 t/ha with an average of 19.48 t/ha. The difference was significant between the two categories of plots on this site. The yield on the control site was 13.65t/ha.

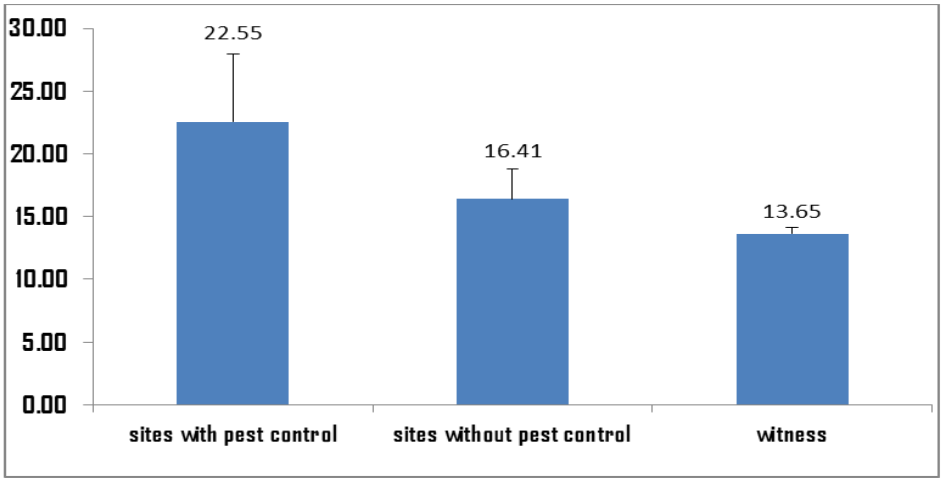

Figure 5: Tomato yields from the observation site (mass capture of T. absoluta) and control (without mass capture)

3.6 Different Pests and Diseases Present at the Two Sites

The main pests and diseases encountered during this study are listed in Table 3. The whitefly (Bemisia tabasi) and the tomato fruitworm (Helicoverpa armigera) are the two insect pests that caused the most damage. Root-knot nematodes of the genus Meloidogyne also often caused the death of tomato plants both in the study site and in the control site. The same is true of tomato leaf curl

disease or TYLC.

Table 3: Most frequent pests on the two sites

pests	Symptoms and damage	Importance
white fly *(Bemisia tabasi)*	Biting, spoliation and dieback of young plants, stunting of plants, drop in flower production, flower abortions...	++++
tomato fruitworm *(Helicoverpa armigera)*	Organ attacked gnawed and riddled with small irregular hole, caterpillar penetrating halfway into the fruits which can fall and rot...	+++
red spider (T*etranychus urticae)*	Under the effect of the bites, spots are formed, the leaves can become discolored and dry.	++
Root-knot nematodes of the genus *Meloidogyne*	Root galls preventing the plant from feeding, which causes stunting and drying out, leading to the death of the plant.	++
damping-off *(Pythiumspp, Rhizoctonia)*	The emerging seedling is attacked at the level of the collar, the tissues of which turn brown. It wilts and sags and is totally decomposed on the ground.	+
leaf spot disease (Xanthomonas campestris)	Small black spots on leaves, stems and fruits. In severe cases the plants wither and die.	++++
Tomato yellow leaf curl virus	Yellowing of the leaves of the tomato which ends up with the death of the plant.	+++

IV. DISCUSSION

The results obtained also show that market gardening occupies all segments of the population of this region. This same observation was made by SNDH (2011) who found that this sector of irrigated crops is a provider of employment in rural areas, particularly for young people and women because nearly 48% of the population is occupied by the said sector. It thus contributes to increased income for vulnerable populations, resulting in a significant reduction in the rural exodus. But market gardening production in our sites is dominated by men with more than 95% of farmers; which is a little pronounced in this region because in 2008, the proportion of women practicing market gardening at the national level was 18.2%. However, in our case, only 13% of market gardeners are illiterate compared to 80% recorded during the general census of agriculture and livestock (Republic of Niger, 2008). This is due to the influence of the city where the school enrollment rate is still very high compared to rural areas. Indeed, the National Institute of Statistics of Niger reported an enrollment rate of nearly 100% against a national average of just over 60% (INS, 2016). In a similar study carried out in a rural area, by Zabeirou *et al.* (2018) reported an illiteracy rate of 67% among market gardeners.

Data analysis showed a significant difference between this type of plot and the control. The damage caused by *Tuta absoluta* which completely dried out tomato plants this year (2018) more than half of the tomato plots that were attacked by *Tuta absoluta* have tomato plants in full regeneration in Tillabéry (Tolkoboye). This situation is consistent with the results of Noura (2017) who worked on the same site. Observations made by Madougou *et al.,* (2015) showed very severe attacks going as far as the complete drying out of all the plants in certain plots. The work of Haougui *et al.,* (2016 and 2017) showed that *Tuta i*s not only voracious but also has a great capacity for dissemination which makes it a very formidable pest. The presence of other enemies on tomato plots is linked to the nature of the plant (tomato) which is one of the most attacked crops in the world. In Niger, Haougui *et al.,* (2015) showed that this speculation, like all solanaceae, can be attacked by more than 30 diseases or pests. They noted that the most important pests are insects (whitefly, tomato fruitworm); the mites (the red spider-Tetranychus urticae), root-knot nematodes of the genus Meloidogyne. The most important diseases are: leaf curl disease (TYLC), bacterial wilt caused by *Raltsonia solanacerum*, bacterial spot disease caused by *Xanthomonas campestris*.

The study showed that 75% of the insecticides used are approved while Moumouni *et al*., (2018) found over 43%. Or Reca (2013) reported only 10% of products approved at the national level. In 2018, this same author gives an estimate of around 20%, just for insecticides and acaricides sold in Niger; which constitutes an improvement in the situation. This phenomenon would result from the awareness campaigns undertaken since the alert given by Reca (2013) on the danger that the use of unapproved pesticides represents for human health and the environment. Indeed, the public services of the state, the financial partners, the development projects and the ONGs have since then carried out a training campaign on the large vegetable production sites to bring the market gardeners to use the

products authorized by the legislation of the country in the matter.

Considering the average yield of the observation site, massive trapping allowed a yield increase of 42.71%. This increase in yield is 65.20% on the plots of the observation site moderately attacked by other pests.

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