

Incidence and severity of insect pests and diseases of Tomatoes (*Solanum lycopersicum* L.) in Ikungi district of Singida region, central Tanzania

Abstract

Less is known on the incidences and severity of insect pests and diseases of vegetables including tomatoes (*Solanum lycopersicum* L.) despite their negative effects on vegetable productivity. A study was carried out among selected tomato fields of three sites (Kituntu, Musamvu and Puma) of Ikungi district of Central Tanzania based on specific objective to determine incidence and severity of insect pests and diseases. Field scoring on the Incidences and Severity of the insect pests and diseases of tomatoes (*Solanum lycopersicum* L.) was conducted among six tomato fields (two fields in each of the three sites) using a Completely Randomized Block Design (CRBD) experiment. Data on the field scores on the incidences of insect pests and disease pathogens were analyzed for Analysis of Variance (ANOVA) using the Statistical Analytical System (SAS) software. Results revealed variable incidences ($P < 0.05$) of three insect pests ranked in the decreasing order ($P < 0.05$) of: tomato leaf miner (*Tuta absoluta*; (66.3 %; (60.7–72.8 %)) > American bollworm (*Helicoverpa armigera* (21.1%; (14.9–28.3 %)) > red spider mites (*Tetranychus urticae* (13.3 %; (15.9–19.8 %)). Early blight (*Alternaria solani*) and Late blight (*Phytophthora infestans*) were the most severe tomato diseases in the study area of Central Tanzania. Six variable tomato disease pathogens' incidences ($P < 0.05$) variable across sites ($P < 0.001$): Early blight (*Alternaria solani* (17.2 %; (9.7–30.6 %)), late blight (*Phytophthora infestans* (15.7 %; (6.3–32.5 %)); fusarium wilt (*Fusarium oxysporum* fsp. *Lycopersci* ((19.2 %; 11.1–29.8 %)), blossom end rot (16.0 %; (11.5–23.1 %)); were identified. Other scored tomato diseases were bacterial spot (*Xanthomonas campestris* (17.2 %; 12.4–21.1 %)), and bacterial wilt (*Ralstonia solanacearum*) (8.7%). Tomato leaf miner (*Tuta absoluta*), a wide spreading insect pest was the most severe insect pest, causing substantial damage to tomato crops, thus exacerbating the overall severity of tomato losses in the field in Ikungi district of Singida region and elsewhere in Tanzania and in the tropical region. Results on the incidences and severity of both insect pests and diseases in Central Tanzania contribute to positive efforts on geospatial, temporal and spatial mapping of the insect pests and diseases for enhanced management. The noted high incidences of *T. absoluta*, *H. armigera* and *Tetranychus urticae* reveal the need for enhanced integrated pest management strategies to mitigate their impacts for enhanced tomato productivity and quality.

Keywords: vegetables, solanacearum, tomatoes, insect pests, entomology, pathology, bacterial diseases, fungal diseases, central Tanzania

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Abbreviations: CRBD, completely randomized design; m.a.s.l, meters Above sea Level; mm, millimeters

Introduction

Optimal productivity potential of vegetables including tomatoes (*Solanum lycopersicum* L.) is limited by insect pests and diseases infestations accounting for 50–80 % yield losses in addition to varieties/ cultivars and abiotic stress factors (e.g., soil nutrient status, pH, salinity, precipitation, humidity, temperature)).^{1,2} Insect pests and diseases infestations have been associated with low productivity of vegetables of 7 t/ha in most African countries.¹ Vegetable productivity including tomatoes (*Solanum lycopersicum* L.) in the tropics including Tanzania is limited by insect pests and diseases infestations.^{1,3} Insect pests and diseases of economic importance that limit vegetable production including tomatoes (*Solanum lycopersicum* L.) range from white flies, red spider mites.^{1,5} The negative impacts of insect pests is further exacerbated by diseases incidences with bacterial diseases, fungal diseases, viral diseases affecting vegetable productivity and quality,^{2,6} and negatively impact profit due increased cost of production as related labor, and the use of chemicals (insecticides, pesticides and fungicides) in addition to toxic effects to the environment caused by

the applied chemicals in the control of insect pests and disease of vegetables globally.⁴

Crop damages caused by the insect pests vary widely ranging from piercing, sucking and extraction of the cell sup/ contents mostly by the aphids following their long, needle- like mouth parts; and mites lead to decreased chlorophyll content and thus reduced photosynthetic efficiency and vegetable productivity.^{2,4} Defoliators/ chewing insects such as caterpillar (e.g., army worms) and flea beetles cause loss of leaves that interferes with the photosynthetic process. Borers (e.g., American bollworm (*Helicoverpa armigera* (Hübner)) distil and tunnel into fruits such as tomatoes at different stages of development decreasing both crop productivity and quality⁴. Other insect pests such as aphids are vectors of diseases for instance viral diseases.^{2,4} However, a comprehensive information is lacking on the incidence and severity of insect pests and diseases, and management practices in many parts of the tropics including Tanzania and semi-arid areas of Central Tanzania, and could hamper the importance of vegetables in income generation and improved human nutrition. Available information on the incidence of insect pests and diseases of vegetables in Tanzania is limited to fruit fly infestation of vegetables in Eastern central and Southern highlands of Tanzania,^{1,3,6} and scanty

data on semi-arid Central and northern Tanzania.^{7,8} Variability also exists among vegetable producers with respect to insect pests and management practices of the common commercially grown vegetable crops compared to those noncommercial or underutilized vegetables⁹ including drumstick, Amaranthus, cherry tomato and Chinese cabbage that vary across geographical regions and agroecologies.^{9,10} Variable efforts have been employed for controlling insect pests and diseases of vegetables including capacity strengthening on vegetable insect pests management techniques,¹¹ the use of agroecological farming practices for controlling fruit flies,¹² and biotechnological approaches for instance eradication of the American bollworm (*Helicoverpa armigera* (Hübner)) using native isolated *Spodoptera litura*- associated Nucleopolyhedro viruses (SlitNPV).¹³ Efforts on control of vegetable insect pests and diseases are partly hampered by limited scoping of the extent of the insect pests and diseases in many countries including Tanzania and Central Tanzania in particular. A participatory study was carried out among selected tomato growers of Ikungi district of Central Tanzania between March and June 2025 to assess incidence and severity of insect pests and diseases in tomatoes (*S. lycopersicum* L.) based on specific objective to determine incidence and severity of insect pests and diseases of tomatoes.

Material and methods

Study area

The study was conducted among selected six tomato farmers' fields of three sites (kituntu, Musamvu and Puma) of Ikungi district (4°-6°S; 34°-35°E) of Singida region characterized by undulating plains (1,200 -1,500 m.a.s.l.),¹⁴ Ikungi district of Singida region of central Tanzania is a humid semi-arid area characterized by cool and hot temperature that range from a minimum temperature of 15°C in July to a maximum temperature of 30°C in October. The area receives unimodal rainfall (600 to 800 mm per annum) between late November/ early December and late April/ late May. Ponde and Bubu rivers are the main drainage systems of Ikungi district that drain to both Bahi swamp in Dodoma and Wembere plains of Iramba district. The area is characterized by fertile soils dominated by clayey loams. Dominant vegetation include *Acacia* spp. (*A. tortilis*, *A. nilotica*, *A. polyacantha*), *Pterocarpus angolensis*, *Brachystegia* woodlands represented by three genera: *Brachystegia* spp. (*B. speciformis*, *B. boehemii*), *Julbernadia* spp. (*J. globiflora*) and *Isobernadia* spp. Other dominant vegetation of Ikungi district include *Azelia quanzensis*, *Podocarpus* spp., *Terminalia* spp., *Combretum* spp. and *Commiphora* spp. Main grown subsistence crops include sorghum (*Sorghum bicolor*), finger millet (*Eleusine coracana*), pearl millet (*Pennisetum glaucum*), maize (*Zea mays* L.), paddy rice (*Oryza sativa* L.), sweet potatoes (*Ipomoea batatas* L.) and cassava (*Manihot esculenta* L.) Sunflower (*Helianthus annuus* L.), cotton (*Gossypium* spp.), sesame (*Sesamum indicum*) and vegetable crops (tomatoes (*Solanum lycopersicum* L.), onion (*Allium cepa*) cabbage (*Brassica* spp.) are the main cash crops with horticultural vegetable production relying mostly on rain fed irrigation systems.^{14,15}

Experimental design

An on-farm completely randomized block design (CRBD) experiment with tomato fields and the three study sites constituting the main blocks was adopted to score incidences and severity of insect pests and diseases on tomatoes (*S. lycopersicum* L.). Scoring of the incidences of insects and diseases was carried in each of a total of 5 plots (20 m x 20 m) temporarily laid out systematically along three transects; two diagonals and a bisector in a Zig Zag pattern in each of the evaluated six tomato fields described earlier.⁸ A tally for the scores of the identified insect pests and diseases in each transect and tomato

field were recorded against the insect pests and diseases' pathogens for later computations and statistical analyses.

Data analysis

Data on the field scores on the incidences of insect pests and diseases' pathogens of tomatoes of the assessed fields were analyzed for Analysis of Variance (ANOVA) using the Statistical Analytical System (SAS) software (SAS)¹⁶ Version 9.4, based on statistical model: $y_{ij} = \mu_{ij} + S_i + p_j + (S \times P)_{ij} + e_{ij}$ whereby y_{ij} are the i^{th} and j^{th} scored incidences of insect pests and diseases' pathogens across sites. A term μ_{ij} is the general term due to the peculiar effects on the incidences of insect pests and disease pathogens common for all observations, S_i is the i^{th} effect due to site on the scored incidence of insect pests/ diseases' pathogens. A term p_j refers to j^{th} effects of insect pests and disease pathogens on the scored incidences of insect pests' / diseases' pathogens. A term $(S \times P)_{ij}$ are the interaction effects due to the effects of sites and insect pests and disease pathogens on the scored incidences of insect pests and disease pathogens in each studied tomato farm and e_{ij} are the random error terms that tend to cancel with each in all observations.

Results

Incidence and severity of insect pests

Results on the incidences of common insect pests of selected tomato fields in Ikungi district of Central Tanzania are presented in Table 1. Incidence of insect pests were variable across insect pests ($P < 0.001$). The study revealed three variable insect pests ($P < 0.05$) of economic importance ranked in the decreasing order of: tomato leaf miner (*Tuta absoluta*; 66.2%) > American bollworm (*Helicoverpa armigera*; 21.1%) > red spider mites (*Tetranychus urticae*) (13.3 %). Incidence of insect pests were not variable both across sites ($P > 0.05$), and due to the intersection effects of sites and insect pests ($P > 0.05$). Tomato leaf miner (*T. absoluta*) was the most severe (60.7 – 72.8 %; across the three study sites ($P < 0.05$)) followed by the American bollworm (*H. armigera*; 14.2 – 28.3 % (Table 1).

Incidences of tomato diseases

Results on the incidences and severity of tomato diseases are indicated in Table 2. Field scoring of tomato diseases revealed six variable tomato diseases pathogens ($P < 0.05$) with variable incidences and severity ($P < 0.05$) across the study sites. Three tomato diseases, namely: early blight (*Alternaria solani*: 17.2 % (9.7 – 30.6 %)), late blight (*Phytophthora infestans*: 15.7 % (6.3 – 32.5 %)), and fusarium wilt (*Fusarium oxysporum fsp. Lycopersci*: 19.2 %; (1.1 – 29.8 %)) were the most severe tomato diseases ($P < 0.05$) among the studied tomato fields of Ikungi district of Singida region, Central Tanzania. A total of six diseases of tomatoes, namely: early blight (*Alternaria solani*) (17.2 %), late blight (*Phytophthora infestans*) (15.7 %), fusarium wilt (*Fusarium oxysporum fsp. Lycopersci*) (19.2 %), blossom end rot (16.0 %), and bacterial spot (*Xanthomonas campestris*), bacterial wilt (*Rastonia solanacearum*) (8.7%) were recorded variable incidences and severity (Table 2). Kituntu site recorded the highest levels of key fungal and bacterial infections ($P < 0.05$) with early blight (*Alternaria solani*; 30.6%), late blight (*Phytophthora infestans*; 32.5%), and fusarium wilt (*Fusarium oxysporum fsp. Lycopersci*; 29.8%), than lower tomato diseases' incidences ($P < 0.05$) for Puma site for instance. Exceptionally, Bacterial wilt (8.7%) was only recorded in Puma site. incidences of diseases of tomatoes were variable across the study sites ($P < 0.001$). Early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) being the most widespread tomato

diseases among the studied tomato fields of Ikungi district of Singida region, Central Tanzania. A total of six diseases of tomatoes, namely: early blight (*Alternaria solani*) (17.2 %), late blight (*Phytophthora infestans*) (15.7 %), fusarium wilt (*Fusarium oxysporum* fsp. *Lycopersci*) (19.2 %), blossom end rot (16.0 %), and bacterial spot (*Xanthomonas campestris*), bacterial wilt (*Rastonia solanacearum*) (8.7%) were identified. bacterial wilt (*Rastonia solanacearum*) was restricted to

only a single site (Puma); (Table 2. The recorded tomato diseases' incidences were not variable due to the interaction effects of sites and diseases causing pathogens ($P>0.05$). The study revealed variable tomato diseases incidences ($P<0.05$) across the study sites. Early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) were the most widespread tomato diseases among the studied tomato fields of Ikungi district of Singida region, Central Tanzania.

Table 1 [§]Incidence and severity (%) of insect pests of tomatoes (*Solanum lycopersicum* L.) in Ikungi District, Central Tanzania.

Site	Kituntu	Msamvu	Puma	Mean
Tomato leaf miner (<i>Tuta absoluta</i>)	72.8 ± 10.27 ^a	60.7 ± 13.26 ^a	65.4 ± 10.27 ^a	66.3 ± 6.56 ^c
American bollworm (<i>H. armigera</i>)	28.3 ± 16.24 ^a	14.9 ± 16.24 ^a	19.9 ± 11.49 ^a	21.0 ± 8.56 ^c
Red spider mite (<i>Tetranychus urticae</i>)	19.9 ± 11.49 ^b	4.0 ± 16.24 ^b	15.9 ± 10.27 ^b	13.3 ± 7.46 ^d
Mean	40.3 ± 7.46	26.5 ± 8.84	33.8 ± 6.74	
[§] Effects of Site	N.S			
Insect pest	***			
Site*insect pest	N.S			

^{a,b,c} Means with the different superscript letters along the same columns and rows differ ($P<0.05$); [§]Level of significance: * ($p<0.005$); ** ($p<0.01$); *** ($p<0.001$); N.S not significant ($p>0.05$)

Table 2 [§]Effects of site on incidence (%) of tomato diseases in Ikungi district of Singida region, Central Tanzania

Diseases/site	Kituntu	Msamvu	Puma	Mean
Bacterial spot (<i>Xanthomonas campestris</i>)	21.1 ± 5.42 ^a	12.4 ± 6.26 ^a	18.1 ± 6.26 ^a	17.2 ± 3.46
Bacterial wilting (<i>Rastonia solanacearum</i>)	n.a	n.a	8.7 ± 7.67 ^a	n.a
Blossom end rot	23.1 ± 7.67 ^a	11.5 ± 7.67 ^a	13.3 ± 4.85 ^a	16.0 ± 3.96
Early blight (<i>Alternaria solani</i>)	30.6 ± 4.85 ^a	11.3 ± 6.26 ^a	9.7 ± 4.85 ^a	17.2 ± 3.09
Late blight (<i>Phytophthora infestans</i>)	32.5 ± 6.26 ^{a,b}	6.3 ± 10.84 ^{a,d}	8.4 ± 5.42 ^{a,d,e}	15.7 ± 4.55
Fusarium wilt (<i>Fusarium oxysporum</i> fsp. <i>Lycopersci</i>)	29.8 ± 5.42 ^a	16.6 ± 6.26 ^a	11.1 ± 10.84 ^a	19.2 ± 4.55
[§] Effect of:				
Site	***			
Pathogens	N.S			
Site* Pathogens	N.S			

^{a,b,c,d,e} Means with the different superscript letters along the same columns and rows differ ($P<0.05$); [§]Level of significance: * ($p<0.005$); ** ($p<0.01$); *** ($p<0.001$); N.S not significant ($p>0.05$)

Discussion

Incidences of insect pests in tomatoes

Insect pests cause substantial damages to horticultural crops including tomatoes that exacerbate severity of tomato losses in the field. The noted high incidences of *T. absoluta*, *H. armigera* and *Tetranychus urticae* in tomato fields could be highly ascribed to decreased crop productivity and revenues from yield losses. High incidence and severity of tomato leaf miner (*Tuta absoluta*) and American bollworm (*H. armigera*) across the studied sites in the study area of Central Tanzania are highly ascribed to damages of tomatoes and reduced tomato productivity in the region. *Tuta absoluta* for instance is a wide spreading insect pest that cause substantial damage to vegetables in the family Solanacea including tomatoes (*S. lycopersicum* L.), thus exacerbating the overall severity of tomato losses in the field in Ikungi district of Singida region and elsewhere in the tropical region. Scored high incidences of the insect pests in the

current study for instance high incidences of *T. absoluta*, *H. armigera* and *Tetranychus urticae* in tomato fields are consistent to previous results reported in other semi-arid areas of Tanzania,^{7,8} other parts of Africa,² and central tropical Asia.⁴ High incidences of insect pests of tomatoes scored among the tomato fields of kungi district of Central Tanzania suggest for intensive integrated pest management (IPM) strategies stipulated by the World Vegetable Centre,⁴ that encompass cultural, biological and chemical control methods (pesticides) and to mitigate the impacts of these pests and diseases in tomatoes for enhanced tomato productivity and quality of the produce in Ikungi, Singida region and other semi-arid agro ecologies of Central Tanzania,^{7,8} and elsewhere in the tropics.¹⁻⁴ Control of the insect pests and diseases of tomatoes and vegetables in general could further harness the use of the indigenous knowledge based on the specific agroecological farming practices

Tuta absoluta, a leaf miner (i.e., a sucking insect) pose threat on tomatoes (*S. lycopersicum* L.) and other vegetable production of

Solanaceous family following its destructive nature, whose both leaf mining and sucking of Cell sap lead to destruction of the Chlorophyll pigment resulting to poor photosynthetic efficiency and the associated decreased productivity of the vegetative, flower and fruit components and decreased crop productivity. *Tuta absoluta* limit solanaceous vegetable production due to negative effects of the *T. absoluta* in solanaceous vegetable production including tomatoes (*S. lycopersicum* L.) is further exacerbated by both its high spreading rate across a wide geographical area and high resistance to many conventional pesticides and thus its difficulty control.⁴ The recorded red spider mites, sucking mite, and American bollworm (*Helicoverpa armigera*), in addition to other insect pests further threaten tomato (*S. lycopersicum* L.) productivity. The scored higher incidences of the recorded insect pests in Kituntu site ranging from 19.9 – 72.8 % than Msamvu (4.0 – 60.7 %) and Puma (15.9 – 65.4 %) indicate both variability in insect pests' infestations between sites and would possibly be ascribed to variability in the damages caused across sites. These observations concur to the previously reported high incidences if insect pests of vegetables and specifically tomatoes in semi-arid areas of Dodoma Central Tanzania and sub-humid Manyara of northern Tanzania.⁷

Incidences of diseases of tomatoes

The recorded high incidences of the scored six diseases of tomatoes in semi-arid Ikungi district of central Tanzania, namely early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), fusarium wilt (*Fusarium oxysporum* fsp. *Lycopersci*), blossom end rot, bacterial spot (*Xanthomonas campestris*), and bacterial wilt (*Rastonia solanacearum*) represent diseases of economic importance in vegetable production including tomatoes. The latter tomato diseases have similarly been reported in Central Eastern Tanzania in Morogoro^{1,3} and semi-erid Dodoma in Central Tanzania and northern Tanzania in Manyara.^{7,8} Results on the scored high incidences of early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), fusarium wilt (*Fusarium oxysporum* fsp. *Lycopersci*), blossom end rot, bacterial spot (*Xanthomonas campestris*), and bacterial wilt (*Rastonia solanacearum*) Concur to bindings demonstrated among tomato fields in semi-arid Central and northern Tanzania^{7,8} and eastern and southern highlands of Tanzania and compare to high incidences of vegetable diseases reported globally.^{2,4} The scored diseases of tomatoes in addition to the insect pests bear positive implications on economic losses from reduced tomato productivity and due to increased costs of chemicals and pesticides spraying in addition to environmental hazards caused thus calling for the integrated pests management (IPM) approaches.

Conclusion

Tomato leaf miner (*Tuta absoluta*) recorded the highest and variable incidences between tomato yields ($P < 0.05$) in relative the American bollworm of Ikungi District. Enhanced tomato productivity in Ikungi district of Singida region is threatened by both tomato leaf miner (*Tuta absoluta*) and American bollworm (*H. amigera*) in addition to other insect pests and diseases. The tomato leaf miner (*T. absoluta*) for instance, is a highly destructive insect pest including tomatoes that can cause significant damage to leaves, stems, and fruits thus interfering with the crop photosynthetic potential in terms of the net photosynthetic rate, transportation of the photosynthetic products, soil mineral nutrients and water thus hampering the overall crop productivity in addition to crop mortality. The American bollworm (*H. armigera*) is a polyphagous insect pest that can feed on various crops, including tomatoes, causing damage to fruits. The presence of these insect pests, along with grasshoppers and red spider mites, suggests a need for integrated pest management (IPM) strategies.

Tomatoes and other vegetables production in Ikungi district of Singida region of Central Tanzania is threatened by both insect pests and diseases infestations. Early blight and late blight, fusarium wilt, bacterial spot)), and blossom end rot are major disease concerns. The dominance of *Tuta absoluta* in addition to the insect pests including American bollworm, along with other pests, highlight the need for effective integrated pest management (IPM) for enhanced crop productivity including vegetables and tomatoes in particular.

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Conflicts of interest

Authors declare that there is no conflicts of interest.

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