

Research Application Summary

Distribution of Blight Diseases of Tomato in Selected Agro-ecological Regions of Uganda

Akello, L.¹, Tugume, A.K.¹, Athman, S.Y.¹, Ibanda, I.², Dramadri, I.^{1,2}, Edema, R.², Tusiime, S.² & Ozimati, A.^{1,2}

¹Department of Plant Sciences, Microbiology and Biotechnology, College of Natural Sciences, Makerere University.

P. O. Box 7062 Kampala, Uganda

²Makerere University Regional Centre for Crop Improvement, College of Agricultural and Environmental Sciences,

Makerere University, P.O Box 7062 Kampala, Uganda

Corresponding author: lydiamatek57@gmail.com

Abstract

Tomato is among the most commonly grown vegetables in Uganda and it is cultivated all year round. Some of the commonly grown varieties include; money maker, marglobe, ansal, azilla, and padma. Based on the survey, Ansal was the most preferred variety because of its big fruit size and long shelf life. A number of production challenges were identified and these included; pests and diseases, high seed cost and drought. Among the most important diseases affecting tomato production were early and late blight against which farmers heavily spray with fungicides. Effective management of plant diseases requires sufficient information. Information concerning early and late blight diseases in Uganda was scanty and the long timespan of research on blight diseases of tomatoes was the problem that led to this research. A survey was done in three agro-ecological regions to assess the incidence and severity of early and late blight diseases. This paper provides information about early and late blight disease distribution. Late blight and early blight diseases were more severe in Lake Victoria crescent region. Nested analysis of variance was used for data analysis. Incidence of early blight disease was not significantly different across all the regions (p-value 0.219916) but significantly different across farms and districts. Late blight incidence was significantly different across all these regions (p-value 0.006898) as well as districts and farms.

Key words: ansal, early blight, incidence, information, late blight, severity

Résumé

La tomate est l'un des légumes les plus couramment cultivés en Ouganda et elle est cultivée toute l'année. Parmi les variétés couramment cultivées, on trouve : money maker, marglobe, ansal, azilla et padma. D'après l'enquête, Ansal était la variété la plus préférée en raison de la grande taille de ses fruits et de leur longue durée de conservation. Un certain nombre de défis de production ont été identifiés, notamment : les ravageurs et les maladies, le coût élevé des semences et la sécheresse. Parmi les maladies les plus importantes affectant la production de tomates figuraient le mildiou précoce et le mildiou tardif, contre lesquels les agriculteurs pulvérisent abondamment des fongicides. La gestion efficace des maladies des plantes nécessite des informations suffisantes. Les informations concernant les maladies du mildiou précoce et tardif en Ouganda étaient rares, et la longue durée de la recherche sur les maladies du mildiou de la tomate était le problème qui a conduit à cette recherche. Une enquête a été réalisée dans trois régions agro-écologiques pour évaluer l'incidence et la gravité des maladies du mildiou précoce et tardif. Cet article fournit des informations sur la distribution des maladies du mildiou précoce et tardif. Les maladies du mildiou tardif et du mildiou précoce étaient plus sévères dans la région du croissant du lac Victoria. Une analyse de variance imbriquée a été utilisée

pour l'analyse des données. L'incidence de la maladie du mildiou précoce n'était pas significativement différente dans toutes les régions (p-valeur 0.219916), mais significativement différente entre les fermes et les districts. L'incidence du mildiou tardif était significativement différente dans toutes ces régions (p-valeur 0.006898), ainsi que dans les districts et les fermes.

Mots-clés : ansal, mildiou précoce, incidence, information, mildiou tardif, gravité

Introduction

Tomato (*Solanum lycopersicum*) belongs to the family Solanaceae, and is among the world's most important crops in terms of production, consumption and trade (Nelson, 2008; Nuwamanya *et al.*, 2023). It is a source of lycopene, beta-carotene, folate, flavonoids, potassium, vitamin E, vitamins A and C (Beecher, 1998). In Uganda, 40,124 tons of tomato are produced from 6,671 hectares (Ddamulira *et al.*, 2021). The common varieties grown are ansal, azilla, marglobe, Rio-grande, and padma. Tomato is consumed by approximately three million people on daily basis due to their nutritive values (Nick and Silva 2016; Ssekyewa 2016). The crop is mainly grown by smallholder farmers who sell the fresh fruits in regional and domestic markets as well as in local markets for income generation (Ddamulira *et al.*, 2019).

Despite the importance of tomato, its production in Uganda is heavily affected by abiotic and biotic factors. The pests and diseases account for >80% of the production constraints. Late blight and early blight diseases are among diseases of economic importance (Mwaule, 1995; Ssekyewa, 2006; Ddamulira *et al.*, 2021) and they cause significant losses in tomato production in most of tomato production regions in Uganda. A recent tracking of tomato production scale in Uganda revealed significant reduction in acreage due to difficulties in managing these two important fungal diseases arising from expensive fungicides.

Late blight (LB), caused by the fungus, *Phytophthora infestans* has characteristic symptoms such as water-soaking, gray-green circular or irregular lesions on the leaves (Bush *et al.*, 2018). As the disease progresses, these spots darken, and a white fungal growth forms on the undersides, eventually colonizing the entire plant. Late blight is reported to be the most destructive disease of tomato causing loss of about 60-70%, (Foolad *et al.*, 2008; Nowicki *et al.* 2012, 2013) and in extreme cases 100% crop losses are recorded in susceptible varieties (Nowicki *et al.*, 2012). In Uganda, LB is more devastating during rainy season making farmers to frequently spray tomato plants i.e. at least twice a week or once in two weeks during the dry season. On the other hand, early blight (EB) is caused by a fungus *Alternaria Solani* (Ellis and G.Martin), and the pathogen survival is favored by warm temperatures (24-29°C) and high humidity. The first symptoms of early blight are small, dark, necrotic lesions that usually appear on the older leaves and spread upwards as the plants become older (Sherf and MacNab 1986). As lesions enlarge, they commonly show concentric rings giving a target board-line appearance and are often surrounded by a yellowing zone (Sherf and MacNab 1986). Early blight affects tomatoes greatly after fruiting and towards maturity, leading to yield loss. The aim of the study was to assess the incidence and severity of LB and EB diseases of tomatoes in different agro-ecological regions of Uganda. It was hypothesized that the incidence and severity of late blight and early blight diseases do not vary across regions in Uganda.

Materials and Methods

Study sites. The study was conducted in six districts from three agro-ecological zones of Uganda. The agro-ecological zones and districts included Lake Victoria Crescent (Luweero and Wakiso), Central Woodland Savannah (Nakaseke and Nakasongola), and Eastern (Sironko and Kapchorwa). The survey was conducted between November and December 2022.

Sampling Strategy. In each district, five farmers were randomly selected from sampling lists obtained from the agricultural officer of each district. At a farm level within each district, a total of 30 plants were sampled in “X” pattern and assessed for disease symptoms of early and late blight. Plants were scored in the field for late blight disease using a scoring of 0-5 developed by Saleem *et al.*, 2016 whereas for early blight severity was scored on a scale of 0-5 by Mayee and Datar (1986).

Computation of early and late blight diseases incidence. Disease incidence was calculated using the formula suggested by (Meya *et al.*, 2015) as; Disease incidence (%) = $n / (N \times 100)$. Where n is the number of plants exhibiting late blight symptoms and N is the total number of plants that were observed with late blight and early blight diseases respectively. Disease severity was calculated by getting averages of scores.

Results

Lake Victoria Crescent region had the highest incidence and severity of both EB and LB diseases while eastern region had the lowest incidence (Figures 1 and 2).

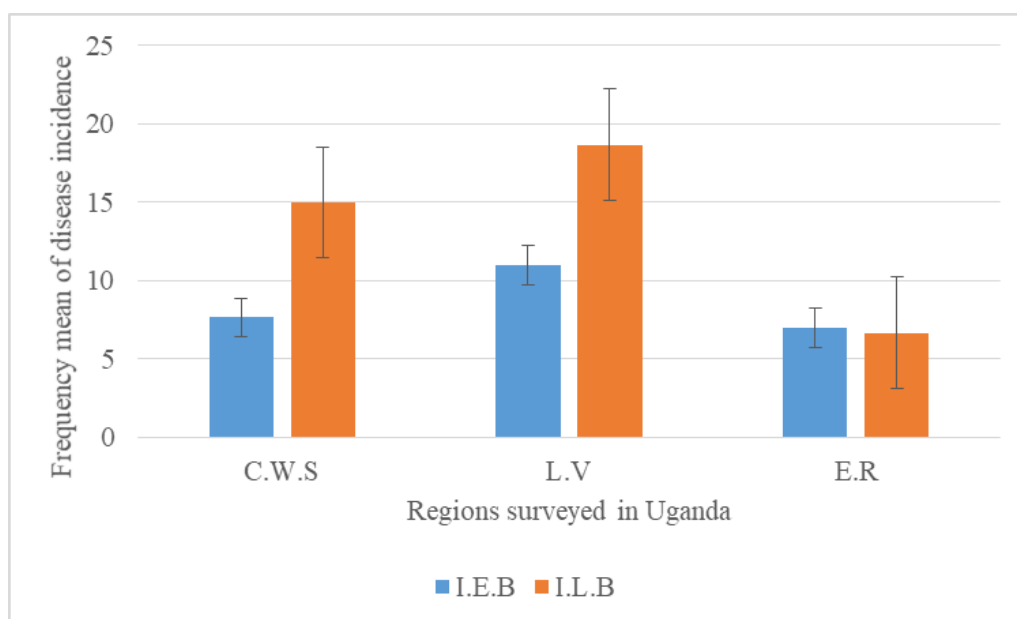


Figure .1 Incidence of early and late blight diseases in the regions surveyed

Lake Victoria Crescent region recorded the highest severity of both EB and LB diseases and eastern region recorded the lowest severity (Figure 2). There was no significant difference in early blight incidence across the regions. However, significant differences were recorded across districts ($p < 0.05$), and farms ($p < 0.001$).

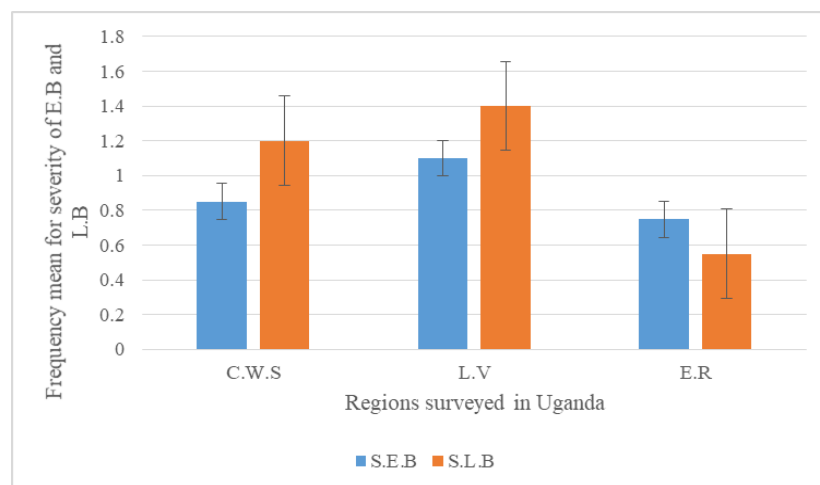


Figure 2. Severity of early and late blight diseases

Table 1. Nested analysis of variance showing incidence of late blight disease

Sources of variation	Df	Sum square	Mean square	F-value	Pr(>F)
Region	2	184	91.8	1.610	0.219916
District	3	558	185.9	3.259	0.038249 *
Farm	4	1878	469.6	8.234	0.000222 ***
District:Farm	20	3854	192.7	3.379	0.002307 **
Farm: Rep	5	107	21.5	0.377	0.859807
Residuals	25	1426	57.0		

Results in Table 2 show that there was a significant difference in the incidence of late blight disease across regions, districts and farms ($p < 0.01$)

Table 2. Nested analysis of variance showing incidence of early blight disease

Sources of variation	Df	Sum Square	Mean Square	F value	Pr(>F)
Region	2	1513	756.4	6.113	0.006898 **
District	3	5709	1903.1	15.380	7.09e-06 ***
Farm	4	2514	628.5	5.080	0.003897 **
District:Farm	20	10508	525.4	4.246	0.000424 ***
Farm: Rep	5	441	88.1	0.712	0.619893
Residuals	25	3093	123.7		

Discussion

Differences in agronomic practices could contributed to variations in incidence of early and late blight diseases because some farmers practiced mulching while others did staking. Some farms had not been properly management in terms of weeding and these recorded highest incidence of late blight disease because the plants were so close to the ground and it was easier for the pathogen to easily attach itself to the plant. Hence these farms hotspots for late blight. Staking of tomato plants were done in Eastern region whereas mulching was done in Lake Victoria Crescent region.

Staking has been reported to minimize fruit rots in tomato. According to Kwapata (1990) staking modifies the soil moisture; air temperature, radiation and evapo-transpiration, an effect which lowers the incidence of tomato diseases. In addition, staking exposes the leaves to the sun and thus increases plant photosynthetic efficiency leading to higher tomato yield compared to unstaked controls. Staking significantly reduced the severity of blight (Quinn, 1974), while Patterson (1990) reported that staking reduced the initiation of early blight in tomato. In eastern region, there was staking hence low incidence and severity of EB and LB diseases.

A study done by Lyimo *et al.* (2012) found out that there was higher incidence of early blight disease in mulched plots than in staked plots. High incidence and severity of both EB and LB were recorded in Lake Victoria crescent regions possibly because farmers practiced mulching. In addition, this region is humid and cool and this condition favors the growth of *P. infestans* hence differences in climatic conditions likely contributed to significant differences in the incidence of these diseases at district levels. The rate of spraying using fungicides such as mancozeb was high in Lake Victoria Crescent region and this was done at least after every three days in a week during rainy season implying that all varieties of tomatoes grown in this region are susceptible to both early and late blight disease.

Conclusions

This study provides information concerning Late blight and early blight incidence and severity across three agro-ecological regions of Uganda. The prevalence of the diseases is dependent on the different farming systems and disease pressures in these regions, with late blight and early blight being more prevalent in Lake Victoria crescent region. All varieties of tomatoes were susceptible to both early and late blight diseases.

Acknowledgement

We thank the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for funding this research under the agreement RU-NARO/2020/Post-Doc/01 and Makerere University Regional Centre for Crop Improvement (MaRCCI) for additional funding support. This paper is a contribution to the 19th RUFORUM Annual General Meeting and Conference held 28th October to 2nd November 2023 in Yaoundé, Cameroon.

References

- Bush, E. Rideout, S. and Waldenmaier, C. 2018. Late blight of tomato and Potato. Virginia Cooperative Extension. Virginia Tech.
- Ddamulira, G., Idd, R., Namazzi, S., Kalali, F., Mundingotto, J. and Maphosa, M. 2019. Nitrogen and potassium fertilisers increase cherry tomato height and yield. *Journal of Agricultural Science* 13:9752-9760
- Foolad, M.R., Merk H.L. and Ashrafi, H. 2008. Genetics, genomics and breeding of late blight and early blight resistance in tomato. *Crit Rev Plant Sci.* 27:75-107.
- Kwapata, M.B. 1990. Response of contrasting tomato cultivars to depth of applied mulch and irrigation frequency under hot dry tropical condition. *Butterworth-West India* 68:301-303
- Lyimo, H.F.J., Tiluhongelwa, T.D.M., Maerere, A.P. and Njau, P. 2012. The effect of mulching and staking on the development of early and late blights of tomato. *Journal of Agricultural Science* 1 (2):167-172.
- Mabbett, T.H. and Phelps, R.H. 1984. Effect of leaf growth in cucumber on deposit dilution and the control of angular leaf spot. *Tropical Pest Management* 30:444-449.
- Meya, A.I., Mamiro, D.P. and Kusolwa, P. 2015. Response of late blight disease resistant variety to common occurring tomato diseases in the field. *Asian Journal of Plant Science Research* 5:8-15.
- Nelson, C.S. 2008. Late blight of tomato (*Phytophthora infestans*). Honolulu (HI): University of Hawaii. 10p. (Plant Disease; PD-45).

- Nowicki, M., Foolad, M.R., Nowakowska, M. and Kozik, E.U. 2012. Potato and tomato late blight caused by *Phytophthora infestans*: An overview of pathology and resistant breeding. *Plant Disease* 96 (1):4-17.
- Nowicki, M., Kozik, E.U. and Foolad, M.R. 2013. Late blight of tomato. Translational genomics for crop breeding, Volume 1: Biotic Stress, 1st edition. Varshney R.K. and Tuberosa, R (Eds). Wiley, Hoboken.
- Patterson, C.L. 1990. Effect of cultural system on initiation, progression and severity of early blight. *Phytopathology* 80: 438-440.
- Ssekyewa, C. 2006. Incidence, distribution and characteristics of Major tomato leaf curl and mosaic virus disease in Uganda. PhD thesis. Faculty of Bioscience Engineering, Ghent, Belgium 233 pp.
- Tumwine, J., Frinking, H.D. and Jeger, M.J. 2010. Tomato late blight (*Phytophthora infestans*) in Uganda. *International Journal of Pest Management* 48 (1):59-64.
- Quinn, J.G. 1974. An evaluation of the method of mulching and staking tomato grown during rains in Samuri, Nigeria. *Horticulture Research* 13:97-104.