Journal of
Plant Pathology & Microbiology
ISSN: 2157-7471

Worku and Sahe, J Plant Pathol Microbiol 2018, 9:11
DOI: 10.4172/2157-7471.1000460

Review Article Open Access

Review on Disease Management Practice of Tomato Wilt Caused *Fusarium oxysporum* in Case of Ethiopia

Melese Worku[1]* and Samul Sahe[2]

[1]Faculty of Agriculture and Environmental Sciences, Debre Tabor University, Debre Tabor, Ethiopia
[2]Faculty of Natural and Computational Science, University of Gondar, Gondar, Ethiopia

Abstract

Tomato (*Lycopersicon esculentum*) is the world's largest growing vegetable crop. Many diseases and disorders affect tomatoes during its growing season. *F. oxysporum* is fungus pathogen widespread soil-borne plant pathogen. This plant pathogenic affects the tomato (*Solanum lycopersicum*). The recommend that farmer should be used resistant tomato cultivar and recommend fungicide spraying was best control and it were the most effective in reducing diseases' incidence and increase the yield of tomato.

Keywords: *Fusarium oxysporum*; Tomato; Fungicide

Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae*. It is one of the world's major vegetables with a total area and production of 4.4 million ha and 115 million metric tons, respectively [1]. As it is a relatively short duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily. Its position in the whole world is after potato and sweet potato both in area and production [2]. The world's average tomato productivity was 34.84 tonnes/ha and the average productivity of Ethiopian was 7.57 tonnes/ha [2]. There is a vast potential for the internal market for domestic fresh tomato fruit primarily in densely populated urban areas and for the processing industries for foreign market, such as Djibouti and Somalia [3]. The climatic and soil conditions of Ethiopia allow cultivation of a wide range of fruit and vegetables including tomato. In 2005, tomato production in Ethiopia reached about 35,407 metric tons from a total harvested area of 4788 ha. Although precise information on the history of tomato in Ethiopia is not available, it is one of the most important vegetable crops grown in the country [4]. Production of tomato is influenced by various biotic and a biotic-factors. Damage inflicted in by diseases and insect pests are the principal biotic constraints in Ethiopia. In order to minimize damage resulting from disease and insect pests considerable research has been conducted both on pathological and entomological problems in the country. Accordingly, about 13 diseases caused by difference fungal, bacteria and viruses' pathogens [5] and 6 economically important insect and mite pests attacking tomato have been identified and documented [6]. Earlier studies indicate as major economically important tomato diseases early blight (*Alternariasolani*), late blight (*Phytopthorainfestans*), Septoria leaf spot (*Septorialycopersici*) and viruses. In course of time, some diseases, which have been considered as minor importance, have become the most important ones. These diseases include Powdery mildew (*Leveilulataurica*), root knot nematode (*Meloidogyne* spp.) and bacterial wilt (*Ralstonia solanacerum*). There is number of factors which limit tomato yield. These include: lack of improved well performing cultivars, poor fruit setting due to heavy rains and excessively high temperatures and pests and diseases. Yield losses of 100% are common, particularly when tomatoes are infected early in development [7]. The average global crop losses of all diseases combined was approximately 12.8% of the potential production but tomato alone was subjected to 21.8% loss [8]. In Ethiopia the disease caused 100% crop loss on unimproved local cultivar, and 67.1% on susceptible cultivars [9].

Literature Review

Tomato vegetable/fruit

Tomato belongs to a large family of plants called the *Solanaceae* which contains many important food crops tomato [10]. Tomato was originated in South America Andes. The cultivated form first taken to Europe by Spanish in the 16th century and from there introduced into southern and eastern Asia, Africa and the Middle East and distributed throughout the world [10]. World tomato production in 2001 was about 105 million tons of fresh fruit from an estimated 3.9 million hectare. As it is a short duration crop, gives a high yield and economically attractive, the area under cultivation is increasing daily [10]. In Ethiopia, no local cultivars of tomato have evolved or been developed and hence all cultivars grown are introduced [11]. Tomato grows in many parts of the country and also among the most important vegetable crops and its production has shown a marked increase since it became the most profitable crop providing a higher income to small scale farmers compared to other vegetable crops [12].

Tomato production

Tomato is grown in many parts of the country in Ethiopia possessing difference agro-ecological conditions. It grows at an altitude between 700 and 2000 meter above sea level, which is characterized by warm and dry days and cooler nights which are favourable for optimum growth and development [13]. The total production of this crop in the country has shown a marked increase [12] since it became the most profitable crop providing a higher income to small scale farmers compared to other vegetable crops. However, the national average of tomato fruit yield in Ethiopia was often low (125 q/ha) compared even to the neighbouring African countries like Kenya (164 q/ha) [1]. Current productivity under farmers' condition in Ethiopia is 90 q/ha whereas yield up to 400 q/ha is recorded on research plots.

***Corresponding author:** Melese Worku, Faculty of Agriculture and Environmental Sciences, Deber Tabor University, Deber Tabor, Ethiopia, Tel: +251913-986518; E-mail: Melese1980@gmail.com

Received August 17, 2018; **Accepted** November 1, 2018; **Published** November 5, 2018

Citation: Worku M, Sahe S (2018) Review on Disease Management Practice of Tomato Wilt Caused *Fusarium oxysporum* in Case of Ethiopia. J Plant Pathol Microbiol 9: 460. doi: 10.4172/2157-7471.1000460

Farmers get lower yield mainly due to diseases, pests and sub-optimal fertilization [14]. Small-scale farmers, commercial growers and state farm enterprises grow the crop for its fruits in difference regions. Most intensive production is found in the rift valley, mainly along Awash River valley and the lakes region [13,15]. Its production ranks foremost among vegetables in the processing industry. The production of this crop mostly serves as source of cash income, supplement to cereal diet by small holder farmers and raw materials for processing industry in the commercial sector, especially in the rift valley regions of Ethiopia. It has also very high export potential. It is produced both during the rainy and dry seasons under supplemental irrigation [15]. Despite its importance, the overall fruit yields of tomatoes in Ethiopia are often very low compared to the yields of many producing countries in Africa and the world average (Table 1).

Importance and use of tomato

Tomato serves in various raw and processed materials. Fresh tomatoes are key ingredients in all around the world and processed tomatoes are used to make soup, juice and other products. Tomato is one of the most important and fames vegetables products in the country and most of the time tomato production rural community is one of the sours of income generation crop of rural areas [16]. The tomato fruit contains abundant and well balanced nutrition consisting of minerals (calcium, iron, and phosphorus), vitamins (vitamin A, vitamin C), protein (essential amino acids), sugars, dietary fibre (pectin), citric acid, etc. [10]. In addition, the red pigment of the lycopene which tomato fruit contains in plenty has attractive interest because the lycopene has high antioxidant ability against oxygen radicals that probably cause cancer, aging, arteriosclerosis, etc. Thus, tomato would contribute to our enjoyable diet and good health all over the world [10,17].

Tomato cultivar

Tomato is one of the world's most widely available fleshy fruits; hundreds of cultivars of diversely colored tomatoes exist in a wide range of sizes and shapes. In Ethiopian is just one of the numerous black tomato cultivars existed. It is becoming increasingly popular, particularly among home gardeners and organic producers, since they tend to produce more interesting and flavourful crops at the cost of disease resistance and productivity. In Ethiopia tomato cultivars are roughly divided into several categories, based mostly on shape and size [16]. The shortage of cultivars and recommended information packages, poor quality seeds, poor irrigation systems, lack of information on soil fertility, disease and insect pests, high post-harvest loss, lack of awareness of existing improved technology and poor marketing systems are the major constrains in Ethiopian tomato production [13]. It has been shown that farmers choose tomato cultivars to grow depending on a number of factors among which include production potential, market demand, regional adaptability, disease resistance and the end use of the product [18]. One of the key constraints in adapting tomato cultivars are crop pests and diseases which may require integrated pest and disease management options [19]. Different types of tomato cultivars cultivated in the study areas in Gondar town in all cultivars difference growth potentials. There are different tomato cultivars grown for various purposes.

The pathogen *Fusarium oxysporumon* tomato

Plant diseases cause severe crop losses *Fusarium oxysporum* and make agriculture highly dependent on adequate disease control. Wilt diseases of tomatoes can be caused by fungal, bacterial, viral, and nematode pathogens, and a biotic factor. Determining which agent is responsible can be vital for prescribing the proper management strategies. The wilt diseases describe the external and internal symptoms produced on the host by each pathogen; tomato wilt disease like growth pattern in the field and environmental conditions like temperatures, humidity that help to disease development [10]. *Fusarium* wilt symptoms wilting of the oldest leaves and then of whole plants which finally turned dry, were particularly visible during dry and hot weather. Initially, the first disease symptoms could be noticed on individual seedlings, and then patches of dead tissues could be observed over the whole area of tomato cultivars. The young plants are more affected by the disease, which is enhanced by poor seedling rooting. Diseases are a major source of crop loss and plant damage that can be caused by a number of plant pathogenic (disease-causing) organisms. Those that are plant pathogens are specific for certain plant hosts and are known as special forms. There are over 100 different special forms of *Fusarium oxysporum*, each usually with a specific host on which they can cause disease by *Fusarium oxysporum*. The fungus is the soil borne hyphomycete and is one of more than 100 *F. oxysporum* that causes vascular wilts of flowering plants [20].

Symptoms of *Fusarium oxysporum* and disease development

Fusarium wilt caused by the soil borne fungus *Fusariumoxysporum f.* sp. *lycopersici*, was formerly the most prevalent and damaging disease of field tomatoes. Symptom commonly found throughout the, *Fusarium* wilt is a fungal disease that attacks tomato, disease fungi *Fusarium oxysporum*, enter through the roots and interfere with the water conducting vessels of the plant. As the infection spreads up into the stems and leaves it restricts water flow, causing the foliage to wilt and turn yellow. Symptoms often appear later in the growing season and are first noticed on the lower (older) leaves. As the disease progresses, the younger leaves will also be affected and the plant eventually dies. In many cases, only one branch or sides of the plant show symptoms. Disease symptoms appear on the lower leaves as yellow blotches, wilting and eventually dropping off [10]. The pathogens are soil borne and occur throughout most tomato growing areas and infected leaves start drooping, curve downwards and turn yellow. Disease symptoms are apparent during flowering and fruiting stages, and leaflets on one side of the plants typically show more severe symptoms than leaves on the other side because of the specific vascular tissue affected by the pathogen [20].

Management of tomato wilt caused by *Fusarium oxysporum*

Use of resistant cultivars/hybrid/cultivars remains the key strategy to control *Fusarium oxysporum*, especially that is caused by

Country/Continent	Area (10^3) ha			Yield (kg/ha)			Production (10^3) MT		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
World	3993	4102	4311	26587	27411	26286	106171	112995	113308
Africa	631	645	645	20153	20023	20103	12720	12925	12973
Egypt	181	181 F	181 F	35019 F	35083 F	6329	6350 F	6350 F	6350 F
Kenya	16	16	16 F	16690 F	16414 F	16250 F	271	259	260 F
Ethiopia	4 F	4 F	4 F	12500 F	12500 F	12500 F	55 F	55 F	55 F

Table 1: Production of tomato in Ethiopia in relation with world, Africa, Egypt, Kenya and Ethiopia.

the broad host range race strains of *R. oxysporum* [21]. Breeding for resistance generally resulted in a good level of site specific resistance. However, a major problem in using these resistant lines/cultivars is their instability. Disease management strategies primarily depend on sanitary practices and well-timed pesticides applications. Many plant diseases heavily depend on agrochemicals and mainly rely on fungicides. These fungicides can prevent infection but not all have curative activity; therefore the interval between sprayings is usually short. In addition to the appearances of more aggressive isolates, and isolates that are no longer inhibited by chemical protectants, hence, the burden on the environment is high. Subsequently, plant pathogens are responsible for large amounts of chemical fungicides applied annually exacerbating control strategies [22]. Various practices are effective in reducing the occurrence of *Fusarium oxysporum.* For example, in some developing countries where the use of clean seed and long crop rotations are not practical solutions to the problems of tomato caused by *Fusarium oxysporum* intercropping has been used as a means of reducing soil populations of the pathogen and root to root transmission [23]. Furthermore, an in depth review was made by [23]. On impacts of the various cropping systems on *Fusarium oxysporum*, this indicates a lower incidence of diseases in tomato grown with bean intercropping.

Life cycle of the pathogen *Fusarium oxysporum*

Fusarium wilt caused by *Fusarium oxysporum* is one of the most damaging soil borne diseases of tomato causing heavy economic losses on plant grown. The life cycle of the plant pathogen, *Fusarium oxysporum* begins with a spore landing on a leaf surface of a susceptible host plant. *Fusarium* wilt can survive for years in the soil and is spread by water, insects and garden equipment. It develops during hot weather and is most destructive when soil temperatures approach 80 degrees F. Dry weather and low soil moisture encourages this plant disease. When environmental conditions of temperature and available moisture are favorable, the spore germinates, It can be efficiently used as spores (especially, conidia), which are more tolerant to adverse environmental conditions during product formulation and field use, in contrast to their mycelial and chlamydo spore forms as microbial propagates [24]. Its hyphae elongate and penetrate into the leaf cuticle, stomata, or wounds. As soon as hyphae enter the leaf, the infection process begins. During the latent stage, the affected leaf area does not show any symptom until a length of time known as the incubation period has elapsed. The affected leaf area then develops symptoms and the pathogen begins to sporulate during the infectious stage. After this infectious stage, disease symptoms remain on the leaf without sporulation; this is known as the removal stage [25] describes the above sequence using four state variables that represent the leaf area affected by each stage (vacant, latent, infectious, and removed area) and three rate variables (occupation, apparition, and removal).

Resistance caused by *Fusarium lycopersicum*

The location effect could be due to difference strains of the pathogen, climate, and/or soil characteristics present in each location impact of the specific nature of *Fusarium oxysporum,* resistance in the tomato breeding strategy. This breeding strategy could be designed for regional or global studies depending on the availability of location nonspecific resistance sources. Similarly reviews of Prior and Steva [26]. Also indicate difference aspects of resistance to *Fusarium oxysporum*. Common outstanding facts of these reviews concerning resistance to wilt were the variability of the host-pathogen interactions, the instability of resistance and the poor understanding of mechanisms underlying resistance. Resistance and tolerance have been commonly used to describe the complex interaction of host and pathogen, and these terms have often been applied with difference meanings to various host/pathogen combinations, which have led to some confusion. The wilt resistance most commonly refers to resistance as any measurable plant mechanism able to overcome completely or to limit the development of a pathogen or its effects [26]. This definition emphasizes the positive control of the pathogen by plant mechanism. Tolerance is defined as the overall ability of a plant to withstand the development of a pathogen without major losses in yield. Inoculation methods may vary slightly for difference crops, but the basic inoculation techniques are similar to the methods first described by Winstead and Kelman. Furthermore review of Hartman and Elphinstone demonstrate all inoculation methods, except for screening conducted in the infested fields, have used *Fusarium oxysporum* suspensions to inoculate above ground portions of plants. In tomato and many other hosts young plants are more susceptible than older plants, but natural infection in the field is usually observed at the flowering stage and later. Resistance is therefore not necessarily comparable between seedlings and adult plants. In this case a review of Hayward [23] indicates that consideration of segregating population is best screened under field conditions at flowering stage rather than by artificial infection.

Soil amendment of *Fusarium oxysporum*

In Ethiopia, farmers get lower yield mainly due to diseases and pests as well as due to sub optimal fertilization. Pandey et al. [27] reported that fruit yield in tomato is highly influenced by the NP fertilizers rates applied. Similarly, Sherma et al. also reported average fruit weight of tomato to have been influenced by the amount of NP fertilizers rates applied. Thus, tomato plant should receive optimum amount of NP fertilizers to produce higher fruit yields. Soil amendment involves the application of organic or inorganic fertilizer to the soil in order to utilize its effect to increase yield and reduce a given disease. Accordingly, difference soil amendment experiments were conducted for the control of *Fusarium oxysporum*. Sun and Huang reported a soil amendment called S-H mixture developed in Taiwan. The study was done as pre-planting soil amendment consisting of CaO (5,000 kg ha^{-1}) and urea (200 kg ha^{-1}N). In the same study it was reported that urea alone did not reduce the population of *Fusariumoxysporum.* Lemaga et al. [28] reported soil amendment consisting of organic materials with *Sesbania Sesbana* and *Leucaena* diverse folia applied in the amount sufficient to supply 100 kg N/ha either singly or combined with inorganic fertilizer was found to reduce disease incidence and increased tuber yield.

Fungicide spraying

The fungicides were sprayed at the rates, schedules and combinations indicated in Table 2. Three fungicides, Ridomil Gold (Metalxyl 8%+Mancozeb 64%) 68% Wp 2.5 kg/ha with protective and curative action and pencozeb 80% WP (Mancozeb) at the rate of 2.5 kg/ha with protective action and Novel was used systemic at the rate of 2.5 kg/ha and control plots were unsprayed with fungicides for to control tomato wilt disease. Spraying was performed by using manually pumped knapsack sprayers of 20 litter's capacity. During fungicide

S. No	Trade name fungicide	Common name	Dosage (kg/ha)	Fungicide spray schedule
1	Pencozeb 80% Wp	Mancozeb	3	Disease on set and 7, 14, 21, 28 days after
2	Ridomil Gold 68% Wp	Metaltxyl+Mancozeb	2.5	Disease on set and 7, 14, 21 days after
3	Novel	--	2.5	Disease on set and 7, 14, 21 days
4	Untreated	--	--	Unsprayed fungicide

Table 2: Name of fungicides.

spraying each plot was surrounded by plastic sheet in order to avoid spray drift to adjacent plots. The each of fungicide treatments was four spray intervals weekly (7 day) and biweekly (14 day), three weekly (21) and 28 day intervals until maturity. The intervals between successive sprays were constant. The fungicide application beginning at started with after artificially inoculation *Fusarium lycopersicum* in one week when diseased symptoms were occurred.

Discussion and Conclusions

Tomato cultivation was affected by the wilt disease caused by *Fusarium oxysporum* is a serious disease in major tomato crop.

1. Choosing diseased resistant cultivars.
2. Use of disease-free seedlings and also certified seeds.
3. Use of soil amendment (fertilizer) and fungicides spray and recommended rating.

References

1. Kader AA, Rolle SR (2004) FAO: The role of postharvest management in assuring the quality and safety of horticultural produce by Agricultural Organization of the United Nations, Rome.
2. FAO (2009) Statistical Bulletin, Rome, Italy 150: 1-2.
3. Workneh TS (2004) The improvement of the shelf life of vegetables through pre and postharvest treatment. A Ph.D. Thesis presented to the University of Free State, South Africa pp: 40-250.
4. Herath E, Lemma D (1994) Horticulture research and development in Ethiopia. Proceedings of Second National Horticultural Workshop of Ethiopia p: 353.
5. Tesfaye T, Habtu A (1986) A review of vegetable diseases research in Ethiopia pp: 495-518.
6. Tsedeke A (1986) A review of crop protection research in Ethiopia. Proceedings of the first Ethiopian Crop protection symposium, Addis Ababa, Ethiopia.
7. Cohen S, Antignus Y (1994) Tomato yellow leaf curl virus: A white fly born Gemini virus of tomatoes. Adv Dis Vect Res 10: 259-288.
8. James CW (1981) Estimated losses of crops from plant pathogens. In: Handbook of Pest Management in Agriculture pp: 80-94.
9. Kassa B, Hiskias Y (1996) Tuber yield loss assessment of potato cultivars with difference levels of resistance to late blight. In: Proceedings of the 3rd Annual conference of Crop Protection Society of Ethiopia, Addis Abeba, Ethiopia.
10. Naika S, Jeude JL, Goffau M, Hilmi M, Dam B (2005) Cultivation of tomato: Production, processing and marketing. Agromisa Foundation and CTA, Wageningen, The Netherlands pp: 6-92.
11. Zewdie Y (1989) Hot pepper and tomato production in Ethiopia. In: Tomato and Pepper Production in Tropics, AVRDC, Taiwan pp: 442-451.
12. Dessalegne L, Zewdie Y, Herath E (1992) Agronomic studies in tomato: Horticulture research and development in Ethiopia. Proceedings of the Second National Horticultural Workshops of Ethiopia, Addis Ababa, Ethiopia p: 163.
13. Lemma D (2002) Research experiences in tomato production, research report No. 55. Ethiopia Agricultural Research Organization, Addis Ababa.
14. Balem T (2008) Response of tomato cultivars differing in growth habit to nitrogen and phosphorus fertilizers and spacing on vertisol in Ethiopia. Acta Agri 2: 1.
15. Lemma D, Herath E (1994) Varietal development on vegetables. In: Proceeding of the Second National Horticultural Workshop (eds.), Herath and Lemma, Addis Ababa, Ethiopia pp: 1-3.
16. Yabuuchi E, Kosako Y, Yano I, Hotta H, Nishiuchi Y (1995) Transfer of two *Burkholderia* and an *Alcaligenes* species to *Ralstoniagen*. no: Proposal of *Ralstoniapicketii*. Microbial Immunol 39: 897-904.
17. Giovannucci E (1999) Tomatoes, tomato-based products, lycopene and cancer: Review of the epidemiologic literature. J Natl Cancer Inst 91: 317-331.
18. Orzolek MD, Bogash SM, Harsh RM, Kime LH, Harper JK (2006) Tomato production will. The Pennsylvania State University 2006 Pennsylvania Vegetable Growers Association pp: 1-6.
19. Raini R, Hoffmann V, Zebitz CPW (2005) Integrated Pest Management (IPM) and information flow: Case study tomato stakeholders' practices in Kenya, Tropentag, Stuttgart-Hohenheim pp: 1-4.
20. Domsch KH, Gams W, Anderson TH (1980) Compendium of soil fungi, Academic Press, New York, USA.
21. Hartman GL, Elphinstone JG (1994) Advances in the control of *Pseudomonas solanacearum* race 1 in major food crops. Bacterial wilt: The disease and its causative agent, *Pseudomonas solanacearum*. Wallingford, UK: CAB Int pp: 157-177.
22. Deahl K, Inglis D, De Muth S (1993) Testing for resistance to metalaxyl in *Phytophthora infestans* isolates from northwestern Washington. Ameri J Potato Res 70: 779-795.
23. Hayward AC (1991) Biology and epidemiology of bacterial wilt caused by *Pseudomonas solanacearum*. Ann Rev Phytopatho 29: 65-87.
24. Amsellem Z, Zidack NK, Quimby PC (1999) Long-term dry preservation of viable mycelia of two mycoherbicide organisms. Crop Protect p: 18.
25. Zadoks JC, Schein RD (1979) Epidemiology and plant disease management. Oxford University Press, New York p: 456.
26. Prior P, Steva H (1990) Characteristics of strains of *Pseudomonas solanacearum* from French West Indies. Plant Disease 74: 13-17.
27. Pandey RP, Solanki PN, Saraf RK, Parihar MS (1996) Effect of nitrogen and phosphorus on growth and yield of tomato cultivars. Punjab Vegetable Grower 31: 1-5.
28. Lemaga B, Kanzikwera R, Kakuhenzire R, Hakiza JJ, Manzi G (2001) The effect of crop rotation on bacterial wilt incidence and potato tuber yield. African Crop Sci J 9: 257-266.