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Distribution and Importance of Tomato Fungal Diseases in Raya Valley, Southern Tigray, Ethiopia

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Abstract

Tomato is one of the most important vegetable crops in Ethiopia that its production was constrained by several biotic and abiotic factors. Among the biotic factors, diseases caused by fungal pathogens are the most important constraints limiting productivity of the crop. However, the importance and distribution status of the diseases has not been studied in Raya valley. Therefore, the present study was conducted to assess the relative importance and distribution status of fungal diseases in the Raya valley of Southern Tigray, Ethiopia. The study was conducted in 2018 and 2019 based on purposive multistage sampling procedures by 5-10 km intervals to assess the fields. The results indicated that late blight, early blight, septoria spot, fusarium wilt and powdery mildew were among the important fungal diseases observed in tomato fields of the study areas. The diseases were prevalent and significantly ($p<0.05$) varied in disease intensity among the districts and peasant associations. The highest extent of prevalence and intensity of the diseases have been recorded from Raya Azebo than Raya Alamata district for both consecutive years. Similarly, under peasant association level there was a significant variation in prevalence and intensity of the diseases. Overall, the present study proved that fungal diseases are found in different extent of prevalence and intensity with different degrees of economic importance in the Raya valley. Therefore, investigation on the variability of the pathogens, association of agronomic practices and environmental conditions with the diseases should obtain the research focus. Besides, to sidestep the destruction and yield losses due to the diseases, all management practices must be coincided in the form of integrated disease management.

Keywords: Disease; Incidence; Prevalence; Severity; Tomato

Introduction

In the Tomato (*Solanum lycopersicum L.*) is one of the most popular warm-season vegetable crops widely grown throughout the world and the most important crop in the industrialized world [1]. It is grown for its fruits that are consumed in fresh and processed forms. Tomato fruits are rich in nutrients, minerals and vitamins. The crop has been produced for the last eight decades in Ethiopia [2]. However, commercialization of crop cultivation was started in 1980 by Merti Agro-industry for both domestic and foreign markets [3]. Gradually, cultivation of this crop was promoted to other parts of the country. Consequently, small-scale commercial production of this crop is currently taking place in different parts of the country.

In Ethiopia, tomato is an important food ingredient in the daily diet of people [4]. The crop has been given top priority in vegetable research of the country in the last decades and planned as high-value commodity crop in future research strategies of the country. The crop plays an important role in the national economy of the country since serves as raw material for the processing industries, an important cash crop to farmers, and a source of employment to the populations. Tigray region shares a significant percentage of the total tomato production of the country whenever the southern zone of Tigray region is the highest tomato-producing zone (CSA, 2020). Despite its economic importance, the average national yield (6.52 t/ha) of the crop was low in Ethiopia (CSA, 2021). This might be occurred due to different biotic and abiotic constraints [5].

Among the major constraints, diseases caused by different fungal pathogens are the major ones [6]. Sommer reported that fungi are the most important and prevalent pathogens causing yield losses of 30 - 100% on crops. Accordingly, yield losses of 14.2% to 52.9% under field conditions were reported due to tomato early blight (*Alternaria solani*) from southern Tigray [7] while up to 100% loss was recorded from tomato late blight (*Phytophthora infestans*) [8]. Septoria spot (*Septoria lycopersici*) is also capable of causing complete defoliation of plants, reducing fruit yield and loss of quality greatly [8]. Additionally, reports indicated the economical importance of fusarium wilt (*Fusarium oxysporum*) [9].

Powdery mildew caused by (*Leveilul ataurica)* is another main concern for tomato-producing communities and is reported to cause up to 40% of yield losses [10]. Recently, fungal diseases have been causing serious problems in the tomato production of Ethiopia and southern zone of the Tigray region in particular [11]. In the southern zone of Tigray, farmers are forced to abandon their production due to disease pressure in the field. Despite this fact, the distribution of fungal diseases and their relative importance across the study areas has not been well profiled. Therefore, this study was initiated to determine the distribution and relative importance of tomato fungal diseases across the study areas that could be used as information to develop proper management strategies for the diseases.

Materials and Methods

Description of the study area

A detailed diagnostic survey was conducted in the southern zone of the Tigray region during 2018 and 2019 under an irrigation cropping

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system. Two major tomato growing districts namely Raya Alamata and Raya Azebo districts purposively selected. The study area is found at 665 km far apart from Addis Ababa to the northern part of Ethiopia. This area is found between an elevation range of 930 - 3171 meters above sea.

Distribution of the diseases

The study was conducted in 2018 and 2019 under an irrigation cropping system to determine the relative importance and distribution of the diseases. Districts and peasant associations were purposively selected by consulting zonal agricultural bureaus and districts agricultural and natural resource offices, respectively. From each peasant association, five farmer's fields were assessed by random sampling method of the fields. The survey trips were made following the main roads and accessible routes in the surveyed districts, and stops were made randomly at every 5 - 10 km intervals based on vehicles odometers. The assessment was carried out along the two diagonals (in an ''X'' fashion) using $2m^2$ quadrants at least 10m far apart from each other approximately. In each field, 5 quadrants were systematically assigned to the respective points and tomato plants within the quadrant were counted and recorded as an infected and healthy plants. Incidence and severity of the diseases were assessed through direct visual observation of the symptoms of the diseases on the tomato plants across the quadrants

The diseases were assessed based on the incidence of the diseases, the number of diseased plants compared to the total number of assessed plants expressed as a percentage of incidence of the diseases. Similarly, severity of diseases was calculated from the ratio of the infected area of tissue to the total area of tissue expressed as a percentage. Severity of each disease was examined visually on the whole plants within the quadrants and recorded as the percentage of plant part (tissue) affected, using the respective scoring scale of each disease. Assessment of tomato late blight, early blight and septoria leaf spot severity was done from ten plants randomly from each quadrant using a 0-9 disease scoring scale according to [11]. Similarly, a 0-5 disease scoring scale [12] was used for fusarium wilt while powdery mildew was assessed using a 0-6 disease scoring scale according [13]. To determine the prevalence of tomato diseases across the study area, the number of tomato fields with disease infection and the total number of tomato fields assessed per district were recorded and calculated using a formula described [14]. Percent severity index was calculated for each disease separately based on the formula used by scholars previously.

Data analysis

Data of disease incidence and severity were analyzed using two stages nested design GLM procedure of SAS 9.4 statistical software. The significance of the difference between means of districts and peasant associations was calculated using the LSD test under a significance level of 0.05.

Results and Discussion

Distribution of the diseases

The study results indicated that tomato diseases were prevalent in both assessed districts of Raya Valley with different extents of disease intensity. During the surveys, five tomato diseases: late blight, early blight, septoria leaf spot, powdery mildew and fusarium wilt were observed as the main bottleneck of tomato production. In line with the present result, previously the importance of these diseases have been reported from different parts of Ethiopia [15]. The result of the present study depicted that the extent of the distribution and intensity of each disease was varied within and among districts. Of the 40 fields assessed, the mean prevalence of tomato late blight was 100%. Tomato late blight disease was equally prevalent in both districts for both consecutive years. Statistically, there was no significant difference ($p < 0.05$) among the districts in the incidence of tomato late blight. However, there was a significant difference among districts in the 2018 cropping season in the severity of tomato late blight. The incidence of late blight was 79.1 and 73.7% in the Raya Azebo district, whereas 67.5 and 68.5 % were recorded from the Raya Alamata district in the 2018 and 2019 cropping season, respectively. Severity of tomato late blight was the higher in Raya Azebo district with a mean value of 36.7 and 31.3% in the 2018 and 2019 years respectively. Our results identified that late blight was economically the important and widely distributed disease in Raya valley known by dryness and rainfall shortage. However, this is by far disagreed with previous facts that the disease is more severe in humid and high rainfall areas [16].

Early blight was among the important diseases recorded during 2018 and 2019 in southern Tigray. During the survey, early blight was 100% prevalent in the Raya Azebo and majority fields of Raya Alamata districts. Statistically, there was a significant difference ($p < 0.01$) in the intensity of tomato early blight among the districts of the study area. The highest incidence of early blight was recorded from Raya Azebo district for both years. Similarly, the highest disease severity was recorded from Raya Azebo district with a mean of 24.7% and 27.4% in the 2018 and 2019 cropping seasons, respectively. The present result proved the report of that identified the economic importance of early blight in southern Tigray. Concurrently, and reported significantly different extent of disease intensity of early blight from a survey conducted in different locations [17]. This variability of early blight intensity between the districts could be associated with tomato variety used, the virulence of the pathogen, environmental conditions and agronomic practices prevailing across the locations [18].

Septoria leaf spot was another important disease in both surveyed districts of the zone. Prevalence of the disease was the highest in the Raya Azebo district with mean values of 95.8% and 100% during the 2018 and 2019 cropping seasons, respectively. In the same way, intensity of this disease was higher Raya Azebo district consecutively for both surveyed years (Table 1). Statistically, there was a significant difference ($p<0.05$) between districts in incidence and severity of tomato septoria spot. In addition, powdery mildew and *Fusarium wilt* were among the diseases that have been identified as the bottleneck of tomato production in southern Tigray. The result of this survey was showed that diseases that have been considered economically minor, have become economically emerging in course of time. Powdery mildew is becoming an important disease in all tomato-growing areas of southern Tigray [19].

Distribution and intensity of the diseases across the peasant associations

Results of the present study indicated that late blight was 100% prevalent in all peasant associations of the study area whereas early blight was 100% prevalent in peasant associations of Raya Azebo district (Table 2). The extent of disease incidences and severities across the peasant associations were significantly different ($p < 0.05$) from each other for all diseases except incidence of powdery mildew and fusarium wilt in 2018 (Table 2). Similarly, in 2019, incidences and severities of the diseases across the peasant associations were significantly different ($p < 0.05$) from each other except severity of powdery mildew. The highest incidence of late blight was recorded from Wergeba, Kera

Table 1: Prevalence and intensity of tomato fungal diseases during 2018 and 2019 in Southern zone of Tigray region under irrigation cropping system.

Year of study	Districts	Late Blight			Early Blight			Septoria Leaf Spot			Powdery Mildew			Fusarium Wilt	
		Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc
2018	Raya Azebo	100	79.1	36.7^{a}	100	72.6^{a}	24.7	95.8	51.3^{a}	16.5^{a}	88	33.7	14.8	66.7	22.1
	Raya Alamata	100	67.5	25.8^{b}	87.5	46.1^{b}	20.6	79.2	27.7^{b}	8.7^{b}	71	31.7	11.1	62.5	20.1
	LSD		NS	8.1		9.4	NS		9.2	4.2		NS	NS		NS
2019	Raya Azebo	100	73.7	31.3	100	78.7^{a}	27.4	100	53.0^{a}	16.7^{a}	100	36.7^{a}	12.2	83.3	19.7
	Raya Alamata	100	68.5	26.2	91.7	52.1^{b}	22.9	83.3	32.7^{b}	12.1^{b}	88	27.5^{b}	11.5	62.5	14.6
	LSD		NS	NS		6.6	NS		6.9	3.8		6.4	NS		NS

Table 2: Prevalence and intensity of tomato fungal diseases during 2018 and 2019 across the peasant associations in Southern zone of Tigray region under irrigation cropping system.

Year of study	Districts	Peasant associations	Late Blight			Early Blight			Septoria Leaf Spot			Powdery Mildew			Fusarium Wilt	
			Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc	Sev	Pre	Inc
2018	Raya Azebo	K.Adisho	100	85.0^{ab}	39.2^{ab}	100	86.7^{a}	27.5^{bc}	100	60.0^{a}	18.3^{a}	83.3	41.7	15.0^{ab}	66.7	16.7
		Wergeba	100	95.0^{a}	51.7^{a}	100	73.3^{ab}	24.2^{bc}	83.3	45.0^{ab}	15.0^{ab}	66.7	21.7	1.7^{b}	50.0	15.0
		Werebaye	100	78.0^{abc}	34.0^{bc}	100	72.0^{abc}	30.0^{b}	100	50.0^{a}	13.0^{abc}	100	26.0	10.0^{ab}	100	34.0
		B.Delbo	100	58.0^{c}	21.7^{c}	100	58.3^{bc}	18.3^{cd}	100	50.0^{a}	19.2^{a}	100	44.2	17.5^{a}	50.0	20.0
	Raya Alamata	Gerjele	100	60.0^{c}	20.0^{c}	100	88.5^{a}	44.2^{a}	100	51.7^{a}	15.0^{ab}	66.7	26.7	14.2^{ab}	66.7	18.3
		K.Lemlem	100	75.0^{abc}	29.2^{bc}	100	54.2^{c}	23.3^{bc}	100	29.2^{bc}	8.3^{bc}	66.7	38.3	21.7^{a}	50.0	20.0
		Limhat	100	67.0^{bc}	30.0^{bc}	83.3	26.7^{d}	10.0^{de}	50.0	16.7^{c}	5.8^{c}	100	42.5	13.3^{ab}	50.0	23.3
		S.Bekalsi	100	67.0^{bc}	24.2^{bc}	66.7	15.0^{d}	5.0^{e}	66.7	13.3^{c}	5.8^{c}	50.0	19.5	10.0^{ab}	83.3	26.7
		$LSD_{(0.05)}$		24.8	16.2		18.9	10.5		18.4	8.5		NS	15.4		NS
2019	Raya Azebo	K.Adisho	100	90.0^{a}	44.2^{a}	100	83.3^{a}	25.8^{bc}	100	62.5^{a}	20.0^{a}	100	40.0^{ab}	14.5	66.7	11.7^{b}
		Wergeba	100	84.2^{ab}	36.7^{ab}	100	85.0^{a}	30.0^{bc}	100	53.3^{ab}	18.3^{a}	100	31.7^{abcd}	7.5	83.3	19.2^{ab}
		Werebaye	100	69.0^{bcd}	28.0^{bcd}	100	84.0^{a}	33.0^{b}	100	52.4^{a}	13.0^{ab}	100	32.0^{abcd}	13.0	100	30.0^{a}
		B.Delbo	100	50.8^{d}	15.8^{d}	100	63.3^{b}	21.7^{c}	100	45.8^{b}	15.0^{ab}	100	42.5^{a}	13.3	83.3	21.5^{ab}
	Raya Alamata	Gerjele	100	55.0^{cd}	19.2^{cd}	100	93.3^{a}	45.8^{a}	100	60.8^{a}	20.0^{a}	66.7	20.0^{d}	9.2	66.7	17.5^{ab}
		K.Lemlem	100	75.0^{ab}	29.2^{bc}	100	63.3^{b}	26.7^{bc}	66.7	41.7^{b}	15.8^{a}	83.3	25.0^{cd}	11.7	50.0	8.3^{b}
		Limhat	100	73.3^{abc}	30.8^{bc}	100	33.3^{c}	12.5^{d}	100	18.3^{c}	7.5^{bc}	100	35.8^{abc}	12.5	66.7	15.0^{ab}
		S.Bekalsi	100	70.8^{bc}	25.8^{bcd}	66.7	18.3^{d}	6.7^{d}	66.7	10.0^{c}	5.0^{c}	100	29.2^{bcd}	12.5	66.7	16.7^{ab}
		$LSD_{(0.05)}$		19.1	12.9		13.3	9.1		13.8	7.6		12.7	NS		15.7

Adisho, Werebaye and Kulugize Lemlem peasant associations with the mean of 95%, 85%, 78% and 75% in 2018, respectively (Table 2). However, there was a slight change in the incidence of the disease in the 2019 cropping season. Statistically, there was a significant difference ($p < 0.01$) among peasant associations in disease intensity of tomato late blight for both consecutive survey years.

The intensity of tomato early blight was also significantly different ($p < 0.05$) among peasant associations of the study areas. The highest incidence and severity of the disease were recorded from the Gerjele peasant association both of the years (Table 2). Whenever the lowest early blight intensity was observed in Selam Bekalsi and Limhat peasant associations of the Raya Alamata district. Correspondingly, reported significantly different extents of early blight intensity across the peasant associations of the same study areas. His study also identified variations of early blight intensity across the locations of southern Tigray was concerned with the altitude, crop growth stage, a crop variety used and tillage frequency, crop rotation, irrigation type, irrigation frequency, weed management, seed source and seedling preparation system that has been prevailing in the areas.

In addition, tomato septoria spot was found economically important in all the surveyed peasant associations of the area during the 2018 and 2019 cropping season. The prevalence of this disease was varied from 83.3 - 100% in Raya Azebo and 50 - 100% in Raya Alamata district whereas the incidence of the disease was recorded from Kara Adisho peasant association with the mean severity of 20% (Table 2). The balance of mean severity of septoria spot was the highest in Raya Azebo peasant associations than that of Raya Alamata peasant associations throughout the surveyed years. Our results also identified the importance of powdery mildew and fusarium wilt across the peasant associations regardless of the distribution and intensity of the diseases. Both of the diseases were 100% prevalent in the Werebaye peasant association of Raya Azebo district (Table 2). Incidence of the disease was not significantly different among peasant associations in the 2018 cropping season for both diseases. However, the incidence of *Fusarium wilt* was significantly different among peasant associations during the 2019 cropping season.

In general, five fungal diseases were recorded during the present study with significantly different extent of disease intensity across the locations. Those significant variations between the locations could be occurred due to divergence of environmental conditions and cultural practices used by farmers. Additionally, growth stage of the crop and crop variety used [20] and virulence variations of the pathogen might be the possible reason for the variation of the intensity of the diseases across the peasant associations.

Summary and Conclusion

Tomato production is constrained by different fungal diseases mainly late blight, early blight, septoria spot, fusarium wilt and powdery mildew in the southern zone of the Tigray region. The complexes of these diseases have been causing significant yield losses of the crop. The study results have been shown the significant extent of distribution and intensity of the diseases in the study areas that could be influenced by environmental and agronomic practices used by farmers. Therefore,

regular assessment of the diseases distribution and intensity might play a crucial role in the planning of proper diseases management strategies. In addition, association of the diseases with environmental and agronomic factors should be intensively investigated to suggest the optimum manipulation of those factors to the farmers. Besides, future works should be emphasized on the identification of integrated disease management options to reduce the risk of yield losses due to these diseases in the study areas.

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References

1. Ashby JA (2009) The impact of participatory plant breeding. Plant breeding and farmer participation, 649-671.
2. Bellon MR (1991) The ethno-ecology of maize variety management: a case study from Mexico. Human Ecol 19:389-418.
3. Qazi HA, Rao PS, Kashikar A, Suprasanna P, Bhargava S (2014) Alterations in stem sugar content and metabolism in sorghum genotypes subjected to drought stress. Funct Plant Biol 41:954-962.
4. Biggs S (2008) The lost 1990s? Personal reflections on a history of participatory technology development. Development in Practice 18:489-505.
5. Ceccarelli S, Grando S (2019) From participatory to evolutionary plant breeding. In Farmers and Plant Breeding 231-244.
6. Ceccarelli S (2012) Landraces: importance and use in breeding and environmentally friendly agronomic systems. Agrobiodiversity conservation: securing the diversity of crop wild relatives and landraces. CAB International 103-117.
7. Ceccarelli S, Grando S, Tutwiler R, Baha J, Martini AM, et al. (2000) A methodological study on participatory barley breeding I. Selection phase. Euphytica 111:91-104.
8. Ceccarelli S, Guimarães EP, Weltzien E (2009) Plant breeding and farmer participation. Food and Agriculture Organization of the United Nations, Rome, Italy.
9. Chiffoleau Y, Desclaux D (2006) Participatory plant breeding: the best way to breed for sustainable agriculture? Int J Agric Sustain 4:119-130.
10. Cleveland DA, Daniela S, Smith SE (2000) A biological framework for understanding farmers' plant breeding. Economic Botany 54:377-394.
11. Acquaah G (2012) Principles of plant genetics and breeding. Wiley-Blackwell, Oxford.
12. Aly RSH (2013) Relationship between combining ability of grain yield and yield components for some newly yellow maize inbred lines via line x tester analysis. Alex J Agric Res 58: 115-124.
13. Comstock RE, Robinson HF (1952) Estimation of average dominance of genes. Heterosis 2:494-516.
14. Griffing B (1956) Concept of general and specific combining ability in relation to diallel crossing systems. Aust J Biol Sci 9: 463-493.
15. Hallauer AR, Miranda Filho JB, Carena MJ (2010) Hereditary variance: mating designs. In quanti gen in maize bre: 81-167.
16. Hill WG (2010) Understanding and using quantitative genetic variation, Philosophical Transactions of the Royal Society B. Biolog Sci 365: 73-85.
17. Johnson GR, King JN (1998) Analysis of half diallel mating designs me: a practical analysis procedure for ANOVA approximation. Silvae Genetica 47: 74-79.
18. Kearsey MJ, Pooni HS (1996) The genetical analysis of quantitative traits. Recent res sci technol 9: 34-56.
19. Khan SA, Ahmad A, Khan A, Saeed M (2009) Using line x tester analysis for earliness and plant height traits in sunflower (*Helianthus annuus L.*). Recent Res Sci Technol 1: 202–206.
20. Clerg EL (1966) Significance of experimental design in plant breeding. Significance of experimental design in plant breeding. Biolog Sci 365: 72-86.