

## Assessment of Turcicum Leaf Blight and Rust Diseases on Maize in Different Agro Ecologies of Ethiopia

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### Abstract

Common leaf rust (*Puccinia sorghi* Schw) and Turcicum leaf blight (*Exserohilum trurcicum*) is the major foliar fungal diseases of maize in Ethiopia causing yield losses in the range of 12% to 61% rely up on the genotypes. Survey was conducted on 13 major maize growing areas of 330 farmer fields, in the mains seasons of 2015 and 2016. The objective of this survey was to assess the severity, incidence and reaction of varieties under production to Turcicum leaf blight (TLB) and Common leaf rust (CLR) in major maize growing agro-ecologies of Ethiopia. Systematic survey was used to collect disease data by followed the main and feeder roads of major maize growing areas. The overall TLB mean prevalence, incidence and severity were 83.3%, 57.5% and 31.2% in assessed areas, respectively. Whereas, the overall CLR mean prevalence, incidence and severity were 39%, 23.6% and 12.9%, in that order. This survey result indicated that TLB has been the major fungal disease problem in most maize growing zones of during survey periods. Most maize varieties were showed susceptible reactions to TLB than CLR disease. Therefore, more attention will be given for TLB disease and race analysis should be done in order to study genetic variability of this disease. Moreover, most susceptible maize varieties for both diseases will be pulled out from production areas and replaced with new resistance maize varieties.

**Keywords:** Common Leaf Rust; *Puccinia sorghi* Schw; Turcicum Leaf Blight; *Exserohilum trurcicum*; Prevalence; Incidence; Severity

### Introduction

Maize (*Zea mays* L.) is one of the popular crops grown in the world, ranking second to wheat and followed by rice [1]. It occupies an important position in the world economy as food, feed, and industrial grain crop. It is a staple food for several million people in the developing world where they derive their protein and calorie requirements from it.

Maize is among the leading cereal crops selected to achieve food self-sufficiency in Ethiopia [2]. Although, improved cultivars have been largely included in the national extension package, the national average yield of maize is only 3.45 tons/ha [3], which is far below the world average of 5.5 tons/ha.

The low yield is attributed to a number of factors such as Biotic (Diseases, insect pests, and weeds), abiotic (moisture, soil fertility, etc). Among biotic factors, foliar diseases such as turcicum leaf blight (*Exserohilum trurcicum*) and common rust (*Puccinia sorghi* Schw) are generally among the important constraints in tropical maize production [4].

Although turcicum leaf blight (TLB) and common leaf rust (CLR) were common in the past, their prevalence, distribution and incidence has been increased in recent years in most major maize growing regions (Personal observation). Common rust caused by *Puccinia sorghi* Schw is a destructive disease in the major maize growing highland areas and causes from 12 - 61% yield loss in disease epidemic years [5]. It is found worldwide in subtropical, temperate, and highland environments with high humidity [6]. Common leaf rust is most conspicuous when plants approach tasseling. It may be recognized by small, elongate, powdery pustules over both surfaces of the leaves. Pustules are dark brown in early stages of infection; later, the epidermis is ruptured and the lesions turn black as the plant matures [6].

TLB has a wide host range and a high pathogenic variability with several races already reported in different parts of the world [7,8]. It can cause yield loss in the range of 13.6 to 56% depending up on the genotype. TLB yield losses can easily exceed 50% if the disease appears before flowering [9,10]. It is known to infect maize from the seedling stage to maturity. The symptoms first start as small elliptical spots on the leaves as grayish green with water soaked lesions parallel to leaf margins, the spots turn greenish with age and increased in size, finally attaining a spindle shape with long elliptical grayish or tan lesions. If the disease starts at an early stage, it causes premature death of blighted leaves. As a result, the crop losses their nutritive value as fodder [11], have reduced germination capacity, Vigor; grain yield and total sugar content [12], have restricted starch formation, chaffy kernels and infected plants are liable to infection with stalk rots [13].

Maize is very important in national economically though there was no quantified data that reflected the intensity of both diseases across maize growing agro ecologies and the reaction of varieties under production to these diseases. Thus, the objective of this study was to assess the severity, incidence and reaction of varieties under production to Turcicum leaf blight (TLB) and Common leaf rust (CLR) in major maize growing agro-ecologies of Ethiopia.

## Materials and Methods

The survey was conducted in two consecutive main growing seasons of maize (2014/15 - 2015/16). The target zones were inspected within three survey routes. The first route was included East Wollega, Illubabor and Jimma zones. The second rout was Horo Guduru Wollega, West Wollega, East and West Gojam. The third route was West Hararghe, and SNNP regional state. Total surveyed zones were 13 including Gedowo zone Gedeb district, Hadiya zone Shone district and other special district like Alaba district.

From each representative Zones, 3 Districts was selected based on maize growing potentials. The District agricultural Development offices of the respective zones were interviewed about the suspected diseases and guided tours were made together with the district agricultural Development offices supervisors and Developmental agents (DAs) of surveyed sites. Relevant information was collected from selected districts by inspection, interviewing of farmers, agricultural workers and Beaur of agriculture (BOA).

### Survey strategy

Systematic survey was used to collect disease data from 33 districts of 330 farmer maize fields. Ten farmer fields per district were selected. We were followed the main and feeder roads based on maize growing potential areas. In each field, 10 maize plants were inspected and disease data recorded for both diseases. Global Positioning Systems (GPS) readings were taken from each farmer field and the coordinates used to generate maps using the Geographic Information Systems (GIS) software Arc View 3.2a and spatial analyst 1.1 (Environmental Systems Research Institute, Inc. Seattle, WA, U.S.A).

### Disease assessment

Turcicum leaf blight and common rust disease incidences in each field were assessed as the proportion of plants showing symptoms in a field by visual observation. In each field 10 plants were randomly selected and the number of plants having TLB and CLR symptoms on a whole plant basis counted and expressed as a percentage of the plant population. Severity of both diseases from 10 randomly selected plants was rated using a scale of 1 - 5 [14]. Where:

1. Very slight to slight infection, one or two to few scattered lesions on lower leaves.
2. Light infection, moderate number of lesions on lower leaves only
3. Moderate infection, abundant lesions are on lower leaves, few on middle leaves.
4. Heavy infection, lesions are abundant on lower and middle leaves, extending to upper leaves.
5. Very heavy infection, lesions abundant on almost all leaves plants prematurely dry or killed by the disease.

Severity scores were converted to percept disease index (PDI) as described by Wheeler [15] using the formula below:

$$\text{PDI} = \frac{\text{Sum of numerical grading}}{\text{Plants examined} \times \text{maximum disease grade}} \times 100$$

### Survey data analysis

Survey data (prevalence, incidence and severity) were analyzed by using the descriptive statistical analysis (means) over districts and varieties. The scale of disease data were changed to severity index percentage for descriptive statistical analysis.

**Results and Discussions**

Among 330 visited maize fields, 100% TLB disease prevalence was recorded at 220 maize fields (Table 1). The highest mean disease prevalence (100%) was recorded at West Hararghe, Sidama, Silite and 2 special zones of Gedeo and Hadiya. The second higher mean disease prevalence was recorded at west Gojam, East Wollega, East Gojam, West Wollega, Illubabor and Jima zones, respectively. None (0%) TLB disease prevalence was recorded at all maize fields of Horo Guduru Wollega Zone. The overall TLB mean prevalence was 83.3% throughout the surveyed major maize growing areas.

More than 50% TLB mean incidence was recorded on 10 zones (77%) of West and East Gojam, East Wollega, Illubabor, West Hararghe, Gedeo, Hadiya, Silite, Sidama and Alaba. None (0%) TLB mean incidence was recorded at Horo Guduru Wollega followed by Jima (46.3%) and West Wollega (48%), respectively (Table 1). Hundred percent TLB incidence was recorded at Dabo district of Illubabor zone. The overall TLB mean incidence was 57.5% at surveyed zones.

The highest TLB severity was recorded at Dabo, Gobusayo, Wayutuqo and Qersa districts, respectively (Table 1). Similarly, the highest TLB mean severity was recorded at Hadiya followed by Gedeo, East Wollega, West Gojam, Illubabor, Silite, Alaba, West Hararghe and East Gojam zones, in that order. The least TLB mean severity was recorded at West Wollega and Jima zones, whereas zero TLB mean severity was noted at Horo Guduru Wollega zone. The overall TLB mean severity was 31.2% in the surveyed areas.

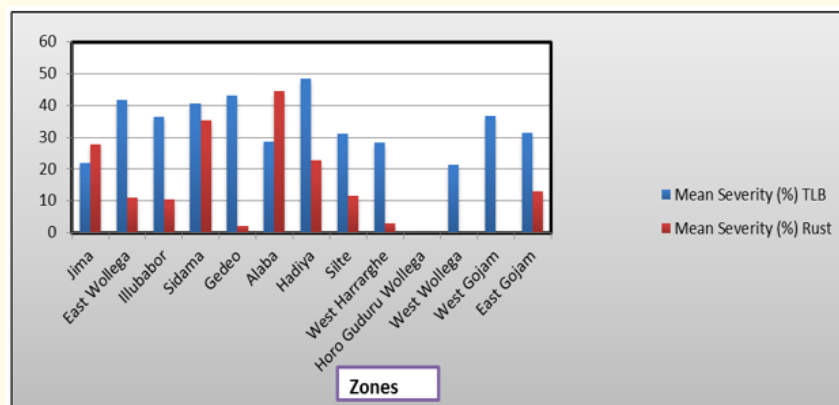
Among 330 observed maize fields, 100% Common leaf rust (CLR) disease prevalence was recorded at 30 maize fields only (Table 1). The highest CLR prevalence (100%) was recorded at Toba, Qersa and Loka Abaya districts of Jima and Sidama zones. The second highest mean prevalence (90%) of CLR was recorded at Jima, Sidama, Alaba and Hadiya zones followed by East Wollega zone with 50%. The least CLR mean prevalence was recorded at Gedeo followed by West Hararghe, Silite and Illubabor zones, respectively. No CLR prevalence was recorded at Horo Guduru Wollega, West Wollega, West and East Gojam zones. The overall CLR mean prevalence was 39% in all observed maize fields.

More than 50% CLR mean incidence was recorded at Sidama Alaba and Hadiya zones (Table 1). Whereas no disease incidence was recorded at 4 zones (Horo Guduru Wollega, West Wollega, West and East Gojam zones).

The highest CLR incidence was recorded on Qersa (75%) followed by Loka Abaya (70%) and Alaba (68%) zones. The overall CLR mean incidence was 23.6% at surveyed areas.

The highest CLR severity was recorded in Qersa (46.3%) followed by Loka Abaya (37.4%) districts, respectively (Table 1). Similarly, the highest CLR mean severity was recorded in Alaba (44.4%) followed by Sidama (35.3%) and Jima (27.7%) zones. The least CLR mean severity was recorded at Gedeo (2%) and West Hararghe (2.7%) zones, whereas 0% CLR mean severity was noted at Horo Guduru Wollega, West Wollega, West and East Gojam zones. The overall CLR mean severity was 12.9% in the surveyed areas.

In general, except Jima, and Alaba special zones, the highest Turcicum leaf blight mean severities were recorded on the 11 maize growing zones (Figure 1). The overall TLB mean intensity (Prevalence, incidence and severity) was higher than CLR in observed areas.



**Figure 1:** Severity of TLB and CLR on major maize growing areas.

Region	Zones	Districts	No. of fields inspects	Prevalence (%)		Incidence (%)		Severity (%)	
				TLB	CLR	TLB	CLR	TLB	CLR
Oromia	Jima	Toba	10	50	100	24	35	3.1	18.8
		Goma	10	60	70	30	40	12.5	18
		Qersa	10	100	100	85	75	50	46.3
	Total/mean		30	70	90	46.3	50	21.9	27.7
	East Wollega	Gobusayo	10	100	50	90	27.3	56.3	18.8
		Sibusire	10	70	40	29.5	17.8	18.8	6.3
		Wayutuqa	10	100	60	53	21	50	7.5
	Total/mean		30	90	50	57.5	22	41.7	10.9
	Illubabor	Chewaka	10	60	40	33.5	24.5	21.3	12.5
		Dabo	10	100	30	100	25	66.3	6.3
		Bedele	10	70	60	31.9	29.4	21.3	12.5
	Total/mean		30	76.7	43.3	55.1	26.3	36.3	10.4
	West Hararghe	Tulo	10	100	10	66	10	30.5	2
		Gemechis	10	100	0	67	0	29.4	0
		Chiro	10	100	30	64.5	15	25.6	6
Total/mean		30	100	13.3	65.8	8.3	28.5	2.7	
Horo Guduru	Jima rare	10	0	0	0	0	0	0	
	Guduru	10	0	0	0	0	0	0	
	Hababo guduru	10	0	0	0	0	0	0	
Total/mean		30	0	0	0	0	0	0	
Oromia	West Wollega	Gimbi	10	40	0	27	0	13.1	0
		Lalo Asabi	10	100	0	58.5	0	31.75	0
		Haru	10	100	0	58.5	0	19	0
	Sub-total/mean		30	80	0	48	0	21.3	0
SNNP	Sidama	Hawasa zuria	10	100	90	73	59	40.4	32.8
		Yiriba Boricha	10	100	80	76.5	58	45	35.8
		Loka Abaya	10	100	100	70.5	70	36.4	37.4
	Sub-total/mean		30	100	90	73.3	52.3	40.6	35.3
	Gedeo	Gedeb	10	100	10	74.5	5	43	2
	Alaba	Alaba	10	90	90	64.5	68	28.6	44.4
	Hadiya	Shone	10	100	90	78.5	53	48.2	22.7
	Silite	Sankura	10	100	30	71.5	15	37.2	6.67
		Wulberreg	10	100	10	70.5	6.5	27.8	2
		Dalocha	10	100	50	68	43.13	28.4	26.25
Sub-total/mean		30	100	30	70	21.5	31.1	11.6	
Amhara	West Gojam	Bure	10	80	0	53	0	31	0
		Denbecha	10	100	0	66.5	0	38	0
		Jabi Tenan	10	100	0	65	0	41	0
	Sub-total/mean		30	93.3	0	61.5	0	36.7	0
	East Gojam	Mechekel	10	90	0	57.5	0	31	0
		Gozamin	10	100	0	59.5	0	31.5	0
		Aneded	10	60	0	40.5	0	22	0
	Sub-total/mean		30	83.3	0	52.5	0	28.2	0
Over all mean		330	83.3	39	57.5	23.6	31.2	12.9	

Table 1: Intensity of TLB and CLR maize diseases in thirteen surveyed zones of Ethiopia.

Maize varieties in the surveyed fields were Limmu, shone, BH540, BH543, BH660, BH661, BH140 and local varieties. The highest distributed maize varieties among farmers were BH660 followed by BH661, Limmu, Local (unknown), Shone, BH540, BH140 and BH543, respectively.

The highest mean TLB disease severity was recorded on BH661 maize variety (Table 2). The second higher mean disease severity was recorded on BH543 maize variety. There were no any TLB disease free farmer fields that planted with these two maize varieties. Varied ranges of TLB severities were recorded on Limmu followed by BH540 and Shone maize varieties, respectively. The least TLB mean severities were recorded on BH660 followed by BH140 maize variety.

The highest rust mean severities were recorded on BH543 (Table 2). The second higher rust mean severity was recorded was on BH 540 followed by Limmu, shone and local (unknown) maize varieties. No rust disease severities were recorded on BH660, BH661 and BH140 maize varieties throughout surveyed areas (Table 2). In general, except B543, seven maize varieties were showed the highest mean TLB disease severities than CLR mean disease severities (Figure 2).

Variety Name	Severity			
	Range		Mean	
	TLB	Rust	TLB	Rust
Limmu	0 - 76	0 - 70	34.1	12.4
Shone	0 - 68	0 - 42	33.9	5.9
BH660	0 - 60	0	18	0
BH661	25 - 60	0	40.7	0
BH540	0 - 70	0 - 76	33.5	21.8
BH140	0 - 35	0	23.8	0
BH543	25 - 50	0 - 75	40.2	40.5
Local (unknown)	0 - 60	0 - 28	29.8	5

Table 2: TLB and Rust survey severity by maize varieties.

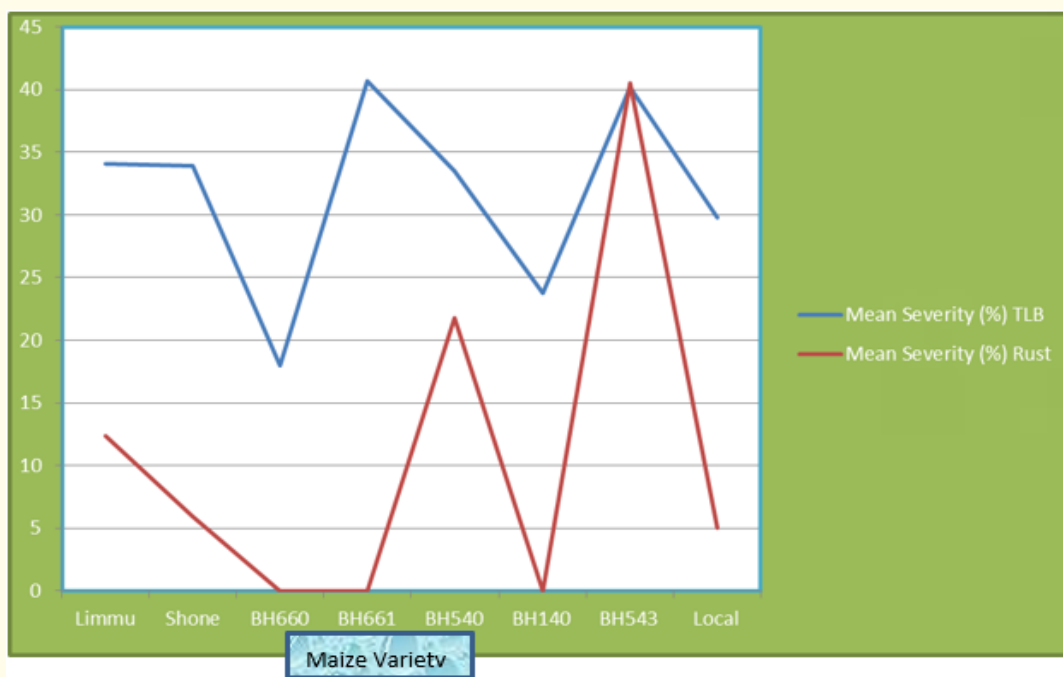


Figure 2: Severity of TLB and CLR on maize varieties.

## Conclusion and Recommendation

Turcicum leaf blight (TLB) and Common leaf rust (CLR) are the most foliar fungal diseases of maize in Ethiopia. Survey was conducted throughout major maize growing areas of the country to know the status of these two diseases. Totally, 13 zones, 33 districts and 330 maize fields were assessed. The overall TLB mean intensity (Prevalence, incidence and severity) was higher than CLR in observed areas.

The overall TLB mean prevalence, incidence and severity were 83.3%, 57.5% and 31.2% in assessed areas, respectively. Whereas, the overall CLR mean prevalence, incidence and severity were 39%, 23.6% and 12.9%, in that order. From 330 inspected maize fields, 0% CLR disease intensity was recorded at 130 fields. But 0% TLB disease intensity was recorded only from 30 maize fields. This survey result indicated that TLB has been the major fungal disease problem in most maize growing zones of during survey periods.

Among 8 maize varieties in the surveyed areas, BH660 was the most widely distributed variety at farmer fields. The least TLB mean severity was recorded on this variety. No CLR severity was recorded on BH660, BH661 and BH140 maize varieties. BH543 maize variety was susceptible for TLB and CLR diseases. In general, most maize varieties were showed susceptible reactions to TLB than CLR disease. Therefore, more attention will be given for TLB disease and race analysis should be done in order to study genetic variability of this disease. Moreover, most susceptible maize varieties for both diseases will be pulled out from production areas and replaced with new resistance maize varieties.

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