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Importance of Wheat Leaf Rust (*Puccinia triticina*) at Minjar, Moretena Jihur and Basonawarena Districts of East Shewa Zone of Amhara Region, Ethiopia

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Abstract: Wheat is the major staple food of around 35% of the globes population than other food source cereals. Ethiopia is the major wheat producer in sub-Saharan African countries. The average yield is still 2.78 t/ha, which is lower than potential yields of 3.57 t/ha which is mainly altered by rusts lack of improved variety and limited agronomic practices. The field survey was carried out during 2019 cropping season in three major wheat growing zone at Minjar, Moretnajihur and Basonawarena districts of east shewa Zones which are which are known as wheat production potential and highly suitable environment for the disease development. Leaf rust can vary across different location and with different severity and incidence score. The aim of this work is to get informed about the importance of wheat leaf rust at Eats Shewa zone of Amhara Region. Leaf rust was distributed across all assessed area of the each district with varying prevalence percentage. The highest leaf rust severity 40% were recorded at Basonawarena districts; while the lowest severity 15% was recorded at Minjar district. Regarding to incidence 100% infection were recorded at Minjar districts whereas the lowest 20%sparsely infection was recorded at moretenajihur district. A 100% severity was observed at Memher Hager peasant associations in Minjar district. But, Zero was at Bollo PA of Moretena Jihur district. The highest level of infection 100% disease incidence and 30% disease severity has been reported in the altitude ranges from 1500 to 2300 m.a.s.l. the higher leaf rust incidence 100% is recorded on Durum wheat; conversely the lower incidence 80% was on bread wheat type. Higher incidence 100% was recorded at maturity stage. Conversely; high severity 40% was recorded at dough stage with susceptible reaction. This indicates that; it is important to points manage leaf rust starting from booting to dough stage since it cause damage.

Keywords: Leaf Rust, Severity, Incidence, Response, East Shewa, Minjar, Basonawarena and Moretnajihur

1. Introduction

Agriculture is the major unlocking for self-food security in Ethiopia. Agricultural is the major backbone to ensure the whole gross domestic product (GDP); it constitutes about 85% of the national growth domestic product of the country. Its economy was registered 7.7% growth in 2017/2018, slower than the 10.9% expansion recorded in 2015/2016. This growth was attributed to 12.2% rise in industrial output, 8.8% expansion in service sector and 3.5% growth in agriculture [18]. Crop production is a major contributor to GDP, among the above-all of crops, cereals are the most important food crop which provides daily food calories to the people. Hence, cereal production and marketing are the means of livelihood strategy

for millions of smallholder households in Ethiopia [19]. Wheat is the major staple food of around 35% of the globes population than other food source cereals. Its rich source of protein, minerals, vitamins, and its produce is larger than five billion quintal of wheat in one harvest year in Ethiopia [17].

Ethiopia is one of the largest wheat producers in terms of total wheat area cultivated and total production [3]. In Ethiopia, wheat ranks third after maize and teff in total production [4]. The highlands of Ethiopia are major producer of wheat [4]. In Ethiopia the national average yield is still 2.78 t/ha, which is lower than potential yields of 3.57 t/ha [3]. Wheat production in Ethiopia is continually threatened by virulent and rapidly evolving fungal pathogens that cause "wheat rusts," age-old and devastating diseases of the crop. Periodic, unpredictable

outbreaks of rust have overcome the resistance of popular wheat varieties in recent years, rendering the varieties obsolete and in urgent need of replacement. Wheat diseases, such as stem rust, yellow rust and leaf rust (P. triticina) are among the critical biotic factors affecting wheat production in Ethiopia. Other major factors that contributed to low wheat yields in Ethiopia are a lack of access to improved varieties, backward agronomic practices, use of marginal agricultural land, and terminal drought stress, among others [7, 16].

All rust diseases and lack resistance varieties were identified as the major production limits for wheat production in Ethiopia [11]. In Ethiopia, wheat leaf rust is one of the most important diseases in most wheat growing areas of the country [6]. Volunteer wheat, winter wheat and/or wind dispersed spores transported from region to region are the prime source of inoculum each year [14]. However, the alternate host is thought to play a role in the evolution of new races [15] as is somatic hybridization [12] although the main source of variation in the pathogen is most likely mutations (Groth, 1984).

The spores produced by the leaf rust fungus would be detached from the leaf for dispersal [1, 9]. Teliospores are produced at the end of the growing season and help the pathogen to overwinter [14]. Monitoring and evaluation of wheat leaf rust is significant to access the importance. Documentation of the seasonal occurrence, severity and incidence of leaf rust will allow for the prevention and control of wheat leaf rust. The aim of this work is to get informed about the importance of wheat leaf rust at Eats Shewa zone of Amhara Region.

2. Materials and Methods

2.1. Assessment of Leaf Rust

The field survey was carried out during 2019 cropping season in three major wheat growing zone at Minjar, Moretnajihur and Basonawarena districts of east shewa Zones which are which are known as wheat production potential and highly suitable environment for the disease development. A total of 42 fields were assessed. Among this; 10 farms were assessed at Minjar, 16 fields from Moretenajihur and also 16 fields were from Basona warena district of the zone. From each district, four Peasant associations (PA's) were selected and from each PA's, four farms were assessed at 5-20 km interval following main and feeder (accessible) roadsides [20]. During the assessment farmer's field; the Farmer's Training Center and research stations were assessed at different crop growth stages based on Zadoks cereal growth stage (0-9) key.

Table 1. *Agro-ecology of assessed areas.*

| Zone | Districts | Coordinates | | Altitude | Temperature (°c) | | RF (mm) |
		N	E	(m.a.s.l)	Min.	Max.	
North Shewa zone	MoretenaJiru	9°36′	39°38′	2828	6.1°C	24°C	890
	Basona werana	10°41′	39°47′	2828	135°C	21.5°C	1000
	Minjar	8°45′	39°15′	2120	13°C	29°C	854

2.2. Disease Data Collection

Observations on response and severity of leaf rust were recorded according to [10]. Disease observations were recorded on response and severity of stripe rust was recorded according to [10].

Table 2. *The observation on response of stripe rust.*

Reaction	Observation	Response value
No Disease	0	0.0
Resistant	R	0.2
Resistant to Moderately Resistant	R-MR	0.3
Moderately Resistance	MR	0.4
Moderately Resistant to Moderately Susceptible	MR-MS	0.6
Moderately Susceptible	MS	0.8
Moderately Susceptible to Susceptible	MS-S	0.9
Susceptible	S	1

Source: [10].

Severity was recorded determined by visual observation:
Readings of severity and reaction were recorded as follow:

Table 3. *Leaf rust severity expressed as percentage coverage of leaves with rust pustules - Cobb`s scale modified by Peterson [13].*

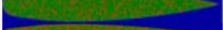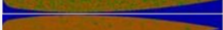| Percentage leaf rust infection relative to susceptible check	Type of resistance
80-100%	Susceptible
50-70%	Race-nonspecific, low resistance
30-50%	Race-nonspecific, moderate resistance
10-20%	Race-specific, high resistance
Less than 10%	Race-specific, high resistance
Less than 5%	Effective, race-specific resistance

Leaf rust severity (%) was recorded from the fields at all growth stage [8]. Estimates of severity were measured according to Modified Cobb Scale [13], which is used to determine the percentage of tissue rusted and was evaluated from 1% to 100%. The severity was recorded as percent of rust infection on the plants (Table 4). The severity of the disease was examined on randomly selected five plants in quadrant as a percentage of stem area infection by rust disease according to modified Cobb scale after [13] (Table 4).

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total nummber plants in the quadrant}} * 100;$$

Geographical data such as Latitude (N), Longitude (E) and Elevation (mm) of were using Garmin 600 model GPS recorded.

Table 4. Standard area diagrams used to estimate wheat leaf rust (Puccinia recondita f. sp. tritici; Prt).

Severity Grade	Severity (%)	standard area diagrams	Description of disease severity for wheat leaf rust (*Puccinia recondita* f. sp. *tritici*; *Prt*)
0	0		No uredie visible, nekrotike lesions may be detected
1 0.	1-5		Small uredie appear pustula with a defined necrosis.
2	5.1-25		average size Uredie, lesions clearly defined
3	25.1-50		Uredia are large, no visible necrosis.
4	50.1-75		Uredia are mainly large and visible
5	75.1-100		Uredia are mainly large

2.3. Data Analysis

Disease incidence and severity data obtained from field survey were analyzed using simple Microsoft excel analysis methods.

3. Result and Discussion

Variation of leaf rust with in the districts of the zone.

Leaf rust can vary across different location and with different severity and incidence score. Leaf rust was distributed across all assessed area of the each district with varying prevalence percentage. The highest leaf rust severity 40% were recorded at Basonawarena districts as compared to others; while the lowest severity 15% was recorded at Minjar district. Regarding to incidence 100% infection were recorded at Minjar districts whereas the lowest sparsely infection about 20% were recorded at moretenajihur district (Table 5). Plants can respond different reaction at different ecologies with different growth performance. A reaction of moderately susceptible to susceptible reaction was recorded at Basonawarena districts but moderately susceptible response of wheat was recorded at Minjarand moretenajihur (Table 5).

Table 5. Leaf rust Severity and Incidence varied within districts of the zone.

Zone	Districts	Severity %	Incidence %	Response
East shewa	Minjar	30	100	MS
	Basona warena	40	80	MS-S
	Moretena Jihur	15	20	MS

During the survey all assessed fields were farms infected by leaf rust. Different severity ranges were starts from 30-100% were observed at all assessed farms of Memher Hager peasant associations in Minjar district. But, the lower were Zero to fifteen at Bollo PA of Moretena Jihur district. In agreement with [21]; higher yellow rust (stripe rust) is favored stripe rust is favored by temperatures between 2 and 23°C and non-limiting moisture, the same result indicated at Duna district has direct correlation with low temperature at high altitude 2495-2546 m.a.s.l (Table 6). Here with different crop responses were recorded from zero to susceptible. At severely infection peasant association; cultivated wheat variety moderately susceptible (MS) to susceptible (S) crop responses.

Table 6. Leaf rust Severity, Incidence and Response of wheat varied at PA's.

Districts	PA's	Incidence %	Severity %	Response
Minjar	Shewa genet	0-25	0-5	Free-MS
	Memher Hager	30-100	30- 100	MS
	Samasenbet	35-40	5-20	MS
	Angolella	0-50	0-20	MS
Basona warena	Bakelo	80	45	S
	Saria	10-15	5-35	MS
	Atikilt	60	25	MS
	Bollo	0	0	0
Moretena Jihur	Gerba	5	2	MS
	Denato	20	15	MS
	Mangudo	15	5	MS

According to the traditional classification system of agro-ecological zones; 500-1500 m.a.s.l is lowlands, 1500-2300 m.a.s.l is mid-lands and 2300-3200 m.a.s.l which is highland. The current survey was carried out at altitude ranges of 1802-2867 m.a.s.l. This study showed that stem rust is important at all altitudes nowadays. The highest level of infection 100% disease incidence and 30% disease severity has been reported in the altitude ranges from 1500 to 2300 m.a.s.l. This shows

leaf rust is also becoming important at higher elevations due to association of with climate change, widespread, susceptible commercial varieties and appearance of new virulent races. At high altitude leaf rust incidence was 80% while the severity was 35 % (Table 7). Leaf rust is adapted to all agro-ecologies which is favored for development and evolvement of new races. The evolving new races will let challenge for production of wheat across suitable ecologies.

Table 7. Leaf rust Severity and Incidence varied at altitudes.

Altitude	Class name	Incidence %	Severity %	Response
1500-2300 (m.a.s.l)	Mid-altitude	100	30	MS
2300-3200 (m.a.s.l)	High altitude	80	35	S

When compared to wheat types by leaf rust incidence and severity; higher incidence 100% is recorded on Durum wheat. Conversely the lower incidence 80% was on bread wheat type. Regarding severity; about 40% was recorded on bread wheat. While low severity percentage was on durum wheat. From the result, susceptible reaction was recorded on the assessed durum wheat. But; bread wheat has revealed moderately susceptible (MS) response (Table 8).

Table 8. Leaf rust Severity and Incidence varied at wheat types.

Wheat types	Incidence %	Severity %	Response
Bread wheat	80	40	MS
Durum wheat	100	30	S

Different leaf rust occurrence percentage was recorded on different cultivated wheat variety. Wider range yellow rust incidence 80 and 100% with complete field infection has been recorded on wheat field cultivated with Kubsa and Mangudo varieties (Table 9). This result indicates that leaf rust is developing complete infection of all wheat cultivars. Conversely narrow range 60% of infection was recorded on kakaba (Table 9). Likewise; less infection 50% were recorded on local cultivars with moderately susceptible response; conversely higher infection with susceptible reaction was recorded on cultivated variety.

Table 9. Leaf rust Severity and Incidence varied at wheat varieties.

Wheat varieties	Incidence %	Severity %	Response
Kubsa	80	40	S
Mangudo	100	30	MS
Kakaba	60	40	MS
Local cultivars	50	20	MS

Maturity stage of wheat has a great contribution for the severity and incidence of leaf rust. Yellow rust occurs at early stage of wheat. The infectivity of leaf rust at early stage boosts to cause a high amount of yield loss. With this regard; higher incidence 100% was recorded at maturity stage. Conversely; high severity 40% was recorded at dough stage with susceptible reaction (Table 9). This indicates that; it is important to points manage leaf rust starting from booting to dough stage since it cause damage. When we are looking the result less incidence and severity were recorded at Milk stage with moderately susceptible reaction during the assessment (Table 10).

Table 10. Leaf rust Severity and Incidence varied at maturity stage.

Maturity stage	Incidence %	Severity %	Response
Matured	100	30	MS
Dough	80	40	S
Milk	15	5	MS

4. Conclusion

Leaf rust is important along the assessed area. During the assessment complete infection and sever damage was recorded. In some area farmers field even whipped out on wheat cultivated with susceptible cultivars. The wheat pathology and breeding program must have to take responsibilities to tackle this global challenge. To do so; it is important to take survey and surveillance during all cropping season. Consequently; distribution factor favors for the development of epidemics and evolvement of new races. Leaf rust disease development is affected by environmental factors: moisture, temperature and altitude. Temperature is more important for leaf rust infection. To reduce this disease distribution; a combination environmentally safe and sustainable disease management practices with disease resistance with some environmentally low hazardous fungicide applications are the most effective means for yellow rust control.

Conflict of Interest

The author has not declared conflict of interest.

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