Agriculture, Forestry and Fisheries
2022; 10(2): 81-85
http://www.sciencepublishinggroup.com/j/aff
doi: 10.11648/j.aff.20221102.13
ISSN: 2328-563X (Print); ISSN: 2328-5648 (Online)

Rate of Stripe Rust (*Puccinia striliformis*) at Ada'a, Lume and Gimbichu Districts of East Shewa Zone, Ethiopia

Zewde Ashagre Asnakew

Plant Pathology, Debre Zeit Agricultural Research Centre, Debre Zeit, Ethiopia

Email address:
ashagre.asnakew@gmail.com

To cite this article:
Zewde Ashagre Asnakew. Rate of Stripe Rust (*Puccinia striliformis*) at Ada'a, Lume and Gimbichu Districts of East Shewa Zone, Ethiopia. *Agriculture, Forestry and Fisheries*. Vol. 10, No. 2, 2022, pp. 81-85. doi: 10.11648/j.aff.20221102.13

Received: February 21, 2022; **Accepted**: March 21, 2022; **Published**: March 29, 2022

Abstract: Stripe (Yellow) rust caused by *Puccinia striiformis* f.sp. *tritici (Pst)* is important wheat diseases causing serious damage on cultivated susceptible wheat variety. The wheat yellow rust assessment was conducted during main rainy season of 2018/19 at Ada'a, Lume and Gimbichu using zigzag method of diseases assessment. Disease data's, agro-eological data and other important parameters were recorded. The disease was prevalent at all districts by diverse incidence and severity ranges. This implies that yellow rust is distributed wheat disease at all surveyed potential districts. The highest yellow rust prevalence 62.5% was recorded at Gimbichu district: conversely; the lowest prevalence percentage 31.25% was recorded at Ada'a district. The highest severity and incidence of yellow rust 60% and 100%, respectively was recorded at Ada'a district with susceptible reaction; while the lowest severity and incidence (30% and 5%) respectively was recorded at Lume districts with moderately susceptible reaction. Yellow rust is governed by many for the distributions and occurrence. Highest yellow rust incidence 100 S was recorded from field cultivated with bread wheat kakaba and Kubsa varieties at growth stage of Milk to matured stage. Local cultivar has shown lowest incidence and severity percentage with moderately susceptible responses than improved varieties.

Keywords: Prevalence, Severity, Incidence, Districts, Yellow Rust

1. Introduction

Wheat is an important food crop which is cultivated at fourth ranks in Ethiopia [14]. Wheat is important cereal crops and strategic for food security which is grown in the highlands. Nowadays, wheat is also cultivated in lowlands [8]. Wheat is a source of food for about 40% of the world population provides a significant proportion of the protein and calories [15, 21]. Ethiopia has experienced production of both bread and durum wheat cultivated in the highlands of the country largely in the areas like East, Central and North West parts [1]. The crop is grown at an altitude ranging from 1500 to 3000 (m.a.s.l) preferably 1,900 and 2,700 m.a.s.l [7] between 6-160N latitude and 35-420 E longitudes. The mean production of the country 3.046 tha^{-1} [10] of the country is still low compared to the global yield, 3.65 t/ha. The low productivity and instability wheat productivity in Ethiopia is caused by biotic and abiotic stresses. Cereal rust fungi (*Puccinia* spp.) are among the most studied plant disease-causing agents, as they affect cereals and grasses in all parts of the world, potentially causing devastating yield losses. Some of the most important cereal rust diseases are stem rust, stripe rust, leaf rust on wheat, leaf rust on rye (*P. recondita*), barley leaf rust (*P. hordei*) and crown rust on oats (*P. coronata*) [23, 9]. Cereal rust species can be subdivided based on their host specificity [13], and all cereal rusts may infect a wide variety of wild grass species. The alternate hosts of *P. graminis* include *Berberis* spp., *Mahonia* spp., *P. recondita* and Clematis [19]. Alternate hosts are important for epidemiology in providing build up inoculum to rust development and in acting as a source of new pathotypes by hosting the sexual stage of the fungal life cycle. Diseases of wheat causes significant yield losses especially stem rust, leaf rust and yellow rust [11]. Under very favorable conditions for the pathogen, especially at high altitude, damages up to 100% crop loss are common [6]. In Ethiopia, frequent yellow rust epidemics have occurred in the past accompanied by appearance of virulent races causing susceptibility on popular bread wheat verities like *Lakech* [16] and Dashen [5]. In Ethiopia, several survey and surveillances has been conducted in bulk this leads to biasness and missed quality. Conducting a survey for specific disease provides complementary evidence for the reliable importance of yellow rust across all similar agro-ecology. There is detailed information gap about the distribution of yellow rust. The purpose of the study was to gather the spread extent of yellow rust at Ada'a, Lume and Gimbichu districts of East shewa zone.

2. Material and Methods

2.1. Field Assessment

The field survey, for the assessment of disease intensity and distribution *Puccinia striliformis* was carried out during 2018/19 main cropping season at three districts of East shewa zone of Oromia region. The three districts namely: Ada'a, Lume and Gimbichu were selected purposely selected based suitable for wheat production and disease development. In view of the criterion, four peasant associations (PA)/kebeles were selected [3] and from each PA, four fields were assessed at 5-20 km interval from main and feeder (accessible) roadsides [3]. A total of 48 cultivated wheat fields were assessed; 16 fields at each three districts were assessed. During assessment farmer's field, Farmer's Training Center (FTC) and agricultural research stations were assessed at crop growth stages between milk and maturity stages based on Zadoks cereal growth stage (0-9) key.

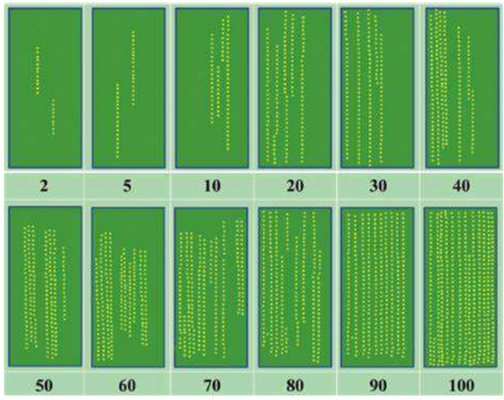

Figure 1. *Yellow rust severity score scale. (Sources: [20, 17]).*

Table 1. *Agro-ecological descriptions of survey study areas.*

Agro-ecology		Districts		
		Ada'a	**Lume**	**Gimbichu**
Latitude (N)		44"	8°58"	8°12"
Longitude (E)		38°57'	39°06'	39°17"
Altitude (m.a.s.l)		1950	2450	1900
	Minimum	8°C	9°C	9.2°C
Temperature	maximum	28°C	29°C	29.3°C
	Average	19°C	17°C	19°C
RF (mm)		851	1200	951

Source: [2] (Gimbichu district).

2.2. Data Collection

The assessment was made at five points along the two diagonals zigzag pattern of the field using 1m x 1m ($1m^2$) quadrate and used to calculate average values. The yellow rust prevalence was calculated by using the formula:

$$\text{Prevalence} = \frac{\text{Number of infected fields}}{\text{Total proportional number fields assessed}} * 100$$

Moreover, disease incidence was estimated by the formula:

$$\text{Yellow rust incidence} = \frac{\text{Number of Diseased plants}}{\text{Total proportional numbr of plants in the quadrat}} * 100$$

Disease observations were recorded on response and severity of stripe rust was recorded according to [20]. [4] referred that yellow rust severity (%) was recorded from the fields at all growth stage [19]. Estimates of severity were measured according to Modified Cobb Scale [22]. The severity was recorded as percent of rust infection on the plants (Figure 1).

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

Reaction	Observation	Response value
No Disease	O	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

In each field, wheat plants within the quadrate were counted and recorded as infected and non-infected and disease incidence was calculated. The incidence yellow rust was calculated as follows.

$$\text{Yellow rust severity} = \frac{\text{Number of Diseased plants}}{\text{Total proportional numbr of plants in the quadrat}} * 100$$

Severity was recorded by visual observation; below 5% severity intervals were as trace (T) to 1.

Readings of severity and reaction were recorded as follow:

TR: Trace severity of resistant type infection.

10MR: 10% severity of a moderately resistant type infection.

30MS: 30% severity of a Moderately Susceptible type infection.

50S: 50% severity of a susceptible type infection.

In addition to the disease parameters, other agronomic and ecological data of the field were recorded. Other important contributing factor of agro-ecological data such as: Latitude, Longitude and Elevation (m.a.s.l) of each field were recorded using Garmin 600 model GPS.

3. Result and Discussion

3.1. Prevalence Percentage of Yellow Rust

The disease detected all surveyed districts with diverse prevalence percentage. During the assessment highest yellow rust prevalence 62.5% was confirmed at Gimbichu district; but; the lowest stripe rust prevalence 31.25% was at Ada'a district. The elevation of Gimbichu district is grouped as high land area. In agreement with [6], [4] reported that yellow rust is more sever by low temperature at high altitude. Stripe rust (*Puccinia striliformis*) disease was reported as principally a disease of wheat grown in cooler climate conditions (2 to 15°C); generally associated with higher elevations, northern latitudes, or cooler conditions. The low yellow rust prevalence percentage at Ada'a is due to categorized under lowland agro ecology. The response of the wheat cultivated infection shown as from zero to susceptible reactions. Based on all assessment criteria; yellow rust is becoming important at all districts as indicated below (Table 3).

Table 3. *Prevalence of yellow rust in assessed districts with varying altitude.*

Districts	Prevalence	Altitude (m.a.s.l)	Incidence (%)	Severity (%)	Response
Ada'a	31.25 %	1879-1957	0-100	0-60%	Zero-S
Lume	56.25%	1811-2003	0-30	0-5	MS
Gimbichu	62.5%	2297-2443	0-60	0-5%	MS

3.2. Incidence, Severity and Response of Yellow Rust Across Districts

Among total 48 assessed fields; yellow rust was detected only at 24 fields. At Ada'a districts five fields out of 16 fields were infected by 100% and 60% S of incidence, severity and response on cultivated wheat (Table 4). Ada'a district is located at mid-altitude. Whereas; at Lume district only nine fields were detected low infection by 30% and 5% incidence and severity with moderately susceptible response. Even more fields are infected low yellow incidence and severity is recorded. This moderately susceptible doesn't indicate that cultivated wheat is not tolerant for the disease because a Lume district is known not important for yellow rust development. Lume district is categorized under low altitude agro ecology. Lume district is not important for yellow rust occurrences.

Table 4. *Variation of stripe rust incidence, severity and response within the districts.*

Districts	Farms detected		Incidence %	Severity %	Response
	Total	Infected			
Ada'a	16	5	100%	60 %	S
Lume	16	9	30%	5%	MS
Gimbichu	16	10	60%	5%	MS

Table 5. *Variation of yellow rust incidence, severity and response in the peasant associations/kebeles in each district.*

Districts	PA	Altitude	Incidence	Severity	Response
Ada'a	Kality	1879-1931	0	0	0
	Ganda Gorba	1915-1957	5%	5%	MS
	Tadechaa	1905-1932	60-80%	20-40%	MS-S
	Denkaka	1874-1928	100%	60%	S
Lume	Golba Godde	1849-1914	0-15%	0-5%	MS
	Tullu re'ee	1960-2003	0-5%	0	MS
	dhaka boora	2029-2094	0-5%	0	MS
	Sharraa dibandiba	1811-1978	30%	5%	MS
Gimbichu	Girmi	2297-2328	0-50%	5%	MS
	Lemlem chefe	2307-2322	5-60%	5%	MS
	Habru seftu	2421-2438	0-25%	0-5%	MS
	Gole	2438-2443	0	0	0

3.3. Incidence, Severity and Response of Yellow Rust Across Peasant Associations

At Kality and Gole PA's of Ada'a and Lume districts were not infected during the assessment fields of peasant associations were infected by yellow rust (stripe rust). Among assessed farms higher yellow rust incidence 100% and 60-80% were observed at Denkaka and Tadecha PA's of Ada'a district (Table 5). When compare the districts by Peasant associations; The highest incidence and severity of yellow rust at Lume district was 15% and 5% at Golba Gode, and Tullu re'ee and dhaka boora each; respectively (Table 5). Regarding severity; lowest yellow rust severity zero (0) were noted at Ada'a district of Kality PA's and Gole of Gimbichu district. But during the survey season wheat crop is severely infected by stem rust at all assessed locations.

3.4. Incidence, Severity and Response oOf Yellow Rust as Affected by Maturity Stage

Disease infection is affected by growth stage. Maturity stage is considered as disease management practice letting the crop escaping of the disease occurrence. A yellow rust occurrence is affected by wheat variety and growth stage. Highest yellow rust incidence ranges 80% recorded on milking wheat growth stage [4]. As a result of the assessment; highest severity 100% S on dough stage at Ada'a district (Table 7). While; the lowest incidence zero was recorded on Booting and Maturity stage. This outcome shows that wheat growth and maturity stage have direct correlation with incidence and severity ranging from zero (0) to complete infection of incidence and susceptible reaction. In addition; cultivated wheat variety also gives a chance for the occurrence of yellow rust. Wheat maturity stag is has its own effect on yellow rust occurrence (Table 6). Early appearance causes marked effect on the growth and vigouricity of the wheat, the growth, growth of leaves being retarded and the final length and breadth greatly reduced [12].

Table 6. *Incidence, severity and response of stripe rust as affected by maturity stage with in the districts.*

Districts	Maturity stage	Incidence	Severity	Response
Ada'a	Booting	0	0	0
	Milking	0-80%	0-40%	Zero-S
	Dough	0-70%	0-100%	Zero-S
	Mature	0	0	0
Lume	Booting	0	0	0
	Milking	0-20	0-5%	MS
	Dough	0-40	0-30%	MS
	Mature	0	0	0
Gimbichu	Booting	0	0	0
	Milking	0-60%	0-5%	MS
	Dough	0-50%	0-5%	MS
	Mature	0	0	0

3.5. Incidence, Severity and Response of Yellow Rust as Affected by Wheat Varieties

A yellow rust occurrence is also affected by wheat variety and growth stage. Highest yellow rust incidence ranges 0-100% found at field cultivated with bread wheat [4]. As a result of the study; higher incidence 100 S was obtained on Kubsa bread wheat variety at growth stage of Milk to matured stage (Table 7). Local cultivar has shown lowest incidence and severity percentage with moderately susceptible responses than improved varieties. Fields cultivated with Mangudo had revealed 80% and 5 MS of incidence and severity of yellow rust, respectively.

Table 7. *Variation of incidence, severity and response of stripe rust on variety.*

Variety	Incidence	Severity	Response
Mangudo	0-60%	5%	MS
Ude	0	0	0
Local Cultivars	0-25%	0-5%	MS
Kubsa	0-100%	60S	S
Kakaba	0-40%	0-15%	MS

4. Conclusion

Yellow rust has wide range spread as of other rusts. This may result development of disease epidemics and newly evolving races to risk of wheat production to cause yield loss. Rust disease is commonly known to evolve and develop new races. To tackle this damage; disease survey and surveillances needs to be conducted at untouched areas to know distribution magnitude of this disease. Survey and surveillances at varying agro-ecology and wheat varieties cultivated need to be conducted. Integration of breeding and pathology programs is a must to develop resistance variety for yellow rust and reduce yield loss. Using local cultivars as a source for genetic improvement is mandatory for sustainable production for food security.

Conflict of Author

The authors declare that they have no competing interests.

Acknowledgements

The research budget was allocated from Ethiopian Institute of Agricultural Research at Debre Zeit Agricultural Research Center (DZARC).

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