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Assessment for the Distribution of Yellow Rust at Lemo, Misha and Duna Districts of Hadiya Zone

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Abstract

Yellow (stripe) rust caused by (*Puccinia striiformis* f.sp. *tritici*), is important wheat disease in Ethiopia nowadays. The objective is to detect the distribution pattern of yellow rust at Hadiya zone. The assessment was carried out during 2018/19 cropping season. Three districts namely; Lemo, Misha and Duna from the zone (Hadiya) were selected which are high wheat production potential and suitability for yellow rust development. From each districts; four peasant associations (PA) and four farms were assessed at 5-20 km interval following main accessible roadsides. Yellow rust was distributed at all assessed districts. Prevalence percentage; 87.5%, 93.75%, 100% of yellow rust was recorded at Duna, Lemo, Misha districts; respectively. Wider yellow rust incidence range was recorded 0-100% at Lemo districts; while the lowest 25-60% was at Misha districts. Bread wheat varieties such Hidase, Kakaba and Kubsa were severely infected with severity of 5-60%. Yellow rust is favored by low temperatures at early wheat growth stage. Highest yellow rust incidence ranges 0-100% on field cultivated with bread wheat varieties. Highest severity ranges 0-60% was recorded on fields cultivated with Kubsa variety with free-susceptible reaction. Regarding growth stage; widest incidence range 0-100% was recorded at Milk stage.

Keywords: Prevalence, Yellow rust, Severity, Incidence and Growth stage

Introduction

Yellow (stripe) rust, is one of important wheat disease caused by (*Puccinia striiformis* f. sp. *tritici*) is common in Ethiopia, causing common and frequent crop failed and causing high economic loss (Jaleta *et al.,* 2019). Ethiopia is the largest wheat producer in sub-Saharan Africa with about 0.75 million ha about 60% and 40% of bread and durum wheat produced under rain fed and irrigated conditions (Majaivana *et al.,* 2016). Wheat (*Triticum aestivum* L.) is an important staple food crop in Ethiopia, It provides about 15% of the caloric intake for the country with over 90 million population (FAO, 2018), placing it second after maize and slightly ahead of tef, sorghum, and enset, which contribute 10 to 12% each (Minot et al., 2015). Wheat is also the fourth largest cereal crop produced by about 5 million smallholder farmers, that is, about 35% of all small farmers in the country. 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 (Bekele et al., 2000) between 6-160N latitude and 35-420 E longitudes. Yellow rust is a highly destructive disease threatening wheat production and quality worldwide. This is mainly due to the pathogen's ability to mutate and multiply rapidly as well as to use its air borne dispersal mechanism from one field to another (Brown and Hovmøller, 2002; Watson and De Sousa, 1983).

Yellow rust infects the leaf, leaf sheath and spikes of the wheat plant; it can cause yield losses of 96% depending on the susceptibility of the cultivars and environmental conditions (Eshetu, 1986).

Wheat stripe rust is a macrocyclic rust disease (Jin et al., 2010), resulting in a significant and serious economic loss in the highly susceptible wheat cultivars. Yellow rust (*Puccinia striiformis* f.sp. *tritici*) and stem rust (*Puccinia graminis* f.sp *tritici*) are highly destructive diseases of wheat in worldwide. Previous literatures reported that under favorable conditions these diseases had the ability to destroy the entire wheat crops (Badebo, 2002). At the field scale, stripe rust is favored at high altitude by low temperatures between 2 to 23°C and non-limiting moisture (Eddy, 2009). The recurrent occurrence of these diseases in the study area causes considerable yield losses. The global distribution of yellow is more common to highland, midland and lower altitudes with pandemics occurrence in the 1970s in East African highlands including Ethiopian due to the breakdown of the Yr2 resistance gene which was present in most of the cultivars (McIntosh, 2009). The areas of east African countries (Ethiopia, Kenya) are prone to serious damage by this pathogen as indicator with suitable environment for the development of disease epidemic (Wellings, 2011). Assessment is primary component of research for detection of disease absence and presence. The objective of the study is to detect the distribution magnitude of yellow rust at Hadiya zone districts.

Materials and Methods

The field survey, for the assessment of disease intensity and distribution *Puccinia striliformis* f.sp. *tritici* races was carried out during 2018/19 cropping season at Hadiya Zones which is purposely selected based on wheat production potential and highly suitable environment for the disease development. Considering the aforementioned criteria, three districts were selected. From each district, three to four peasant associations (PA) (Ali and Hodson, 2017) were selected and from each PA, four farms were assessed at 5-20 km interval following main and feeder (accessible) roadsides. In addition to farmer's field, the survey included wheat fields in Farmer's Training Center (FTC) and agricultural research stations. The survey was conducted between milk and maturity stages based on Zadoks cereal growth stage (0-9) key.

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

Agro-ecology		**Hadiya zone**		
		Districts		
		Lemo	**Misha**	**Duna**
Latitude (N)		70 30''	7° 56'	7°20'
Longitude (E)		37055''	38°52"	37°39'
Altitude(m.a.s.l)		2001	2143	2450
Temperature	Minimum	13 °C	10.5°c	12°C
	maximum	26 °C	22.54°c	24°C
	Average	19°C	18°C	17°C
RF(mm)		1150	868.97	932

Source: Amistu et al., 2016

Disease observation. Observations were recorded at the first appearance of stripe rust infection on the susceptible wheat lines. Observations on response and severity of stripe rust were recorded according to Loegering (1959)

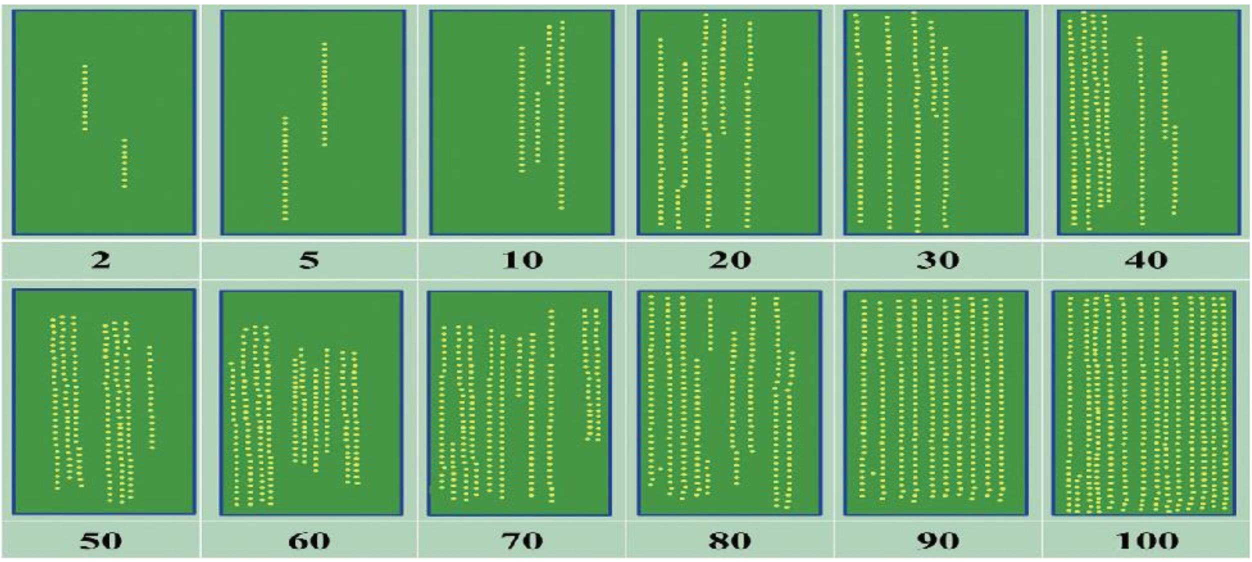
Disease observations were recorded on response and severity of stripe rust was recorded according to Loegering (1959) and Hussain (1997). Yellow rust severity (%) was recorded from the fields at all growth stage (Large, 1954). Estimates of severity were measured according to Modified Cobb Scale (Paterson *et al.*, 1948), 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 (Fig. 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

Severity was recorded determined by visual observation; below 5% severity, the intervals were as trace (T) to 2. Generally, 5% intervals were used from 5-20% severity and 10% intervals for higher readings. 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.



Disease observation. Observations were recorded at the first appearance of stripe rust infection on the susceptible wheat lines. Observations on response and severity of stripe rust were recorded according to Loegering (1959)

Fig. 1. Scale of rust severity (percent of leaf area infected).

Results

Incidence

Incidence data is the critical data for disease distribution assessment. Yellow rust was distributed across all assessed districts of the zone. Wider yellow rust incidence range was recorded 0-100% at Sena lisana association of Lemo districts (Table 3). While the lowest range 25-60% was recorded at Hage peasant association at Misha districts. During the assessment bread wheat varieties such Hidase, Kakaba and Kubsa was severely infected. This severity is forced by much other diseases interaction such as stem rust, leaf rust and other biotic and abiotic factors including yellow rust.. Agro-ecological variations have contributions for the distributions and epidemic occurrence of yellow rust. During the survey the area were categorized under high altitude.

High altitude and susceptible variety are good factor for the occurrence of yellow rust (Table 3). At the field scale, stripe rust is favored by temperatures between 2 and 23°C and non-limiting moisture Eddy (2009). Temperature and moisture effects on stripe rust infection and latency studied under controlled environments (de Vallavieille-Pope et al., 1995; Milus et al., 2009) gave optimal temperatures of 5 to 12, 7 to 12, 10 to 15, or 10 to 18°C.

Table 3. Yellow rust incidence % and severity related at each peasant associations.

Districts	Peasant Associations	Variety	Maturity stage	Altitude (m.a.s.l)	Incidence	Severity	Response
Duna	Barkuncho	Kubsa, Hidase, Land race, Mangudo	Milk-Dough stage	2498-2516	0-70%	0-40%	Zero-S
	Kankicho	Kubsa and Hidase	Milk-Dough stage	2495-2546	60-100%	5-60%	MS-S
Misha	Abushra	kubsa	Milk-Dough stage	2463-2510	25-100	5-25%	MS
	Morsuto	kubsa, Mangudo and hidase	Milk-Dough stage	2560-2613	20-100%	5-25%	MS-S
	Guna	Landrace,Kubsa and mangudo	Milk	2456-2558	100%	5-50%	MS-S
	Hage	Hidase and Landrace	Dough	2386-2449	25-60%	5-25%	MS
Lemo	Ambicho gode	Kekeba, Mangudo and kubsa	Dough	2229-2280	5-40%	5-15%	MS
	Bellessaa	Kubsa and Hidase	Milk, Dough-Matured	2192-2219	15-60%	5-15%	MS
	Ajo tayisa	kakaba and kaubsa	Dough-Matured	2198-2201	5-50%	5-15%	MS
	Sena lisana	Hidase, kakaba and Kubsa	Dough-Matured	2180-2232	0-100%	0-15%	Zero-MS

Severity

During the survey all assessed fields were farms infected by yellow rust (stripe rust). Different severity ranges were starts from 5-60% were observed at all assessed farms of Kankicho peasant associations in Duna district. But, the lower were Zero to fifteen at Sena lisana of Lemo district. In agreement with Eddy, (2009); 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 3). Wheat growth stage has also additional effect; especially lowest maturity stage; milk to booting stage of susceptible variety is important stage for yellow rust infection (Table 3). 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.

Prevalence

Yellow rust was distributed across all assessed area of the each district with varying prevalence percentage. During the assessment high stripe rust prevalence 100% was recorded at Misha districts, but the low 87.5% was recorded at Duna district. This indicates that yellow rust is important wheat disease at all assessed districts. The breeder and other wheat improving programs and institutes need to focus on to get resistant variety to reduce the damage. Proportionally all assessed farms of every district were incidentally infected ranging up to 100% (Table 4). Regarding yellow infection range; wider ranges 0-100% were at Lemo and Duna districts; while lowest ranges 20-100% were at Misha district. Based on all assessment criteria; yellow rust is equally important at all districts as indicated below (Table 4).

Breeding for different agro-ecology of each critical epidemic disease is important to tackle the loss of crop by diseases. Daniel and Tamirat, (2021) find that high land with low temperature is the hot spot zone for yellow rust (*Puccinia striiformis* (*Pst*)) e.g. Meraro and Bekoji are sites yellow rust epidemics for frequent occurrence due favorable environmental and higher pressure of inoculums in the areas.

Table 4. Prevalence of yellow rust at all assessed districts.

Districts	Prevalence (%)	Response recorded	Incidence %	Severity %
Lemo	93.75%	MS	0-100%	0-15%
Misha	100%	MS-S	20-100%	5-25%
Duna	87.5	MS-S	0-100%	0-60%

Infectivity of yellow rust by variety

Different yellow rust (stripe rust) incidence percentage were recorded on different cultivated wheat variety during the assessment. Wider range yellow rust incidence 0-100% with complete field infection has been recorded on wheat field cultivated with Kubsa (bread wheat) and Mangudo (Durum wheat) varieties (Table 5). This result indicates that yellow rust is developing non preference mechanisms as alternatives host of all wheat land races and varieties. Conversely narrow range 60-100% with severe infection was recorded on Landrace (Table 5). Likewise; less infection 0-10% were recorded on Mangudo with free to moderately susceptible response; conversely higher infection 0-60% were recorded on Kubsa with Free-susceptible reaction of cultivated variety. Recently released variety; Hidase has shown that susceptible reaction MS-S with 25-100% and 5-25% incidence and severity value, respectively (Table 5).

Table 5. Yellow rust incidence and severity recorded on wheat varieties.

Variety/ Cultivar	Wheat variety		
	Incidence	Severity	Response
Kubsa	0-100%	0-60%	Free-susceptible
Kekeba	30-80%	5-15%	Moderately susceptible
Hidase	25-100%	5-25%	MS-S
Mangudo	0-100%	0-10%	Free-MS
Land race	60-100%	5-40%	MS-S

Maturity and growth stage

Maturity stage is the critical indicator for yellow occurrence. Yellow rust occurs at early stage of wheat. The occurrence of yellow rust at early stage enhances to cause a huge amount of yield loss. Higher incidence 0-100% was recorded at Milk stage than other growth stage. Similarly; high severity 0-60% was recorded at milk stage too (Table 6). This indicates that; breeding for seedling resistance is important points to manage the yellow rust damage. When we are looking the crop response Resistance (R) to susceptible was also recorded at milk stage.

Table 6. Severity and incidence of yellow rust as affected by wheat growth stage.

Maturity stage	Maturity and growth stage		
	Incidence	Severity	Response
Milk stage	0-100%	0-60%	R-susceptible
Dough	5-90%	5-25%	MS-S
Matured	0-60%	0-15%	R-MS

Discussion

Stripe rust is highly distributed at all assessed areas of the zone with severe infection by the fact that the area is suitable for the development. Consequently; distribution factor may favors for the development of epidemics and evolvement of new races. Stripe rust disease development is mainly dependent on three environmental factors: moisture, temperature and altitude. Low night temperature is more important for yellow rust infection than day-time temperature and light is not required for germination it provides enough moisture in cold air. To reduce this dangerous and alarming 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 declared no conflict of interest

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References

Addis Ababa Chamber of Commerce and Sectoral Associations (AACCSA), 2017. Value chain study on wheat industry in Ethiopia by afro-universal consultant and general trading P.L.C. final report Addis Ababa, January, 2017: 12-59.

Ali, S. and Hodson, D., 2017. wheat rust surveillance: field disease scoring and sample collection for phenotyping and molecular genotyping. In *wheat rust diseases*. 3-11. Humana Press, New York, Ny.

Amistu, K., Temesgen, M., Alemu, A. and Tarekegn, W., 2016. Assessment of beef cattle fattening and marketing system and contribution to household food security in case of lemmo woreda, hadiya zone, southern ethiopia. Journal Of Marketing And Consumer Research, 29: 1-10. nd regions, 28.

Badebo, A., 2002. Breeding bread wheat with multiple disease resistance and high yielding for the Ethiopian highlands: Broadening the genetic base of Yellow rust and tan spot resistance [Ph.D. Thesis]. Georg-August University of Goettingen. 115.

Bekeke, H.K, Varkuijl, H., Mwangi, W., Tanner, D.G., 2000. Adaptation of improved wheat technologies in Adaba and Dodola woredas of the Bale highlands, Ethiopia. Mexico D.F: International Maize and Wheat Improvement Centre (CIMMYT) and Ethiopian Agricultural Research Organization (EARO).

Brown, J.K. and Hovmøller, M.S., 2002. Aerial dispersal of pathogens on the global and continental scales and its impact on plant disease. *Science*; *297*(5581): 537-541.

Daniel, K. and Tamirat, N., 2021. Evaluation of Ethiopian wheat germplasm against yellow rust (*puccinia striiformis*) disease under field condition. *Agriculture, Forestry and Fisheries*. 10 (2) 61-65. doi: 10.11648/j.aff.20211002.14**.**

De Vallavieille-Pope, C., Huber, L., Leconte, M., and Goyeau, H. 1995. Comparative effects of temperature and interrupted wet periods on germination, penetration, and infection of *Puccinia recondita* f. sp. *tritici* and *P. striiformis* on wheat seedlings. Phytopathology 85:409-415.

Eddy, R., 2009. Logistic regression models to predict stripe rust infections on wheat and yield response to foliar fungicide application on wheat in Kansas. Thesis, Kansas State University, Manhattan.

Eshetu, B., 1986. A review of research on diseases of barley, tef, and wheat in Ethiopia. *In*: Tsedeke, A. (eds.). A review of crop protection research in Ethiopia. Proceedings of the first Ethiopian Crop Protection Symposium. 4-7 February, 1985. Addis Ababa, Ethiopia. pp. 79-108.

FAO – Food and Agriculture Organization of the United Nations (2018): Food Chain Crisis, Early Warning Bulletin – Forecasting threats to the food chain affecting food security in countries and regions. 28(62).

Hussain, M., 1997. Report on Evaluation of Candidate Lines against Stripe and Leaf Rusts under National Uniform Wheat, Barley and Triticale Yield Trials, 1996-97. PARC, Islamabad, Pakistan, pp. 23.

Jaleta, M., Hodson, D., Abeyo, B., Yirga, C. and Erenstein, O., 2019. Small holders coping mechanisms with wheat rust epidemics: Lessons from Ethiopia Plos one, 14,e0219327-e0219327.

Large, E. C., 1954. Growth stages in cereals-illustration of the Feekes scale. *Plant Pathol.* 3:128-129.

Loegering, W. Q. 1959. Methods for Recording Cereal Rust Data in International Spring Wheat Rust Nursery (IRN). United States Department of Agriculture, Washington, DC., USA.

Majaivana, D., Magwende, L. and Haile, F., 2016. Determinant of optimum plant density, nitrogen and phosphorus fertilization for different wheat genotypes. *Intern. J man and fertili,* **4(2)**: 592-599.

McIntosh, R.A. 2009. History and status of the wheat rusts. In: McIntosh, R.A. (ed.) Proceedings of the Borlaug global rust initiative 2009 technical workshop BGRI Obregon, Mexico, Pp 11-23.

Milus, E. A., Kristensen, K., and Hovmoller, M. S. 2009. Evidence for increased aggressiveness in a recent widespread strain of *Puccinia striiformis* f. sp. *tritici* causing stripe rust of wheat. Phytopathology 99:89-94.

Minot, N., Warner, J., Lemma, S., Kassa, L., Gashaw, A. and Rashid, S., 2015. The Wheat Supply Chain in Ethiopia: Patterns, Trends, and Policy Options. International Food Policy Research Institute (IFPRI) Washington, DC.

Peterson, R. F., Campbell, A. B. and Hannah, A. E. 1948. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. *Can. J. Res.* 26:496-500.

Watson, I.A. and De Sousa, C.N.A., 1983. Long distance transport of spores *of Puccinia graminis* f.sp *tritici* in the southern hemisphere. In *Proceedings of the Linnean Society of New South Wales*. 106, No. 4, (311-321).

Wellings, C.R. 2007. P. striiformis in Australia: a review of incursion, evolution, and adaptation of stripe rust in the period 1979-2006. Australian Journal of Agricultural Research, 58: 567-575.

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