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Screening of Wheat Genotypes (*Triticum spp*) Against Yellow Rust in Arsi, Ethiopia

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Abstract: Wheat is one of the most widely grown cereal crops globally. Most wheat production in Ethiopia comes from small holder farmers. It is the third most important cereal crop after teff (*Eragrostis tef*) and maize (*Zea mays*) in area coverage and production in Ethiopia. The pathogen causing stripe rust disease infects the green parts on the cereals and grasses. Infection can happen anytime from the one-leaf to plant maturity phase provided the host plants are still green. Screening of 38 wheat genotypes (*Triticum spp*) was made to identify resistant against yellow rust (*Puccinia Striforma.fs.Tritici*) at Kulumsa agricultural research center and Meraro station in 2015 cropping season in Ethiopia. The experiment was laid out in augmented (non- replicated) design. Each plot consisted of two rows of 1-m long with spacing of 0.20m between rows. The average coefficient of infection varied from 0 to 100. The disease was as high as 100 CI on the susceptible check Lackech. The field response of wheat lines on resistance wheat lines were zero. Wheat lines Denbi, Mangudo, Hetossa, DZ -04-118, Yerer, Meraro and bollo had the least average coefficient of infection and regarded as resistance and wheat lines LD-157, dashen, lackech, Kulkulu and kubsa had the highest average coefficient of infection and regarded as susceptible to yellow rust at field.

Keywords: Wheat Genotypes, Coefficient of Infection, Resistant

1. Introduction

The world population (the total number of living humans on Earth) was 7.349 billion as of July 1, 2015 according to the medium fertility estimate by the United Nations Department of Economic and Social Affairs, Population Division. Population in the world is currently (as of 2015-2016) growing at a rate of around 1.13% per year. The average population change is currently estimated at around 80 million per year. The rising continent, Africa also has increasing population in the world having the population of about 1.116 billion [13]. Ethiopia is second ranking country in Africa with its population of over 90 million. The great majority of Ethiopian -population (85%) lives in rural areas, where agriculture is the major stake of livelihood activities. The ever increasing population needs to have increased food source but the only way of increasing productivity is through intensification because the land couldn't have an infinite space for extension. In order to feed the ever increasing population we have to increase wheat production at the rate 1.6% which can be achieved by developing high yielding varieties having a good tolerance level for biotic stress [16].

Wheat is one of the most widely grown cereal crops globally. In 2010, world wheat production was 651 million tonnes, making it the third most produced cereal after maize and rice. The most common species grown are *Triticum aestivum* L. (common wheat) and *Triticum turgidum var. durum* L. (durum wheat) of consumed wheat worldwide common wheat accounts 95% of the total wheat production [23]. It is also major crop in Ethiopia that is central to achieving development in agriculture. Most wheat production in Ethiopia comes from small holder farmers. Wheat is mainly grown in the central and south-eastern highlands during the main (Meher) rainy season (June to September) and harvested in October-November. It is the third most important cereal crop after teff (*Eragrostis tef*) and maize (*Zea mays*) in area coverage and production in Ethiopia. On average, from 2004-2009, wheat production covered 1.51 million hectares of land, and yielded 2.29 million metric tons of grain yield per year [33]. In 2013/14, Ethiopia produced about 3.32 million tons of wheat, almost double the quantity produced in 2010 [7]. Arsi and Bale highlands in south eastern Ethiopia are the major common wheat producing provinces of Ethiopia and are considered the wheat belts of East Africa. The highlands of Bale alone contribute about 11% of the country's wheat production. However, high yield and quality losses due to diseases are confronting farmers [8].

Among the most important diseases of wheat that significantly reduce wheat production are the rusts (yellow, stem and leaf rusts). The rusts of wheat are among the most widely spread pathogens that can be found in most areas of the world where wheat is grown. The disease causing wheat rust fungi are spread in the form of clonally produced dikaryotic urediospores, which can be dispersed by wind for thousands of kilometers from initial infection sites across different areas from continent to oceans. Epidemics of wheat rusts can occur on a continental scale due to the widespread dispersal of urediospores [16].

Wheat rust fungi are highly specific obligate parasites. Rust populations can be characterized by distribution of races and the frequencies of virulence against specific rust resistance genes on a defined set of wheat differential hosts [16]. Wheat leaf, stripe and stem rusts have devastating role in reducing crop yield resulting in socio-economic instability many times across the world. The semi-dwarf wheat varieties with race specific resistance could not survive longer due to the evolution of new rust races [25].

Stripe rust prevalence changes from year to year and from place to place, depending on climatic conditions and variety grown [33]. Major stripe rust (*Puccinia striiformis* f. sp. *tritici*) epidemics occurred in Ethiopia in 1970's, 1988, 2010 [21]. In the Bale highlands, wheat is produced twice a year favoring the continuous perpetuation of the three rusts pathogen year round. Yellow rust monitoring conducted over 1996 to 2000, and surveys indicated that the disease is more important, endemic and severe in the main season (August to December) than in short season (March to July). The development of yellow rust epidemics, in addition to favorable weather factors, depends on the level of cultivar susceptibility, which affects the disease occurrence and its progress, cropping systems and management practices [8]. This situation provides the pathogen not only with a substrate both in area and time, but also results in successive evolution of pathotype lineages and/or new races of the evolution of pathotype lineages and/or new races of the pathogen [15].

The disease occurs regularly in highland areas over 2000 masl where wheat is commonly grow. In 2010 more than 400,000 ha were affected which led to serious losses, though difficult to measure. The epidemic covered almost all wheat growing regions in the country except Tigray Regional state. Most of the commercial bread wheat cultivars were susceptible to yellow rust [21].

Importance and History of Wheat Rusts

The three rusts are known to occur all over the world, in areas where wheat is produced but the damage and injury they cause depends on the environmental conditions and the types of cultivars grown. Stripe rust probably occurred long before wheat was grown for food, the disease was first described by Gaddin Europe in 1777 [6]. It has been reported in more than 60 countries and on all continents except Antarctica. The pathogen causing yellow rust infects the green tissues of wheat plants. Infection can occur anytime from the one-leaf stage to plant maturity provided plants are still green [6]. With the discovery of genetic resistance by deBiffen [5], physiological specialization in the rust by Stakman and Levine [31], and the gene for gene interaction theory by Flor [11], the use of race specific types of resistance has been predominating in wheat improvement. However, resistance based on single race-specific genes often becomes ineffective within few years producing "boom and bust" cycles in wheat production. The "bust" cycles (when rust resistance has been overcome) are caused by pathogens mutating to acquire virulence, virulent races migrating into a new region or the appearance of races favored by selection pressure from the existing pathogen population [34].

Multi-location disease testing of germplasm is used to obtain data to support breeding strategies aimed at broadening the genetic base of resistance by International Maize and Wheat Improvement Centre (CIMMYT), International Centre for Agricultural Research in Dry Areas (ICARDA) and Ethiopian Institute of Agricultural Research (EIAR). Gene postulation based on comparative response data from multi-pathotype tests, and genetic and cytogenetic analyses of segregating hybrid populations make up the principal methods for identifying rust resistance genes in wheat germ plasm and cultivars [1].

Most of wheat varieties released previously in Ethiopia were not tested for race specificity and released variety covers large area in short periods of time. When aggressive pathogen, susceptible host and suitable environmental condition occurred at the same time diseases epidemics were occurs and released varieties were whipped out completely and high shortages of food and loss of produce is occurred. The activity was done to address yellow rust problems in study area through selecting resistance varieties/ genotypes against yellow rust in hot spot area with objectives of identifying resistant genotypes/varieties against yellow rust at hotspot areas under natural condition and recommend best performing wheat genotypes for the breeding program.

2. Literature Review

2.1. Origin and Distribution of Yellow Rust

The worldwide population structure and the center of origin of the pathogen were still unknown. Analyses of linkage disequilibrium and genotypic diversity indicated a strong regional heterogeneity in levels of recombination, with clear signatures of recombination in the Himalayan (Nepal and Pakistan) and near-Himalayan regions (China) and a predominant clonal population structure in other regions. The higher genotypic diversity, recombinant population structure and high sexual reproduction ability in the Himalayan and neighboring regions suggests this area as the putative center of origin of PST. The investigation used clustering methods and approximate Bayesian computation (ABC) to compare different competing scenarios describing ancestral relationship among ancestral populations and more recently founded populations. Their analyses confirmed the Middle East-East Africa as the most likely source of newly spreading, high- temperature-adapted strains; Europe as the source of South American, North American and Australian populations; and Mediterranean-Central Asian populations as the origin of South African populations [14]. The existence of a high genotypic diversity, a high sex ability as well as the independent maintenance of strongly differentiated populations in the Himalayan region pinpoint this region as the possible centre of origin of PST [28].

2.2. The Signs and Symptoms of Yellow Rust

The pathogen causing stripe rust disease infects the green parts on the cereals and grasses. Infection can happen anytime from the one-leaf to plant maturity phase provided the host plants are still green. Signs appear about 1 week after infection. Sporulation has been observed as starting about 2 weeks after infection, under optimal temperature surroundings. The symptoms produced by the disease on host appear as chlorotic or necrotic specks on plants showing resistance. The fungus forms long, yellow to orange-colored fine stripes on leaves (usually between veins) and on leaf sheaths, glumes and awns on vulnerable plants. Once infection occurs on a leaf, the stripe rust pathogen continues to grow parallel to the leaf axis to produce long stripes. The straight strip formed of pustules is an important distinguishing characteristic of this disease. These strips are formed of tiny rust pustules, called uredia. Each uredium contains thousands of urediniospores. A single urediniospore is too small to be seen without microscopic tool. On seedlings, an individual infection is not restricted by leaf veins, and may develop to produce pustules that entirely cover the leaf tissue of the host plant [17, 6].

2.3. Host Ranges of Yellow / Stripe Rusts of Wheat

Puccinia striiformis has its hosts only in the Gramineae family. In the cereal group, wheat and barley are the principal hosts. Several wild grasses can harbor stripe rust pathogenic to wheat and barley, but their role in the epidemiology of stripe rust differs from area to area [26]. Additionally barberry serves as host for yellow/ stripe rusts [12].

2.4. Yellow / Stripe Rust Management

Rust management is crucial because rust increases the cost of wheat production all over the world and which in turn increases food cost.

2.4.1. Cultural Methods of Yellow Rust Management

No single practice is effective under all conditions, but using a series of cultural practices greatly enhances the existing resistances. Removing the green bridge with tillage or herbicides is an effective control measure for epidemics that would result from endogenous inoculums, gene deployment (can be obtained by a grower if more than one cultivar are used that differ in resistance and from those grown by immediate neighbors), control of timing and frequency and amount of irrigation and fertilization applications [27].

2.4.2. Chemical Methods of Yellow Rust Management

Foliar fungicides can effectively control stripe rust. Applied when the crop is at the boot stage of development, the fungicides should provide protection for the upper leaves that contribute most of the energy used to produce grain. Products belonging to the strobilurin class of fungicides (Headline, Quadirs) provide excellent activity against stripe rust but are most effective when applied before infection. If stripe rust is already present in a field at the time of application, it is better to use products belonging to the triazole class of fungicides (Folicur, Prosaro, Tilt) or premixes of the two classes (Quilt, Stratego, Twinline). The triazole class of fungicide is generally considered to have stronger curative activity [35]. Four active ingredients are currently registered as seed treatments for the control of stripe rust in seedlings: flutriafol, triadimenol, triticonazole and fluquinconazole [19].

2.4.3. Host Plant Resistance

Genetic resistance is the main method for controlling obligate parasites. However, effective disease control requires that durable, race nonspecific resistance is incorporated into high yielding genotypes. In some areas, a shift in breeding strategies toward this durable type of resistance, based on minor additive genes, is required to avoid the ‘boom and bust’ cycles that are frequently observed. This is particularly true for areas where a single genotype is sown and the risk of mutation to new virulent races increases under selection pressure [10]. Two types of genetic resistance to stripe rust are known: a) seedling resistance and b) adult plant resistance. Seedling resistance, which is controlled by a single gene, is highly effective and lasts throughout the wheat life cycle [18]. The vulnerability can be reduced by making available new host cultivars that have additional or different sources of resistance [26]. Emmer wheat and durum wheat accessions are good source of resistance to wheat ruts [20].

Different survey and survulace of rusts were done in most wheat producing areas of the country, during irrigated, belg (short rain periods) and rain fed. Yellow rust was recorded as destructive diseases in wheat fields. The incidence of the diseases was as high as to 100 percent compared with the other diseases under irrigated area of rib [30]. Most Yr genes have been showed susceptibility to stripe rust race populations. More than 66% of Yr genes were susceptible to the race populations of the pathogen. This indicated that broader virulence spectra of the pathogen in the area putting considerable wheat genotypes at menace. Susceptibility to head infection was higher for the Yr genes that sustained severity level up to 100S and it seems that there was a positive correlation between head and leaf infection [33].

Pavon-76 bread wheat variety contains Yr 29APR gene. The adult plant genes Yr29 present in cultivar Pavon-76 showed MS type reaction and have relative level of resistance [24]. During 2010 diseases epidemics at Kulumsa virulence was detected for stripe rust resistance genes Yr1, Yr2, Yr6, Yr7, Yr8, Yr9, Yr17, Yr18, YrA, Yr18+, Yr21, Yr25, Yr27, Yr27+, Yr27+Yr18, Yr28, Yr29 and Yr31, at meraro Yr4+, Yr5, Yr2+Yr6+Yr25, Yr2+Yr9, Yr10, Yr15, YrSD+Yr25 and YrSP were effective stripe rust resistance genes and At Arsi Robe virulence was detected for Yr1, Yr2, Yr6, Yr6+Yr20, Yr7, Yr9, Yr17, YrA, Yr18, Yr18+, YrA+Yr18, Yr21, Yr25, Yr27, Yr27+, Yr27+Yr18, Yr28, Yr29 and Yr31 genes [9]. Yr3, Yr5, Yr10, Yr15 and YrSP in synthetic hexaploids are identified as seedling resistance genes and postulated [29]. Genes Yr3a, Yr4a, Yr10, Yr17, and Yr26 confer high resistance to the tested Ethiopian isolates. Yr genes Yr6+2, Yr9+2, and Yr24 provide moderate resistance [4]. Bread wheat cultivars, HAR416, TUSIE (HAR 1407), BATU, DASHEN and GARA, exhibited resistance spectra. They showed low infection types to all eight races but were susceptible to 230E158 the four yellow rust resistance genes Yr1, Yr3V, Yr4+and Yr17 identified in the nine bread wheat genotypes were different from the ones in commercial wheat cultivars from Ethiopia. Out of the advanced bread wheat genotypes, 8.3.8 (B) and 11.6.24 were released to farmers in Ethiopia, with names KBG-01 and Meraro, during 2001 and 2005 respectively. The former was resistant to the nine races and, based on F2 segregation ratio, two complementary recessive genes, Yr9+ and Yr7 were postulated, [3].

3. Materials and Methods

The study was contain one component: phenotyping (field screening) of thirty six (36) wheat genotypes to yellow rust in Ethiopia in 2016 cropping season at two locations, at Kulumsa station and Meraro station.

3.1. Description of the Study Area

The experiment was done at two site of kulumsa agricultural research center mandate area, namely Meraro and Kulumsa agricultural research center. Meraro station is located at 39^{0}14'56"East and 07^{0}24'27"North and at 2990 meter above sea level. It receives about 1196 mm of rain annually. The monthly mean minimum and maximum temperatures are 5.7°C and 18.1 °C, respectively. The dominant soil type is Clay soil (Nitosols) and kulumsa is located at 39^{0}09'11"East 08^{0}01'10"North and at 2200m above sea level and receives 820mm of rainfall annually. The monthly mean minimum and maximum temperatures are 10.5°C and 22.8°C, respectively. The dominant soil type is Clay soil (Luvisols).

3.2. Field Test

The 38 wheat genotypes and suseptible and resistance check were planted in augumented design. The germplasm were planted in two rows of 0.2m apart and 1m long using a seeding rate of 100 kg/ha. Fertilizer Urea and DAP were applied at the rate of 50kg/ha and 100kg/ha, respectively. Weed manegment and intercultivation was carried out according to the recommendation in each location. The rust that was harvested from field during different previous year was multiplied in the greenhouse using susceptible plants grown in pots during 2016 were used for inoculating the wheat genotypes at tillering and stem elongation stages. Spreader rows were planted in mixtures of the most susceptible bread wheat cultivars, Morocco wheat cultivars in one row around the experimental field block. The rust inoculation carried out on spreader row which was planted adjusant to the trail on both sides of each block. The inoculation were carried out during tillering stage by spraying method.

Spray method: Spraying of yellow rust on spreader row during tillering stage was done by mixing yellow rust spore with meniral oil and sprayed to spreader row by pumping (spraying) machine.

3.3. Data Collected from the Field Experment

The data were collocted at the field from the leaf of each germplasm of wheat by observing the spore severity on the leaves. Disease severity as a percentage of covered leaf area was assessed following a modified Cobb's scale [22]. Field response was recorded 2 to 3 times at 10 days interval starting from mid- Augest and the final score was done at soft-dough stage. The data on disease severity and host reaction was combined to calculate the coefficient of infection (CI) following Pathan and Park (2006), by multiplying the severity value by a value of 0, 0.2, 0.4, 0.6, 0.8, or 1.0 for host response ratings of immune (I), resistant (R), moderately resistant (MR), intermediate (M), moderately susceptible (MS), or susceptible (S), respectively. After the last disease score when the disease progress ceased, according to Stubbs *et al*. [32], the field severity data were converted to Coefficient of Infection (CI) by multiplying with constant values of response. Genotypes with coefficient of infections ranging 0 to 20 were considered as resistant while 20 to 30, 30 to 40, 40 to 60 and 60 to 100 were moderately resistance, moderately susceptible, moderately susceptible to susceptible and susceptible, respectively based on the reaction of check cultivars.

4. Results

Field Responses of Wheat Lines against Yellow Rust at Kulumsa Agricultural Research Center and Meraro Substation.

The following figure 1 below shows that yellow rust tested both at kulumsa agricultural research station and Meraro substation of Kulumsa agricultural research center indicates that wheat lines have different response to yellow rust. At Kulumsa research station most of durum wheat varieties have low CI values and also yellow rust severity when compared to meraro area and also bread wheat varieties tested at kulumsa also revealed that about thirty one wheat genotypes have severity and CI values of below 20 but the rest genotypes have CI and severity values of above thirty which indicates that susceptible to yellow rust pathogen at kulumsa agricultural research center during the last cropping season. At meraro testing site most of wheat lines, both durum and bread wheat cultivars have high severity or CI values and which indicates to be susceptible to yellow rust due to favorable weather condition in area and high rust pressure due to suitable environmental condition to rust pathogen. At meraro about seventeen wheat varities have severity/CI values below twenty which indicates these genotypes have resistance reaction to yellow rust pathogen but the rest wheat genotypes have CI/ severity percentages of above thirty which reveals that the aforementioned genotypes have susceptible nature or reaction to yellow rust at meraro.

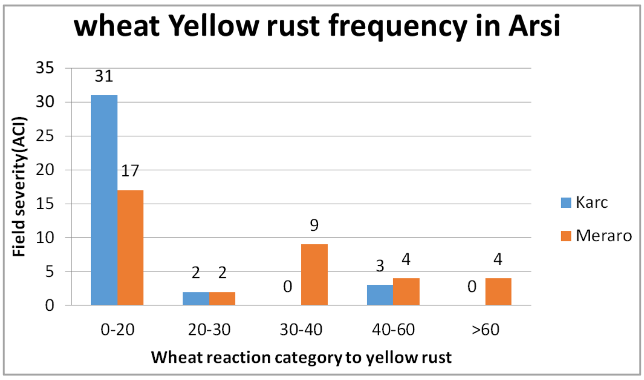

Figure 1. *Response frequency of wheat lines in Arsi.*

Table 1. *Field responses of wheat lines to yellow rust at KARC.*

s.n	Durum wheat field response				Bread wheat field response			
	Genotypes	**severity**	**reaction**	**CI**	**Genotypes**	**severity**	**Reaction**	**CI**
1	Denbi	0	0	0	Meraro	0	0	0
2	Mangudo	0	0	0	Bolo	0	0	0
3	DZ-04-118	0	0	0	KBG-01	5	Ms	4
4	Hitossa	0	0	0	Gasay	5	Ms	4
5	Yerer	0	0	0	Kekeba	5	MsS	4
6	Quamy	3	Mr	0.6	Huluka	5	MsS	4
7	Mukiye	3	Mr	0.6	Abola	5	Mss	4
8	Gerardo	5	Mr	1	Hoggena	10	MsS	8
9	Utuba	3	Mr	1.2	Hidassie	10	Ms	8
10	Ude	3	Mr	1.2	Paven-76	10	MsS	8
11	Boohai	10	Mr	2	Millenium	10	S	10
12	Coccorit-71	5	MsMr	3	Shorima	10	S	10
13	Bichena	5	MrMs	3	Tussie	10	S	10
14	Asassa	5	Mss	4	Sulla	20	MsS	16
15	Top-66	10	MrMs	6	Kulkulu	20	S	20
16	Ginchi	10	MrMs	6	Laketch	20	S	20
17	Foka	15	S	15	Dashen	40	S	40
18	LD-357	40	S	40	Kubsa	40	S	40

Table 1 above indicates the varieties tested at kulumsa research center during 2015 cropping season. The above table shows that most of durum wheat varieties tested at kulumsa have severity values of below kubsa (susceptible check) and which implies that the durum wheat varieties are resistance to yellow rusts in the same manner the results from the field indicates that except dashen bread wheat variety all of the rest varieties have severity values less than susceptible check (kubsa) but most of the varieties couldn't have severity values below resistance varieties Meraro and KBG-01 at Kulumsa as indicated in Table 1 above.

Table 2. *Field responses of wheat lines to yellow rust at Meraro sub-station.*

s.n	durum wheat field response				Bread wheat field response			
	genotypes	**severity**	**Reaction**	**CI**	**Genotypes**	**severity**	**Reaction**	**CI**
1	Mangudo	0	0	0	Meraro	0	0	0
2	Mukiye	0	0	0	Millenium	10	Ms	8
3	Boohai	5	Mr	1	KBG-01	10	SMs	10
4	DZ-04-118	5	Mr	1	Bolo	10	S	10
5	Quamy	5	Mr	1	Kulkulu	30	S	30
6	Denbi	3	Mr	1.2	Sulla	30	S	30
7	Gerardo	3	Mr	1.2	Gasay	30	S	30
8	Hitossa	3	Mr	1.2	Hoggena	30	S	30
9	Utuba	3	Mr	1.2	Huluka	30	S	30
10	Ude	3	Mr	1.2	Tussie	30	S	30
11	Coccorit-71	5	S	5	Hidassie	30	S	30
12	Yerer	5	SMs	5	Dashen	30	S	30
13	Asassa	15	SMs	15	Shorima	40	S	40
14	Top-66	20	S	20	Abola	40	S	40

s.n	durum wheat field response				Bread wheat field response			
	genotypes	severity	Reaction	CI	Genotypes	severity	Reaction	CI
15	Bichena	20	SMs	20	Paven-76	40	S	40
16	Foka	30	S	30	Kekeba	60	S	60
17	Ginchi	50	S	50	Kubsa	60	S	60
18	LD-357	60	S	60	Laketch	100	S	100

Meraro is hot spot location for yellow rust which has suitable environmental condition and used as test site for international wheat materials against yellow rust pathogen. As indicated in (Table 2) above durum wheat have lower severity at field condition when compared to bread wheat genotypes at Meraro. Among eighteen durum wheat genotypes/varieties fifteen varieties have lower severity or average coefficients of infection but, Foka, Ginchi and LD-357 varieties were susceptible to yellow rust at field condition of Meraro with rust severity percentages of above thirty. Bread wheat tested at Meraro station have different severity level but when compared to durum wheat varieties the bread wheat varieties have high severity or average coefficient of infection at field condition. Among eighteen bread wheat varieties tested at meraro sub-station Meraro, KBG-01, Bolo and Millenium varieties have low severity /CI values with lower than twenty severity percentage but the rest bread wheat varieties have yellow rust severity or average coefficient of infection above thirty which indicates susceptible to yellow rust in that specific area and specific cropping season.

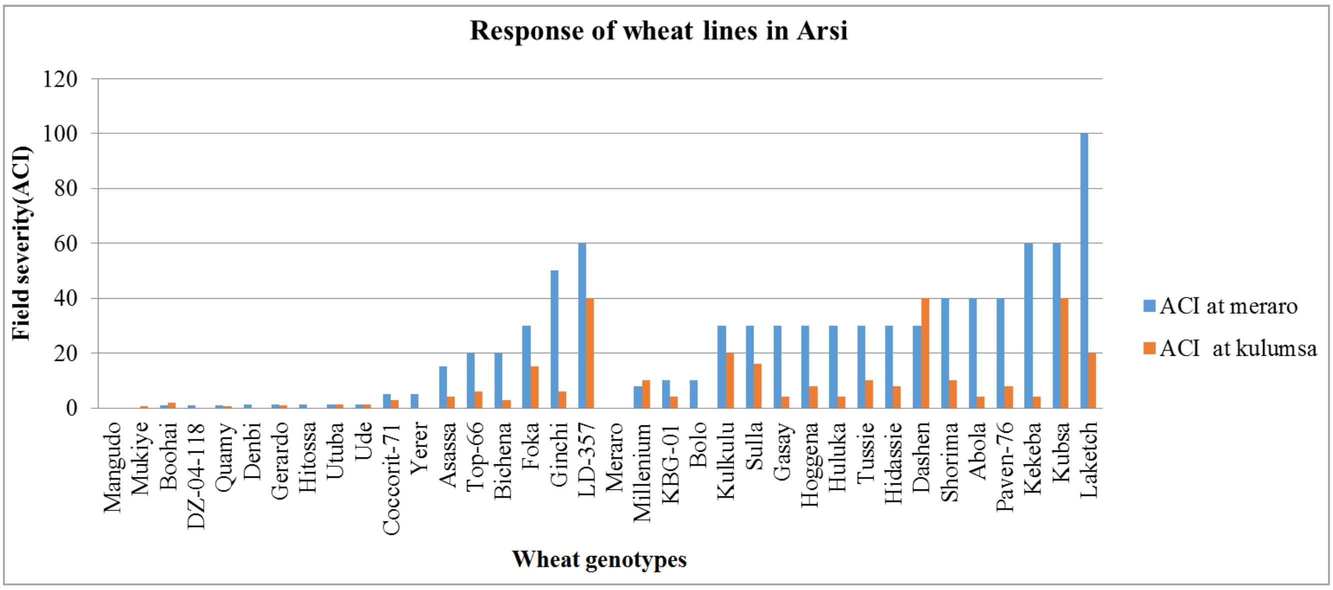

Figure 2. *Responses of wheat lines against yellow rust in Arsi.*

The combined field response in figure 2 above indicates that wheat varieties tested across location have varied field reaction against yellow rust both at kulumsa research station and meraro sub-station of kulumsa research center. Durum wheat varieties Mangudo, Mukiye and also bread wheat variety Meraro have no visible pustule of yellow rust at field condition and the aforementioned wheat varieties are considered as immune to different races found at two testing locations. Wheat varieties Boohai, DZ-04-118, Quamy, Dembi, Gerardo, Hitossa, Utuba, Ude, Coccorit-71, assasa, yerer, Top-66, Bichena, KBG-01 and Bolo have severity/CI values below twenty and considered as resistance at both location but, the rest wheat varieties shows susceptible reaction to yellow rust with severity/CI values above thirty in both locations.

The following figure 3 indicates that the performance of susceptible wheat lines and how severely attacked spreader to increase the inoculums to the testing materials at meraro station.

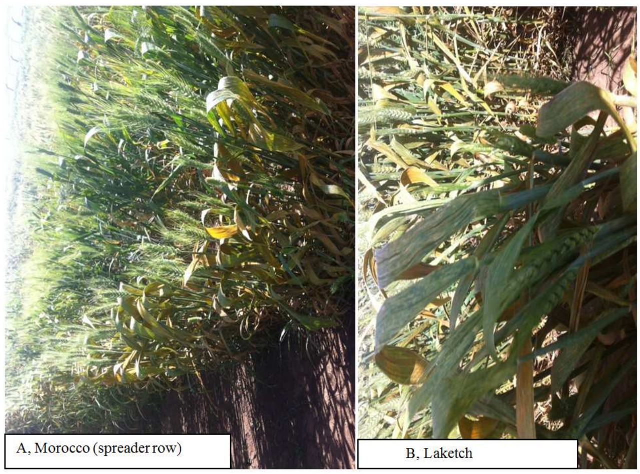

Figure 3. *Spreader (Morocco) and severely attacked wheat variety at Meraro.*

The figure 3 A above indicates that the performance of susceptible variety Morocco at the field condition of Meraro. Morocco is the most universal susceptible variety without any resistance genes. Now a day this susceptible variety serves as spreader row to facilitate the infection or innoculum in the field.

Figure 3 B above indicates that in the fields of screening to yellow rust the most susceptible variety Lackech which severely attacked by yellow rust and totally not set seed due to high pressure of yellow rust during the 2015 cropping season at meraro.

5. Discussion

In Ethiopia, several wheat cultivars have been released for farmers since the inception of wheat breeding in the 1950s, however, most of these were abandoned from production due to their susceptibility to diseases especially the cereal rusts, yellow rust (Puccinia striiformis Westend.) and stem rust (*P. graminis f. sp. tritici*) [2]. Monitoring the threatening pathogens and races/ virulence, inventory of the resistance genes employed in the current wheat cultivars and searching for new sources of resistance are amongst the major objectives of successful wheat improvement program.

The resistance of wheat cultivars under farmers' condition varied according to location, species and variety. Bread wheat was the dominating wheat species. The bread wheat variety laketch was the most susceptible to yellow rust at meraro followed by kubsa and Dashen (Table 2) and kubsa was the most susceptible varieties at kulumsa (Table 1). The two varieties KBG-01 and and Meraro were resistance to yellow rust which has similar result (not contradicting) with previous research [3].

In this study among tested varieties 94.4% of Durum wheat and 88.9% of bread wheat varieties were resistance to yellow rust but, 5.6% of durum wheat and 11.1% of bread wheat varieties were susceptible to yellow rust at kulumsa agricultural research center (Table 1). Meraro the hot spot area for yellow rust revealed that among tested wheat varieties 83.3% of durum wheat and 22.2% of bread wheat varieties were resistance but, 16.7% of durum wheat and 87.8% of bread wheat varieties were susceptible to yellow rust (Table 2).

6. Summary and Conclusion

The results of current study showed that the lines had diversity regarding resistance reaction, ranging from resistance to susceptible lines. Most of the evaluated lines exhibited moderate or good performance under high disease pressure shown by susceptible Check. Resistance of all categories of partial resistance to yellow rust was observed. Most of Durum wheat varieties except LD-357 have resistance reaction to yellow rust at Kulumsa station but, at meraro except varieties LD-357, Foka and Ginchi most of varieties tested were under the category of resistance and moderately resistance during 2015 cropping season. At both location most of bread wheat varieties have exhibited susceptible reaction to yellow rust except Millenium, KBG-01 and meraro. As indicated in the Table 1 and Table 2 above the field reaction of wheat varieties indicates that there was a great variability of yellow rust pathogen races over two locations.

List of Acronym

ABC: approximate Bayesian computation
CI: Coefficient of infection
CIMMYT: International Maize and Wheat Improvement Centre
CSA: Central statistic authority
CWANA: Central and West Asia and North Africa
DAP: Die Ammonium Phosphate
EIAR: Ethiopian Institute of Agricultural Research
ICARDA: International Centre for Agricultural Research in Dry Areas
KARC: Kulumsa Agricultural research center
PST: *Puccinia striiformis f. sp. tritici*
Yr: Yellow rust

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