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Assessment of Prevalence and Severity of Wheat Rusts in the Wheat Growing Areas of Eastern Hararghe and Efforts in Managing These Diseases

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ABSTRACT

The major diseases caused by obligate pathogens of wheat are yellow rust (Puccinia striiformis), stem rust (Puccinia graminis f.sp. tritici) and leaf rust (Puccinia recondita f.sp. tritici). The rusts infect the foliage, stem and sometimes the spikes, resulting in maximum yield losses of 30-50%. Hence, regular monitoring and assessment is crucial to manage rusts before causing loss. Accordingly, survey of wheat rusts was accomplished in 2013 with the objective of identify and quantifying the intensity of wheat rusts in Eastern Hararghe. Summarized result of the 2013 assessment revealed that yellow rust was observed on 16 (20.8%) of the 77 wheat fields inspected. The number of fields assessed in Jarso, Kurfa Chele, Girawa, Meta, Deder, Melka Belo and Fedis districts were 10, 10, 10, 13, 12, 10 and 12 of which 5, 4, 3, 3, 3,0 and 0 fields were affected with yellow rust, respectively. Furthermore, the leaf rust assessment revealed that it was observed on 21 (27.3%) of the 77 wheat fields inspected. The highest mean (100%) incidence of leaf rust was recorded in Meta and Fedis districts, while the lowest score (0%) was noted in Deder. The disease severity showed similar trend as of the incidence. The higher mean severities were recorded in Fedis and Meta districts with mean severity values 85s and 80s for the two districts respectively. Lastly, with regard to stem rust, it was highly prevalent in the mid-altitude areas of the districts assessed. Stem rust was observed only in three of the districts assessed. Out of the 77 fields assessed only 8(10.4%) of them were observed to be affected by stem rust. The highest mean incidence of 83% was observed at Fedis followed by 71% record at Meta. From the adaptation trial accomplished in 2011 at Kurfa chele and Jarso, the highest grain yield was recorded by Mede Welabu, (70 quintal/hectare) followed by Tussie, Digalu and Millinium that gave 67.44, 64.44 and 62.78 qt/ha respectively at Kurfa chele. On the other hand at Jarso, the highest grain yield of 57.78 qt/ha was recorded by Mede Welabu and Kubsa followed by Digalu, Tussie and Dure that gave 49.67, 48.11 and 44.78 qt/ha respectively. Mede Welabu and Dure were the varieties preferred by farmers at both locations. From adaptation trial at Girawa in 2012, the highest grain yield of 74.33 qt/ha was record by Digalu followed by Danda'a (71.94qt/ha) and then Meda welabu (65.02qt/ha). The least grain yield (48.38qt/ha) was recorded by local variety. Farmers also preferred these two varieties. A total of 134 farmers in four districts namely Kurfa chele, Jarso, Girawa and Meta got access to seeds of improved varieties of bread wheat and fertilizer DAP and Urea according to their preference in 2013 cropping season and their land size.

Keywords: *Rusts, Grain yield, Farmers' selection criteria, improved variety*

1. INTRODUCTION

Wheat (Triticum spp.) is the second major food crop of the world in its importance next to rice. Wheat (Triticum aesvivum L.) is one of the major crops cultivated in Ethiopia. The area covered by wheat had increased from 0.77 million ha in 1997 to 1.55 million ha in 2011, and it was third among the crops next to teff (Eragrostis tef) and maize (Zea mays L) in 2011 cropping season(CSA, 2011 & CSA, 1998). Wheat ranks second both in terms of volume of production and productivity after maize (Zea mays L) with the total volume of production of 2.85 million tons at the national level. The national average consumption of wheat in Ethiopia was estimated to be 39kg/year/head during 1994-97 and to meet the national wheat requirements, 331,000 tons of wheat per year were imported during the 1995-97 period (CSA, 2002). Both tetraploid (Triticum turgidum L.) and hexaploid (Triticum aestivum L.) species are grown in potential wheat growing areas of the country. Bread wheat is an introduced crop where as the tetraploids are indigenous crops.

The most important limiting factors that reduce yield of wheat in Ethiopia are poor yielding varieties, diseases, insects, poor soil fertility, water logging, and weed competition. On average, diseases and pests destroy 20% or more of potential grain harvest either in the field or in storage. The major diseases caused by obligate pathogens of wheat are yellow rust (Puccinia striiformis), stem rust (Puccinia graminis f.sp. tritici) and leaf rust (Puccinia recondita f.sp. tritici). The rusts infect the foliage, stem and sometimes the spikes, resulting in maximum yield losses of 30-50%.

Puccinia graminis (causing stem or black rust), P. recondita (causing leaf or brown rust), P. striiformis (causing yellow or stripe rust), P. hordei (causing dwarfing or leaf rust) and P. coronata (causing crown or leaf rust) regularly cause serious losses of wheat, barley, oats and rye throughout the world. Owing to their prime role in limiting the productivity of these cereal crops in almost every major cereal-producing country, the rust diseases deserve special and detailed attention.

Wheat rusts - notably stem and stripe rust, have periodically caused damaging losses to Ethiopian wheat production. The 2010 season wheat crop had been seriously affected by stripe rust. Similarly, these stripe rust outbreaks were reported in 2010 from other countries such as Syria, Iraq and Turkey. The stripe rust epidemic in Ethiopia had similarities to those experienced in other countries earlier. In many of the previous 2010 outbreaks, widely grown cultivars known to carry the Yr27 resistance gene were highly susceptible. Climatic conditions favourable to stripe rust permitted early infection and sustained disease development. Exactly the same factors were driving the 2010 epidemic in Ethiopia. Stripe rust is exceptionally favoured with climatic conditions such as prolonged above average rainfall and optimal temperatures. The favourable climatic conditions permitted early infection on susceptible varieties, with the first outbreaks of stripe rust observed at the beginning of August. Cultivars carrying the Yr27 gene were widely grown in 2010 cropping season e.g., Kubsa (Attila) and Galema; both cultivars are highly susceptible to yellow rust. These varieties were varieties released for their high yield from Research Centers in earlier times. Especially Kubsa was widely distributed and grown by farmers in the highlands of Eastern Hararghe and known by the local name 'Packegii'. In Ethiopia, a stripe rust race which overcame the resistance of Kubsa has been reported earlier by Badebo et al. (2008). This race was first detected in Uganda in 1995 and then in Ethiopia in 1998. Three regions were known to be highly affected by stripe rust; Oromya, Amhara and Southern Nations Nationalities People (SNNP). According to the Ministry of Agriculture and Rural Development (MoARD), over 400,000 ha of wheat were estimated to be infected by stripe rust, of which wheat in the Oromiya region was the worst hit.

Different authors tried to estimate losses due to rusts on cereals. Accordingly, Roelfs et. al., 1992 compiled an overview of losses due to the cereal rusts in the United States of America (USA) from 1918 to 1976, noting state wide yield reductions of 50% or more in epidemic years due to stem (black) rust and leaf (brown) rust. Although stripe (yellow) rust was more restricted in distribution, losses of up to 70% in commercial fields were recorded. Wiese, 1977 quantified yield loss on wheat due to rusts to be over one million tonnes (2%) annually in North American during the 1960s. Moreover, Saari and Prescott 1985, reported yield loss due to leaf rust in wheat range from 10 percent under moderate conditions to 65 percent under intense epidemics since the early 1800s. Abdel Hak et al., 1980 estimated crop losses of up to 50% due to leaf rust infection in Egypt. According to McIntosh et al., 1995, stripe rust epidemics in selections of the International Maize and Wheat Improvement Centre (CIMMYT)-generated wheat line, Veery, caused significant yield losses in Yemen, Ethiopia and Iran.

Before designing rust management or after application of management activities, it is important to assess rusts to quantify the distribution and severity of the disease in the area. In this regard, disease surveying is basic to all effective control and research programs. Surveys are essential in the development of such programs in order to determine their emphasis and direction. They are equally important while research is in progress as a means of assessing the effectiveness of control measures. Surveys may be made for either regulatory or non-regulatory purposes. Regulatory surveys usually aim to delimit known infestations and to follow the spread of new ones (often for plant quarantine purposes), whereas non-regulatory surveys are primarily geared towards the assessment of actual disease levels (frequently for planning control programs). Survey could be planned with regard to the known characteristics of the pathogen (its reproductive rate, virulence, mode of dispersal, etc.), the host (its stage of maturity, defense mechanisms, nutritional status, etc.), and the environment (both physical and chemical). In this regard, it was uncommon to assess and repeatedly monitor diseases of wheat as well as other crops' in Eastern Hararghe rather a 'fire extinguishing' style of crop protection which try to utilize control strategies where disease outbreak occurred. So, it was rational to assess diseases in order to make decision on selection or designing of sustainable control or management strategies or to assess the effective ness of the management activities applied in a given area.

Several methods of control are utilized in controlling wheat rusts among which resistance breeding and chemical control are the most important. Several effective chemicals are now available for controlling of rusts, especially stripe rust and leaf rust. Besides, with timely application effective stem rust control can also be achieved. Fungicides such as flutriafol, propiconazole, tebuconazole and triadimefon can be utilized to control rusts. Chemical fungicides can be applied prophylactically and repeatedly with the expectation of returns on investment under high yielding situations. However, in small scale poor farmers' condition, less intense agriculture and low yielding/low priced situations chemical use becomes difficult to justify.

Countrywide epidemic of yellow rust that occurred in the year 2010 cropping season in Ethiopia didn't miss the wheat growing areas of Eastern Hararghe. Preliminary diseases assessment made by Fedis Agricultural Research Center staff revealed that there was a severe infection of yellow rust with 100% incidence and up to 85s severity in the wheat growing Woredas of Eastern Hararghe, Jarso and Kurfa chele. Hence, these two districts use local varieties and variety 'Kubsa' which are susceptible to yellow rust and this aggravate the epidemics and the severity of the disease. Based on the assessment, the staff delivered their recommendation to farmers to spray chemicals as

immediate solution. However, this could not be a sustainable solution because farmers couldn't access this chemical easily and it is also not economical to spray in small plots of land like the one possessed by farmers in these areas. Besides, the staff decided on searching sustainable solution to farmers, in that, varieties that resist the disease pressure in the area should be brought from research centers working on wheat and be seen for their adaptation, so that farmer could access these varieties easily. With all the above facts in mind, this trial was accomplished to assess and quantify wheat diseases in wheat growing areas of Eastern Hararghe and to search sustainable solutions for the identified disease problems in the area.

2. MATERIALS AND METHODS

2.1 Survey of Wheat Rusts in Wheat Growing Areas of Eastern Hararghe

Wheat rusts survey was accomplished in six highland districts (Kurfa chele, Jarso, Girawa, Meta, Deder and Melka Belo) and in one mid-altitude district (Fedis) in 2013 cropping season with the objective of identifying and quantifying diseases intensity on wheat. These districts were identified as major wheat growing areas of the Eastern Hararghe zone.

Purposive sampling was utilized both in selection of the PAs in the Districts and wheat fields from the PAs. PAs with high wheat coverage were selected from the Districts. On the other hand, wheat fields were assessed at every 5^{th} to 10^{th} km along the main and accessible roadsides. The plant samples with in a selected field were taken in X-fashion throwing 5-10 quadrants depending on the size of the field assessing rusts and other diseases of the plants. Rusts incidence and severity were recorded from five to ten quadrants along the two diagonals of the X axis in the field and used to calculate average values. The incidence of rusts' was calculated by using the number of infected plants and expressed as a percentage of the total number of plants assessed. Similarly, Disease severity was assessed with the modified Cobb scale (Peterson, et al. 1948) based upon percentage of the plant infected and type of disease reaction. The prevalence of the disease was computed using the number of fields affected divided by total number of fields assessed and expressed in percentage.

2.2 Adaptation, Demonstration and Participatory evaluation trials of improved bread wheat varieties at Kurfa chele, Jarso and Girawa districts

Experimental trials on identifying suitable improved varieties for the area were conducted at Jarso and Kurfa chele Woredas on farmers' field during the main cropping season of 2011. The varieties considered in the study were previously released rust resistant bread wheat varieties such as Mede Welabu, Digalu, Tusie, Dure and Millinium released for the highlands of Ethiopia. Locally grown Kubsa was used as control. These varieties were planted in a plot size of 2 x 4.5m in three replications with RCBD design. Furthermore, other set of trial consisting of four varieties (Meda welabu, Digalu and Danda'a) of bread wheat including local variety were sown on four farmers' field in a plot size of 7X7m considering farmers as a replication at Girawa district of Rasa Janata PA in 2011/2012 cropping season and were evaluated by farmers. Farmers' field day was prepared to give chance for more farmers and other stakeholders to evaluate the varieties and to lay ground for scaling up varieties' of farmers preference.

The land was ploughed three times using oxen plough. The varieties were planted with row spacing of 30cm and drilled in the prepared rows at a seed rate of 100 kg/ha. Shallow planting of 3-4cm depth was used in the presence of ample soil moisture. Fertilizer rate of 150kg/ha for DAP and 100 kg/ha of Urea was applied with DAP all at sowing and Urea half at sowing and half at stem elongation stage respectively. Two effective weeding was accomplished; one at one month after sowing and the other after two months after sowing respectively.

2.3 Pre-scaling up

Pre-scaling activities on improved varieties of wheat were undertaken after conducting awareness creation and spot training at various level that targeted experts at Woreda Office of Agriculture, Development Agents, Farmers' Research Groups and individual intervention farmers to ensure effective implementation of the activities. In the awareness creation process, emphasis was given among other things on how to share technological and technical outputs among the farmers, and responsibilities with the different stakeholders so as to lay the foundations for future scaling up activities. Farmers were also awared on the terms and conditions of the pre-scaling activities

Sites and farmers selection were done jointly with Woreda agricultural offices, DAs and researchers based on pre-agreed criteria. Farmers were selected mainly based on their willingness and interests in participating in the programme and also availability of the required plots of land. In areas where the demand for technologies exceeded the supply, priority was given to members of FRG members and female-headed households. Improved seeds of the varieties of wheat and other necessary inputs were provided by the Center. In addition, seeds of improved varieties brought from the Sinana Agricultural Research Center and Kulumsa Agricultural Research Center.

Farmers were given on spot practical training and field demonstrations are made on planting methods, input application, and also the general agronomic practices to be followed. Researchers provided technical supports for DAs and the farmers, and also made supervisions at different times.

2.4 Data Management and Statistical Analysis

Data on number of plant stand per plot, plant height (cm), days to heading, number of tillers per plant, number of seed per head, number of head per plant, thousand seed weight (gm), grain yield (quintal/ha), head size in cm, disease incidence (%), disease severity, insect incidence (%), maturity date, harvesting date and other relevant data were collected following standard procedure for each parameters. Farmers were invited to evaluate and select varieties of their preference to ease scaling up activities

Analyses of Variance (ANOVA) of all quantitative data were accomplished using SAS computer software (SAS Institute, 1999). LSD values were obtained following Duncan's multiple range test to know the significant difference between mean values of the treatments for the character in question. Finally, this data was utilized in selecting the best variety that significantly reduces disease incidence and results in better yield.

3. RESULTS AND DISCUSSION

3.1 Site Description

Eastern Hararghe is situated in the Eastern part of Ethiopia, bordering Somali Region as well as the urban administrative regions of Dire Dawa and Harari. The highland area of Hararghe is the potential place where climatic conditions allow rain fed agriculture. Eastern Hararghe comprises of three agroclimatic belts. Lowlands, the kolla, ~35% of the area, midlands, the weyna dega, ~40% and highlands, the dega, ~25%. There are two rainy seasons, the small belg and the main meher. Belg production is limited within the dega belt and part of the wetter weyna dega. Belg rains are widely used for land preparation for long-cycle meher crop production.

3.2 Distribution and Intensity of Wheat Rusts in Eastern Hararghe

In the main crop-growing season of 2013 77 fields planted with bread wheat were assessed for the intensity of the diseases in three and eight districts of Eastern Hararghe respectively. Yellow rust, Stem rust and leaf rust diseases were observed in all surveyed districts with yellow rust prevalent on the highlands and stem rust at mid altitude areas and leaf rust towards the lowlands. The result of the survey revealed that the intensity of the disease vary from slight to complete infection of wheat fields depending on the variety and agro-ecological divergence. Summarized result of the 2013 assessment revealed that yellow rust was observed on 16 (20.8%) of the 77 wheat fields inspected. The number of fields assessed in Jarso, Kurfa Chele, Girawa, Meta, Deder, Melka Belo and Fedis districts were 10, 10, 10, 13, 12, 10 and 12 of which 5, 4, 3, 3, 3,0 and 0 fields were affected with yellow rust, respectively. The highest mean (100%) incidence of yellow rust was recorded in Jarso and Kurfa chele districts, while lowest the score (0%) was noted in Melka Belo and Fedis districts. Similarly, the disease severity showed similar trend as of the incidence. The highest severity was recorded in Kurfa chele and Jarso districts with mean severity value 85s for both districts (Table 1). This was followed by Meta district, with mean severity of 80s. The highest severity (85s) was recorded where the highest incidence (100%) was noted at Jarso and Kurfa chele districts. In these districts farmers planting local varieties and Kubsa were highly affected with yellow rust in contrary with those planted with improved bread wheat varieties such as Digalu, Mada walabu, Danda'a and Dure (Fig. 1.).

A B

Fig 1: Yellow rust disease severities on Local variety (A) as compared with improved bread wheat Variety Digalu (B) at Kurfa Chele

Leaf rust was also the other most important disease observed in the area with its prevalence greater in the mid-altitude and lowland areas of the districts. Summarized result of the assessment revealed that leaf rust was observed on 21 (27.3%) of the 77 wheat fields inspected. The highest mean (100%) incidence of leaf rust was recorded in Meta and Fedis districts, while lowest the score (0%) was noted in Deder. The disease severity showed similar trend as of

the incidence. The higher mean severities were recorded in Fedis and Meta districts with mean severity values 85s and 80s for the two districts respectively (Table 1). Leaf rust highly affected all the varieties planted at Fedis farmers' field and the only resistant variety observed was variety called 'Buck prunto' an introduced variety from America by Fedis Agricultural Research Center (Figure 2). Hence, this called attention for the center to multiply and distribute this variety for the farmers.

A B

Fig 2: Leaf rust severities on Local variety (A) as compared to improved bread wheat Variety Buck prunto(B) at Fedis

With regard to stem rust, it was highly prevalent in the mid-altitude areas of the districts assessed. Stem rust was observed only in three of the districts assessed. Out of the 77 fields assessed only 8(10.4%) of them were observed to be affected by stem rust. The highest mean incidence of 83% was observed at Fedis followed by 71% record at Meta (Table 1). The highest mean severity of 75S was recorded both at Fedis and Meta. Various levels of stem rust severities were observed in the districts but with no resistant varieties (Figure 3.)

A B

Fig 2: Stem rust severities on Local variety (A) as compared to improved bread wheat Variety Buck prunto(B) at Fedis

In general, all the 77 fields assessed were sown with bread wheat varieties with most of the fields were planted with local varieties and Kubsa which were susceptible to rusts. From this assessment prevalence of yellow rust was increased with altitude, susceptible varieties and rain fall amount as a result of which areas with higher altitudes are highly affected with this disease. Leaf rust was observed in the mid-altitude and in the lowland areas. On the other hand, stem rust was prevalent in the mid-altitude areas.

Table 1: Prevalence and intensity of wheat rusts in seven districts of Eastern Hararghe in 2013

Districts	Altitude Range in masl	No of fields	Diseases									Efforts by farmers, DAs and Experts
			Yellow rust			Leaf rust			Stem rust			
			Prevalence %	Mean Incidence %	Mean Severity	Prevalence %	Mean Incidence %	Mean Severity	Prevalence %	Mean Incidence %	Mean Severity	
Jarso	1700-2800	10	50	100	85S	10	100	25MS	0	0	0	Fungicide/ resistant variety
Kurfa Chele	1800-2600	10	40	100	85S	20	60	15MR	0	0	0	some Resistant Variety(RV)
Girawa	1900-2800	10	30	80	75S	10	63	15MR	0	0	0	RV
Meta	1700-2700	13	30.8	90	80S	23.1	100	80S	15.4	71	75S	RV
Deder	2300-3000	12	33	90	60S	0	0	0	8.3	23	10S	No
Melka Belo	1400-2900	10	0	0	0	30	70	65S	0	0	0	No
Fedis	1300-1900	12	0	0	0	100	100	85S	50	83	75S	No
Total /mean	**1300-3000**	**77**	**26.26**	**65.71**		**27.59**	**70.43**		**10.53**	**25.59**		

3.3 Adaptation, Demonstration and Participatory Evaluation Trials of Improved Bread Wheat Varieties

During the trial period, it was observed that none of the wheat rusts appeared. As a result, analysis of variance of yield parameters of the varieties at Kurfa chele revealed non-significant ($P<0.01$) variation for all of the parameters considered except for number seeds per spike. On the other hand, at Jarso number of effective tillers per plant and number of seed per spike showed significant ($P<0.05$) variation among the varieties. In all other parameters such as plant height, spike length and grain yield the varieties varied insignificantly at both locations (Table 2). The highest grain yield was recorded by Mede Welabu, (70 quintal/hectare) followed by Tussie, Digalu and Millinium that gave 67.44, 64.44 and 62.78 qt/ha respectively at Kurfa chele. On the other hand at Jarso, the highest grain yield of 57.78 qt/ha was recorded by Mede Welabu and Kubsa followed by Digalu, Tussie and Dure that gave 49.67, 48.11 and 44.78 qt/ha respectively (Table 2). It is known that all these varieties including the check are improved varieties and have the potential to give high yield provided that the necessary management practices from sowing to maturity is accomplished properly. However, under sever rust infestation varieties such as Digalu, Mede Welabu, Dure, Tussie and Millenium were known and released for their resistance/tolerance to some of the devastating wheat rusts such as yellow rust and stem rust. Moreover, Kubsa, beside its high yield, is a variety which is out production in most of the potential wheat growing highlands of Ethiopia such as Bale and Arsi highlands as a result of its susceptibility to yellow rust except Eastern Hararghe highlands. Furthermore, demonstration of the varieties for farmers and development agents was accomplished at crops maturity stage both at Kurfa chele and at Jarso. As a result, farmers' preference and criteria for selection were assessed. Accordingly, Mede Welabu and Dure were the varieties preferred by farmers at both locations. It is known that farmers selection criteria is beyond yield and they selected these two varieties based on maturity, their spike length and their tolerance to drought. They considered these criteria because of redundant rain shortage that occurred in their area.

Table 2: Mean grain yield and agronomic data of bread wheat varieties tested under variety adaptation trial at Kurfa chele and Jarso districts of Eastern Hararghe in 2011 main cropping season

	Kurfa					**Jarso**				
Varieties	**No effective tillers**	**Plant Height (cm)**	**Spike length (cm)**	**No seed/ spike**	**yield/ ha/qt**	**No effective tillers**	**Plant Height (cm)**	**Spike length (cm)**	**No seed/ spike**	**yield/ ha/qt**
Meda welabu	2.93	93.60	8.00	71.33	70.00	3.07	94.60	9.20	51.00	57.78
Dure	2.67	95.67	8.47	65.67	59.22	3.87	98.67	9.40	49.33	44.78
Tussie	2.00	93.33	7.60	80.67	67.44	4.20	90.47	9.87	49.00	48.11
Digalu	2.60	92.53	9.13	80.67	64.44	4.53	90.40	8.73	72.00	49.67
Millinium	2.40	92.80	7.53	80.33	62.78	3.53	91.60	8.13	64.33	43.67
Kubsa	2.07	91.27	7.53	105.67	56.67	5.53	101.13	7.07	55.33	57.78
SE+	**0.38**	**2.70**	**0.54**	**4.50**	**4.56**	**0.44**	**5.36**	**0.62**	**3.97**	**3.22**
LSD	**ns**	**ns**	**ns**	**14.17**	**ns**	**1.39**	**ns**	**1.96**	**12.52**	**ns**
CV%	**27.00**	**5.00**	**11.60**	**9.60**	**24.90**	**18.50**	**9.80**	**12.30**	**12.10**	**22.20**

At Girawa, the analysis of variance of some of the parameters like days to maturity, plant height, number of fertile tillers per plant, number of seeds per spike and grain yield revealed significant variation among the varieties. In terms of maturity, local variety (131.25 days) matured earlier than others followed by Meda welabu (134.5 days) (Table 3). All the improved varieties MW, Digalu and Danda'a were taller than the local variety and Danda'a (104.5cm) was the tallest of all the varieties. Even though, Meda Welabu(9.38cm) had the tallest spike from all the varieties, Digalu and Danda'a beat Mada welabu and local varieties in terms of number of fertile tillers, number of seeds per spike which was finally resulted in better grain yield than the later two varieties (Table 3). The highest grain yield of 74.33 qt/ha was record by Digalu followed by Danda'a (71.94qt/ha) and then Meda welabu (65.02qt/ha). The least grain yield (48.38qt/ha) was recorded by local variety (Table 3). Moreover disease incidence and severity on the varieties were also recorded. Hence, all the improved varieties showed resistant to tolerant reaction for all of the rusts except local variety which was susceptible to the most important wheat rust (yellow rust) problem which occurred most of the time in the early growth stage of the crop in the area (Table 3). Lastly, the varieties were evaluated by the farmers using their own criteria. Hence, based on disease resistance, stand vigour, spike length, number of seeds per spike and stand uniformity, farmers

selected varieties Digalu and Danda'a. In contrary to the above trial, farmers' selection for the varieties was in line with the analyzed data.

Table 3: Mean grain yield and agronomic data of bread wheat varieties tested under variety adaptation trial at Girawa district of Eastern Hararghe in 2012 main cropping season

Variety	Days to maturity	Plant height (cm)	Spike length (cm)	No. of fertile tillers plant^{-1}	No. of seeds spike^{-1}	Grain yield (kg ha^{-1})	YR* Incid(%)	YR Sev.
M W	134.50	102.00	9.38	2.15	54.40	6502.50	5	5MR
Digalu	141.75	103.50	7.85	2.60	68.26	7432.50	0	0
Danda'a	137.75	104.70	8.48	2.35	64.55	7193.75	4	10MR
Local	131.25	86.55	8.13	1.70	60.40	4835.0	100	75s
SE ±	0.64	2.91	0.45	0.14	2.55	439.00	-	-
LSD	2.03	9.31	ns	0.45	8.17	1404.40	-	-
CV (%)	0.93	5.87	10.72	12.86	8.25	13.53	-	-

*yellow rust

The average yield of the varieties (48.9qt/ha) Danda'a in other locations was even less than their yield in Eastern Hararghe highlands. Danda'a is late maturing varieties and need to be grown in highland areas (2000 to 2500 m) (Solomon and Firdissa, 2012). However, it should be noted that the varieties have a slow type of resistance, technically known as Adult Plant Resistance (APR), and not totally immune to the rusts (Solomon and Firdissa, 2012). They are moderately resistant (MR) types. This means that the level of infection is kept much below threshold level to cause yield loss due to rusts. This type of resistance is intentionally developed into these cultivars in order to make the resistance more durable and sustainable (Solomon and Firdissa, 2012).

3.4 Pre-scaling Up Activities

A total of 134 farmers in four districts namely Kurfa chele, Jarso, Girawa and Meta got access to seeds of improved varieties of bread wheat and fertilizer DAP and Urea according to their preference in 2013 cropping season and their land size. Moreover on spot training on the necessary management practice that goes with the varieties was given to the farmers and the DAs. Furthermore DAs were given brochures to enable them monitor and evaluate the farmers. Researchers were also evaluated the performance of the varieties on farmers field and the varieties were in a very good status and free of rust diseases.

4. CONCLUSIONS AND RECOMMENDATION

The major diseases caused by obligate pathogens of wheat are yellow rust (Puccinia striiformis), stem rust (Puccinia graminis f.sp. tritici) and leaf rust (Puccinia recondita f.sp. tritici). The rusts infect the foliage, stem and sometimes the spikes, resulting in maximum yield losses of 30-50%. Summarized result of the 2013 assessment revealed that yellow rust was observed on 16 (20.8%) of the 77 wheat fields inspected. The number of fields assessed in Jarso, Kurfa Chele, Girawa, Meta, Deder, Melka Belo and Fedis districts were 10, 10, 10, 13, 12, 10 and 12 of which 5, 4, 3, 3, 3,0 and 0 fields were affected with yellow rust, respectively. Furthermore, the leaf rust assessment revealed that it was observed on 21 (27.3%) of the 77 wheat fields inspected. The highest mean (100%) incidence of leaf rust was recorded in Meta and Fedis districts, while lowest the score (0%) was noted in Deder. The disease severity showed similar trend as of the incidence. The higher mean severities were recorded in Fedis and Meta districts with mean severity values 85s and 80s for the two districts respectively. Lastly, With regard to stem rust, it was highly prevalent in the mid-altitude areas of the districts assessed. Stem rust was observed only in three of the districts assessed. Out of the 77 fields assessed only 8(10.4%) of them were observed to be affected by stem rust. The highest mean incidence of 83% was observed at Fedis followed by 71% record at Meta.

From the adaptation trial at three locations, the highest grain yield was recorded by Mede Welabu, (70 quintal/hectare) followed by Tussie, Digalu and Millinium that gave 67.44, 64.44 and 62.78 qt/ha respectively at Kurfa chele. On the other hand at Jarso, the highest grain yield of 57.78 qt/ha was recorded by Mede Welabu and Kubsa followed by Digalu, Tussie and Dure that gave 49.67, 48.11 and 44.78 qt/ha respectively. Mede Welabu and Dure were the varieties preferred by farmers at both locations. At Girawa, the highest grain

yield of 74.33 qt/ha was record by Digalu followed by Danda'a (71.94qt/ha) and then Meda welabu (65.02qt/ha). The least grain yield (48.38qt/ha) was recorded by local variety. Farmers also preferred these two varieties. A total of 134 farmers in four districts namely Kurfa chele, Jarso, Girawa and Meta got access to seeds of improved varieties of bread wheat and fertilizer DAP and Urea according to their preference in 2013 cropping season and their land size.

Previously, farmers in Eastern Hararghe were accustomed to use a variety known as Kubsa and other varieties which are highly susceptible to the prevailing rust diseases such as yellow rust, stem rust and leaf rust. As a result farmers used to get low yield of wheat and they were not interested to allocate their land for wheat. The introduction of these varieties in to the area raised the farmers' interest to grow wheat again.

The team has recommended that integrated effort of all organization both governmental and non-governmental organization involved in agricultural sector is very crucial in dissemination, scaling up and scaling out of these varieties to all farmers growing wheat. Moreover, all the varieties released at national level should be brought to these areas and planted on farmers' fields and so that farmers should select a variety of their preference. Besides considering the rusts pressure from the survey result, the national wheat improvement programme of the country should consider wheat growing areas of Eastern Hararghe as a replica for any research activities accomplished since Hararghe has diverse agroecology from extreme highlands to extreme lowlands where different wheat trials could be accomplished.

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