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# Evaluation of Bread Wheat (*Tritium aestivum* L.*)* Varieties for Rust Resistance at Wolaita Zone, Southern Ethiopia

Abrham Taddele (M.Sc) Alemayehu Balcha (PhD)
Wolaita sodo university, plant protection , Sodo Ethiopia
Email address: abrhamtaddele@yahoo.com & Balchaal@yahoo.com

**Abstract**
The bread wheat is an important crop of Ethiopia. The average yield of wheat in the country is much behind the potential yield of the improved wheat cultivars. The low yield of wheat is the consequence of many factors including rust diseases that cause yield along with quality losses. Most of breeding programs in the country lack facilities for screening against rust diseases. Usually, selection is done with inadequate rust epidemic or improper pathotypes. As a result, only a few of released cultivars exhibit desired resistance against the prevailing rust diseases. A study was conducted during 2013 rainy season at sodo zuria woreda to provide information on the level of resistance in 20 released bread wheat varieties against rust diseases. The experiment was conducted using 20 bread wheat varieties and it was arranged using randomized complete block design (RCBD) with three replications. Plots having the size of 2 X 1 m was prepared. There are 10 rows per plot and the space between rows, plots and replications was 0.2, 0.5 and 1m respectively. Incidence and severity of wheat rust diseases were recorded with ten days interval and data on yield and yield components were taken at harvest. Remarkable difference at (P=0.05) were observed in incidence, severity, AUDPC values of the disease and yield component between the twenty varieties. Area under leaf rust progress curve (AULRPC) was also significantly different at P<0.05 between wheat varieties. The highest of AULRPC values (825%, 616.7 %, 525%,& 378% ) was recorded on galema, pavon-76,jefarson, and gassay respectively. Galema, medawelebu, pavon-76 showed the highest area under yellow rust progress curve AUYRPC with 1092,193.3 and 133.3% respectively. The lowest area under yellow rust progress curve AUYRPC with 28, 28, 21& 53 % was recorded on the varieties danda, digelu, hidasie and kakaba respectively. The results indicated that varieties exhibited compatible reaction with prevailing rust diseases of stripe and leaf rust. Varieties danda, hidasie, kakaba and digelu demonstrated type of resistance against naturally prevailing stripe& leaf rust diseases. Disease severity, incidence and area under disease progress curve (AUDPC) were negatively correlated with wheat yields harvested from four central rows. More extensive studies for assessment of bread varieties for specific regions and identification of control measures against rust disease would contribute to stabilizing wheat production in Ethiopia
**Keywords:** rust diseases, bread wheat varietie

## 1.INTRODUCTION

Wheat is an important cereal crop in Ethiopia that is widely cultivated in a wide range of altitude (Hailu, 1991). It is the main staple food for about 36% of the Ethiopian population (CSA, 2010; CIMMYT, 2005). The national average yield of wheat in Ethiopia is about 1.83 t/ha (CSA, 2010). This is far by bellow the word's average which is about 2.5 t/ha (Curtis, 2002).Multifaceted biotic and abiotic factors are responsible for this low yield. Cultivation of unimproved low yielding varieties, insufficient and erratic rainfall, poor agronomic practices, diseases and insect pests are among the most important constraints to wheat production in Ethiopia (Hailu, 1991 Dereje and Yaynu, 2000)

The most important wheat rusts, a group of diseases cause by fungal pathogens, are stem rust (black rust), stripe rust (yellow rust) and leaf rust (brown rust) are the most prevalent ones. These three rust diseases have the potential to infect wheat and cause economic damage in susceptible wheat varieties (Milus, 2009).Three regions are currently known to be highly affected by rust diseases; Oromya, Amhara and SNNPR. According to the Ministry of Agriculture and Rural Development (MoARD), over 400,000 ha of wheat are estimated to be infected by wheat rusts.

Currently, the majorities of commercial bread wheat cultivars have become susceptible to stem rust and/or yellow rust (SARC, 2004).In most parts of the country rust disease effectively controlled with resistant varieties, but they can cause problems in areas where susceptible varieties are grown. To determine the level of disease that optimizes economic returns on disease management strategy, the relationship between wheat yields and rusts severity needs to be known precisely. Furthermore, the development and rate of progress of the diseases in relation to host growth are important epidemiological factors determining the level of yield loss.

Recently the diseases have emerged as an important production constraint of wheat in Wolaita Zone, Southern Ethiopia. In last year, heavy yield losses are encountered due to the disease in the important producing areas such as (Sodo zuria, Damotie gaie,Boloso sorie etc), southern Ethiopia. Observations have shown that the most popular cultivar which sown at Wolaita zone "HAR-604" is appeared to be susceptible to wheat rusts (Wolaita

 

zone bureau of agricultural and rural development).

**Therefore, this research was conducted with the objectives**

- To quantify the incidence and severity of leaf and yellow rusts and their rate of temporal progression on different bread wheat varieties
- To assess the effect of some bread wheat varieties on the development of rust diseases
- To determine the effect of wheat rusts on yield and yield of bread wheat

## 2. MATERIALS AND METHODS

### 2.1. Treatments and Experimental design

The experiment was conducted at Sodo zuria, Kokote Kebele using 20 bread wheat varieties including local check. Varieties were collected from Kulumsa and Hollota agricultural research center, Ethiopian. The experiment was arranged in RCBD with three replications. Plots having the size of 2 X 1 m was prepared. There are 10 rows per plot and the space between rows, plots and replications was 0.2, 0.5 and 1m respectively. To initiate sufficient disease development, known very susceptible bread wheat varieties( 604) to rust was sown on the bordered of all plots. Seed of each variety was planted in each plot by hand drilling at the rate 150 kg/ha, which was recommended for the area was used. Fertilizers at a rate of 46 kg/ha N and 46 kg/ha P2O5 was applied during planting. Weeds were controlled by hand weeding. was carried out according the farmers' practices of the areas. Natural infection was used to initiate the epidemics of the disease.

### 2.2. Data collection

#### 2.2.1.Diseases data

**Disease incidence**: Rust incidence was recorded on each experimental plot by counting number of diseased plants from 16 randomly taken and tagged plant/plot from eight central rows and calculated as the proportion of the diseased plants over the total stand count (16 plants) at 10days interval.

**Disease severity:** Proportion of the stem and leaf of the plant affected by the disease, recorded using the modified Cobb's scale (Peterson et al., 1948). Starting from the appearance of the sign or symptoms, each plant with in each plot was visually evaluated for percent foliar infection (severity) at 10 days interval.

### 2.2. 2.Yield, Yield Components and Agronomic Data

Data like thousand kernel weight: the weight of thousand seed sampled at random from the total grains harvested from each experimental plot was measured. Days to maturity: the number of days from planting to the date when 75% of the plants became yellow. Grain yield in gram per plot at 12.5% moisture content was recorded and translated to kg/ha. Only four of the internal rows of the plots were harvested for yield and biomass estimations, excluding 0.1m m on both sides along the length of the plot Harvest index **(%)**

Harvest index (%) of each plot was computed in each replication using the following the formula harvesting index = $\frac{\text{Grain yield plot}^{-1}}{\text{Total Biomass plot}} \times 100$

### 2.3. Data Analysis

From disease severity the area under the disease progress curve (AUDPC) was calculated by using the formula of (AUDPC) as described by (Campbell and Madden, 1990).

$$\text{AUDPC} = \sum_{i=1}^{n-1} (\text{Xi} + \text{Xi} + 1)/2(\text{ti} + 1 - \text{ti})$$

Where, xi is the disease severity expressed in percentage at $i^{th}$ observation, ti is time at the $i^{th}$ observation and n is total number of days disease was assessed. Data on rust incidence and severity yield, yield components, AUDPC and all agronomic data were subjected to statistical analysis using SAS software (SAS, 2003). Means were compared using Fisher's protected least significant difference test at the 5% significance level (LSD5 %).

 

## 3. Results

### 3.1. Disease reaction

**Incidence of leaf rust (Brown rust) and Stripe rust (Yellow rust)**

Table 1. Mean disease incidence(%), initial and final severity(%) of leaf rust and AUDPC for 20 bread wheat varieties grown at Sodo Zuria

| Variety | LR incidence | Initial severity | Final severity | AUDPC |
|---|---|---|---|---|
| Galema | 87 | 47 | 75 | 825 |
| Pavon-76 | 81 | 24 | 92 | 616 |
| Jeferson | 52 | 13 | 73 | 525 |
| Huluka | 62 | 39 | 82 | 523 |
| Gassay | 72 | 3 | 78 | 378 |
| Galil | 78 | 7 | 11 | 320 |
| Medawelebu | 73 | 27 | 65 | 285 |
| Shorim | 19 | 0 | 55 | 240 |
| Tay | 78 | 11 | 4 | 202 |
| Agancho | 3 | 17 | 56 | 190 |
| Hogona | 13 | 12 | 28 | 190 |
| Wattera | 28 | 5 | 72 | 173 |
| Et-13 | 43 | 6 | 48 | 135 |
| Kakaba | 77 | 3 | 29 | 90 |
| Hidase | 44 | 0 | 7 | 58 |
| Merarro | 6 | 5 | 5 | 53 |
| Daphae | 20 | 0 | 5 | 32 |
| Alidro | 7 | 0 | 4 | 22 |
| Digwlu | 3 | 0 | 4 | 12 |
| Danda | 1 | 0 | 0 | 3 |
| **CV(%)** | **22** | **24** | **17** | **11** |
| **LSD** | **16** | **4** | **11** | **45** |

Leaf rust incidence was also significantly different at $P<0.05$( Table 1). Higher leaf rust incidences (86.7 ,72%, 81%, 77.7% and 72.7%) were recorded on galema, gassay, pavon-76, galil and medawelebu respectively. Leaf rust incidence on variety danda, digelu & alidro was lowest (1%, 2.6% ,7%). Shorm and et-13 had intermediate disease incidence Likewise strip rust incidence was significantly different at $P<0.05$ among the twenty bread varieties. Lowest strip rust incidence (0%, 0% ,2%, 2.3%, 3.3% , 3.3%) was recorded on
digelu, daphae, shorim gassay ,Mrerarro and alidro varieties while, the highest (91%,40%) on galem a& jefferson respectively (Table 2).

The results agreed with Headrik and Pataky(1987) stated that low level of disease incidence on a variety in the presence of the disease in the other varieties indicates that the variety possesses major gene resistance against the prevalent of pathogen since this type of resistance is known to prevent infection from occurring.

 

**Table 2. Mean disease incidence(%), initial and final severity (%), and AUDPC of stripe rust for 20 bread heat varieties grown at Sodo Zuria**

| Variety | SR incidence | Initial severity | Final severity | AUDPC |
|---|---|---|---|---|
| Galema | 91 | 48.33 | 96.67 | 1092 |
| Agancho | 31.33 | 13.33 | 73.33 | 200 |
| Medawelebu | 13.67 | 9.667 | 50 | 193 |
| Huluka | 24.33 | 0.667 | 60 | 155 |
| Pavon-76 | 13 | 12 | 50 | 133 |
| Jeferson | 40 | 5.333 | 13.33 | 90 |
| Wattera | 15 | 2 | 30 | 75 |
| Hogona | 17.33 | 2.667 | 13.33 | 70 |
| Et-13 | 14.33 | 3.667 | 53.33 | 68 |
| Tay | 15 | 0.333 | 11 | 65 |
| Hidase | 1.333 | 4.333 | 0.333 | 53 |
| Gassay | 3 | 3 | 5.667 | 45 |
| Galil | 24.33 | 0.667 | 6.667 | 43 |
| Alidro | 3.333 | 0 | 12.33 | 37 |
| Shorim | 2 | 4.667 | 7.667 | 34 |
| Kakaba | 13.33 | 1.333 | 5.333 | 35 |
| Danda | 8.667 | 0.667 | 6 | 28 |
| Merarro | 2.333 | 0.333 | 4 | 22 |
| Daphae | 0 | 1.667 | 3.333 | 13 |
| Digwlu | 0 | 1.667 | 2 | 6 |
| **CV(%)** | **20** | **22.5** | **18.2** | **19** |
| **LSD** | **5.5** | **2.2** | **7.5** | **38.62** |

**Disease severity of stripe rust (Yellow rust) and leaf rust (Brown rust)**

Stripe rust severity on twenty varieties was significantly different ($P<0.05$). The lowest initial and final stripe rust severity (0.67 and 0 0%,1.6 and 2%, 1.6 and 3.3% 3 and 5.6%,0 and 0.33 %and 11%) was recorded on the variety danda, digelu, gassay, daphae tay while severity was highest (48.3 and 96.7%, 12 and 50%,13% and 73%) on galema,pavon -76 and agancho respectively (Table 2). Similary, leaf rust severity was also significantly different at $P<0.05$ among the varieties. The lowest initial and final leaf severity (0 and 0%,0% and 4%, 0 and 4.3, 0% and 5.3%,) was recorded on the varieties danda,digelu, alidro and daphae while the highest (46.7and 75%,39 and 81.7 %, 24 and 91.7%) on galema, huluka and pavon-76 at sodo zuria (Table 1)

**Area under disease progress curve based on severity ($AUDPC_S$)**

Area under leaf rust progress curve (AULRPC) was also significantly different at $P<0.05$ between wheat varieties. The highest AULRPC values (825 %, 616.7 %,525%,523%, 378 % ) was recorded on galema, pavon-17,jefarson, huluka and gassay respectively. The lowest AULRPC (3.3, 12 ,21.7 and 31.7 %) on danda, digelu, alidro and daphae respectively . During the study period galema, medawelebu, pavon-76 showed the highest area under yellow rust progress curve AUYRPC with 1092,193.3 and 133.3 respectively. Among all the 20 Verities galema, pavon-76, agancho, jeferson were fast rusting where as danda, hidasie, mererro were a slow rusting variety against yellow rust (Table 1 & 2). There was statistically significant ($p<0.001$) difference among cultivars with regard to their AUDPC values. The high AUDPC value recorded for the three varieties (galema, jeferson and pavon-76 ) is a reflection of their degree of susceptibility to rust prevailing in wolaita. AUDPC is a good indicator of adult plant resistance under field condition (Wang *et al*., 2005). In this study, the lowest AUDPC values were recorded for bread wheat cultivars such as danda,digelu, daphae, hidasie.

 

### 3.2. Growth parameter, yield and yield components

**Table 3. Mean values for maturity days, grain yield and harvest index , thousand kernel weight of 20 bread wheat varieties grown at Sodo Zuria**

| Varieties | DTM | Grain yield(k/ha) | HI(%) | 1000-seed weight(g) |
|---|---|---|---|---|
| Danda | 108 | 6405 | 35 | 44 |
| Hidase | 105 | 6233 | 40 | 48 |
| Gassay | 111 | 6228 | 35 | 41 |
| Hogona | 108 | 5994 | 36 | 44 |
| Tay | 117 | 5979 | 33 | 44 |
| Galil | 103 | 5862 | 35 | 45 |
| kakaba | 99 | 5844 | 39 | 48 |
| Medawelebu | 111 | 5626 | 33 | 34 |
| Alidro | 106 | 5587 | 36 | 42 |
| Digwlu | 115 | 5578 | 34 | 44 |
| Merarro | 118 | 5771 | 32 | 41 |
| Daphae | 116 | 5488 | 34 | 43 |
| Shorim | 107 | 5414 | 37 | 40 |
| Agancho | 108 | 5499 | 33 | 42 |
| Huluka | 111 | 5346 | 37 | 41 |
| Jeferson | 121 | 5437 | 33 | 39 |
| Galema | 119 | 5077 | 33 | 37 |
| Pavon-76 | 106 | 4990 | 31 | 40 |
| Et-13 | 120 | 4901 | 31 | 44 |
| Wattera | 102 | 4353 | 37 | 39 |
| **CV(%)** | **3.3** | **2.3** | **6.2** | **11.8** |
| **LSD** | **5.87** | **217.7** | **3.6** | **8.12** |

**Thousand Kernel Weight (g)** Analysis of variance showed highly significant between varieties ranged from 34-48 g. Maximum kernels weight (48,48 and 44 g) were obtained from varieties kakaba, hidasie and galil respectively. However, grains with minimum weight(34,37 and 39 g) were observed in wheat varieties medawelebu galema and Jeferson respectively(Table 3)

**Days to maturity**: among varieties ranged from 98.7 to119.7cm where maximum numbers of days to maturity (119.7 and 118.3 days) were taken by et -13 and merarro while kakaba and alidro with 98.7 and 106 days, respectively, took minimum days to maturity and thus were amongst the early maturing wheat maturity (Table 3).

**Grain Yield (kg ha$^{-1}$)** Highly significant differences ($p<0.01$) were observed in average grain yield of varieties ranged from 4353-637 kg ha$^{-1}$. Maximum grain yield of 6372, 6233, 6228 5999, 5995, 5979 and 5911 kg ha$^{-1}$ was recorded in the varieties danda, hidasie, gassay, agancho, hogona,tay &kakaba , respectively while wheat varieties wattera,alidro,et-13 and jeferson with 4353,4887,4898 and 5071 kg ha$^{-1}$, respectively(Table 3)

**Harvest Index (%) :**Analysis of variance showed highly significant differences among varieties. HI of varieties ranged from 30-40%. Maximum harvesting index of 40, 39,37, and 37 was recorded in wheat varieties hidasie, kakaba,sorim and huluka respectively. Majority of the wheat cultivars exhibited good seed index ranging between 35 and 37%, however, lowest index 31 was observed in wheat variety et-13, %32 % was observed in wheat varieties mererro,,pavon-76, and 33 % was observed in varieties galema, jeferson medawelebu, agancho and hogona (Table 3).

### 3.3. Correlations between disease and yield parameters

Highly significant and positive correlation coefficients(0.96 - 0.3) were obtained between the disease parameters suggesting the possibility of using any of the parameters in assessing wheat rust diseases and evaluating the efficacy of control measure. All the disease parameters i.e. incidence, severity and AUDPCs had negative correlations with total yield, affirming the negative impact of rust diseases on wheat yield. These results also prove the need to efficiently manage the disease to get acceptable yield from wheat fields. In addition, the results provide clear evidence for the possibility of using any of the disease parameters to make valid predication about rust development and impact under various production practices

## 4. SUMMARY AND CONCLUSION

Results of the experiment showed that the tested varieties had significant difference in disease incidence, severity, AUDPC & yield. Among the varieties, significantly lower disease pressure and higher yields were

 

obtained from wheat varieties hidasie, danda, kakaba and gassay. Thus these four varieties play an important role in managing rust diseases and hence should be planted by farmers in areas, where rust diseases are prevalent. However, emphasis should also be given to other features including agronomic traits, quality of yield , and farmers preferences before final recommendations. The experiment was carried out under uncontrolled conditions, more information on rust resistance would be obtained from controlled inoculation under green house experiment. Further study is needed on different locations by including other growing seasons to account for weather variability to identify genotypic differences among varieties.

## 5. ACKNOWLEDGEMENT

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