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ORIGINAL ARTICLE

Evaluation of advanced bread wheat (*Triticum aestivum* L.) genotypes for yield and stem rust resistance at Southern Ethiopia

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Twenty four bread wheat (*Triticum aestivum* L.) genotypes including one local and one standard check obtained from Kulumesa agricultural research center were evaluated for their yield and stem rust resistance at Mareko Woreda during 2021 cropping season. The treatments were assigned using randomized completely block design with four replications. Data were collected on yield, yield, yield components and disease. The ANOVA showed that the genotypes significantly ($p<0.05$) different in most of the traits considered in the study. The highest average yield recorded was 5215.8 kg/ha and the lowest yield was 2848.3 kg/ha from ETBW-172640 and Ogolecho (the local check) respectively. Eighteen genotypes recorded above the grand mean (3788 kg/ha). Their reaction to stem rust ranges from resistance to highly susceptible. 70.8% were showed low rusting therefore could be suggested either for release to production or also could be used for stem rust resistance breeding. The best wheat genotypes have been further evaluated at different locations and years for their yield and disease resistance.

Keywords: Disease, Genotype, Grand mean, Moderately resistance, Stem rust.

Introduction

Wheat is the most widely grown cereal crop globally and feeds 4.5 billion people in 95 developing countries Braun et al. (2010). The most common species grown are *Triticum aestivum* L. (Bread wheat) and Triticum turgidum var. durum L. (durum wheat). Bread wheat accounts for 95% of the total wheat consumed worldwide Randhawa et al. (2013). The development of improved varieties of bread wheat (*Triticum aestivum* L.) has always remained a focal point for wheat breeders all over the world Edwards (2001).

Wheat is one of the strategic crops in Ethiopia, because of its role for food security, import Substitution and supply of raw material for agro-processing industry. Ethiopia is the third largest wheat producing country in Africa (CSA, 2018). Produced by 4.6 million smallholder farmers on 1.8 million hectares of land with an estimated annual production of 5.0 million tons at an average productivity of 2.92 t/ha which has been consistently increasing for the last 25 years, but much lower than the world average 3.3 t/ha(CSA, 2018).

Agronomic, morphological and phonological traits are very important for grouping wheat genetic resources and also are essential and useful for plant breeders seeking to improve existing germplasm by introducing novel genetic variation for certain traits into the breeding populations (Zarkti et al., 2010; Najaphy et al., 2012).

Low productivity is partially attributed to the prevalence of wheat rust diseases, deficient in durable resistant variety. Among various biotic stresses, three rust diseases (stem rust, leaf rust and stripe rust) are the major threats to wheat production globally Murray (2009). Of the rusts, stem rust is a globally, in more than 60 countries Stubbs et al. (1985). Recently, stem rust has become a serious threat to wheat, especially in case of highly susceptible varieties; losses may escalate as high as 80% Beard et al. (2007). In Ethiopia, stem rust of wheat was first reported since the early 1940s, and the disease occurs regularly in midland areas.

Under favorable environmental conditions, stem rust can cause yield losses of up to 100% in susceptible wheat varieties Roelfs (1985). The yield loss due to this disease is usually greatest if the disease becomes severe before the grain is completely formed, but yield losses are generally influenced by the resistance level of the cultivar grown, the weather conditions and the onset of the disease Roelfs (1985). The objective of this study was to evaluate the yield performance and stem rust resistance of advanced bread wheat genotypes from observation nursery trial.

Materials and Methods

Description of experimental material and design

A total of twenty four bread wheat genotypes including two checks were evaluated for yield and stem rust resistance at Mareko in 2021 cropping season. The genotypes were promoted from observation nursery trail based on different desirable traits. The planting materials were obtained from Kulumesa Agricultural Research Center. The genotypes were assigned in Randomized Complete Block Design (RCBD) with four replications. The plot area was 3 m^2 (2.5 m × 1.2 m) and each plot consisted of six rows spaced 20 cm apart. A 1.5 m distance was maintained between replication and 50 cm between plots used for the experiment. Fertilizers was applied at the rate of 150 kg/ha urea at the time of planting and tillering and 100 kg/ha NPS at the time of planting. 125 Kg/ha seed rate was used for the experiment. Seed and fertilizer was drilled uniformly by hand. Other agronomic management practice was carried out as per recommendations for all the treatments uniformly.

Data collected and statistical analysis

The major agronomic data:-plant height, spike length, number of tillers, seeds per spike, days to maturity, biomass, grain yield and other yield related traits were collected. Plant height, spike length, tillers per plants and seeds per spike were collected from five plants from the central four rows. Biomass and yield were measured from the entire four central rows.

The stem rust assessment was made using the Modified Cobb's scale (Peterson et al., 1948). The terminal severity was used to categorize the genotypes into resistant and susceptible groups. The severity was converted to coefficient of infection (ACI) values by multiplying the severity by constant values (Roelfs et al., 1992). The constant values are: R=0.2, MR=0.4, MS=0.8 and S=1. Based on the ACI values, the genotypes were categorized under four resistant groups: The first group was 0-10% severity (resistant), the second with severity 15-20% (moderately resistant), and the third with severity of 25-30% moderately susceptible whereas the rest were considered as susceptible.

A significance test was adopted by analysis of variance (ANOVA) for Randomized Complete Block Design. The ANOVA was carried out using SAS Version 9.4 procedure. For factors showing significant effects, mean comparisons were made using Least Significance Difference (LSD) at 5% level of significance.

Results and Discussion

The genotypes showed significant differences ($P<0.05$) on collected parameters indicating the presence of adequate variability (Table 1). The physiological maturity of the genotypes ranges from 92.3 to 111.8 days after sowing. The shortest date of maturity (92.3 days) was recorded from Ogolecho genotype while the longest date of maturity (111.8 days) was recorded from ETBW-172686 genotype. The average plant height of varieties ranged from 81.9 to 97.8 cm. In the present study the tallest plants were measured from ETBW-172777 genotype with 97.8 cm and the shortest plant height recorded were 81.9 cm from ETBW-174342 genotype. Longov et al. (2014) reported the presence of significant ($P<0.05$) difference among five promising wheat varieties in the case of plant height.

The average spike length per plants significantly differs among the genotypes and it ranges from 7.2 to 8.9 cm. ETBW-172777 genotype recorded the tallest spike length of 8.9 cm while ETBW-172832 genotype recorded the shortest length of 7.2 cm. Significance differences in the number of productive tillers were observed among genotypes. The average number of productive tiller ranges from 2.2 (ETBW-172640) to 3 (ETBW-172686). Related range and mean was reported from the finding of Obsa (2014).

There was significant variation in the number of kernels per spike and thousand kernel weights. The value of kernels per spike ranges from 33.1 (ETBW-120082) the smallest to 46.5 (ETBW-172687) the largest number of kernel per spike for the tested genotypes. The maximum thousand kernel weight recoded was 42.5 g (ETBW-172687) while the minimum was 25.9 g (Ogolecho). However, in contrast to this non-significant difference between genotypes for seed weight has also been reported (Khan et al., 2011).

The analysis of variance showed that there were significant ($P<0.05$) differences among bread wheat varieties on grain yield. The highest average yield recorded was 5215.8 kg/ha (ETBW-172640) and the lowest yield was 2848.3 kg/ha from Ogolecho varieties. The result is in line with Falaki et al. (2009) reported different responses of wheat varieties in respect to the yield and yield components examined and suggested that it could be due to their varied genetic composition and adaptation to the soil and climatic conditions under which the study was conducted.

Stem rust severity ranges from 10% from resistance to 90% on susceptible varieties (Table 2). Out of 24 genotypes tested for stem rust resistance, 4 genotypes exhibited resistance reaction, 13 were moderately resistant, 5 were moderately susceptible and the remaining 2 were completely susceptible. The high level of stem rust severity was attributed to the susceptibility of many of the genotypes to stem rust.

Table 1. Mean performance of Genotypes on collected parameters.

Genotypes	PH (cm)	SL (cm)	NT	SS	DTM	TSW (g)	GY (kg/ha)
ETBW-174364	95.5	7.7	3.0	36.0	109.5	30.5	4001.7
ETBW-172777	97.8	9.0	2.8	38.5	108.8	35.8	3672.8
ETBW-120082	92.2	8.1	2.6	33.1	96.8	31.8	3354.1
ETBW-172832	94.3	7.3	2.7	42.4	105.3	34.8	4866.5
ETBW-172575	96.9	8.3	2.7	39.6	101.3	36.2	4711.5
ETBW-172640	91.2	8.4	2.3	35.3	97.8	39.3	5215.8
ETBW-172794	94.7	8.1	2.9	35.6	107.0	38.7	4954.1
ETBW-172687	92.5	8.1	2.5	46.5	110.3	42.5	5158.8
ETBW-172686	93.2	8.4	3.0	44.0	111.8	39.3	4282.3
ETBW-172711	94.5	8.0	2.7	36.6	98.3	27.1	3336.3

ETBW-172719	93.0	8.7	2.8	39.5	97.5	28.9	3215.0
ETBW-172625	90.8	7.9	2.8	41.1	110.8	34.8	4354.0
ETBW-172657	91.1	7.5	2.8	41.8	111.5	35.3	5107.9
ETBW-172653	88.3	7.9	2.6	40.8	107.3	40.9	4428.0
ETBW-172711	89.2	8.1	2.7	43.4	110.0	38.3	4653.4
ETBW-172642	88.7	8.4	2.5	44.9	99.8	39.1	4418.0
ETBW-174342	81.9	7.6	2.3	36.1	99.5	33.2	4174.5
ETBW-172712	85.7	8.3	2.7	42.1	111.0	34.9	4837.1
ETBW-172726	93.1	7.6	2.8	36.6	107.0	38.2	4533.9
ETBW 172628	88.7	8.4	2.5	36.1	106.5	40.0	4005.0
ETBW-174420	83.3	7.8	2.5	38.0	98.5	35.4	4434.7
ETBW-172638	88.2	8.2	2.7	43.3	104.5	37.3	5001.3
Ogolecho	97.8	8.1	2.8	37.5	92.3	26.0	2848.3
Kingbird	87.6	7.5	2.3	37.4	104.8	30.6	3365.2
Mean	91.2	8.0	2.6	39.4	104.5	35.4	4288.8
LSD (0.05)	5.6	0.6	0.6	10.1	8.6	5.1	411.3
CV (%)	14.4	9.5	11.8	18.1	11.1	10.3	12.7

Table 2. Average stem rust severity of tested genotypes**.**

Genotypes	Stem Rust Severity	ACI
ETBW-174364	25MS	20
ETBW-172777	10R	2
ETBW-120082	50S	50
ETBW-172832	10R	2
ETBW-172575	35MSS	28
ETBW-172640	30MS	24
ETBW-172794	15MR	6
ETBW-172687	15MR	6
ETBW-172686	20MR	8
ETBW-172711	20MR	8
ETBW-172719	30MS	24
ETBW-172625	20MR	8
ETBW-172657	15MR	6
ETBW-172653	20MR	8
ETBW-172711	10R	2
ETBW-172642	15MR	6
ETBW-174342	20MR	8
ETBW-172712	10R	2
ETBW-172726	20MR	8
ETBW 172628	20MR	8
ETBW-174420	25MS	20
ETBW-172638	25MRMS	8
Ogolecho	90S	90
Kingbird	15MR	6

Conclusion

Highly significant differences among wheat genotypes were observed on collected parameters. This suggests the importance of the assessment of genotypes under different parameters in order to identify better performing genotypes for particular breeding programs. Disease tolerant wheat genotypes are believed the main issues in wheat breeding agriculture research programs to protect wheat plants from disease epidemics and thus from yield loss. From the results of this study, there were wheat genotypes better than both the local and standard checks interims of yield and disease resistance. Thus, among the 24 genotypes evaluated, 70.8% were showed low rusting therefore could be suggested either for release to production or also could be used for stem rust resistance breeding in Ethiopia. The best wheat genotypes have been further evaluated at different locations and years for their yield and disease resistance.

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Conflicts of Interest
The authors declare no conflict of interest. The funders had no role in the study design; in the collection, analysis, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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