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Evaluation of Selected Durum Wheat (*Triticum turgidum Subsp. durum*) Local Cultivars for Their Reaction to Leaf Rust (*Puccinia triticina)*

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Abstract: *Puccinia triticina* is causative agent of wheat leaf rust, which is the most significant disease of wheat worldwide. It causes a huge amount of yield losses up to 30- 50%. In Ethiopia; the disease categorized as a huge yield loss causing agent on wheat yield loss due to this disease has reached up to 75%. The experiment is conducted on wheat disease screening nursery and main research field at Debre Zeit Agricultural Research Center in 2018/19 using 20 local cultivars collected from chefe donsa district which is known availability of local cultivars in the area. Digelu, Arendato and Morocco seeds were sown as susceptible standard checks. Cultivars such as (16, 4, 7, 12, 14, 20, 1, 3 and 2) have shown lesser TRS with resistance types at both locations during the life of the experiment. In the same way Cultivar such as (12 and 14) has shown equal low disease progress rate at screening nursery and main research field. Among tested 20 cultivars such as (19, 6, 7, 11, 12, 13, 3, 2) have revealed less IC value with resistance character than standard check at both locations. It is important to search local variants and cultivars for available gene to tackle the identified and newly evolving races. The available major and minor gene should be identified to know the specific resistance gene. These generate an opportunity to improve durum wheat variety and cultivars resistance against leaf rust.

Keywords: Leaf-Rust, Cultivars, TRS, DPR and Infection Coefficient

1. Introduction

Use of improved agriculture production technology is important to Africa continent to meet the need of population food security. Crop production is a major contributor to GDP, accounting for approximately 28% from the sub-sectors of agriculture [6]. Cereal crops such as Teff, wheat, maize, sorghum and barley are the most important food crop which ensures daily food. Hence, cereal production and marketing are the means of livelihood strategy for millions of smallholder households in Ethiopia.

Among crops; wheat is ranged at third level under cereals crops produced in Ethiopia and taken as strategic crop [5]. The productivity of wheat is less in Ethiopia which is highly constrained by rusts that can cause significant yield losses [9]. The rust pathogens are among the most important pathogens causing a continuous threat to wheat production and have been reported to cause a vast amount of losses in different areas, years and environments favoring disease epidemics [11, 16]. Rust fungi are adaptable for their virulence; *Puccinia triticina* is causative agent for wheat leaf rust is one of the economically important disease of wheat rust disease worldwide [3]. Rusts are important pathogens of angiosperms and gymnosperms including cereal crops and forest trees. Leaf rust is one of the three wheat rusts and is economically important disease of wheat worldwide.

In agreement with K. James, *Puccinia triticina* is known as one of a causative agent for wheat leaf rust at all wheat production area globally [7]. This disease occurs at almost all wheat growing areas and causes severe yield losses ranging from 30 to 50% [10]. In Ethiopia; leaf rust is categorized as one of the challenging diseases on wheat. Adult Plant Resistance (APR)/minor gene offer resilient resistance to rust diseases. Z. Li et al. stated that there is resistance gene in all wheat cultivars for Leaf Rust resistance [8]. Therefore, in search of new resistance cultivars endowed naturally; provides durable and rust-resistant wheat cultivars and gives to develop new traits in the future [1]. It is important to through put capabilities allowing detection of whole-genome by scoring hundreds of polymorphic loci by sequence and co-dominance with a large number of available markers [15]. The objective of the research is to find a new resistance source of durum wheat for wheat leaf rust (Puccinia tritici). Responding to the by the lowered severity rate of wheat rust epidemics, breeders needs to have identified durable, long-lasting source resistance.

2. Materials and Method

2.1. Planting Materials and Sites Selection

A total of 20 durum wheat cultivars collections from highland of highland area of east shewa zone at Gimbichu district. They were evaluated against leaf rust (Table 1). The experiment was conducted at two locations at screening nursery and main research field. The mixture of bread wheat cultivar Morocco, Digelu, and Arendato were used as susceptible check and spreader row which are known standard susceptible checks. The experiment was conducted following augmented design only checks were randomized.

Table 1. *Pedigree of used cultivars.*

Cultivar	Pedigree	Cultivar	Pedigree
Digelu	**SHA7/KUAZ**	**Digelu**	**SHA7/KUAZ**
Arendato	**---**	**Arendato**	**---**
Morocco	**INRA 1781, Sel in “Cyprus 3”Bittern ‘S’ or sel in<<JO’S. AA “:S’//FG’S’>>**	**Morocco**	**INRA 1781, Sel in “Cyprus 3”Bittern ‘S’ or sel in<<JO’S. AA “:S’//FG’S’>>**
Cultivar-16	NA	Cultivar-10	NA
Cultivar-5	NA	Cultivar-15	NA
Cultivar-17	NA	Cultivar-11	NA
Cultivar-18	NA	Cultivar-12	NA
Cultivar-4	NA	Cultivar-13	NA
Cultivar-19	NA	Cultivar-14	NA
Cultivar-6	NA	Cultivar-20	NA
Cultivar-7	NA	Cultivar-1	NA
Cultivar-8	NA	Cultivar-3	NA
Cultivar-9	NA	Cultivar-2	NA

Note: NA: not available.

2.2. Leaf Rust Data Collection

The leaf rust severity was recorded as percent of the rust infection according to the modified Cobb’s scale [13] and the infection type [14]. The disease data were converted to slow rusting parameters ACI, TRS, AUDPC [4] and DPR [2]. The data on severity and host reaction was combined to calculate the coefficient of infection (CI) by multiplying the value of 0.2, 0.4, 0.8, 1.0 for host response ratings R, MR, MS, S, respectively [12].

Table 2. *Host reactions in the field.*

Reaction	Description	Mark	value
R	Visible chlorosis	R	0.2
MR	Small uredia surrounded by necrotic areas	MR	0.4
M	Have Mixted small and medium sized pustules	M	0.6
MS	Medium sized uredia with no necrotic distinct	MS	0.8
S	Large uredia and little/ no chlorosis present.	S	1.0

3. Result

3.1. Terminal Rust Severity (TRS)

TRS is important parameter for the evaluation leaf rust. During the experiment Digelu, Arendato and Morocco wheat variety were used as standard check. Digelu has shown 1% TRS with reaction of moderately susceptible at screening nursery which is not severely infected. In the other case Arendato has shown 40% TRS with the response of MS and S at screening nursery which is categorized as susceptible. Cultivars such as (16, 5, 17, 18, 4, 6, 7, 8, 9, 10, 15, 11, 13, 14, 20, and 1 and 2) at screening nursery have shown the same and greater value than standard checks susceptible reaction than other cultivars (Table 3). Conversely; cultivars such as (19, 12 and 3) has shown lesser TRS value with the value of 30, 25 and 15; respectively with MS reaction (Table 3). Conversely; cultivars (16, 4, 7, 12, 14, 20, 1, 3 and 2) has shown greater TRS value than susceptible standard checks and other cultivars (Table 3).

Table 3. *Terminal rust severity (TRS) results for cultivars in respect to standard checks.*

Cultivar	Screening nursery		Main research field	
	Host response	TRS	host response	TRS
Digelu	MS	1	MS	5
Arendato	MS	40	S	40
Morocco	Moderately Susceptible	30	Moderately Susceptible	40
Cultivar-16	Susceptible	50	Moderately Susceptible	35
Cultivar-5	Susceptible	40	Moderately Susceptible	45
Cultivar-17	Susceptible	70	Moderately Susceptible	40
Cultivar-18	Susceptible	40	S	50
Cultivar-4	Susceptible	60	Moderately Susceptible	15
Cultivar-19	Moderately Susceptible	30	Moderately Susceptible	40
Cultivar-6	Moderately Susceptible	40	Moderately Susceptible	40
Cultivar-7	Moderately Susceptible	40	Moderately Susceptible	20
Cultivar-8	Susceptible	50	Moderately Susceptible	40
Cultivar-9	Moderately Susceptible	40	Moderately Susceptible	40
Cultivar-10	Moderately Susceptible	50	Moderately Susceptible	40
Cultivar-15	Susceptible	70	Moderately Susceptible	50
Cultivar-11	Moderately Susceptible	40	Moderately Susceptible	40
Cultivar-12	Moderately Susceptible	25	Moderately Susceptible	5
Cultivar-13	Moderately Susceptible	40	Moderately Susceptible	30
Cultivar-14	Susceptible	40	Moderately Susceptible	5
Cultivar-20	Susceptible	50	Moderately Susceptible	25
Cultivar-1	Susceptible	60	Moderately Susceptible	20
Cultivar-3	Moderately Susceptible	15	Moderately Susceptible	30
Cultivar-2	Susceptible	40	Moderately Susceptible	15

3.2. Disease Progress Rate (Rust Progress Rate) (DPR)

Disease progression rate used to show how fast the cultivars rust. The susceptible standard checks (Digelu, Arendato and Morocco) has 0.92, 0.90, 0.67 disease progress rate at screening nursery. Cultivars (such as 16, 5, 17, 4, 19, 7, 8, 9, 10, 15, 11, 13, 20, 1 and 2) have shown greatest DPR. While Cultivar such as (18, 6, 12, 14 and 3) has less DPR value of 0.44, 0.44, 0.55, 0.44 and 0.46, respectively. At main research field; the standard checks has reached the maximum Disease progress rate 1 (one) with final rust response of susceptible. Cultivars as (19, 6, 8, 9, 10, 15, 11, 20, 1, 3 and 2) have shown susceptible reaction (Table 4). While; cultivar like (16, 5, 17, 18, 4, 7, 12, 13 and 14) has shown less DPR. With special case cultivar such as (7, 12 and 14) have revealed zero (0) value at main research field. Cultivar such as (12 and 14) has shown equal low disease progress rate at both locations (Table 4).

Table 4. *Disease progress rate as results for cultivars in respect to standard checks.*

Cultivars	Screening nursery		DPR at	Host at main research field		DPR at main
	Initial	Final	nursery	Initial	final	research field
Digelu	Moderately Susceptible	Susceptible	0.92	Susceptible	Susceptible	1
Arendato	Moderately Susceptible	Susceptible	0.90	Moderately Susceptible	Susceptible	1
Morocco	Moderately Susceptible	Susceptible	0.67	Moderately Susceptible	Susceptible	1
Cultivar-16	Moderately Susceptible	Susceptible	0.85	Moderately Resistance	Moderately Susceptible	0.23
Cultivar-5	Moderately Susceptible	Susceptible	0.69	Moderately Resistance	Moderately Susceptible	0.21
Cultivar-17	Moderately Susceptible	Susceptible	1	Resistance	Moderately Susceptible	0.44
Cultivar-18	Moderately Susceptible	Susceptible	0.44	Moderately Resistance	S	0.41
Cultivar-4	Susceptible	Susceptible	1	Moderately Resistance	Moderately Susceptible	0.46
Cultivar-19	Moderately Susceptible	Moderately Susceptible	1	Moderately Resistance	Moderately Susceptible	1
Cultivar-6	Moderately Susceptible	Moderately Susceptible	0.44	Moderately Resistance	Moderately Susceptible	0.98
Cultivar-7	Moderately Susceptible	Moderately Susceptible	0.98	Moderately Resistance	Moderately Susceptible	0
Cultivar-8	Moderately Susceptible	Susceptible	1	Moderately Resistance	Moderately Susceptible	1
Cultivar-9	Moderately Susceptible	Moderately Susceptible	0.69	Moderately Resistance	Moderately Susceptible	1
Cultivar-10	S	Moderately Susceptible	0.87	Moderately Resistance	Moderately Susceptible	0.69
Cultivar-15	Moderately Susceptible	Susceptible	1	Moderately Resistance	Moderately Susceptible	1
Cultivar-11	Moderately Susceptible	Moderately Susceptible	1	Moderately Resistance	Moderately Susceptible	1
Cultivar-12	Susceptible	Moderately Susceptible	0.55	Moderately Resistance	Moderately Susceptible	0
Cultivar-13	Moderately Susceptible	Moderately Susceptible	1	Moderately Resistance	Moderately Susceptible	0.54
Cultivar-14	Moderately Susceptible	Susceptible	0.44	Moderately Resistance	Moderately Susceptible	0
Cultivar-20	Susceptible	Susceptible	0.99	Moderately Resistance	Moderately Susceptible	1
Cultivar-1	Moderately Susceptible	Susceptible	0.81	Moderately Resistance	Moderately Susceptible	1
Cultivar-3	Moderately Susceptible	Moderately Susceptible	0.46	Moderately Resistance	Moderately Susceptible	1
Cultivar-2	Moderately Susceptible	Susceptible	0.98	Moderately Resistance	Moderately Susceptible	1

3.3. Infection Coefficient (IC)

The data on infection coefficient of (IC) recorded during main rainy season 2018/19. The average infection coefficient (ACI) of 20 genotypes is listed in the (Table 5). Susceptible checks have revealed moderately susceptible (MS) to susceptible (S) reaction of ACI values. Among tested 20 cultivars such as (19, 6, 7, 11, 12, 13, 3, 2) have revealed less IC value with resistance character than standard check at both locations while the others has revealed IC value above susceptible checks reaction for tested races (Table 5). These resistance genotypes can be used as a potential source for breeding program in Ethiopia, while the other tested wheat genotypes were varied in their response. For tested susceptible cultivars including standard checks has showed some immune character this means. Thus, we cannot conclude if these genotypes were effective for other location or not by the results of this study.

Table 5. *Infection coefficient as results for cultivars in respect to standard checks.*

Cultivars	screening nursery		Infection Coefficient (IC)	
	Initial	Final	Screening nursery	Main research field
Digelu	MS	S	19	30
Arendato	MS	S	43	40
Morocco	MS	S	32	30
Cultivar 16	MS	S	49	26
Cultivar 5	MS	S	40	38
Cultivar 17	MS	S	81	31
Cultivar 18	MS	S	44	41
Cultivar 4	S	S	65	10
Cultivar 19	MS	MS	24	22
Cultivar 6	MS	MS	40	24
Cultivar 7	MS	MS	32	16
Cultivar 8	MS	S	51	19
Cultivar 9	MS	MS	36	22
Cultivar 10	S	MS	60	26
Cultivar 15	MS	S	65	30
Cultivar 11	MS	MS	31	19
Cultivar 12	S	MS	33	4
Cultivar 13	MS	MS	24	20
Cultivar 14	MS	S	50	4
Cultivar 20	S	S	59	10
Cultivar 1	MS	S	62	10
Cultivar 3	MS	MS	14	18
Cultivar 2	MS	S	40	8

4. Conclusion

The evaluation for slow rusting character was based on AIC, TRS, AUDPC and Disease Progress Rate. The cultivars have showed varying level of disease reaction against leaf rust under natural field at DZARC grouped by different category slow rusting character. Based on the study; it is important that continuously characterize and identification of resistance cultivars against newly evolving leaf rust races which requires attention. Use of slow rusting cultivars for breeding programs for variety improvement to replace the available and susceptible variety like cultivar-12 have better resistance against leaf rust and promising for variety improvement, and gene deployment. The available major and minor gene should be identified to know the specific resistance gene. These generate an opportunity to improve durum wheat variety and cultivars resistance against leaf rust and future works need to be conducted to wheat for their resistance to leaf. Anywhere local cultivated durum wheat cultivars and cultivars are important to search the available gene for their resistance against the identified and newly evolving races is mandatory across all leaf rust important areas.

The economic importance of finding and searching for resistance genes to leaf rust from old and new cultivars of wheat as a valuable tool has indicated by the Global Rust Initiative (2005).

Conflict of Interest

The author has no any declaration of conflict of interest on the paper.

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