The Reaction of Bread Wheat Lines and Varieties to Stripe Rust at Seedling and Adult Plant Growth Stages

Ayele Badebo, Temesgen Kebede, Zewdie Alemayehu, Bedada Girma
Institute of Agricultural Research
PO Box 2003, Addis Ababa, Ethiopia

Osman Abdalla
International Maize and Wheat Improvement Center (CIMMYT)
Addis Ababa, Ethiopia

Abstract

A total of 218 commercial bread wheat varieties and advanced lines were evaluated for their reaction to stripe rust (*Puccinia striiformis* Westend f. sp. *tritici*) isolates at seedling stage, and these entries were also exposed to natural infestation at Meraro, Arsi, during the 1995 and 1996 cropping seasons. Relatively high proportions of the entries (25.5%) were susceptible to the 'Dashen' isolate while susceptibility to the 'K 6295-4A' isolate was less than 7%. The commercial bread wheat varieties such as 'ET 13', 'K 6295-4A', and 'Enkoy' were resistant to the 'Dashen' isolate but were susceptible to the 'K 6295-4A' isolate at the seedling stage. The field test results indicated that more than 60% of the entries were resistant to leaf and spike infection during both seasons. The severity of stripe rust on 'ET 13', 'Enkoy' and 'K 6295-4A' was relatively low when compared with 'Dereselign' which was highly susceptible. The majority of the advanced lines which showed complete resistance were from the CIMMYT crosses such as 'Lira S', 'Chilero S', and 'Carpentero S'. These lines have been reported to be resistant in earlier investigations, and are suggested to be incorporated in the crossing program.

Introduction

Stripe (or yellow) rust, caused by *Puccinia striiformis* Westend f. sp. *tritici*, has been an important disease of wheat in temperature climates as well as in high altitudes of East Africa, the Middle East, South Asia, and Latin America (Stubbs 1988). So far, several stripe rust resistance genes have been identified (McIntosh et al. 1995). However, the resistance of most of the known genes has been overcome by apparently new races of the pathogen, singly or in various combinations (Stubbs 1988). Many wheat varieties developed in the past 50 years possess the Rye chromosome. The first stripe rust race with virulence for 1B/1R varieties was detected in Europe in the 1970s (Stubbs 1985). In later years it was detected in Kenya in 1982, and in Ethiopia in 1986 (Danial & Stubbs 1992, Ayele et al. 1990). Since 1986 stripe rust has remained the major threat to wheat production in the high altitudes of Arsi and Bale regions in Ethiopia. Recently the disease became very important in the central and northwestern parts of the country. Yield loss due to stripe rust could reach 100%, depending on the variety and environmental conditions in Arsi. Stripe rust races detected in Ethiopia were among the most virulent ones in the world (Ayele & Wondimu 1992). The most frequent race since 1986 has been 134 (166) E150 (158). This race attacked the high yielding bread wheat varieties such as 'Gara' (BOW 'S') and 'Dashen' (BEE 'S'), and was also found to be virulent on related CIMMYT crosses.

Monitoring race and virulence, and identification of resistance sources to the prevailing races of the pathogen is very important in wheat improvement programmes. This report summarises the results of tests conducted during the 1995 and 1996 seasons.

Materials and Methods

Planting Materials

A total of 218 bread wheat varieties and lines from the national wheat breeding programme, standard stripe rust differentials from IPO-Wageningen and the University of Sydney were used in this study. Some of these lines were tested to 19 stripe rust races from different countries at seedling stage (Ayele et al. 1990) and evaluated at adult plant stage across years and locations and found to be resistant (Ayele & Wondimu 1992).

Seedling test

Stripe rust inoculum: Naturally infected wheat leaves were collected from two bread wheat varieties, 'Dashen' (Veery "S"), and 'K 6295-4A' (Romany X GB-Gamenya) at Kulumsa and Meraro in Arsi region. The spores were transferred to a susceptible check, 'Morocco', and then maintained on respective varieties in top-opened plastic cages in a green house at Kulumsa during the 1995 off-season.

Seedling evaluation: Twelve seeds were placed in 5 cm^3 plastic pots filled with sand, soil and compost in a ratio of 1:2:1 in a greenhouse. Eight days old seedlings were inoculated using sterilised fine hair brushes. Fine wheat flour was used as spore carrier in a 9:1 (flour: spore) ratio. Inoculated seedlings were kept in plastic cages and incubated at 9°C for 24 hr. The seedlings were kept in a cool portion of the greenhouse supplemented with artificial light for 4-5 days and then transferred to a wirehouse for optimum illumination. The test was conducted during October to early December when day and night temperatures were expected. After 15 days of inoculation disease notes were taken on a 0-9 scale, where 0-6=resistant, and 7-9=susceptible (McNeal et al. 1971).

Adult plant test

Stripe rust differentials: Seventeen spring type differentials developed by the University of Sydney were planted on two rows of 1 m length at four locations in Arsi during 1996.

Commercial varieties and advanced lines: The entries were planted at Meraro (2990 m) during 1995 and 1996 main seasons. Non-replicated two rows of 1 m length were used for each entry. Fertilizer and other cultural practices were applied according to recommendations for the area. Stripe rust notes were taken three times in the growing season using Modified Cobb scale (Stubbs 1985). Relevant agronomic data were recorded and seed evaluation was made in the laboratory.

Results and Discussion

Differential Lines

There were differential interactions of the isolates tested on 'Dashen' and 'K 6295-4A' (Table 1). The 'Dashen' isolate tended to have more virulence than that of 'K 6295-4A'. High infestation type (IT=7) was noted on the recently released bread wheat variety, 'Kubsa'. Susceptibility to stripe rust in a similar cross, 'Attila', was reported in Uganda. Intermediate infestation types (IT=5-6) on differential lines, Yr SD (Strubes Dickkopf), Yr SU (Suwon/Omar), Yr9+(Clement), Yr3N (Nord Desprez), and Yr8 (Compair) were due to testing environments. Earlier reports have shown virulences on the indicated differentials (Ayele et al. 1990).

Table 1. Phenotypic characterization of two stripe rust isolates used four seedling test.

Lines	Yr genes[1]	Infection type (0-9) Isolate	
		'K 6295-4A'	'Dashen'
Chines 166	1	0	0
Lee	7	9	9
Vilmorin 23	3V	0	4
Moro	10	0	0
Strubes Dickkopf	SD	0	6
Suwon/Omar	SU	0	5
Clement	9+	0	5
Hybrid 46	4+	0	0
Reichersberg 43	7+	0	7
Peko	6+	0	7
Nord Desprez	3N	0	5
Compair	8	0	6
Carstens V	CV	0	0
Spadlings Prolific	SP	0	0
Heins VII	2+	0	2
Dashen	?	2	8
HAR 1685	?	5	7
K 6295-4A	?	7	2
Morocco	0	8	9

[1]*Stripe rust resistance genes (McIntosh et al. 1995)*

The near isogeneic lines currently developed by the University of Sydney (Wellings et al. 1996) were included in the field tests (Table 2). There were no virulences for Yr1, Yr5, Yr15, and Yr17. The last one confers adult plant resistance (McIntosh et al. 1995). The absence of virulence for the first three genes including Yr3V ('Vilmorin 23'), and Yr4 ('Hybrid 46') has been reported in East Africa (Ayele & Stubbs 1995, Danial & Stubbs 1992).

Table 2. The reaction of differential lines to stripe rust at four locations in Arsi during 1996 season

Differential/lines	Yr genes	Location			
		Kulumsa	A.Robe	Asasa	Meraro
Kalyansona	2	40S	20S	30S	25MS
Lee	7	20MS	40MS	5MS	60S
H. Kolben	6	-[1]	10MS	-	40MS
H. Peko	6+	10MS	0	0	5MR
Compair	8	5MS	0	TMR	0
Fed 4*/KVZ	9	40MS	TMS	30S	40MS
Aroona	?[2]	15MS	60S	25MS	40MS
Avocet S	?	90S	90S	70S	40MS
Aroona*5/Yr1	1	0	0	0	0
Aroona*6/Yr5	5	0	0	0	0
Aroona*6/Yr8	8	10MR	5MR	20MR	30MS
Aroona*6/Yr17	17	0	0	0	0
Yr15/6* Avocet s	15	0	0	0	0
M 2435	?	30MS	60S	20MS	30MS
Yr10/6* M 2435	10	40MS	0	50S	20MS
Jupateco R	18	20MS	0	15MR	10MR

[1]*Data not available.* [2]*not designated*

Bread Wheat Varieties and Lines

The tested entries showed different seedling interactions to the two isolates tested (Fig. 1). The majority of the entries (61%) were resistant to both isolates. Relatively high proportion (25%) of the entries showed susceptibility to the 'Dashen' isolate and resistance to the 'K 6295-4A' isolate. About 6% of the entries were susceptible to the 'K 6295-4A' isolate and resistant to the 'Dashen' isolate.

There were differential interactions among released bread wheat varieties to stripe rust isolates tested (Table 3). However, 'Dereselign' was susceptible to both isolates. Relatively high infection types (IT=6-8) were noted on 'HAR 1709' and 'HAR 1595' to the 'Dashen' isolate.

Variations among bread wheat varieties and lines to leaf and spike infections were noted (Fig. 2). About 57% showed resistance to leaf and spike infection while 23% were susceptible both to leaf and spike infections. Resistance to leaf and susceptibility to spike infection was noted on 15% of the entries while only 5% showed the reverse phenomenon. Similar findings were reported earlier on different sets of bread wheat varieties and lines (Ayele & Temesgen 1995).

The response of released bread wheat varieties to stripe rust under field conditions is shown in Table 3. The recently released varieties seemed to have adequate level of resistance under natural conditions except 'HAR 1709' which showed a high level of spike infection. The level of susceptibility of 'Enkoy' and 'K 62950-4A' to stripe rust has increased especially on spikes.

The two varieties were known to have adequate level of resistance (slow rusters) for more than two decades. However, they still have some level of resistance (residual) when compared with susceptible varieties such as 'Dereselign'. There were variations among released varieties to leaf and spike infection. The recently released varieties, 'HAR 604' and 'HAR 1595', were free from stripe rust infection.

The highest proportion of seed infection was noted on 'K 6290-Bulk'. Seed weight loss due to seed infection was relatively low on 'K 6295-4A' and 'ET 13'. Some bread wheat lines showed complete resistance to stripe rust both in the field and seedling tests (Table 4). Resistance of these lines to several isolates was studied in detail at seedling stage and under field conditions across years, and they were found to be resistant to the prevailing races of the pathogen in the country as well as elsewhere in eastern Africa (Ayele & Wondimu 1992, Ayele & Stubbs 1995). These lines are recommended to be incorporated in the bread wheat improvement programme.

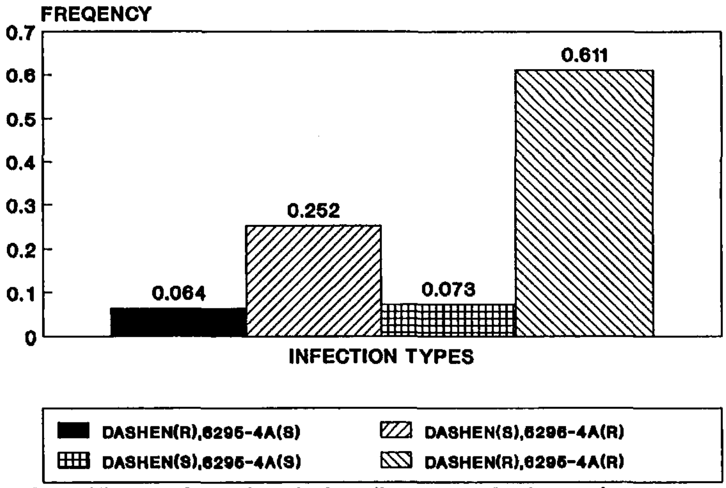

Fig. 1 The reaction of bread wheat lines to the Dashen and K6295-4A yellow rust isolates

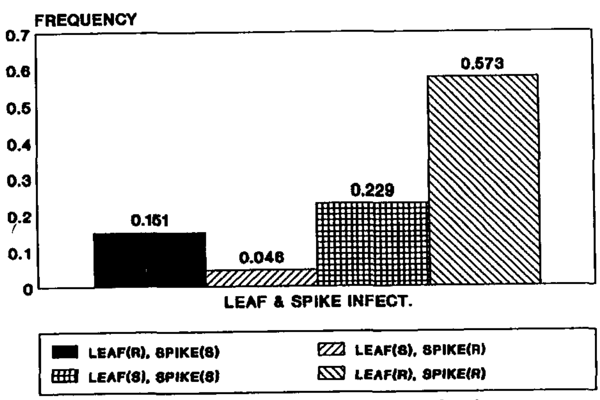

Fig 2. Variations among bread wheat varieties of leaf and spike infection by yellow rust

Table 3. The reaction of commercial bread wheat varieties to stripe rust at seedling and adult plant stages (0-9 scale)

Variety	Adult plant				Seedling (0-9)	
	1995		1996		Isolates	
	Leaf	Ear (0-5)	Leaf	Ear (0-5)	K 6295-4A	Dashen
Israel	40MS	4.0	25MS	3.5	7	3
Bonde	15MS	0.5	30MS	0.5	2-8	2
Mamba	10MR	0	TMS	0	2-4	2-3
Romany BC	80S	3.0	40MS	2.5	5	2-6
Dereselign	90S	3.0	80S	4.0	8	7
Pavon-76	40S	3.0	60MS	4.0	8	2
K 6295-4A	50MS	2.5	40MS	2.5	7	4
K 6290-B	70S	4.0	70MS	5.0	4	5
ET 13	30MS	0.5	30MS	3.0	7	2
Enkoy	30MS	3.5	20MS	1.0	6	2-4
Gara	10MS	0.5	20MS	2.5	2	8
Dashen	1M	Tr	30MS	1.5	2	7
HAR 416	0	0	TMR	0.5	2	0
HAR 1709	5M	1.5	0	0.5	5	6
HAR 710	0	0.5	0	Tr	2	2-3
HAR 604	0	0.0	0	Tr	2-3	0
HAR 1685	0	0.5	0	0	5	6
HAR 1522	0	0.5	0	Tr	2	4
HAR 1595	0	0	0	0	1	8
HAR 1407	0	TR	0	0	0	1

Table 4. Seedling reaction and agronomic characteristics of bread wheat lines which showed complete stripe rust resistance at Meraro during 1995-96

Lines	Cross/Pedigree	Seed colour	TKW (gm)	Seed Eval. (0-3)	Seedling reaction (0-9)	
					Isolates	
					Dashen	K 6295-4A
HAR 719	LIRA'S'	W	42.8	3	2	2
HAR 727	PER'S'	W	39.0	3-	2	1
HAR 723	CHIL'S'	R	44.6	3-	1-2	1-2
HAR 1018	L109.36/Vee/4 /WRM//KAL/BB/ 3/KAL/BB/ALD	W	42.2	3-	0	2
HAR 733	ETX-C-3H-6H-OH	W	43.8	2+	0	2
HAR 820	CHIL'S'	W	42.6	3-	2	2
HAR 845	MYNA-VUL	W	45.8	3-	0	2
HAR 1008	BOW/YD/ZZ	W	46.0	3	2	2

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