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Evaluation of Different Wheat Genotypes Reaction to Stripe Rust (*Puccinia striiformis f.sp. tritici*) under Field Conditions in Ardabil Province

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Abstract

In order to assess the reaction of different wheat genotypes to *134E134A⁺* race of yellow rust at adult plant stage, 100 wheat genotypes were evaluated at Ardabil and Moghan under field and mist irrigation conditions. Infection type was recorded at flag leaf stage when disease appeared in susceptible genotypes (infection of around 80%). Disease severity on leaves was evaluated by Modified Cobb's Scale in which 0: immune, 0%-5%: resistant, 5%-10%: moderately resistant, 10%-30%: moderately susceptible, more than 30%: highly susceptible. Mean coefficient of infection and mean area under disease progress curve (AUDPC) of flag leaf were calculated in each region separately. Analysis of variance indicated significant difference between genotypes for all traits. Results of this experiment according to coefficient of infection indicated that in Ardabil area, 1% of the genotypes were Immune, 29% were resistant, 52% were moderately resistant and 18% were susceptible. In Moghan area 25% of the genotypes were Immune, 59% were moderately resistant and 16% were susceptible to yellow rust disease. Cluster analysis based on infection type characteristics, disease severity and coefficient of infection in Moghan classified genotypes into four main groups. On the other hand, cluster analysis in Ardabil according to aforementioned traits, classified the varieties into three main groups. Compound analysis of variance according to infection type characteristics, disease severity and coefficient of infection in two regions indicated there is a significant difference between examined genotypes and interaction of genotype × region.

Keywords: Iran; Infection type; Pathotype; Resistance; Stripe rust; Wheat

Introduction

Wheat is cultivated in most regions of Iran. This crop is affected by various diseases such as fungal disease each year. Stripe rust, caused by the obligate parasite *Puccinia striiformis* f.sp. *tritici*, is one of the most important diseases of wheat (*Triticum aestivum* L.) in Iran [1-5]. This forma specials infects numerous wheat cultivars, as well as a few barley cultivars and certain grass species [6,7]. This disease, in comparison with the leaf rust (*P. triticina*) and stem rust (*P. graminis* f.sp. *tritici*) pathogens of wheat, the global distribution of *P. striiformis* f.sp. *tritici* is more restricted [8]. Stripe rust can severely damage wheat production worldwide [6] and cause yield losses from 10% to 70% and reducing the quality of grain and forage [1,9]. Stripe rust was the dominant wheat disease in Central Asian countries in the late 1990s and early 2000s, accounting for yield losses of 20%-40% in 1999 and 2000 [10]. Stripe rust epidemics in most of the wheat growing-areas of Iran caused over 30% crop loss and estimated grain losses were 1.5 million tons and 1.0 million ton in 1993 and 1995, respectively [1]. On susceptible cultivars, stripe rust can cause 100% yield loss if infection occurs very early [4,7]. Controlling of Stripe rust is done by fungicides or resistant cultivars [6,9,10]. Although fungicides cause a considerably effect in controlling of yellow rust disease, it can't be used as the only controlling strategy of this disease because of environmental contaminations and high cost in long term [10]. Resistance to fungicides is also another main disadvantage in using the fungicides for controlling this disease [9]. Using the resistant cultivars is the most important controlling approach in increasing the wheat yield [6,11-13]. However, growing resistant cultivars is the most efficient, economical, and environmentally friendly approach to control the disease [6,12]. Two types of resistance have been identified in several cereal-rust pathosystems: hypersensitive or qualitative (race-specific) and quantitative (race nonspecific) resistance. This type of resistance [3,14] with evaluating the reaction of 415 genotypes to 3 races of yellow rust at seedling and adult plant stage, indicated that most of genotypes are susceptible to all three races at seedling stage, the contrary, most of genotypes had considered resistance to all three races at adult plant stage. Umirov et al. [15] at Uzbekistan with evaluating reaction of 4500 wheat genotypes to yellow rust indicated that 66 genotypes were Immune, 118 genotypes were resistant, and 278 genotypes were moderately susceptible. Foroutan and Ahmadian moghaddam [2] with studying 137 lines of selected resistant wheat from experiments of some areas at 1996- 1997 and 1997- 1998 and further evaluating of them at 1998-1999 at in Mazandaran, Iran. Compound analysis of variance concludes that 33 lines of experiments of 1997- 1998 were resistant to yellow rust in most of examined areas. Torabi et al. [1] with assessing the resistance of wheat advanced lines to some races of yellow rust at seedling stage and by cluster analysis, classified wheat cultivars into three groups. 1; lines which had infection type of 7-9 2; lines which had infection type of 0-3 and 3; lines which had infection type of 4-6. Nazari [5] with assessing wheat lines resistance to three races of yellow rust by measuring relative mean area under disease progress curve (rAUDPC), obtained field resistance to race of *134E134A⁺* that positive and significant correlation was observed between seedling infection type and rAUDPC to mentioned race. Coefficient of infection is obtained from multiplication of infection percentage (0% to 100%) and host respond to pathogen (I=0,

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R=0.2, MR=0.4, M=0.6, MS=0.8 and S=1) that were Immune; Resistant; moderately resistant; intermediate resistant; moderately susceptible and susceptible respectively. rAUDPC will be calculable when disease severity is recorded during disease development in several times. Iran is one of the major wheat growing countries in the world [1]. In Ardabil province of Iran where different wheat varieties are grown, table wheat are major productions and play very important role in the provincial agriculture. Due to the importance of yellow rust in the Ardabil and Moghan fields, this study was conducted and completed between 2009 and 2010 to evaluate resistance of different wheat genotypes to strip rust *(Puccinia striiformis* f.sp. *tritici*) in order to identify the resistant and moderately resistant genotypes for recommendations to the national and international wheat research centers.

Materials and Methods

Reaction of 100 wheat genotypes to race *134E134A*+ of wheat yellow rust was evaluated in two regions of Ardabil and Moghan for two years (2009 and 2010) in field conditions (Table 1). Field tests were conducted at two locations (Ardabil and Moghan regions) in a Randomized Complete Block Design (RCBD) with 3 replications. Wheat entries were planted in November 2009 (first year) and 2010 (second year) at the rate of 10 g-15 g of seed on two 1 m long rows and spaced 30 cm apart. In this experiment, a susceptible cultivar (cv. Bolani) was planted in a margin and between of each 10 genotypes for spreading disease. Experiment was carried out under field condition and mist irrigation. Besides, artificial inoculation of the nurseries was done by mixing spores with talcum powder using a duster and before of flag leaf emergence. At the flag leaf stage, infection type (IT): R (resistant), MR (moderately resistant), MS (moderately susceptible) and S (susceptible), of each entry was evaluated based on Roelfs et al. [16] method, when disease developed well on susceptible check. The percentage leaf area affected (0-100, disease severity) also scored using the modified Cobb's scale at the same time. The infection type and disease severity scored each time were used to calculated coefficient of infection (CI) and finally Area Under Disease Progress Curve (AUDPC). For statistical analyzing and mean comparison, MSTATC software was used and for ranking and clustering genotypes, SPSS software was used.

Genotype/Pedigree	No.	Genotype/Pedigree	No.
Bolani	Bolani	*Bolani*	Bolani
Emu"s"/tjb	51	*Tajan*	1
Azd//top	52	*ald"s"/snb"s"/5/alborz4030*	2
Fin/acc	53	*ald"s"/snb"s"/5/alborz4031*	3
Gk.zombor/attila	54	*Alborz/4/k6290914/4036*	4
Attila-4//arvand/glenson	55	*Alborz/4/k6290914/4039*	5
Ns732.her//darab	56	*40-71-23//kayson/glenson4042*	6
Opata	57	*40-71-23//kayson/glenson4044*	7
Kalyansona/glenson4276	58	*M-70-4/5/ alborz/4/k4048*	8
Kalyansona/glenson4279	59	*M-70-4/5/ alborz/4/k4051*	9
R37/gh1	60	*M-70-4//kayson/glen4056*	10
Bolani	Bolani	*Bolani*	Bolani
N-75-16	61	*Unknown4067*	11
R37/gh1/21	62	*Unknown4072*	12
Bav92	63	*4777//fkn/gb/towpe*	13
Munia	64	*4777//fkn/gb/angas4087*	14
Chil/2/star	65	*4777//fkn/gb/angas4089*	15
Pr1/bau"s"4190	66	*4777//fkn/gb/vf620*	16
Pr1/bau"s"4191	67	*Karawan1/yamama4105*	17
Pr1/bau"s"4192	68	*Karawan1/yamama4108*	18
Na160/bagula	69	*Karawan1/yamama4112*	19
Jup/falat	70	*Karawan1//sun*	20
Bolani	Bolani	*Bolan*	Bolani
Jup/maya4196	71	*Tajan*	21
Jup/maya4197	72	*Shirodi*	22
Jup/maya4198	73	*Skauz2/96*	23
Jup/maya4199	74	*Star2/99*	24
Jup/trifon4200	75	*Oasis/star/3*	25
Jup/trifon4202	76	*Chum18*	26
Ures/bow4203	77	*Sw89.3060/kauz*	27
Ures/bow4204	78	*Pri/bagula*	28
Ures/bow4205	79	*Oasis/kauz4/111*	29
Bualbek/bagula	80	*Oasis/kauz4/112*	30
Bolani	Bolani	*Bolani*	Bolani
Tajan	81	*Oasis/kauz4/113*	31
Maya/falat4208	82	*Oasis/kauz4/114*	32
Maya/falat4209	83	*Gen/kauz*	33
Maya/falat4210	84	*catbird*	34
Maya/falat4211	85	*Milan159*	35
Maya/ures	86	*Milan161*	36
Maya/bau4214	87	*Milan162*	37
Maya/bau4215	88	*Bow/nkt*	38
Thb"s"ton	89	*Lfn/1158*	39
Ias58/kal/bow17	90	*Ng8319*	40
Bolani	Bolani	*Bolani*	Bolani
Ias58/kal/bow18	91	*N-75-15*	41
Ias58/kal/bow19	92	*Dove"s"/buc*	42
Ias58/kal/bow20	93	*Shi//4414/vee4223*	43
Ias58/kal/bow24	94	*Shi//4414/vee4224*	44
Ias58/kal/bow25	95	*Shi//4414/hd2169*	45
Pri/bagula	96	*Vee"s"/nac//kasyon/genaro.81*	46
Pri/bagula/milan	97	*Chil"s"/cham4*	47
Imbabura	98	*Chil"s"/kavz"s"*	48
Batanf96	99	*pvn"s"/cii//nac*	49
Bekele.100	100	*Azd//inia*	50

Table 1: Parentage and pedigree of different wheat genotypes under study in Ardabil province during 2009-

Results and Discussion

In the field assessment, genotypes with disease severity of 0 were placed in Immune group, 0%-5% in resistant group, 5%-10% in moderately resistant group, 10%-30% in moderately susceptible group and genotypes with disease severity of more than 30 were placed in highly susceptible group. According to infection type in Ardabil region, genotypes *Alborz/4/k6290914/4036*, *Azd//top*, *Gk.zombor/attila*, *Azd//inia*, *Bav92, M-70-4//kayson/glen4056*, *Fin/acc*, *Munia*, *Gen/kauz*, *40-71-23//kayson/glenson4044*, *40-71-23//kayson/glenson4042*, *Alborz/4/k6290914/4039*, *M-70-4/5/alborz/4/k4051* and *Kalyansona/glenson4276* placed in susceptible group. Genotypes *Ias58/kal/bow20*, *Ias58/kal/bow24, Tajan, Milan159*, *Ias58/kal/bow25*, *Pri/bagula/milan*, *Maya/falat4210*, *Sw89.3060/kauz*, *Oasis/kauz4/113*, *Ias58/kal/bow17*, *Maya/falat4208*, *Na160/bagula*, *up/falat*, *Oasis/kauz4/114*, *Star2/99*, *Oasis/star/3*, *Pri/bagula*, *Pri/bagula*, *Jup/maya4196*, *Jup/trifon4202*, *Ias58/kal/bow18* and *4777//fkn/gb/vf620* placed in resistant group. Other examined genotypes were placed in moderately susceptible group. In Moghan, genotypes *4//kayson/glen4056*, *M-70-4/5/alborz/4/k4051*, *R37/gh1*, *Chil/2/star* and *Azd//inia* were placed in susceptible group. Genotypes *Ures/bow4205, Alborz/4/k6290914/4036*, *Vee"s"/nac//kasyon/genaro.81*, *Kalyansona/glenson4279*, *Imbabura*, *Ias58/kal/bow25*, *Chil"s"/cham4*, *Maya/ures*, *Shi//4414/vee4224*, *Chum18*, *4777//fkn/gb/angas4087*, *Shi//4414/hd2169*, *Pri/bagula*, *4777//fkn/gb/angas4089*, *Ias58/kal/bow18*, *Ias58/kal/bow19*, *Tajan*, *Pri/bagula*, *Ias58/kal/bow24*, *Pri/bagula/milan*, *Ias58/kal/bow20*, *Karawan1/yamama4108*, *ald"s"/snb"s"/5/alborz4031*, Ures/*bow4203* and *Ns732.*

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her//darab were placed in resistant group. Genotypes *M-70-4//kayson/glen4056*, *Kalyansona/glenson4276*, *Bav92*, *Munia*, *Chil/2/star*, *Batanf96* and *Bekele.100* showed susceptibility to yellow rust in both regions. Genotypes *Ias58/kal/bow18*, *Ias58/kal/bow20*, *Ias58/kal/bow24*, *Pri/bagula*, *Pri/bagula/milan*, *Sw89.3060/kauz* and *Pri/bagula* showed resistance to stripe rust disease about infection type in both regions. In Ardabil and Moghan regions, Genotypes *Alborz/4/k6290914/4039, 40-71-23//kayson/glenson4042, R37/gh1, Bekele.100, 40-71-23//kayson/glenson4044, Gk.zombor/attila, M-70-4/5/alborz/4/k4051, M-70-4//kayson/glen4056, Azd//inia, Azd//top, Batanf96, Kalyansona/glenson4276, Bav92, Munia, Chil/2/star* and *Fin/acc* with having coefficient of infection more than 15 belong to susceptible genotypes to yellow rust and it will be excluded from commercial production and using them in improvement programs. Experiments results indicated that in Ardabil and Moghan areas some of genotypes had significant differences in rating resistance. This subject indicates pathogenicity difference of used races and climate difference of Ardabil and Moghan. It shows Moghan with having warm climate can't be a suitable region for assessing resistance and selection of resistant sources. Genotypes *Pri/bagula*, *4777//fkn/gb/vf620*, *Ias58/kal/bow25*, *Ias58/kal/bow20*, *Ias58/kal/bow24*, *Pri/bagula/milan*, *Ias58/kal/bow18*, *Sw89.3060/kauz*, *Chum18*, Oasis/*kauz4/114*, *Ias58/kal/bow17*, *Pri/bagula*, *Tajan* and *Ng8319* had coefficient of infection less than 15 in both Ardabil and Moghan regions so above genotypes will inter to commercial production and will be used in future improvement program (they have better coefficient of infection than control). Similarly, Torabi et al. [1], Foroutan et al. [2], Malihipour et al. [3], Nazari [5], Youssef et al. [17], Ali et al. [18] and Shahin et al. [19] also carried out field assessment of resistance to yellow rust for ranking of genotypes. According to the resistance level based on disease severity along with other resistance parameters, they found that resistance level ranged from very low to very high among the tested genotypes. There wasn't possibility of comparison one genotype in Ardabil and Moghan regions due to qualitative recording factor in the field. With calculating the average coefficient of infection, that is determined through applying constant for each type of infection at adult plant stage, a genotype reaction can be compared quantitatively in different regions (Ardabil and Moghan areas). In this method for infection type of S, MS, MR, R, and O were considered 1, 0.8, 0.4, 0.2 and 0 respectively. So, for reactions of 50S and 40MS were considered coefficient of infection 50 and 32 (50 × 1 and 40 × 0.8). Although environmental conditions and racial diversity in Ardabil and Moghan regions can affect reaction of examined genotypes, genotypes with coefficient of infection less than 15 will be introduced as suitable genotypes for using in improvement programs for resistance to yellow rust. Results of our study and the differences in the reaction of genotypes to yellow rust disease are in agreement with those of previous studies (McIntosh, [20]; Bariana and McIntosh, [21]; Torabi et al. [1]; Malihipour et al. [3]; Foroutan and Ahmadian-Moghaddam, [2]; Afshari, [4]; Youssef et al. [17]; Wellings and Park, [22]; Herrera-Fossel et al. [23]; Bux et al. [13]; Shahin and Abu El-Naga, [19]). Different researchers studied the reaction of different wheat varieties to stripe rust disease in different countries [11,12,18,24]. Like in our study, the results of their study also showed that different varieties showed variable reactions to the disease and they ranked from immune to highly susceptible. The overall results of this study show that it may be possible to introduce some moderately resistant and resistant domestic wheat varieties to yellow rust disease. These varieties may be used as a genetic source in the development and production of resistant wheat varieties both on national and international scales. Compound analysis of variance indicated that region effect was significant at the 5% level of probability. There is basic and general difference between regions in disease severity. Since yellow rust mainly develops under colder climate with higher altitude, in north latitude and colder years, condition for development and spread yellow rust disease in Moghan is unsuitable than Ardabil. So, genotypes *4777//fkn/gb/angas4089*, *Shi//4414/vee4223*, *Chum18*, *Sw89.3060/kauz, Karawan1/yamama4108*, *4777//fkn/gb/angas4087*, *Ns732.her//darab*, *Maya/ures, Imbabura*, *Chil"s"/cham4*, *Pri/bagula*, *Ias58/kal/bow24*, *Pri/bagula/milan*, *Ias58/kal/bow25*, *Ias58/kal/bow20*, *Ias58/kal/bow19*, *Ias58/kal/bow18, Ures/bow4203*, *Shi//4414/hd2169*, *Shi//4414/vee4224* and *Pri/bagula* in Moghan region were as Immune but these same genotypes in Ardabil indicated different reaction from sensitivity to resistance. Results of our study and the differences in the reaction of genotypes to *Puccinia striiformis* f.sp. *tritici* are in agreement with those of previous studies [1,4,17,18]. Compound analysis of variance indicated effects of cultivar is so significant at the 5% level of probability. There is a significant difference between mean genotypes in Ardabil and mean genotypes in Moghan. Compound analysis of variance indicated interaction of genotype × region is completely significant. It shows that reaction of genotypes in Ardabil and Moghan regions to yellow rust wasn't equal. It means there is an interaction between genotype and region. Each genotype in both regions had a different reaction to yellow rust. Genotypes *Pri/bagula/milan*, *Star2/99*, *Oasis/kauz4/114*, *Ias58/kal/bow18*, *Ias58/kal/bow17*, *Ias58/kal/bow20*, *Pri/bagula*, *Sw89.3060/kauz* and *Pri/bagula* in both regions indicated resistance to *Puccinia striiformis* f.sp. *tritici*. Other examined genotypes in both regions showed different reaction to yellow rust. With decreasing of interaction between genotypes and environment, we can distinguish resistant genotypes to yellow rust in both regions. Similarly, Youssef et al. [17] and Shahin et al. [19] also the results obtained demonstrated the superiority of *Yr8* at both seedling and adult stages. Susceptible genotypes have higher mean and variance in AUDPC than resistant genotypes. According to Figure 1 in Ardabil, between genotypes, *Bolani* has the most AUDPC and genotypes *Thb"s"ton*, *Pr1/bau"s"4191* and *Jup/falat* have the least one. Genotypes *Azd//inia, 40-71-23//kayson/glenson4044*, *M-70-4//kayson/glen4056* and *Ures/bow4204* with having moderate resistance can be used to create more stable resistance than other genotypes. Based on Figure 2 in Moghan, between genotypes, *Bolani, Azd//inia* and *M-70-4//kayson/glen4056* have the most AUDPC and genotypes *Pr1/bau"s"4191*, *up/falat, Ures/bow4204* and *Thb"s"ton* have the least AUDPC (Table 2). Genotype *40-71-23//kayson/glenson4044* with having moderate resistance can be used in creating more stable resistance than the others. Comparison of two figures shows genotypes *M-70-4//kayson/glen4056* and *Azd//inia* in Ardabil have middle AUDPC but the same genotypes in Moghan have the most AUDPC. Genotype *40-71-23//kayson/glenson4044* in both regions, according to figures has middle AUDPC. Infection rating

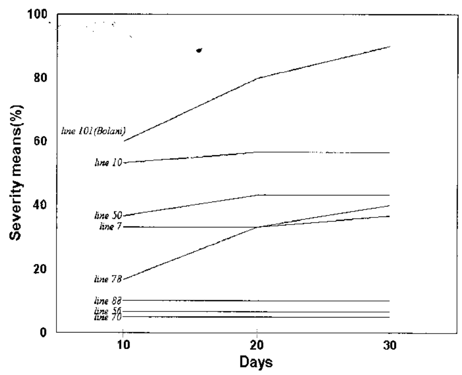

Figure 1: AUDPC in flag leaf for 8 wheat genotypes to yellow rust in field conditions using Cluster analysis in Ardabil region.

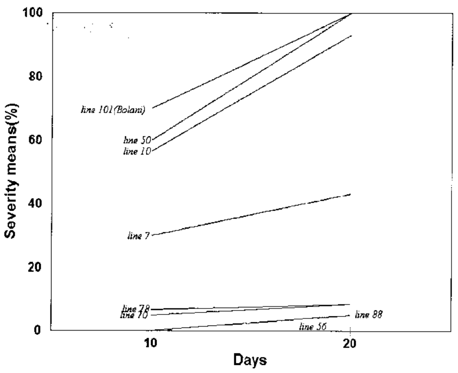

Figure 2: AUDPC in flag leaf for 8 wheat genotypes to yellow rust in field conditions using Cluster analysis in Moghan region.

Moghan					Ardabil			
Genotypes	AUDPC	S1D	DS2	DS3	Genotypes	AUDPC	S1D	DS2
Bolani	2000	60	80	90	*Bolani*	1000	70	100
1	86	4.3	4.3	4.3	1	25	0	5
2	117	6.7	5	6.7	2	25	0	5
3	183	8.3	10	8.3	3	25	0	5
4	734	36.7	36.7	36.7	4	83.5	10	6.7
5	800	40	40	40	5	400	33.3	46.7
6	717	33.3	36.7	36.7	6	216.5	13.3	30
7	683	33.3	33.3	36.7	7	366.5	30	43.3
8	166	8.3	8.3	8.3	8	25	0	5
9	966.5	43.3	50	50	9	750	50	100
10	1117	53.3	56.7	56.7	10	750	56.7	93.3
Bolani	2000	60	80	90	*Bolani*	1000	70	100
11	134	6.7	6.7	6.7	11	58.5	5	6.7
12	134	6.7	6.7	6.7	12	75	6.7	8.3
13	183.5	6.7	10	10	13	75	10	5
14	134	6.7	6.7	6.7	14	0	0	0
15	134	6.7	6.7	6.7	15	0	0	0
16	0	0	0	0	16	8.5	0	1.7
17	166	8.3	8.3	8.3	17	67	6.7	6.7
18	134	6.7	6.7	6.7	18	0	0	0
19	166	8.3	8.3	8.3	19	66.5	5	8.3
20	166	8.3	8.3	8.3	20	75	5	10
Bolani	2000	60	80	80	*Bolani*	1000	70	100
21	149.5	5	8.3	8.3	21	66.5	5	8.3
22	134	6.7	6.7	6.7	22	66.5	5	8.3
23	108.5	6.7	5	5	23	50	5	5
24	100	5	5	5	24	75	5	10
25	100	5	5	5	25	50	5	5
26	108.5	5	5	6.7	26	0	0	0
27	100	5	5	5	27	0	0	0
28	100	5	5	5	28	0	0	0
29	117	6.7	5	6.7	29	50	5	5
30	200	10	10	10	30	75	6.7	8.3
Bolani	2000	60	80	90	*Bolani*	2000	10	70
31	100	5	5	5	31	50	5	5
32	100	5	5	5	32	25	0	5
33	783.5	36.7	40	40	33	25	0	5
34	175	6.7	10	8.3	34	67	6.7	6.7
35	100	5	5	5	35	50	5	5
36	166	8.3	8.3	8.3	36	0	6.7	6.7
37	200	10	10	10	37	0	6.7	8.3
38	166	8.3	8.3	8.3	38	0	0	5
39	200	10	10	10	39	50	6.7	10
40	150.5	100	6.7	6.7	40	75	5	6.7
Bolani	2000	60	80	90	*Bolani*	2000	70	100
41	158	6.7	8.3	8.3	41	50	6.7	8.3
42	134	6.7	6.7	6.7	42	25	6.7	10
43	134	6.7	6.7	6.7	43	25	0	0
44	134	6.7	6.7	6.7	44	67	0	0
45	134	6.7	6.7	6.7	45	50	0	0
46	134	6.7	6.7	6.7	46	0	0	0
47	166	8.3	8.3	8.3	47	0	0	0
48	134	6.7	6.7	6.7	48	0	6.7	8.3
49	166	8.3	8.3	8.3	49	50	0	5
50	833	36.7	43.3	43.3	50	75	60	100
Bolani	2000	60	80	90	*Bolani*	2000	70	100

Table 2: Field reaction and AUDPC different wheat genotypes to yellow rust disease in Ardabil province during 2009-2010.

of all genotypes was less than *Bolani* during 2009-2010. Similarly, Wellings [22], Ali et al. [18] and Umirov et al. [15] and the present study demonstrated that infection rate seemed an unreliable estimate of resistance when compared with disease severity, coefficient of infection and AUDPC, because it did not mark some genotypes as having different level of resistance with regard to other parameters. This group comprised genotypes with varying degrees of resistance which has been advocated to be more durable [5,14]. Moreover, lines with acceptable levels of partial resistance restrict the evolution of new virulent races of the pathogen because multiple point mutations are extremely rare in nature [18,19]. Since stripe rust disease caused by *Puccinia striiformis* f.sp. *tritici* is a serious disease of wheat around the world, results of such studies may be promising and could be used in the formulation of integrated control strategies for the management of this destructive disease around the world. The results of this study may have practical applications in formulation of disease management strategies for controlling yellow rust in a safe environment. The use of resistant and moderately resistant genotypes to manage different plant diseases including wheat yellow rust can potentially replace or minimize the application of harmful chemical fungicides and could be used as an important component of integrated pest management (IPM) which is a promising approach to a sustainable agriculture.

Conclusion

In general, results of our study and the differences in the reaction of genotypes to yellow rust disease are in agreement with those of previous studies. Results of this study were promising and some immune, resistant, and moderately resistant genotypes to *Puccinia striiformis* f.sp. *tritici* were identified and they may be used as a resistance genetic source for management of the disease in national and international programs. In Ardabil, genotypes *Oasis/star/3*, *Ias58/kal/bow25*, *Pri/bagula*, *Ias58/kal/bow20*, *Pri/bagula*, *Star2/99*, *Ias58/kal/bow24*, *Pri/bagula/milan*, *Sw89.3060/kauz*, *Jup/maya4196*, *up/falat*, *Milan159*, *Ias58/kal/bow17*, *Jup/trifon4202*, *Oasis/kauz4/113*, *Tajan*, *Maya/falat4210, Na160/bagula*, *Oasis/kauz4/114* and *Ias58/kal/bow18* were placed in resistant group. Genotypes *M-70-4//kayson/glen4056*, *Azd//inia*, *Munia*, *Alborz/4/k6290914/4036*, *N-75-16*, *Alborz/4/k6290914/4039*, *Fin/acc*, *Gen/kauz*, *M-70-4/5/alborz/4/k4051*, *Azd//top*, *Kalyansona/glenson4276*, *Gk.zombor/attila*, *Bav92*, *40-71-23//kayson/glenson4042*, *40-71-23//kayson/glenson4044* and *Ures/bow4204* were placed in susceptible group. The others were placed in moderately susceptible to yellow rust disease. In Moghan, genotypes *Vee"s"/nac//kasyon/genaro.81*, *Shi//4414/vee4224*, *Sw89.3060/kauz*, *Shi//4414/hd2169*, *Tajan*, *Chil"s"/cham4*, *Pri/bagula*, *Ns732.her//darab*, *Ias58/*

kal/bow20, *Ias58/kal/bow19*, *Ias58/kal/bow18*, *Ias58/kal/bow24*, *Shi//4414/vee4223*, *Ias58/kal/bow25*, *4777//fkn/gb/angas4087*, *4777//fkn/gb/angas4089*, *Karawan1/yamama4108, Kalyansona/glenson4279* and *Chum18* were placed in Immune group. Genotypes *Pri/bagula/milan*,*Thb"s"ton, ald"s"/snb"s"/5/alborz4030*, *Imbabura*, *Gen/kauz*, *Tajan, ald"s"/snb"s"/5/alborz4031*, *M-70-4/5/alborz/4/k4048*, *Bow/nkt*, *Unknown4067*, *4777//fkn/gb/vf620*, *Oasis/kauz4/114*, *pvn"s"/cii//nac*, *Jup/trifon4200*, *Bualbek/bagula*, *Maya/falat4211, Maya/bau4215, Pr1/bau"s"4190* and *Ias58/kal/bow17* placed in resistant group. Genotype *Azd//inia* was placed in susceptible group. The other genotypes were placed in moderately susceptible groups. Wheat yellow rust in Iran has caused significant crop loss and resulted in unprecedented costs in chemical control expenditure in epidemic seasons. It can be anticipated that control measures will be largely based on the development and release of resistant cultivars, although chemical control may have a place in high input/high yield situations in irrigation areas and high rainfall zones. Breeding for resistance will continue to be based on current awareness of variability in *Puccinia striiformis* f.sp. *tritici*, the search for and commercial development of new and effective resistance combinations, and the resolve of industry to adopt best management practices that minimize disease risk.

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