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Detection of some registered barley varieties reactions to barley leaf stripe disease

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ABSTRACT

Cereals are a significant agricultural product group with the highest cultivation area and production in Turkey. Among these cereals, barley is an important cereal used in human and animal nutrition, and the most widelycultivated plant after wheat. There are biotic and abiotic factors which affect the yield and quality parameters of barley. Of the biotic factors, barley leaf stripe (agent: *Pyrenophora graminea* (anamorph: *Drechslera graminea*) is an important fungal disease. Infections can occur in diseased seeds and in the presence of suitable environmental conditions. Hence, the use of disease-free seeds and resistant cultivars (cvs.) against this pathogen are crucial. With this in mind, this study was carried out with a highly virulent isolate of *Pyrenophora graminea*, obtained from the Disease and Pest Resistance Unit culture collection in 57 registered barley cultivars in the greenhouses of the Central Research Institute of Field Crops (TARM) in 2021. The experiments were conducted in 3 replications in a randomized block design. Of 57 registered barley cultivars 62%, 15% and 36% of these barley cultivars expressed resistance, moderate resistance, and susceptible reactions, respectively. As a result of the analysis of variance performed on the results obtained, it was concluded that the difference between the mean values of 57 varieties was statistically significant at 1% level (P<0.01).

1. Introduction

Barley is one of the cereal groups with the highest vegetation area and yield both in the world and in Türkiye. The production of barley in the world between 2020 and 2021 has been reported at 158 million tonnes (Anonymous 2021). According to 2020 data, barley is the second cereal, after wheat, in Türkiye in terms of yield and cultivation area. Barley is used as green hay, for malt production, and for human nutrition. It mostly grows in Central Anatolia, Southeastern Anatolia, and the Aegean Region, as well as in other parts of Türkiye (Anonymous 2021).

There are biotic and abiotic factors that affect the yield and quality of barley. The most significant biotic factor is barley stripe disease (*Pyrenophora graminea (anamorph: Drechslera graminea*) that contaminates viainfected seeds and could be damaging. Many studies across the world have also reported severe losses due to this disease (Porta-Puglia et al. 1986, Arabi et al. 2004, Karakaya et al. 2016).

The pathogen mostly develops in barley-growing areas, particularly in rainy weather conditions , and has led to a nearly 10-15% yield loss in the Central Anatolia Region (Aktaş 2001; Anonymous 2008). A symptom of this disease can be seen as yellow stripes that cover the barley leaf from bottom to tip. As the disease develops, these yellow stripes turn to brown necrotic lesions and sometimes tearing in leaves can be observed due to these necrotic areas. Dwarfing can generally be observed in diseased plants and plants may dry completely in early stages especially in dryland areas. Spikes may not appear or may have a malformation. Condia could occur abundantly on conidiophores. In the heading stage, the pathogen produces many conidia and these can infect the healthy spikes via wind. The pathogen cannot survive in crop debris, although mycelium of the pathogen can be carried via seed, hull and pericarp. When contaminated seeds are sown, the fungi/fungus will move systematically and the disease develops (Anonymous 2008).

There are various ways to control the disease such as fungicides. Even though seeds are treated with chemicals against stripe disease, during planting the disease can still be observed in low levels. Additionally the disease becomes common under suitable conditions when untreated seeds are planted over several years (Nielsen and Scheel 1997). Due to this, developing tolerant/resistant cultivars (cvs.) is crucial because it is the most efficient and environmentallyfriendly approach (Arabi and Jawhar 2005). In addition to developing cultivars, it is important to obtain knowledge about the virulence of the disease agent (Arabi and Jawhar 2012; Mokrani et al. 2012; Nielsen et al. 2002).

There are different studies that have determined various barley materials in order to explore potential candidate genotypes for breeding studies (Nielsen et al 2002; Benkorteby-Lyazıdı et al. 2018; Çelik Oğuz et al. 2017; Çelik et al. 2016; Çelik Oğuz 2019). The aim of this study is to identify the reactions of 57 registered cultivars, developed in Türkiye, using the most virulent *Pyrenophora graminea* isolate obtained from the culture

collection of Disease Resistance Unit of Field Crops Central Research Institute under greenhouse conditions.

2. Materials and Methods

2.1. Materials

The materials of this study consist of 57 barley cvs. from Türkiye and a highlyvirulent isolate of *Pyrenophora graminea.* The isolate was provided from the collection of Disease Resistance Unit in Central Research Institute for Field Crops.

2.2. Methods

2.2.1. Seed ınoculation and growing the plants

The "sandwich" method, which was developed by (Mohammed and Mahmood 1976), wasapplied in this study. The isolate of *P.graminea* was developed in PDA media at 22°C until it covered the petri dishes. The seeds of each genotype were treated with 1% sodium hypochlorite (NaOCl) for 3 min in order to disinfect the surface of the seeds and then washed with sterile water. After sterilization, 20 seeds of each barley genotype were placed into half of the 10 days old fungi cultures and the other half of the same culture were folded and placed into the other half, shaped like a sandwich. After keeping the petri dish for 72 h at 22°C under light, they were incubated for 5-7 days at +4°C, depending on the seed germinations. After incubation, 20 seeds placed into PDA were planted into 16 cm diameter pots filled with a mix of sand-fertilizer-soil (1:1:3 ratio, respectively). The experiment was set according to a randomized block design with three replicates. The pots placed in the greenhouses with day and night temperatures changed between 10-22 ± 3°C.

2.2.2. Assessment of the disease

The reactions of the infected 57 cvs. were assessed 60 days after planting the soil with 1-3 scale developed by Tekauz (1983).

According to the scale;

1: Resistant (stripe infection %<5%)= R

2: Moderate Resistance (stripe infection %<5-17%)= MR

3: Susceptible (stripe infection %>17%)= S

The Duncan test analysis was performed by using *agricolae* package of R language (version 1.3).

3. Results and Discussion

The seedling reactions of fifty-seven registered cvs. were identified with a highly virulent *Pyrenophora graminea.* According to the Tekauz scale, the cultivars which had less than 5%, between 5% and 17% and more than 17% disease scores were grouped as resistant, moderate resistance and susceptible, respectively. Variance analyses shows that the difference between the mean values of 57 varieties was statistically significant at about 1% (P<0.01). The difference between the varieties was also controlled using the Duncan Test. All data is reported in Table 1. According to Table 1, Keykubad, Olgun, Akhisar 98, Sur-93, Şahin-91, Altıkat, Barış, Hevsel, Hamidiye, Çıldır 02, Erginel 90, İnce-04, Keser, Özdemir, Ünver, Bilgi-91, Sabribey, Yüksel, Çetin 2000, Zeynel Ağa, Akar, Özen, Tosunpaşa, Bozlak, Asil, Anka-06, Misket, Martı, Bolayır, Harman, Hasat, Yaprak, Sladoran, Helke, , Ocak and Yeşilköy 387 cvs. were grouped as resistance. Kıral-97, Güldeste, Ay, Cumhuriyet 50, Tarm-92, Tokak 157/37, Avcı 2002, Burakbey and Yalın were identified as moderate resistance. Additionally, susceptible cvs. were Larende, Karatay, Ayrancı, Samyeli, Kendal, Dara, Yerçil-147, Bülbül 89, Aydanhanım, Yesevi 93, Orza 96 and Cacabey.

Table 1. Results of 57 registered barley cultivars reactions tobarley leaf stripe between 2020 and 2021

No	Varieties	Mean	Result
1	Kıral-97	8e	Moderate Resistance
2	Larende	67a	Susceptible
3	Karatay 94	62ab	Susceptible
4	Ayrancı	19d	Susceptible
5	Keykubad	0f	Resistance
6	Güldeste	8e	Moderate Resistance
7	Ay	9e	Moderate Resistance
8	Olgun	0f	Resistance
9	Akhisar 98	0f	Resistance
10	Sur-93	0f	Resistance
11	Şahin-91	0f	Resistance
12	Altıkat	0f	Resistance
13	Samyeli	21d	Susceptible
14	Kendal	25d	Susceptible
15	Barış	0f	Resistance
16	Hevsel	0f	Resistance
17	Dara	19d	Susceptible
18	Hamidiye	0f	Resistance
19	Bilgi-91	0f	Resistance
20	Cumhuriyet 50	10e	Moderate Resistance
21	Çıldır 02	0f	Resistance
22	Erginel 90	0f	Resistance
23	İnce-04	0f	Resistance
24	Keser	0f	Resistance
25	Özdemir	0f	Resistance
26	Yerçil-147	21d	Susceptible
27	Ünver	0f	Resistance
28	Sabribey	0f	Resistance
29	Yüksel	0f	Resistance
30	Avcı-2002	12e	Moderate Resistance
31	Aydanhanım	67a	Susceptible
32	Bülbül 89	57b	Susceptible
33	Çetin 2000	0f	Resistance
34	Tarm-92	10e	Moderate Resistance
35	Tokak 157/37	10e	Moderate Resistance
36	Yesevi 93	25d	Susceptible
37	Zeynel Ağa	0f	Resistance
38	Akar	0f	Resistance
39	Özen	0f	Resistance
40	Burakbey	9e	Moderate Resistance
41	Yalın	9e	Moderate Resistance
42	Tosunpaşa	0f	Resistance
43	Orza 96	67a	Susceptible
44	Bozlak	0f	Resistance
45	Asil	0f	Resistance
46	Anka 06	0f	Resistance
47	Cacabey	40c	Susceptible
48	Misket	0f	Resistance
49	Martı	0f	Resistance
50	Bolayır	0f	Resistance
51	Harman	0f	Resistance
52	Hasat	0f	Resistance
53	Yaprak	0f	Resistance
54	Sladoran	0f	Resistance
55	Helke	0f	Resistance
56	Ocak	0f	Resistance
57	Yeşilköy 387	0f	Resistance

According to a study done with fifteen different cultivars using 5 different isolates, Yerçil-147 variety was scored as resistant, whereas Erginel 90, Orza 96, Çetin 2000 and Aydanhanım were found susceptible to 3 isolates. The same study revealed that Erginel 90 cvs. were resistant to an isolate obtained from Yenimahalle Ankara while Çetin 2000 showed moderate resistance (Ulus and Karkaya 2007). This study showed that Yerçil-147, Orza 96 and Aydanhanım cvs. were susceptible but Erginel 90 and Çetin 2000 cvs. were resistant.

Another study illustrated that Durusu, Balkan 96 (Igri), Çumra 2001 and Anadolu 98 cultivars reacted resistant to all thirteen barley stripe pathogen isolates while Atılır and Larende were found to be susceptible (Bayraktar and Akan 2012). It was observed in this study that Larende were also susceptible.

In astudy of23 various barley genotypes, twenty of which were barley landraces and 3 were registered varieties, were tested with 10 different isolates and Larende and Atılır expressed a susceptible response to nine isolates, but Çumra 2001 reacted resistant to all isolates (Çelik et al. 2016). This study has found similar results that Larende showed susceptibility.

Tunalı (1992) used a virulent isolate and found that Bülbül 89, Erginel 90 and Cumhuriyet 50 were resistant and Tokak 157/37 and Yerçil-147 were moderately resistant and susceptible, respectively. This study found that Tokak 157/37 and Cumhuriyet 50 were moderately resistant while and Yerçil-147 was identified as susceptible. Additionally, Bülbül-89 reacted susceptible but Erginel 90 was resistant.

Çetin et al. (1995) identified Tokak 157/37, Tarm 92, Bülbül 89, Orza 96 and Yerçil 147 as susceptible. While, Tarm 92, Bülbül 89, Orza 96 and Yerçil 147 were detected as susceptible, Tokak 157/37, were detected as a moderate resistant reaction in this study, differently.

Konak and Scharen (1994) detected Tokak 157/37 reacted as resistant. Cumhuriyet 50 exhibited resistance to an isolate but reacted to another isolate as moderately resistant. However this studywas found that Tokak 157/37 and Cumhuriyet 50 varieties showed a moderate resistance reaction.

Comparing the studies done for the last 27 years with this study, it is observed some cvs. reacted differently. Though isolates of *Pyrenophora graminea* in Turkey are thought to be homogenous genetically (Bayraktar and Akan 2012), variances in virulence degree of the isolates support the genetic diversity in *P.graminea*. Therefore, this might be the reason for the dissimilar results of the cultivars used in this study.

In a study carried out in 2004, protein profiles of 27 different isolates were described with the SDS PAGE method and a high degree of genetic diversity revealed (Arabi and Jawhar 2004). In another study, 34 different progeny were produced matching an isolate with a high virulence with a low virulent isolate in vitro and significant diversities observed among these progenies (Arabi and Jawhar 2007). Also many researchers have reported various levels of pathogenic diversity between *P.graminea* isolates (Hammouda 1988, Mohammad and Mahmood 1976; Tunalı 1992; Tunalı 1995; Ulus and Karakaya 2007; Çelik et al. 2016). Therefore, the reactions between cultivars may differ due to the diversity of isolates. However, there are limited studies done in this subject and it is important to uncover the underlying reasons forthis diversity with recent molecular techniques.

4. Conclusion

Though there are ways to control this disease, such as chemicals, the most efficient way is to develop tolerant cultivars that are environmentally friendly and less costly. Nevertheless, resistant cultivars may lose their tolerance degree against new virulent patotypes/races (Andersen et al. 2018). For this reason it is significant to survey and determine the pathogenic variation both phenotypically and genotypically andbreeding new varieties with this information. The effect of the disease on some important agricultural characters could also be investigated in further studies.

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