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Research
Araştırma

DETERMINATION OF THE SEEDLING REACTIONS OF TWENTY BARLEY CULTIVARS TO SIX ISOLATES OF *DRECHSLERA TERES* F. *MACULATA*

Pınar USTA[1] Aziz KARAKAYA[1*] Arzu Çelik OĞUZ[1] Zafer MERT[2] Kadir AKAN[2] Lütfi ÇETİN[2]

[1]Department of Plant Protection, Faculty of Agriculture, University of Ankara, Dışkapı, Ankara, Turkey
[2]Central Research Institute for Field Crops, Yenimahalle, Ankara, Turkey
***karakaya@agri.ankara.edu.tr**

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ABSTRACT: Seedling reactions of 20 barley cultivars grown in Turkey were determined under greenhouse conditions to six isolates of *Drechslera teres* f. *maculata*, the causal agent of spot form of barley net blotch disease. Isolates were obtained from different provinces of Turkey. Differences among the reactions of the cultivars to the isolates of the fungus were observed. Isolate differences in pathogenicity for each cultivar were also present. The reactions of cultivars to the isolates ranged between susceptible to resistant. Reaction of the cultivar Bülbül 89 ranged between susceptible to moderately susceptible. Barley cvs Obruk 86 and Anadolu 86 exhibited reactions between moderately susceptible-susceptible to moderately susceptible to isolates. Reactions of the cultivars Aydanhanım, Zafer 160, Akar, Keser, Yeşilköy 387, Samyeli, Kaya and Durusu ranged between moderately susceptible-moderately resistant to resistant-moderately resistant. Barley cvs Avcı 2002, Larende, Şahin 91, Bolayır, Olgun, Altıkat, Hilal and Harman exhibited reactions between moderately resistant to resistant to isolates. Cultivar Martı was found resistant to six *Drechslera teres* f. *maculata* isolates. Ankara-Nallıhan isolate was the most virulent isolate.
Keywords: Barley, disease resistance, *Drechslera teres,* net blotch, *Pyrenophora teres,* Turkey

YİRMİ ARPA ÇEŞİDİNİN *DRECHSLERA TERES* F. *MACULATA'* NIN ALTI İZOLATINA FİDE DÖNEMİ TEPKİLERİNİN BELİRLENMESİ

ÖZET: Türkiye' de yetiştirilen 20 arpa çeşidinin ağ benek hastalığının nokta formu etmeni *Drechslera teres* f. *maculata'* nın altı izolatına karşı sera şartlarında fide dönemi reaksiyonları belirlenmiştir. Bu hastalığa karşı çeşitlerin gösterdiği reaksiyonlar arasında farklılıklar görüldüğü gibi her bir çeşit düzeyinde izolatlar arasında da virülens bakımından bazı farklılıklar belirlenmiştir. Çeşitler izolatlara hassas ile dayanıklı arasında değişen tepkiler vermişlerdir. Bülbül 89 çeşidi izolatlara hassas ile orta derecede hassas arasında değişen tepkiler vermiştir. Obruk 86 ve Anadolu 86 çeşitlerinin izolatlara tepkileri orta derecede hassas-hassas ile orta derecede hassas arasında değişmiştir. Aydanhanım, Zafer 160, Akar, Keser, Yeşilköy 387, Samyeli, Kaya ve Durusu çeşitlerinin izolatlara tepkileri orta derecede hassas-orta derecede dayanıklı ile dayanıklı-orta derecede dayanıklı arasında değişmiştir. Avcı 2002, Larende, Şahin 91, Bolayır, Olgun, Altıkat, Hilal ve Harman çeşitlerinin izolatlara tepkileri orta derecede dayanıklı ile dayanıklı arasında değişmiştir. Martı çeşidi altı *Drechslera teres* f. *maculata* izolatına karşı dayanıklı olarak bulunmuştur. Ankara-Nallıhan izolatı en virülent izolat olarak bulunmuştur.
Anahtar Sözcükler: Arpa, hastalıklara dayanıklılık, *Drechslera teres,* ağbenek hastalığı, *Pyrenophora teres,* Türkiye

1. INTRODUCTION

Barley is an important crop both in the world and in Turkey (Newman and Newman, 2008; Geçit *et al*., 2009). In the world, barley is planted in approximately 48 million ha area with a production of 126 million tonnes. In Turkey, it is planted in 3 million ha area with a production of 7.3 million tonnes (Anonymous, 2010a ;Anonymous, 2010b) and Central Anatolia region is an important barley growing area (Akar *et al*., 1999). Barley is used as feed and in malt industry (Kün, 1996, Geçit *et al*., 2009).

One of the most important diseases affecting barley is net blotch disease. Net blotch is caused by the fungus *Drechslera teres* (Sacc.) Shoem. (teleomorph: *Pyrenophora teres (*Died.) Dreschs.). There are two biotypes of the fungus. *Pyrenophora teres* f. *teres* causes the net form of the disease and *P. teres* f. *maculata* causes the spot form of the disease (Shipton *et al*., 1973; Mathre, 1982; McLean *et al*., 2009; Liu *et al*,. 2011). This disease is common both in Turkey and in the world. The losses caused by this disease range between 10-40% (Göbelez, 1956; Mathre, 1982). In a study performed in Central Anatolia, Turkey, Aktaş (1997) found the disease in 210 fields out of 246 fields that were inspected. Both forms of the disease was found. The spot form was prevalent (93.8%). Karakaya *et al*. (2001) reported that the disease was common in the Central Anatolia region of Turkey.

Cultivation of resistant cultivars is an efficient

method used to combat this disease. Planting a resistant cultivar is economical and environmentally sound. It is necessary to obtain information about the response of barley cultivars to *Drechslera teres* f. *maculata* (*Dtm*) to implement efficient control measures. It is also important to obtain knowledge about the pathogenic variations of this fungus (Shipton *et al,*. 1973; Mathre, 1982; McLean *et al*., 2009, Liu *et al.,* 2011). In this study, seedling reactions of 20 barley cultivars to 6 different *Dtm* isolates collected from different regions of Turkey were assessed under greenhouse conditions.

2. MATERIALS AND METHODS

This study was carried out at the Central Research Institute for Field Crops, Ankara, Turkey. Twenty barley cultivars obtained from Central Research Institute for Field Crops, Ankara, Turkey and Thrace Agricultural Research Institute, Edirne, Turkey were used in the experiments. Cultivars Avcı 2002, Zafer 160, Yeşilköy 387, Martı, Olgun and Altıkat are 6-rowed, and Bülbül 89, Aydanhanım, Şahin 91, Obruk 86, Anadolu 86, Akar, Keser, Larende, Bolayır, Samyeli, Kaya, Hilal, Durusu and Harman are 2-rowed. Cultivars Bülbül 89, Şahin 91, Obruk 86, Anadolu 86, Akar, Keser, Larende, Yeşilköy 387, Martı, Altıkat, Samyeli and Durusu have facultative growth habits. Cultivars Avcı 2002, Aydanhanım, Bolayır, Olgun and Harman are winter type and cultivars Zafer 160, Kaya and Hilal are spring type. Cultivars Aydanhanım, Bolayır and Durusu are malt type. Cultivars Avcı 2002, Zafer 160, Yeşilköy 387, Martı, Olgun, Altıkat, Bülbül 89, Şahin 91, Obruk 86, Anadolu 86, Akar, Keser, Larende, Samyeli, Kaya, Hilal, Harman are feed type.

During May and June 2012, barley leaves infected with *Dtm* were collected from Ankara-Nallıhan, Kırşehir-Central district, Eskişehir-Sivrihisar, Konya-Bozkır, Eskişehir-Odunpazarı and Sivas-Şarkışla, Turkey. Leaves were surface sterilized with 1% NaOCl for 1 minute. Later on, the leaves were placed into Petri plates containing sterile filter paper. After sporulation, single spores were taken under a stereomicroscope and placed onto Petri plates containing Potato Dextrose Agar.

Fifteen seeds from each cultivar were seeded in 7 cm diameter plastic pots containing soil. Plants were watered as necessary. The temperature of the greenhouse was 18-23±1 ^{o}C for night and day with a 14h/10h light/dark regime. For inoculum production, mycelia were scraped from petri plates using a No.12 paintbrush. Inoculum concentration was adjusted using a hemocytometer to 15-20x10^4 mycelial parts per ml (Douiyssi *et al.*, 1998; Karakaya and Akyol, 2006; Taşkoparan and Karakaya, 2009). One drop of Tween 20 was added for each 100 ml of the inoculum (Aktaş, 1995). Plants were covered with plastic bags for 72 hours following inoculation. Plants were inoculated at growth stages 12-13 (Zadoks *et al.*, 1974). Seven days later, plants were evaluated with a scale developed for spot form of net blotch by Tekauz (1985). Three replicate pots were used in the experiment.

3. RESULTS

Two days after inoculation with *Dtm*, symptoms appeared in some cultivars. After third and fourth days, symptoms were evident in all plants.

Barley cv Bülbül 89 exhibited reactions between susceptible and moderately susceptible to the isolates. This cultivar exhibited a susceptible reaction to the Nallıhan isolate, moderately susceptible-susceptible reaction to the Şarkışla, Kırşehir and Bozkır isolates, and moderately susceptible reaction to the Sivrihisar and Odunpazarı isolates (Table 1).

Reactions of the cv Avcı 2002 to isolates ranged between resistant-moderately resistant and moderately resistant. Avcı 2002 cultivar exhibited resistant-moderately resistant reaction to Şarkışla, Kırşehir, Sivrihisar, Bozkır and Odunpazarı isolates and a moderately resistant reaction to the Nallıhan isolate.

Reactions of the cv Aydanhanım to isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. This cultivar exhibited a moderately resistant-moderately susceptible reaction to Nallıhan and Şarkışla isolates, moderately resistant reaction to Bozkır, Sivrihisar and Odunpazarı isolates, and a resistant-moderately resistant to Kırşehir isolate.

Barley cv Şahin 91 exhibited reactions between resistant-moderately resistant and moderately resistant to the isolates. This cultivar exhibited a moderately resistant reaction to Nallıhan isolate and a resistant-moderately resistant reaction to the Şarkışla, Kırşehir, Bozkır, Sivrihisar and Odunpazarı isolates.

Reactions of the cv Zafer 160 to isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. Cultivar Zafer 160 exhibited a moderately resistant-moderately susceptible reaction to the Nallıhan isolate, moderately resistant reaction to the Şarkışla, Kırşehir, Bozkır and Odunpazarı isolates, and a resistant-moderately resistant reaction to the Sivrihisar isolate.

Reactions of the cvs Obruk 86 and Anadolu 86 to isolates ranged between moderately susceptible-susceptible to moderately susceptible. These cultivars exhibited a moderately susceptible-susceptible reaction to Nallıhan, Şarkışla and Kırşehir isolates, and moderately susceptible reaction to Bozkır, Sivrihisar and Odunpazarı isolates.

Barley cv Akar exhibited reactions between resistant-moderately resistant to moderately resistant-moderately susceptible to the isolates. This cultivar exhibited a moderately resistant-moderately susceptible reaction to Nallıhan, Şarkışla and Kırşehir isolates, moderately resistant reaction to Sivrihisar and Odunpazarı isolates, and a resistant-moderately resistant reaction to Bozkır isolate.

Table 1. Seedling reactions of 20 barley cultivars to 6 *Drechslera teres* f. *maculata* isolates. A 1-9 scale developed for spot form of net blotch by Tekauz (1985) was used in the evaluations. Numbers are mean of three replications.

Barley cultivars	Isolates												
	Nallıhan		Şarkışla		Kırşehir		Bozkır		Sivrihisar		Odunpazarı		Mean
	Mean scale value	Reaction type	Mean scale value	Reaction type	Mean scale valuei	Reaction type	Mean scale value	Reaction type	Mean scale value	Reaction type	Mean scale value	Reaction type	
Bülbül 89	8.67	S*	7.67	MS-S	8.33	MS-S	7.67	MS-S	7	MS	7	MS	7.72
Avcı-2002	2.67	MR	1.67	R-MR	2.33	R-MR	2.33	R-MR	1.67	R-MR	2	R-MR	2.11
Aydanhanım	5	MR-MS	5	MR-MS	2.33	R-MR	3.67	MR	3	MR	3	MR	3.67
Şahin-91	3.67	MR	1.67	R-MR	2.33	R-MR	2.33	R-MR	2	R-MR	2.33	R-MR	2.39
Zafer 160	4.33	MR-MS	3	MR	2.67	MR	2.67	MR	2.33	R-MR	3	MR	3.0
Obruk 86	8.33	MS-S	8.33	MS-S	8.33	MS-S	6.33	MS	7.33	MS	7.33	MS	7.66
Anadolu 86	7.67	MS-S	8	MS-S	7.67	MS-S	6.33	MS	6.33	MS	6.33	MS	7.06
Akar	5	MR-MS	5	MR-MS	4.33	MR-MS	2.33	R-MR	2.67	MR	3	MR	3.72
Keser	4.33	MR-MS	3.67	MR	3.67	MR	3.67	MR	3	MR	3	MR	3.56
Larende	3	MR	2	R-MR	3.67	MR	2.67	MR	2.33	R-MR	3	MR	2.78
Yeşilköy 387	5	MR-MS	2	R-MR	2	R-MR	3.67	MR	2.67	MR	2.33	R-MR	2.84
Bolayır	3.67	MR	3.67	MR	3.67	MR	3.67	MR	3	MR	3	MR	3.45
Martı	1.33	R	1	R	1.33	R	1.33	R	1.33	R	1.33	R	1.28
Olgun	3	MR	3	MR	3.67	MR	2.67	MR	3.67	MR	3.67	MR	3.28
Altıkat	3.67	MR	1.33	R	1.33	R	3.67	MR	2.33	R-MR	2.33	R-MR	2.44
Samyeli	4.33	MR-MS	2.67	MR	5	MR-MS	5	MR-MS	2.33	R-MR	2.67	MR	3.67
Kaya	5	MR-MS	3.67	MR	3.67	MR	3.67	MR	2.67	MR	2.67	MR	3.56
Hilal	2.33	R-MR	2	R-MR	2.33	R-MR	3	MR	2.33	R-MR	2	R-MR	2.33
Durusu	4.33	MR-MS	4.33	MR-MS	3.67	MR	3.67	MR	2.67	MR	2.67	MR	3.56
Harman	2.67	MR	1.33	R	3	MR	2.33	R-MR	1.33	R	1.33	R	2.00
Mean	4.40		3.55		3.77		3.45		3.10		3.20		3.6

* Resistant, (R); Resistant – Moderately Resistant, (R - MR); Moderately Resistant, (MR); Moderately Resistant– Moderately Susceptible, (MR - MS); Moderately Susceptible, (MR); Moderately Susceptible – Susceptible, (MS - S); Susceptible, (S)

Reactions of the cvs Keser and Kaya to isolates ranged between moderately resistant to moderately resistant-moderately susceptible. These cultivars exhibited a moderately resistant-moderately susceptible reaction to Nallıhan isolate, and moderately resistant reaction to Şarkışla, Kırşehir, Bozkır, Sivrihisar and Odunpazarı isolates.

Barley cv Larende exhibited reactions between resistant-moderately resistant to moderately resistant to the isolates. This cultivar exhibited a moderately resistant reaction to Nallıhan, Kırşehir, Bozkır and Odunpazarı isolates, and resistant-moderately resistant reaction to Şarkışla and Sivrihisar isolates.

Reactions of the cv Yeşilköy 387 to isolates ranged between resistant-moderately resistant to moderately resistant-moderately susceptible. This cultivar exhibited a moderately resistant-moderately susceptible reaction Nallıhan isolate, resistant-moderately resistant reaction to Şarkışla, Kırşehir and Odunpazarı isolates, and moderately resistant reaction to Bozkır and Sivrihisar isolates.

Cultivars Bolayır and Olgun exhibited a moderately resistant reaction to all 6 isolates.

Martı cultivar exhibited a resistant reaction to all 6 isolates.

Reactions of the cv Altıkat to isolates ranged between resistant and moderately resistant. Cultivar Altıkat exhibited a resistant reaction to Şarkışla and Kırşehir isolates, moderately resistant reaction to Nallıhan and Bozkır isolates, and resistant-moderately resistant reaction to Sivrihisar and Odunpazarı isolates.

Barley cv Samyeli exhibited reactions between resistant-moderately resistant and moderately resistant-moderately susceptible to the isolates. Cultivar Samyeli exhibited a moderately resistant-moderately susceptible reaction to Nallıhan, Kırşehir and Bozkır isolates, moderately resistant reaction to Şarkışla and Odunpazarı isolates, and resistant-moderately resistant reaction to Sivrihisar isolate.

Reactions of the cv Hilal to isolates ranged between resistant-moderately resistant and moderately resistant. Cultivar Hilal exhibited a resistant-moderately resistant reaction to Nallıhan, Şarkışla, Kırşehir, Sivrihisar and Odunpazarı isolates, and moderately resistant reaction to Bozkır isolate.

Barley cv Durusu exhibited moderately resistant and moderately resistant-moderately susceptible reaction to the isolates.

Cultivar Durusu exhibited a moderately resistant-moderately susceptible reaction to Nallıhan and Şarkışla isolates, and moderately resistant reaction to Kırşehir, Bozkır, Sivrihisar and Odunpazarı isolates.

Reactions of the cv Harman to isolates ranged between resistant and moderately resistant. Cultivar Harman exhibited a moderately resistant reaction to Nallıhan and Kırşehir isolates, resistant reaction to Şarkışla, Sivrihisar and Odunpazarı isolates, and resistant-moderately resistant reaction to Bozkır isolate.

Ankara-Nallıhan isolate was the most virulent isolate (Table 1).

4. DISCUSSION

In this study seedling reactions of 20 barley cultivars to 6 *Dtm* isolates obtained from different regions of Turkey were determined under greenhouse conditions.

In previous studies, successful results were achieved using mycelial inoculum (Karakaya and Akyol, 2006; Taşkoparan and Karakaya, 2009). Also in our study, the use of mycelial inoculum was successful.

Aktaş and Tunalı (1994) evaluated the reactions of some barley cultivars to an isolate of *Drechslera teres.* They found cvs Anadolu 86 and Obruk 86 suceptible, cv Zafer 160 and Yeşilköy 387 moderately susceptible. In our study, reaction of cultivars Obruk 86 and Anadolu 86 to 6 isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. Reactions of the cv Zafer 160 to 6 isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. Reactions of the cv Yeşilköy 387 to 6 isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. In Zafer 160 and Yeşilköy 387, differences in their responses to different isolates showed the pathological variations of the fungus.

Aktaş (1995) reported cv Bülbül as suceptible to an isolate of *Pyrenophora teres*. In our study, reaction of cv Bülbül 89 to 6 *Dtm* isolates ranged between moderately susceptible and susceptible.

In a study performed by Karakaya and Akyol (2006), seedling reactions of 15 barley cultivars to 4 isolates of *Dtm* was determined. In their study, cultivar Bülbül 89 exhibited a susceptible reaction to Gölbaşı and Department isolates, and moderately susceptible-susceptible reaction to Kalecik and Bala isolates. In their study, cv Avcı 2002 exhibited a resistant reaction to Bala isolate, and a resistant-moderately resistant reaction to other 3 isolates. In Karakaya and Akyol's study (2006), cv Şahin 91 exhibited a resistant-moderately resistant reaction to Kalecik isolate and moderately resistant reactions to other 3 isolates. Also in their study, cv Aydanhanım exhibited a moderately resistant reaction to Gölbaşı and Bala isolates and moderately resistant-moderately susceptible reaction to Kalecik and Department isolates. In our study, reactions of the cv Bülbül 89 to 6 *Dtm* isolates ranged between susceptible and moderately susceptible. This cultivar exhibited a susceptible reaction to the Nallıhan isolate, moderately susceptible-susceptible reaction to the Şarkışla, Kırşehir and Bozkır isolates, and moderately susceptible reaction to the Sivrihisar and Odunpazarı isolates. In our study, reactions of the cv Avcı 2002 to 6 isolates ranged between resistant-moderately resistant and moderately resistant. Avcı

2002 cultivar exhibited resistant-moderately resistant reaction to Şarkışla, Kırşehir, Sivrihisar, Bozkır and Odunpazarı isolates and a moderately resistant reaction to the Nallıhan isolate. In our study, reactions of the cv Aydanhanım to 6 isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. This cultivar exhibited moderately resistant-moderately susceptible reaction to Nallıhan and Şarkışla isolates, moderately resistant reaction to Bozkır, Sivrihisar and Odunpazarı isolates, and a resistant-moderately resistant to Kırşehir isolate. In our study, reactions of the cv Şahin 91 to 6 isolates ranged between resistant-moderately resistant and moderately resistant. This cultivar exhibited a moderately resistant reaction to Nallıhan isolate and resistant-moderately resistant reaction to the Şarkışla, Kırşehir, Bozkır, Sivrihisar and Odunpazarı isolates. In both studies, reactions of these cultivars to *Dtm* isolates was mostly similar.

Aktaş and Katırcıoğlu (2008) reported the reactions of cvs Zafer 160 and Yeşilköy 387 to an isolate of *Drechslera teres* as susceptible. In our study, reactions of cultivar Zafer 160 and Yeşilköy 387 to 6 different *Dtm* isolates ranged between resistant-moderately resistant and moderately resistant-moderately susceptible. Differences in the virulence of isolates was evident.

Aktaş and Katırcıoğlu (2008) reported the reaction of cv Anadolu 86 to an isolate of *Drechslera teres* as susceptible. In our study, reaction of this cultivar to 6 different *Dtm* isolates ranged between moderately susceptible and moderately susceptible-susceptible.

Aktaş and Katırcıoğlu (2008) reported the reaction of cv Kaya to an isolate of *Drechslera teres* as susceptible. In our study, reaction of this cultivar to 6 different *Dtm* isolates ranged between moderately resistant and moderately resisatnt-moderately susceptible. This cultivar exhibited a moderately resistant reaction to Şarkışla, Kırşehir, Bozkır, Sivrihisar and Odunpazarı isolates. Differences in the pathogenicity of isolates was evident.

Taşkoparan and Karakaya (2009) reported the reaction of cv Bülbül 89 to an isolate of *Dtm* obtained from Haymana as susceptible. In our study, reaction of this cultivar to 6 different *Dtm* isolates ranged between moderately susceptible and susceptible.

Karakaya and Akyol (2006), and Taşkoparan and Karakaya (2009) reported 6 rowed barley cultivars more resistant to spot form of net blotch as compared to 2 rowed cultivars. Our results support this view.

Other researchers also reported variation in the reactions of barley cultivars and lines to *Pyrenophora teres* (Jorgensen *et al*., 2000, Douiyssi *et al.*, 1998, Karakaya and Akyol, 2006, Taşkoparan and Karakaya 2009).

Cultivars differed in their reaction to *Dtm*. Some differences in the virulence of *Dtm* isolates for each cultivar were also observed. This suggested virulence variations of the fungal isolates. However, this variation was not high. There was no cultivar that showed a resistant reaction to one isolate and a susceptible reaction to the other. Variations in the virulence of the fungus should be tested with more isolates from more diverse areas.

Ankara-Nallıhan isolate was found as the most virulent isolate. The virulence of the Eskişehir-Sivrihisar isolate was low. Limited pathological variation in the fungus was observed. Pathogenic variation was reported from a number of different countries (Tekauz, 1990; McLean *et al.*, 2009; Liu *et al.*, 2011).

The reactions of the barley cultivars evaluated in this study to *Dtm* isolates ranged between resistant and susceptible. However, in majority of the cultivars evaluated in this study, certain amount of resistance was evident. Also some cultivars such as Martı showed a high degree of resistance to isolates. The percentage of resistant cultivars should be increased in seed programs and farmers should be informed about the resistant varieties.

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