



Assessment of the Seedling Reactions of Some Hulless Barley Genotypes to *Drechslera teres* f. *maculata*

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ABSTRACT

The seedling reactions of three barley cultivars, one hulless barley cultivar, two candidate hulless barley lines and nine hulless barley genotypes were determined under greenhouse conditions to ten isolates of *Drechslera teres* f. *maculata*, the causal agent of spot form of net blotch. Isolates were obtained from Ankara, Çankırı, Eskişehir, Kayseri, Konya and Şanlıurfa provinces. The reactions of the cultivars and hulless cultivar ranged between susceptible-resistant. The reactions of the hulless candidate lines and genotypes ranged between resistant-moderately resistant-moderately susceptible with the exception of Candidate line 8 which showed a moderately susceptible reaction to the 3 isolates. There were differences among the reactions of the cultivars and genotypes to the isolates of the fungus. Isolates showed some differences in pathogenicity for each cultivar. Generally, resistance was found among the hulless barley cultivars and genotypes to *Drechslera teres* f. *maculata*. Tomarza isolate was the most virulent isolate.

1. Introduction

Barley (*Hordeum vulgare* L.) is an important cereal both in Turkey and in the world. It is mainly used as an animal feed and in malt industry (Kün 1996).

In the world, barley is produced in 48.6 million ha area with a production of 124 million tonnes. In Turkey, barley is produced in nearly 2.9 million ha area with a production of 7.6 million tonnes (FAO 2011).

Turkey is among the gene centers of barley. Archeological excavations in Turkey revealed the remains of barley seeds (Harlan 1992; Kün 1996; Tan 1998). Barley is one of the most important cereal crops in Turkey. It is the second most important cereal following wheat (Kün, 1996; Mızrak and Yalvaç 2001; Geçit et al. 2009)

There is an increasing interest in the hulless barley (*Hordeum vulgare* var. *nudum*) in recent years. In hulless barleys, hull is easily separated during the harvest. Hulless trait is controlled by a single recessive gene (*nud* gene) located in the long arm of the chromosome

7H. Hulless barley is used as human food and as animal feed. It is also used in food sector and has industrial uses (Yalçın et al. 2006; Newman and Newman 2008).

Net blotch is one of most important barley diseases. It is common both in the world and in Turkey (Shipton et al. 1973; Mathre 1982; Aktaş 1987; Liu et al. 2011). Losses due to this disease range between 10-40% (Mathre, 1982). Net blotch is caused by the fungus *Drechslera teres* (Sacc.) Shoem. (teleomorph: *Pyrenophora teres* (Died.) Drechs.). The disease agent has two biotypes: *Drechslera teres* f. *teres* causes net form of the disease and *Drechslera teres* f. *maculata* causes the spot form of the disease. In a study performed in Turkey, Aktaş (1997) found that both forms were present in Turkey. In Central Anatolia he found the both forms. Spot form was prevalent (93.8%).

Developing and planting resistant cultivars are important in disease control (Aktaş 1995; Liu et al. 2011). In Turkey, there is no resistance study regarding hulless barley genotypes. The variation in the fungi is also important in resistance studies.

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In this study, seedling reactions of 12 hullless barley genotypes to *Drechslera teres* f. *maculata* isolates obtained from Kayseri/Kocasinan, Eskişehir/Sivrihisar, Konya/Çumra, Şanlıurfa/Birecik, Ankara/Bala, Ankara/Şereflikoçhisar, Konya/Ereğli, Konya/Akşehir, Çankırı/Ilgaz and Kayseri/Tomarza were determined. The cultivars Bülbül 89, Avcı 2002 and Aydanhanım, which their reactions are reported in some previous studies, were also included in the experiment (Aktaş 1995; Karakaya and Akyol 2006; Taşkoparan and Karakaya 2009).

2. Materials and Methods

This study was carried out at the greenhouse of Central Research Institute for Field Crops, Ankara, Turkey. A total of 15 barley genotypes [Four barley cultivars (one hullless), 2 candidate hullless barley lines and 9 hullless barley lines] were obtained from Central Research Institute for Field Crops. Among the cultivars Bülbül 89, Avcı 2002 and Aydanhanım are commonly used barley cultivars. Özen is a newly developed hullless barley cultivar. Candidate line 7, Candidate line 8, Ç-647, Ç-645, Ç-636, Ç-643, Ç-641, Ç-633, Ç-646, Ç-638 and Ç-642 genotypes are hullless barley genotypes. Some characteristics of these cultivars and genotypes are presented in Table 1.

Surveys were conducted in May and June of 2012 in barley growing areas of Ankara, Eskişehir, Kayseri, Çankırı, Şanlıurfa and Konya provinces of Turkey. Leaves infected with *Drechslera teres* f. *maculata* were taken and surface sterilized with 1% NaOCl for one minute. Later on, diseased leaves were placed into Petri plates containing moistened sterile filter papers. Under stereomicroscope single spores were taken and placed into Petri plates containing Potato Dextrose Agar (PDA).

15 seeds from all cultivars and genotypes were seeded to plastic pots containing soil. Plants were grown in a greenhouse with an 18–23 ±1°C temperature regime (night/day) and 14/10 light/dark period.

Inocula were prepared from 10 day old fungal cultures grown on PDA. Mycelium was scraped from plates using a paintbrush, filtered using a cheesecloth, adjusted to 15 – 20 x 10⁴ mycelium parts/ml using a hemacytometer and sprayed to plants which were in growth stage 12-13 (Zadoks et al. 1974, Douiyssi et al. 1998, Karakaya and Akyol 2006, Taşkoparan and Karakaya 2009). For each 100 ml of inoculum 1 drop of Tween 20 was added (Aktaş 1995). After inoculation, plants were covered with moistened plastic bags for 72 hours. Seven days later plants were evaluated using a scale developed for spot type of net blotch by Tekauz (1985). Experiments were repeated three times.

3. Results

First symptoms were present in some cultivars and genotypes three days later after inoculation. Symptoms were present in all plants after 4th day.

Reaction types and mean scale values of barley cultivars and genotypes after inoculation with 10 isolates of *Drechslera teres* f. *maculata* were presented in Tables 2 and 3.

The reactions of barley cv Bülbül 89 ranged between susceptible and moderately susceptible. Bülbül 89 gave a moderately susceptible reaction to the Akşehir and Şereflikoçhisar isolates. The response of the Bülbül 89 to Birecik, Çumra, Ilgaz, Kocasinan, Sivrihisar and Tomarza isolates was moderately susceptible-susceptible. This cultivar gave a susceptible reaction to the Bala and Ereğli isolates.

The reactions of barley cv Avcı 2002 to the isolates ranged between resistant and moderately resistant-moderately susceptible. The response of the Avcı 2002 to Akşehir, Birecik, Çumra, Ilgaz, Kocasinan, Şereflikoçhisar and Tomarza isolates was resistant-moderately resistant. This cultivar showed a moderately resistant reaction to Ereğli isolate and moderately resistant-moderately susceptible reaction to the Bala isolate.

Barley cv Aydanhanım exhibited a resistant-moderately resistant reaction to Şereflikoçhisar isolate, moderately resistant reaction to Akşehir, Çumra and Sivrihisar isolates and moderately resistant-moderately susceptible reaction to the Bala, Birecik, Ereğli, Ilgaz, Kocasinan and Tomarza isolates.

The reactions of hullless barley cv Özen to the isolates ranged between resistant and moderately resistant-moderately susceptible. This cultivar exhibited a resistant reaction to Şereflikoçhisar isolate, resistant-moderately resistant reaction to the Çumra isolate, moderately resistant reaction to the Akşehir, Sivrihisar and Birecik isolates, moderately resistant-moderately susceptible reaction to the Bala, Ereğli, Ilgaz, Kocasinan and Tomarza isolates.

The reactions of hullless Candidate line 8 to the isolates ranged between moderately resistant and moderately susceptible. This line exhibited a moderately resistant reaction to Çumra, Sivrihisar and Şereflikoçhisar isolates, moderately resistant-moderately susceptible reaction to the Akşehir, Bala, Ereğli and Kocasinan isolates and moderately susceptible reaction to the Birecik, Ilgaz and Tomarza isolates.

Hullless Candidate line 7 exhibited a moderately resistant reaction to Akşehir, Bala, Çumra, Kocasinan, Sivrihisar and Şereflikoçhisar isolates, and moderately resistant-moderately susceptible reaction to the Birecik, Ereğli, Ilgaz and Tomarza isolates.

The reactions of hullless Ç-647 genotype to the isolates ranged between resistant and moderately resistant. This genotype exhibited a resistant reaction to Akşehir,

Birecik and Şereflikoçhisar isolates, resistant-moderately resistant reaction to Bala, Ereğli, Kocasinan and Tomarza isolates, and moderately resistant reaction to Çumra, Ilgaz and Sivrihisar isolates.

The reactions of hulless Ç-645 genotype to the isolates ranged between resistant and moderately resistant.

This genotype exhibited a resistant reaction to Akşehir, Birecik, Kocasinan, Sivrihisar and Şereflikoçhisar isolates, resistant-moderately resistant reaction to Bala, Ereğli and Ilgaz isolates, and moderately resistant reaction to Çumra isolate.

Table 1

Some characteristics of the barley cultivars, candidate lines and lines used in this study.

Cultivars and lines	Registration date	Row type	Growth habit	Owner of the cultivar	Recommended areas
Avcı 2002	02.05.2002	6 row	Winter	Central Research Institute for Field Crops	Central Anatolia, Transitional zones and Eastern Anatolia
Bülbül 89	20.04.1989	2 row	Winter-Facultative-	Central Research Institute for Field Crops	Central Anatolia and Transitional zones
Aydanhanım	02.05.2002	2 row	Winter	Central Research Institute for Field Crops	Central Anatolia and Transitional zones
Özen	17.04.2012	2 row	Spring	Central Research Institute for Field Crops	Central Anatolia and Transitional zones
Candidate 7	Registration work is in progress	2 row	Winter-Facultative	-	-
Candidate 8	Registration work is in progress	2 row	Winter-Facultative	-	-
Ç – 633	-	2 row	Spring	-	-
Ç – 636	-	2 row	Spring	-	-
Ç – 638	-	2 row	Spring	-	-
Ç – 641	-	2 row	Spring	-	-
Ç – 642	-	2 row	Spring	-	-
Ç – 643	-	2 row	Spring	-	-
Ç – 645	-	2 row	Spring	-	-
Ç – 646	-	2 row	Spring	-	-
Ç – 647	-	2 row	Spring	-	-

Hulless Ç-636 genotype exhibited a resistant reaction to Akşehir, Çumra, Kocasinan, Sivrihisar and Şereflikoçhisar isolates, and resistant- moderately resistant reaction to Bala, Birecik, Ereğli and Ilgaz isolates.

The reactions of hulless Ç-643 genotype to the isolates ranged between resistant- moderately resistant and moderately resistant-moderately susceptible. This genotype exhibited a resistant-moderately resistant reaction to Akşehir, Çumra and Şereflikoçhisar isolates, moderately resistant reaction to Birecik, Ilgaz, Kocasinan and Tomarza isolates, and moderately resistant-moderately susceptible reaction to Bala, Ereğli and Sivrihisar isolates.

The reactions of hulless Ç-641 genotype to the isolates ranged between resistant and moderately resistant-moderately susceptible. This genotype exhibited a resistant reaction to Akşehir isolate, resistant-moderately resistant reaction to Ilgaz and Şereflikoçhisar isolates, moderately resistant reaction to Birecik and Çumra iso-

lates, moderately resistant-moderately susceptible reaction to Bala, Ereğli, Kocasinan, Sivrihisar and Tomarza isolates.

Hulless Ç-633 genotype exhibited a resistant reaction to Akşehir, Çumra and Şereflikoçhisar isolates, resistant-moderately resistant reaction to Bala, Birecik, Kocasinan and Sivrihisar isolates, and moderately resistant reaction to Ereğli, Ilgaz and Tomarza isolates.

The reactions of hulless Ç-646 genotype to the isolates ranged between resistant and resistant-moderately resistant. This genotype exhibited a resistant reaction to Akşehir, Çumra, Kocasinan and Şereflikoçhisar isolates, and resistant-moderately resistant reaction to Bala, Birecik, Ilgaz and Sivrihisar isolates.

The reactions of hulless Ç-638 genotype to the isolates ranged between resistant and moderately resistant. This genotype exhibited a resistant reaction to Akşehir, Çumra, Sivrihisar and Şereflikoçhisar isolates, resistant-

moderately resistant reaction to Ilgaz and Kocasinan isolates, and moderately resistant reaction Bala, Birecik, Ereğli and Tomarza isolates.

Hulless Ç-642 genotype exhibited a resistant reaction to Akşehir, Çumra, Sivrihisar and Şereflikoçhisar isolates, resistant-moderately resistant reaction to Bala, Ereğli and Kocasinan isolates, and moderately resistant reaction to Birecik and Ilgaz isolates.

Table 2

Seedling response of 4 Turkish barley cultivars (one hulless), 2 hulless candidate lines and 9 hulless genotypes to *Drechslera teres* f. *maculata* isolates obtained from Kocasinan, Sivrihisar, Çumra, Birecik and Bala under greenhouse conditions. For evaluation a 1-9 scale developed by Tekauz (1985) used, Numbers are mean of 3 replications.

Barley cultivars and lines	Isolates										Mean
	Kocasinan		Sivrihisar		Çumra		Birecik		Bala		
	Mean scale value	Reaction type *	Mean scale value	Reaction type							
Bülbül 89	8.00	MS - S	7.67	MS - S	7.67	MS - S	8.00	MS - S	9.00	S	8.07
Avcı 2002	2.33	R - MR	1.33	R	1.67	R - MR	2.33	R - MR	5.00	MR - MS	2.53
Aydanhanım	4.33	MR - MS	3.00	MR	3.67	MR	4.33	MR - MS	5.67	MR - MS	4.20
Özen	4.33	MR - MS	2.67	MR	2.00	R - MR	2.67	MR	5.00	MR - MS	3.33
Candidate line 8	5.00	MR - MS	3.67	MR	3.00	MR	6.33	MR	5.00	MR - MS	4.60
Candidate line 7	2.67	MR	3.00	MR	3.00	MR	5.00	MR - MS	3.67	MR	3.47
Ç - 647	1.67	R - MR	2.67	MR	3.00	MR	1.33	R	1.67	R - MR	2.07
Ç - 645	1.00	R	1.33	R	1.33	R	1.00	R	1.67	R - MR	1.27
Ç - 636	1.33	R	1.33	R	1.33	R	2.00	R - MR	2.00	R - MR	1.60
Ç - 643	3.67	MR	4.33	MR - MS	2.33	R - MR	2.67	MR	5.00	MR - MS	3.60
Ç - 641	4.33	MR - MS	4.33	MR - MS	3.00	MR	3.67	MR	5.00	MR - MS	4.07
Ç - 633	2.00	R - MR	1.67	R - MR	1.00	R	2.00	R - MR	2.33	R - MR	1.80
Ç - 646	1.00	R	1.67	R - MR	1.33	R	2.00	R - MR	2.00	R - MR	1.60
Ç - 638	1.67	R - MR	1.33	R	1.33	R	2.67	MR	3.67	MR	2.13
Ç - 642	2.33	R - MR	1.33	R	1.00	R	3.00	MR	2.00	R - MR	1.93
Mean	3.04		2.76		2.44		3.27		3.91		3.08

* 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)

4. Discussion

In this study, seedling reactions of 4 barley cultivars (one hulless), 2 cultivar candidate hulless barley genotypes and 9 hulless barley genotypes to *Drechslera teres* f. *maculata* isolates obtained from Kayseri/Kocasinan, Eskişehir/Sivrihisar, Konya/Çumra, Şanlıurfa/Birecik, Ankara/Bala, Ankara/Şereflikoçhisar, Konya/Ereğli, Konya/Akşehir, Çankırı/Ilgaz and Kayseri/Tomarza were determined.

Previous studies reported the success of using mycelial inoculum for inoculations (Karakaya and Akyol 2006; Taşkoparan and Karakaya 2009). Also in our study mycelial inoculation was successful.

Aktaş (1995) found the barley cv Bülbül 89 susceptible to a virulent strain of *Pyrenophora teres*. In our study, reactions of Bülbül 89 cultivar ranged between susceptible and moderately susceptible. Bülbül 89 gave

a moderately susceptible reaction to the Akşehir and Şereflikoçhisar isolates. The response of the Bülbül 89 to Birecik, Çumra, Ilgaz, Kocasinan, Sivrihisar and Tomarza isolates was moderately susceptible-susceptible. This cultivar gave a susceptible reaction to the Bala and Ereğli isolates.

In a study performed by Karakaya and Akyol (2006) seedling reactions of 15 Turkish barley cultivars to 4 isolates of *Pyrenophora teres* f. *maculata* were determined. They found clear differences among the reactions of the cultivars to the isolates of the fungus ranging from very susceptible to resistant. In this study, reaction of the cv Bülbül 89 ranged between susceptible and moderately susceptible-susceptible. The response of cv Avcı 2002 ranged between resistant and moderately resistant. The response of cv Aydanhanım ranged between moderately resistant and moderately resistant-moderately susceptible. The researchers found small differences among the cultivars in response to isolates. Gölbaşı isolate was

found as the most virulent isolate. In our study, reactions of Bülbül 89, Avcı 2002 and Aydanhanım ranged between susceptible and moderately susceptible, resistant

and moderately resistant-moderately susceptible, and resistant-moderately resistant and moderately resistant-moderately susceptible, respectively.

Table 3

Seedling response of 4 Turkish barley cultivars (one hulless), 2 hulless candidate lines and 9 hulless genotypes to *Drechslera teres* f. *maculata* isolates obtained from Şereflikoçhisar, Ereğli, Akşehir, Ilgaz and Tomarza under greenhouse conditions. For evaluation a 1-9 scale developed by Tekauz (1985) used. Numbers are mean of 3 replications.

Barley cultivars and lines	Isolates										Mean
	Şereflikoçhisar		Ereğli		Akşehir		Ilgaz		Tomarza		
	Mean scale value	Reaction type *	Mean scale value	Reaction type							
Bülbül 89	7.33	MS	9.00	S	7.33	MS	8.00	MS - S	8.33	MS - S	8.00
Avcı 2002	1.67	R - MR	3.00	MR	2.00	R - MR	1.67	R - MR	1.67	R - MR	2.00
Aydanhanım	2.00	R - MR	4.33	MR - MS	3.00	MR	5.00	MR - MS	4.33	MR - MS	3.73
Özen	1.33	R	5.00	MR - MS	3.67	MR	5.67	MR - MS	5.67	MR - MS	4.26
Candidate line 8	3.67	MR	4.33	MR - MS	4.33	MR-MS	7.00	MS	6.33	MS	5.13
Candidate line 7	2.67	MR	5.00	MR - MS	3.67	MR	5.67	MR - MS	4.33	MR - MS	4.27
Ç - 647	1.00	R	2.00	R - MR	1.33	R	3.67	MR	2.00	R - MR	2.00
Ç - 645	1.00	R	2.00	R - MR	1.00	R	2.33	R - MR	X*	X	1.58
Ç - 636	1.00	R	2.00	R - MR	1.00	R	2.00	R - MR	X	X	1.50
Ç - 643	1.67	R - MR	5.00	MR - MS	2.33	R - MR	2.67	MR	3.67	MR	3.07
Ç - 641	1.67	R - MR	4.33	MR - MS	1.33	R	2.00	R - MR	4.33	MR - MS	2.67
Ç - 633	1.00	R	2.67	MR	1.33	R	2.67	MR	2.67	MR	2.13
Ç - 646	1.00	R	X	X	1.33	R	2.00	R - MR	X	X	1.44
Ç - 638	1.00	R	2.67	MR	1.33	R	2.33	R - MR	3.00	MR	2.07
Ç - 642	1.00	R	2.00	R - MR	1.33	R	3.00	MR	X	X	1.83
Mean	1.93		3.54		2.42		3.71		4.21		3.04

* "X" isolate is not used due to insufficient amount of seed

Taşkoparan and Karakaya (2009) found cv Bülbül 89 susceptible to a *Drechslera teres* f. *maculata* isolate obtained from Haymana, Ankara. In our study, reactions of cv Bülbül 89 to isolates ranged between susceptible to moderately susceptible. The reactions of the cultivars and hulless cultivar ranged between Susceptible-resistant. The reactions of the hulless candidate lines and genotypes ranged between resistant-moderately resistant-moderately susceptible with the exception of Candidate 8 which showed a Moderately Susceptible reaction to the 2 isolates. There were differences among the reactions of the cultivars and genotypes to the isolates of the fungus. Isolates showed some differences in pathogenicity for each cultivar. Generally, resistance was found among the hulless barley cultivars and genotypes to *Drechslera teres* f. *maculata* (Tables 2 and 3)

In our study, Kayseri/Tomarza isolate was found as the most virulent isolate (Tables 2 and 3). Ankara/Şereflikoçhisar isolate was found as the least virulent isolate. Some variation was present in *Drechslera teres* f. *maculata* isolates. For example, Candidate line 8 exhibited

moderately resistant reaction to the Sivrihisar, Çumra and Şereflikoçhisar isolates. The reaction of Candidate line 8 to the Ilgaz, Tomarza and Birecik isolates was moderately susceptible. Hulless barley cv Özen exhibited a resistant reaction to the Şereflikoçhisar isolate and a moderately resistant-moderately susceptible reaction to the Ereğli, Ilgaz, Tomarza, Kocasinan and Bala isolates. Pathogenic variation in *Pyrenophora teres* isolates was also reported from other countries (Tekauz 1990; Gamba and Tekauz 2000; Liu et al. 2011).

It appears that there are differences in the resistance status of barley genotypes. However, certain amount of resistance was present in the hulless barley genotypes. Turkey is one of the gene centers of barley. Resistant genotypes should be determined and farmers should be encouraged to plant resistant varieties.

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7. References

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