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## Foliar diseases of barley and wild barleys in Siirt Province, Türkiye

Siirt ilinde arpa ve yabani arpalarda görülen yaprak hastalıkları

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### ABSTRACT

In May 2023, surveys were conducted in the barley growing areas of the Central district, Baykan, Kurtalan, Pervari, Şirvan, Eruh, and Tillo districts of Siirt province, Türkiye. Leaf diseases occurring in barley and wild barley (*Hordeum spontaneum*, *Hordeum bulbosum*) plants were determined. On barley plants, net and spot forms of net blotch disease caused by *Pyrenophora teres* f. *teres*, and *Pyrenophora teres* f. *maculata*, powdery mildew caused by *Blumeria graminis* f. sp. *hordei*, scald caused by *Rhynchosporium commune*, barley stripe caused by *Pyrenophora graminea* and spot blotch disease caused by *Cochliobolus sativus* were detected. On wild barley plants, the net form of net blotch disease caused by *Pyrenophora teres* f. *teres*, spot form of net blotch disease caused by *Pyrenophora teres* f. *maculata*, powdery mildew caused by *Blumeria graminis* f. sp. *hordei*, scald caused by *Rhynchosporium commune*, barley stripe caused by *Pyrenophora graminea* and brown rust disease caused by *Puccinia hordei* were found.

### INTRODUCTION

Barley (*Hordeum vulgare*) is a cool-season cereal resistant to cold and arid conditions, and it can be grown even in nutrient-poor soils (Mathre 1997). Barley, a cereal with high feed value, is primarily used in animal nutrition. Additionally, barley is utilized in human nutrition and malt production (Geçit 2016). Barley is a significant cereal crop in Turkish agriculture and has been cultivated in Anatolia for a considerable period. After wheat, barley is the most commonly planted cereal in Turkish agriculture. Türkiye is one of the important gene centers of both barley and wild barleys (Karakaya et al. 2016a, 2020, Kün 1996). In 2022, barley was planted in 7350, 2400, 9000, 1500, 2620,

11260, and 200 decares of land in Siirt Central district and Baykan, Kurtalan, Pervari, Şirvan, Eruh and Tillo districts, respectively (TÜİK 2024).

Barley plants are affected by various abiotic and biotic disease agents (Mathre 1982). It is crucial to identify these diseases that reduce yield and quality and take necessary measures. In studies conducted in Türkiye, various barley disease agents such as *Pyrenophora teres* (anamorph: *Drechslera teres*), *Rhynchosporium commune* (formerly named as *R. secalis* (Zaffarano et al. 2011)), *Pyrenophora graminea* (anamorph: *Drechslera graminea*), *Puccinia hordei*, *Cochliobolus sativus*,

and *Blumeria graminis* f. sp. *hordei* (*Erysiphe graminis* f. sp. *hordei*) were identified (Saraç Sivrikaya et al. 2019, 2021). One of the wild barley species, *Hordeum spontaneum* is naturally grown in the Fertile Crescent region (Karakaya et al. 2016a) and it has been reported as an important disease-resistance source (Çelik and Karakaya 2017). *Hordeum bulbosum*, also common in the region, is in the barley secondary gene pool (Karakaya et al. 2020, Ruge-Wehling and Wehling 2014, Saraç Sivrikaya et al. 2023). In this study, 46 barley fields, 95 naturally grown *H. spontaneum* populations, and 40 naturally grown *H. bulbosum* populations in Siirt province of Türkiye were examined for the presence of foliar diseases.

## MATERIALS AND METHODS

In May 2023, a survey was conducted in Siirt province, Türkiye to determine the presence of diseases on *H. vulgare*, *H. bulbosum*, and *H. spontaneum*. A total of 46 barley fields were examined, with 11, 7, 10, 2, 6, and 10 fields surveyed in Siirt Central district, Baykan, Kurtalan, Pervari, Şirvan, and Eruh, respectively, for the presence of foliar diseases. At each barley field, at least 100 plants were inspected, except for Tillo district, which was not sampled due to its small barley cultivation area. The sampling method used was systematic sampling (Aktaş 2001). Additionally, 95 *H. spontaneum* populations and 40 *H. bulbosum* populations were inspected. Twenty-eight, 10, 9, 12, 16, 12, and 8 *H. spontaneum* populations in Siirt Central district, Baykan, Kurtalan, Pervari, Şirvan, Eruh and Tillo districts were investigated, respectively. Eight, 5, 6, 3, 13, and 5 *H. bulbosum* populations in Siirt Central district, Baykan, Kurtalan, Pervari, Şirvan, and Tillo were investigated, respectively. At each location, at least 50 *H. spontaneum* plants and at least 30 *H. bulbosum* plants were inspected. No samples were taken from the Eruh district, which has a small *H. bulbosum* population.

Wild barley and barley plants were visually inspected for foliar diseases in the field (Mathre 1997, Zaffarano et

al. 2011). Disease severity was assessed using Saari and Prescott's (1975) 0-9 scale, which is designed to evaluate the intensity of foliar diseases in wheat but can also be used for barley foliar diseases. On this scale, 0 means no infection, and 9 means severe infection, with 5 representing disease development up to the midpoint of the plant. This scale allows for the quick assessment of a large number of plants. In our study, we used these scale values as disease severity values. For suspected samples, isolations were made from the diseased leaf samples, and inocula were prepared and sprayed onto susceptible Bülbül 89 seedlings under greenhouse conditions as explained in Çelik Oğuz and Karakaya (2017 a,b). When calculating the average incidence, fields with and without disease were evaluated together.

## RESULTS AND DISCUSSION

Inoculations were performed on the susceptible Bülbül 89 cultivar to confirm the leaf symptoms suspected to be caused by *P. teres* forms and *Cochliobolus sativus*. After inoculation with the suspected fungal cultures, we observed typical net form of net blotch, spot form of net blotch, and spot blotch symptoms. In the barley surveys conducted in Siirt province, both forms of net blotch disease caused by *P. teres* f. *maculata* and *P. teres* f. *teres*, scald caused by *R. commune*, barley stripe caused by *P. graminea*, powdery mildew caused by *B. graminis* f. sp. *hordei*, and spot blotch disease caused by *C. sativus* were found in barley plants (Tables 1-3). Out of the 46 barley fields examined in Siirt province, the following diseases were observed: *Blumeria graminis* f. sp. *hordei* in 24 fields, *P. teres* f. *maculata* in 19 fields, *R. commune* in 17 fields, *P. graminea* in 15 fields, *P. teres* f. *teres* in 14 fields, and *C. sativus* in 3 fields. Powdery mildew and the spot form of net blotch were the most commonly observed diseases in the fields, followed by scald.

**Table 1.** Barley (*Hordeum vulgare*) foliar diseases observed in Siirt province, Türkiye. For disease severity, a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum vulgare</i> )	<i>Pyrenophora teres</i> f. <i>teres</i>			<i>Pyrenophora teres</i> f. <i>maculata</i>			<i>Rhynchosporium commune</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	11	3	1.45%	3-5(3.66)	5	11.27%	1-5(3.8)	2	0.45%	3(3)
Baykan	7	1	0.14%	3(3)	4	0.86%	1-3(2.5)	5	4.42%	3-5(4.2)
Kurtalan	10	5	1.1%	3(3)	6	0.8%	3(3)	1	0.3%	3(3)
Pervari	2	2	1%	3(3)	1	0.5%	3(3)	2	2.5%	3(3)
Şirvan	6	1	0.17%	3(3)	1	0.5%	5(5)	3	1.66%	3(3)
Eruh	10	2	0.5%	3(3)	2	0.3%	3(3)	4	0.9%	1-3(2)

**Table 2.** Barley (*Hordeum vulgare*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum vulgare</i> )	<i>Pyrenophora teres f. teres</i>			<i>Pyrenophora teres f. maculata</i>			<i>Rhynchosporium commune</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	11	3	2.73%	3-5(3.66)				4	0.45%	-
Baykan	7	4	0.86%	3(3)	-	-	-	4	0.57%	-
Kurtalan	10	5	3%	3-5(3.8)	-	-	-	4	0.8%	-
Pervari	2	2	1.5%	3(3)	-	-	-	1	1%	-
Şirvan	6	6	2.16%	3-5(3.33)	-	-	-	-	-	-
Eruh	10	4	1%	3(3)	-	-	-	2	0.4%	-

**Table 3.** Barley (*Hordeum vulgare*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum vulgare</i> )	<i>Cochliobolus sativus</i>		
		Field	Incidence (%)	Severity (mean)
Central	11	3	20%	5-7(5.66)
Baykan	7	-	-	-
Kurtalan	10	-	-	-
Pervari	2	-	-	-
Şirvan	6	-	-	-
Eruh	10	-	-	-

Disease severity values ranged from 3 to 5 for *P. teres f. teres*, *R. commune*, and *B. graminis f. sp. hordei*. For *P. teres f. maculata* and *C. sativus*, disease severity values were between 1-5 and 5-7, respectively.

The net form of net blotch was observed in all examined Siirt districts except the Tillo district, from which no sample was taken. This disease was most prevalent in the Central district (1.45%). The spot form of net blotch was observed in all districts, with the highest incidence observed in the Central district (11.27%). Scald was also observed in all districts, with the highest incidence found in the Baykan district (4.42%). Powdery mildew was seen in all districts, with an incidence of 2.73% in the central district and 2.16% in the Şirvan district, while being lower in other districts. Barley stripe was observed in all districts except the Şirvan district, with a low intensity of the disease. Spot blotch was observed only in the central district (20%). Additionally, no disease was observed in one barley field in the Eruh district.

*Rhynchosporium commune* was observed in 57 populations, *B. graminis f. sp. hordei* in 54 populations, *P. teres f. teres*

in 13 populations, *P. teres f. maculata* in 11 populations, *P. graminea* in 11 populations, and *P. hordei* in 2 populations out of 95 *H. spontaneum* populations examined in Siirt province (Tables 4 and 5). Scald and powdery mildew were the most common diseases encountered in *H. spontaneum* populations. Disease severity values varied between 3-5 for *P. teres f. teres*, *P. teres f. maculata*, and *R. commune*, 5-7 for *C. sativus*, 3 for *P. hordei*, and 1-5 for *B. graminis f. sp. hordei*. The net form of net blotch was observed in all districts except Baykan, Kurtalan, and Tillo districts. This disease was most prevalent in the Central district (5.75%). The spot form of net blotch was observed in all districts except in Baykan, Şirvan, and Tillo districts. The highest incidence of this disease was recorded in Siirt Central district (5.17%). Scald was observed in all districts, with the highest incidence found in the Kurtalan district (17.77%). Powdery mildew was observed in all districts. It was most common in the Tillo district (8.75%). Barley stripe was observed in all districts except the Baykan and Kurtalan districts, with a low incidence. Brown rust was seen only in the Baykan and Şirvan districts. No disease was observed in 2, 3, 2, 2, and 2 *H. spontaneum* populations in the Central district and Eruh, Şirvan, Pervari, and Kurtalan districts.

In Siirt province, out of 40 *H. bulbosum* populations examined, the following diseases were observed: *B. graminis f. sp. hordei* in 18 populations, *R. commune* in 4 populations, *P. teres f. teres* in 3 populations, *P. hordei* in 1 population, *P. teres f. maculata* in 1 population, and *P. graminea* in 1 population (Tables 6 and 7). The most common diseases were powdery mildew and scald. Disease severity values in these populations were 3 for *P. teres f. teres*, *P. teres f. maculata*, *R. commune*, and *P. hordei*, and varied between 1 and 5 for *B. graminis f. sp. hordei*. The net form of net blotch was observed in the Central district, Kurtalan, and Tillo districts. The spot form of net blotch was only seen in the

**Table 4.** Wild barley (*Hordeum spontaneum*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum spontaneum</i> )	<i>Pyrenophora teres f. teres</i>			<i>Pyrenophora teres f. maculata</i>			<i>Rhynchosporium commune</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	28	7	5.75%	3-5(3.42)	8	5.17%	3-5(4.25)	16	0.04%	3-5(3.62)
Baykan	10	-	-	-	-	-	-	7	6.8%	3-5(3.57)
Kurtalan	9	-	-	-	1	0.11%	3(3)	2	17.77%	3-5(3.57)
Pervari	12	2	0.17%	3(3)	1	0.83%	3(3)	9	2.5%	3-5(3.44)
Şirvan	16	1	0.06%	3(3)	-	-	-	9	2.5%	3-5(3.44)
Eruh	12	3	0.42%	3(3)	1	0.83%	3(3)	6	2.08%	3-5(3.33)
Tillo	8	-	-	-	-	-	-	8	7.75%	3-5(3.25)

**Table 5.** Wild barley (*Hordeum spontaneum*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum spontaneum</i> )	<i>Blumeria graminis f. sp. hordei</i>			<i>Puccinia hordei</i>			<i>Pyrenophora graminea</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	28	15	4.07%	3-5(3.4)	-	-	-	1	0.04%	-
Baykan	10	6	2.6%	3-5(3.33)	1	0.1%	3(3)	-	-	-
Kurtalan	9	6	2.11%	1-3(2.66)	-	-	-	-	-	-
Pervari	12	3	0.33%	3(3)	-	-	-	1	0.83%	-
Şirvan	16	9	1.63%	3-5(3.44)	1	0.06%	3(3)	2	0.13%	-
Eruh	12	7	1.42%	1-3(2.42)	-	-	-	1	0.17%	-
Tillo	8	8	8.75%	3(3)	-	-	-	6	3.25%	-

Baykan district. Scald was observed in the Central district, Pervari, Şirvan, and Tillo districts. Brown rust was observed only in Baykan district, and barley stripe was present only in Tillo district. The incidence of these diseases was recorded as low. Powdery mildew was observed in all districts except Baykan. It was most common in Şirvan (2.62%), Kurtalan (2.5%), and Pervari (2.33%) districts. No disease was observed in 4, 1, 7, 5, and 4 *H. bulbosum* populations in the Central district and Tillo, Şirvan, Kurtalan, and Baykan districts. The only disease found in Siirt barley fields that was not present in the *H. spontaneum* and *H. bulbosum* populations in Siirt province was spot blotch. Additionally, a small amount of brown rust was discovered in the populations of *H. spontaneum* and *H. bulbosum*, which was not seen in *H. vulgare* fields.

A survey of barley fields in the Eskişehir province of Türkiye revealed the presence of net blotch, brown rust, barley stripe, powdery mildew, scald, stem rust, and smut diseases. Among these, net blotch and scald were the most

common (Çelik and Karakaya 2015). In a study by Karakaya et al. (2016a), it was found that scald was the most common disease in populations of *H. spontaneum* grown in Gaziantep, Şanlıurfa, Diyarbakır, Şırnak, Mardin, Siirt, Kilis, and Hatay provinces of Türkiye. Following scald disease, powdery mildew and net blotch were also prevalent. Additionally, brown rust, barley stripe, loose smut, and semi-loose smut were observed in the populations of *H. spontaneum*. However, nine *H. spontaneum* populations were found to be disease-free. Özdemir et al. (2017) identified both forms of net blotch, scald, barley stripe, powdery mildew, yellow rust, stem rust, and barley brown rust in barley fields in Kırıkkale province, with net blotch and scald being the most prevalent diseases. In the Çubuk district of Ankara, Türkiye, İlgen et al. (2017) reported the presence of net blotch (both forms), barley stripe, scald, yellow rust, powdery mildew, stem rust, and barley brown rust diseases in the barley fields they investigated. In the Bala district of Ankara, Ertürk et al. (2018) reported the presence of net and spot forms of net

**Table 6.** Wild barley (*Hordeum bulbosum*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum bulbosum</i> )	<i>Pyrenophora teres f. teres</i>			<i>Pyrenophora teres f. maculata</i>			<i>Rhynchosporium commune</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	8	1	0.13%	3(3)	-	-	-	1	0.13%	3(3)
Baykan	5	-	-	-	1	0.6%	3(3)	-	-	-
Kurtalan	6	1	0.17%	3 (3)	-	-	-	-	-	-
Pervari	3	-	-	-	-	-	-	1	0.33%	3(3)
Şirvan	13	-	-	-	-	-	-	1	0.23%	3(3)
Tillo	8	1	0.6%	3(3)	-	-	-	1	1%	3(3)

**Table 7.** Wild barley (*Hordeum bulbosum*) foliar diseases observed in Siirt province, Türkiye. For disease severity a 0-9 scale developed by Saari and Prescott (1975) was used

District	Total field ( <i>Hordeum bulbosum</i> )	<i>Blumeria graminis f. sp. hordei</i>			<i>Puccinia hordei</i>			<i>Pyrenophora graminea</i>		
		Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)	Field	Incidence (%)	Severity (mean)
Central	8	3	0.37%	3(3)	-	-	-	-	-	-
Baykan	5	-	-	-	1	0.2%	3(3)	-	-	-
Kurtalan	6	1	2.5%	3 (3)	-	-	-	-	-	-
Pervari	3	3	2.33%	3-5(3.66)	-	-	-	-	-	-
Şirvan	13	7	2.62%	3-7(3.85)	-	-	-	-	-	-
Tillo	8	4	1.8%	1-3(2)	-	-	-	1	0.2%	-

blotch, barley stripe, scald, and powdery mildew in the barley fields they surveyed. The most common diseases found were the spot and net forms of net blotch. Saraç Sivrikaya et al. (2019) conducted a study in the Elazığ province of Türkiye and found both forms of net blotch, powdery mildew, scald, barley brown rust, and barley stripe in barley fields. Both forms of net blotch were prevalent, with scald being the next most common disease. In the Bingöl province of Türkiye, Karakaya et al. (2020) investigated the diseases affecting *H. bulbosum* plants. They found that five *Hordeum bulbosum* populations showed no disease symptoms, while other populations exhibited symptoms of spot form of net blotch, powdery mildew, brown rust, and scald. Saraç Sivrikaya et al. (2021) identified the leaf diseases that occurred in *H. vulgare* fields and *H. spontaneum* populations in the Batman province and surrounding areas of Türkiye. They found scald, both forms of net blotch, spot blotch, powdery mildew, brown rust, and barley stripe. Except for barley stripe and spot blotch, the same diseases were also found in *H. spontaneum* populations. Barley scald was the most commonly seen disease in both barley and wild barley. Among the Siirt barley fields and both wild barley populations, barley stripe disease

was observed. In a study conducted in Central Anatolia, Türkiye, barley stripe disease was found in 40% of the fields surveyed (Karakaya et al. 2016b). Saraç Sivrikaya et al. (2023) identified the barley and wild barley diseases present in the Şanlıurfa province of Türkiye. They observed both forms of net blotch, barley stripe, and scald. Seidi Arslan et al. (2024) identified the barley diseases present in Edirne, Türkiye. The most prevalent disease in Edirne was the net form of barley net blotch, followed by scald, barley brown rust, spot form of barley net blotch, powdery mildew, and spot blotch. During our survey of barley fields in Siirt, we observed both forms of net blotch, scald, powdery mildew, barley stripe, and spot blotch diseases. Powdery mildew was the most common disease, followed by the spot form of net blotch. We also encountered spot blotch disease in our barley survey. Among *H. spontaneum* populations, scald and powdery mildew were the most common diseases. In *H. bulbosum* populations, powdery mildew and scald were the most common diseases. In wild barley plants, we found *P. hordei* in 3 populations, but this pathogen was not detected in the Siirt barley fields.

In this study, 46 fields of *H. vulgare*, 95 populations of naturally-grown *H. spontaneum*, and 40 populations of naturally-grown *H. bulbosum* in the Siirt province of Türkiye were examined for foliar diseases. Powdery mildew was the most common disease among the barley fields. It was followed by the spot form of net blotch, scald, barley stripe, net form of net blotch, and spot blotch. Among the *H. spontaneum* populations, scald was the most common disease, followed by powdery mildew, the net form of net blotch, the spot form of net blotch, barley stripe, and barley brown rust. In the populations of *H. bulbosum*, powdery mildew was the most common disease, followed by barley scald, the net form of net blotch, the spot form of net blotch, barley stripe, and barley brown rust. Powdery mildew, net blotch, and scald were commonly found in the barley fields and wild barley populations that were surveyed in Türkiye. These diseases have been reported by other researchers (Çelik and Karakaya 2015, Ertürk et al. 2018, İlgen et al. 2017, Karakaya et al. 2014, 2016a, 2020, Özdemir et al. 2017, Saraç Sivrikaya et al. 2019, 2021, 2023, Seidi Arslan et al. 2024). It is necessary to develop control methods for these diseases. Populations of wild barleys with no diseases under natural conditions could be used in breeding studies for disease resistance after testing under controlled and field conditions.

#### Author's Contributions

Authors declare the contribution of the authors is equal.

#### Statement of Conflict of Interest

The authors have declared no conflict of interest.

#### ÖZET

Siirt ilinin Merkez ilçe, Başkan, Kurtalan, Pervari, Şirvan, Eruh ve Tillo ilçelerinin arpa yetiştirilen alanlarında ve yabancı arpa (*Hordeum spontaneum*, *Hordeum bulbosum*) popülasyonlarında 2023 yılı mayıs ayında sürveyler yapılmış, arpa ve yabancı arpa bitkilerinde görülen yaprak hastalıkları belirlenmiştir. Arpa bitkilerinde *Pyrenophora teres* f. *teres* ve *Pyrenophora teres* f. *maculata*'nın sebep olduğu Arpa ağbenek hastalığının ağ ve nokta formları, *Blumeria graminis* f.sp. *hordei*'nin sebep olduğu Külleme hastalığı, *Rhynchosporium commune*'nin sebep olduğu Arpa yaprak lekesi hastalığı, *Pyrenophora graminea*'nın sebep olduğu Arpa çizgili yaprak lekesi ve *Cochliobolus sativus*'un sebep olduğu Yaprak lekesi hastalığı tespit edilmiştir. Yabancı arpa bitkilerinde ise *Pyrenophora teres* f. *teres*'in sebep olduğu Arpa ağbenek hastalığının ağ formu ve *Pyrenophora teres* f. *maculata*'nın sebep olduğu Arpa ağbenek hastalığının nokta formu, *Blumeria graminis* f. sp. *hordei*'nin sebep olduğu Külleme hastalığı, *Rhynchosporium*

*commune*'nin sebep olduğu Arpa yaprak lekesi hastalığı, *Pyrenophora graminea*'nın sebep olduğu Arpa çizgili yaprak lekesi ve *Puccinia hordei*'nin sebep olduğu Kahverengi pas hastalığı tespit edilmiştir.

Anahtar kelimeler: Siirt, *Hordeum vulgare*, *Hordeum spontaneum*, *Hordeum bulbosum*, arpa yaprak hastalıkları

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