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ORIGINAL ARTICLE

Evaluation of Hazelnut (*Corylus avellana* L.) Cultivars on Susceptibility to Brown Leaf Spot Fungus, *Mamianiella coryli*

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A R T I C L E I N F O

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A B S T R A C T

Brown leaf spot (leaf blight) is a fungal disease caused by *Mamianiella coryli*, causal agent of early defoliation in summer, and is widely distributed in hazelnut (*Corylus avellana* L.) growing regions of Iran. During 2019-2020, 48 native and foreign hazelnut cultivars/ and or genotypes were evaluated for susceptibility against *M. coryli* under natural infection conditions at Astara Horticultural Research Station (northern Iran). One hundred infected leaves were randomly collected from four geographical directions and middle of canopy of each hazelnut tree. Disease severity index (DSI%) on leaves was calculated based on 1-5 rating system (1= >0 to 20% leaf area affected and 5= >80% of leaf area affected) and levels of reactions were determined based on DSI% (<1%= Highly resistant and >50%= Highly susceptible). None of the hazelnut cultivars had genetic resistance to *M. coryli* and all of the genotypes were grouped into two categories included susceptible (25.1-50%) and highly susceptible. Seven cultivars and/or genotypes included Souchi, Gerdoii 89, Pashmineh 89, Rimsky, Segorbe, Dedobestani and Pronnes were high susceptible and the rest were in the susceptible categories. It was concluded that sanitation of leaf debris in the fall, pruning for better air circulation or fungicide applications in the spring might be useful in disease outbreak conditions.

Introduction

Hazel is the common name for the flowering plant genus *Corylus*, usually placed in the *Betulaceae* family; although some botanists consider it a separate family, *Corylaceae* (Cotini *et al*., 2011). Iran, with about 25500 ha hazelnut growing area and about 21550 tons of annual production is the seventh major hazelnut producer in the world. Given the commercial value of hazelnuts as a non-oil export item, statistics show a general increase in the area of land that is currently being used for their cultivation in Iran. Many cultivars of hazelnut are grown for specific qualities of the nut, including large nut size, early/late fruiting, whereas others are grown as pollinators (Salimi and Hosseinova, 2012). In Iran, hazelnut is mainly cultivated in Eshkevarat, a region in the Guilan province (northern Iran). The province of Guilan accounts for 71% of the total Iranian area planted to hazelnut and with about 16000 ha and annual production of 15300 t.

Fungus disease are limiting factor for commercial production of many plants (Makheti Mutebi and Atieno Ondede, 2021)

Hazelnut production and quality are negatively affected by several diseases and pests. One of the important diseases of hazelnut in the cool areas during hot summer (especially foggy areas) is brown leaf

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blight caused by *Mamianiella coryli* (Batsch ex Fries) Höhn (Taherzadeh *et al*. 1998). The *M. coryli* is a species of fungi in the family Gnomoniaceae (Diaporthales) (Yang *et al*., 2020). *Mamianiella coryli* var. *spiralis* (Ceratostomataceae) was found in the living leaves of *Corylus cornuta* (Morgan-Jones 1981). Seymour and Earle (1885) reported brown leaf blight on leaves of Beaked hazelnut, *C. rostrata* in Italy. The disease is currently spreading in Italy, Japan and China. Ershad *et al*., (2009) record for the first time *M. coryli* associated with hazelnut (*C. avellana*) in Iran (Astara, northern Iran). Mir-Hosseini Moghaddam and Taherzadeh (2007) studied the distribution and damage of *M. coryli* in hazelnut orchards of Guilan province (northern Iran). The disease causes untimely defoliation in July and August in foggy areas. The Mamianiella leaf infection is characterized by the appearance of brown spots on the upper surface of hazelnut leaves, development in the last necrotic processes, and early (sudden) defoliations. When *M. coryli* infects the majority of the foliage, the tree weakens and the leaves defoliate. Towards the end of the season black overwintering reproductive structures (perithecia) are formed on the lower surface of affected fallen leaves, which is visible with the naked eye (Mir-Hosseini Moghaddam *et al*., 2010). The early defoliation significantly slows down the aging of shoots and negatively affects the frost resistance of the hazelnut trees. The Mamianiella leaf blight is one of the important factors in reducing the quantity and quality of hazelnut in these regions.

Razzaz-Hashemi and Zakeri (2000), Mir-Hosseini Moghaddam *et al*. (2007), and Davari *et al*., (2008) reported *M. coryli* on hazelnut from Qazvin, Guilan, and Ardebil provinces, respectively. The Mamianiella leaf blight is nowadays one of the most common diseases almost in the enire hazelnut-producing areas of Iran. One of the major priority is introducing a disease resistance/tolerant cultivar for widespread commercial production. Although Mamianiella leaf spot has been reported for many years from the hazelnut growing regions of Iran, in recent years, it has developed greatly on native and improved hazelnut cultivars. Genetic resistance is the first choice not only for its efficiency, low cost, and environmental friendliness but also for qualitative disease resistance that can be relatively easy to use in breeding programs. There is no current data that reported any *M. coryli* disease resistance/ tolerate hazelnut cultivar (*C. avellana* L.).

Material and Methods

Experimental site location

In 2003, 50 introduced and 22 Iranian (or local) hazelnut cultivars/ and or genotypes were grown and preserved in a nursery of Astara Horticultural Research Station, northern Iran (48° 52´ 30" E and 38° 26´ 00" N) as one of the national hazelnut collection. The soil type was sandy loam. The ecological conditions for hazelnut genetic plantation are the most suitable for this species to grow and Mamianiella brown leaf spot (blight) disease (*Mamianiella coryli*) outbreak (Table 1).

Table1. Climatic parameters at Astara Horticultural Research Station

Altitude (m)	Min. temp.(◦C)	Max. temp.(◦C)	Humidity of the first 5 months of the year (%)	Average precipitation in the first 5 months of the year	Annual rainfall (mm)
22	-5	36.5	79	281	1348

Selection of hazelnut cultivars/ or genotypes

The reaction of 48 Iranian and foreign cultivars/ and or genotypes of hazelnut (*C. avellana*) to brown leaf blight was evaluated under field natural *M. coryli* infection at Astara Horticultural Research Station (northern Iran) from 2019-2020. The hazelnut cultivars/ and or genotypes that were assessed in this study are listed in Table 2. No pesticides were used in the experimental site.

Sampling method

The samples were obtained on 20 July while ensuring of the relative spread of leaf spot infection in the orchard. Twenty infected leaves were randomly collected from each direction of north, south, east, west, and the center of trees.

Evaluation of brown Leaf blight severity

Evaluation of natural infection of leaves in the experimental site was carried out when brown leaf spot symptoms were fully developed. To our knowledge, there has been no standardized method/ and or standard area diagram for measuring Mamianiella blight disease on hazelnut and screening of cultivars to disease in the world. The susceptibility the reaction of cultivars/ and or genotypes was calculated as disease severity index (DSI) according to the type of leaf infection. To this aim, the margins of the leaf spots were drawn on a transparent clear plastic sheet and transferred to the white paper. Then, the area on the surface of leaves was measured using a digital planimeter. Scoring of the infection type followed the five-point rating system based on the infection area% (covered with leaf spots): (1= > 0 to 20% of leaf area affected; 2= > 20 to 40%; 3=> 40 to 60%; 4=> 60 to 80%; 5=> 80%). The disease severity index (DSI) was obtained from the following equation:

(%) DSI= [Σ (grade value × number of leaves in that grade) / Total leaf number× Highest-grade value] × 100

The reaction levels of hazelnut cultivars to Mamianiella blight was determined based on the DSI (modified Reddy *et al*., 2006; Sujatha *et al*., 2008; Table 3).

Table 2. The hazelnut cultivars/ and or genotypes studied in this study.

NO.	Cultivar/Genotypes	Origin	NO.	Cultivar/Genotypes	Origin	NO	Cultivar/Genotypes	Origin
1	Ganja	Azerbaijan	**17**	Zorchneskiy	Georgia	**33**	Dedobestani	Georgia
2	Kazmaz	Georgia	**18**	Negret	Spain	**34**	President	Turkey
3	Eizdeb	Georgia	**19**	Nemsa	Georgia	**35**	Khachakhkuria	Georgia
4	Qafqaz	Azerbaijan	**20**	Dokominskiy	Georgia	**36**	Fertile de Coutard	Spain
5	Souchi	Russia	**21**	Yagli findiq	Azerbaijan	**37**	'Ronde du Piedmont'	Spain
6	Paeuner	Georgia	**22**	Boliba	Georgia	**38**	Kristina	England
7	Shveliskhura.	Georgia	**23**	Vartashen	Azerbaijan	**39**	Trabzon	Turkey
8	Gerdoii 89	Iran	**24**	Futburami	Georgia	**40**	Zaqatal	Azerbaijan
9	Gercheh	Iran	**25**	Baigane	Azerbaijan	**41**	Khastenskiy	Georgia
10	Chelsea-Dzudzu	Georgia	**26**	Atrak	Azerbaijan	**42**	Rimskiy	Georgia
11	Morfilessky	Georgia	**27**	Koloisiva	Georgia	**43**	Reysinat	Georgia
12	Bağmarnsky	Georgia	**28**	Shastak-2	Iran	**44**	Pronnes	Georgia
13	Victoria	England-Australia	**29**	Merveille de Bollweiler	Germany	**45**	Quban	Azerbaijan
14	Khechitoy	Georgia	**30**	Daviana	England	**46**	Long de spain	Spain
15	Perestroika	Russia	**31**	Segorbe	Spain	**47**	'Foşa'	Turkey
16	Qalib	Azerbaijan	**32**	Pashmineh 89	Iran	**48**	Deroche	Georgia

Table 3. Five reaction levels of hazelnut cultivars to Mamianiella leaf blight disease.

Average disease index	Reaction category
<1%	Highly resistant
>1 to 5%	Resistant
>5 to 25%	Moderately resistant
>25 to 50%	Susceptible
>50%	Highly susceptible

Results

In order to evaluate the susceptibility of 48 Iranian and foreign cultivars/ and or genotypes of hazelnut (*C. avellana*) to Maminialla leaf spot (blight), disease severity index (DSI%) was calculated (Table 4). DSI values of total hazelnut cultivars ranged from 22.99 to 71.46% (Table 4). Based on the DSI value at orchard conditions and by 1-5 scale for rating Maminialla leaf spot, all the hazelnut cultivars/ and or genotypes were grouped into two categories included susceptible (25.1-50%) and highly susceptible (>50%). Of the 48 cultivars/ and or genotypes, seven cultivars Rimsky (50.74%), Pashmineh-89 (52.24%), Gerdoii-89 (52.36%), Pronnes (55.02%), Segorbe (55.71%), Dedobestani (62.33%) and Souchi (71.46%) showed highly susceptible and remaining 41 cultivars manifested susceptible reactions. None of the cultivars exhibited resistant reaction to the disease. DSI values were between 31.89 and 52.36% in Iranian group, 28.49% and 44.63 % in Azerbaijan group, 30.79 % and 55.71% in Spanish group and 39.63% and 43.95 % in Turkish group. High DSI values were mainly observed in Russian (71.46%), Georgian (62.33%, 55.02%, and 50.74%) and Iranian groups (52.36%, 52.24%). High DSI values were not observed in Turkish group. The results revealed 48 hazelnut cultivars had a low level of variation in their susceptibility/ and or resistance to *M. coryli*. Totally 87.5% of the cultivars were susceptible. The susceptibility distribution of cultivars/and or genotypes was not uniform in the geographical groups (Table 4). Susceptibility reaction was mainly presented in the groups Russia, Iran, and Georgia.

Table 4. Brown leaf spot disease severity index of different hazelnut cultivars caused by *Mamianiella coryli* at Astara Horticultural Research Station during two years (2019-2020)

Cultivar No.	2019	2020	Mean	SL[x]	Cultivar No.	2019	2020	Mean	SL[x]
16	38.97	40.41	39.69	S	**33**	62.17	62.49	62.33	HS
3	38.12	39.50	38.81	S	**34**	43.29	44.63	43.96	S
2	28.56	42.66	35.61	S	**5**	68.87	74.07	71.46	HS
6	44.47	44.17	44.32	S	**26**	26.73	30.24	28.49	S
12	35.55	38.84	37.19	S	**22**	21.81	24.18	22.99	S
1	28.30	39.32	33.81	S	**10**	45.80	46.22	46.01	S
18	41.71	43.99	42.73	S	**43**	34.98	46.98	40.98	S
11	29.61	31.98	30.79	S	**25**	36.61	38.56	35.09	S
9	30.16	41.19	35.68	S	**24**	28.41	29.39	28.90	S
13	23.14	31.66	27.40	S	**39**	39.69	42.57	39.63	S
8	51.47	53.24	52.36	HS	**19**	23.39	34.87	29.13	S
7	29.62	43.16	36.39	S	**41**	32.89	37.22	35.06	S
17	31.29	33.65	32.47	S	**32**	45.04	59.46	52.24	HS
20	36.49	44.82	40.66	S	**48**	30.83	38.84	34.85	S
4	36.06	38.11	37.09	S	**45**	38.71	50.54	44.63	S
47	42.30	45.17	43.74	S	**31**	51.88	59.54	55.71	HS
14	30.09	40.50	35.29	S	**46**	37.19	36.05	36.62	S
29	34.65	34.95	34.80	S	**27**	41.14	45.08	43.11	S
23	36.89	42.16	39.53	S	**37**	44.56	44.63	44.59	S
15	26.03	35.74	30.89	S	**21**	28.27	28.47	28.37	S
30	36.51	38.81	37.66	S	**35**	25.36	32.70	29.03	S
44	55.13	58.90	55.02	HS	**42**	47.63	53.84	50.74	HS
28	29.40	34.38	31.89	S	**40**	36.28	36.92	36.60	S
36	32.79	34.19	33.49	S	**38**	41.88	48.06	44.97	S

X=Susceptibility level; HS=Highly susceptible; S= Susceptible

Discussion

Hazelnut brown leaf spot, caused by *M. coryli* is one of the serious fungal diseases of hazelnut. The disease mainly affects the leaves. Diseased leaves drop prematurely, and strongly affected trees may be defoliated by mid-summer. As far as we know, there was no information about the resistance of hazelnut germplasms in the world. A field experiment was conducted in Astara Horticultural Research Station, Guilan Province, Iran in 2019 to 2020. Each hazelnut cultivar was planted in 5×5 m plot (with 5-m spacing between rows). It seems this work was a relatively comprehensive evaluation of hazelnut cultivars reaction to Mamianiella brown leaf spot. Evaluation of reaction level represented a real status of hazelnut cultivar/ genotype trees expressed in orchards. In this study, Mamianiella disease was quantified (accurate quantification, not visual estimates of disease) as the plant surface affected by the disease on individual leaves expressed as a percentage or proportion of the total area.

All the trees were affected, in more or less extent by this disease. This genetic variation was relatively higher in the year of study at site probably due to the interferences generated by the plantation free-stress, the higher severity, and the lower heterogeneity of the disease incidence during this year of infection. There was no considerable genetic variation in hazelnut brown leaf spot among the studied *C. avellana* germplasms. This research classified 48 hazelnut cultivars into two groups based on susceptibility levels. Among the forty-eight cultivars/genotypes tested under field conditions, forty-one showed susceptible and the rest of the seven were found to be highly susceptible.

The development of disease is progress of interaction between host and pathogen. The determination of the resistance mechanisms would be helpful before starting a breeding program for leaf spot resistance. Our results showed that most hazelnut cultivars used in the study exhibited susceptibility to Mamianiella leaf blight. This study revealed 12.5% of 48 cultivars were highly susceptible. We concluded that, there are no hazelnut cultivars/and or genotypes were potentially valuable sources of Mamianiella leaf spot resistance. Also, the variation was not related to the geographic distribution of the hazelnut cultivars. Application of effective fungicides based on the disease forecasting system recommend for better control as soon as signs of Mamianiella leaf infection were observed.

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