Powdery mildews observed on *Onobrychis* spp. in Turkey

Arzu Çelik · Aziz Karakaya · Süleyman Avcı ·
Cengiz Sancak · Sebahattin Özcan

Received: 17 January 2011 / Accepted: 23 May 2011 / Published online: 31 May 2011
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Abstract *Erysiphe trifolii* and *Leveillula taurica* on *Onobrychis* spp. in Turkey, are described and illustrated.

Keywords *Erysiphe trifolii* · *Leveillula taurica*

Sainfoin (*Onobrychis* spp.) is a cross-pollinated perennial legume used for hay and forage in dry regions of central and eastern Anatolia, Turkey. Sainfoin can grow in many climates, it grows well on calcareous soils, has a deep tap root, which makes it drought-tolerant and the plant has an important role in crop rotations (Elçi 2005). So far, 162 species have been described around the world in the genus *Onobrychis*. This genus extends from the Mediterranean region to Caucasia, the Zagros Mountains and Asia. The genus is concentrated in Anatolia (52 species), Iran (53 species) and Caucasia (39 species). Iran and Anatolia appear to be the main centers of genetic diversity (Aktoklu 1995; Yıldız et al. 1999; Emre et al. 2007). Wild sainfoin species can grow under different environmental stress conditions including cold, dry weather, soil salinity, diseases and pests. These species have wide adaptation capability.

In a field trial carried out in the Field Crops Research Farm of Ankara University, Turkey, in order to determine

genetic variability of 63 sainfoin species, subspecies and varieties, powdery mildew was observed on 1- and 2-years old plants in 2009 and 2010.

Two powdery mildew species, *Erysiphe trifolii* Grev. (Kapoor 1967; Braun 1995) and *Leveillula taurica* (Lév.) G. Arnaud (Braun 1987, 1995; Karakaya 1998) were found causing diseases on *Onobrychis* spp. (Table 1). Plant parts severely affected by powdery mildew were dried and fell off. The disease caused by *Erysiphe trifolii* started in late April and May, however, the disease caused by *Leveillula taurica* started in July and August. For identification of these fungi morphological measurements were done on fresh specimens. Specimens were mounted in water. Fifty conidia and 20 other fungal structures were used for measurements for each *Onobrychis* species.

These fungi were identified by the following features: First symptoms of *Erysiphe trifolii* were white dust patches on adaxial surface of leaves, gradually these patches enlarged and spread to adaxial and abaxial surface of leaves, petioles, stem and floral receptacles. Mycelium epiphytic, thin, fine and white powder appearance, on both sides of the leaves, more obvious on the adaxial surface. Hyphae (3–)4–4,5(–6,5) µm wide, conidiophores straight, unbranched, (37,5–)50–56(–70)×(7,5–)8–9(–10) µm, foot cells (25–)30–35(–45)×(7,5–)8–8,5(–10) µm, followed by 0–2 cylindrical cells. Conidia produced singly at the apex of the conidiophore, hyaline, ellipsoid, cylindric, doliiform, (22,5–)28–35(–42,5)×(12,5–)15,5–20(–24) µm. No fibro-sin bodies were observed. Appressoria slightly lobed, 1–2 times the length of conidia when put in dextrose solution for 24 h, generally originated from subterminal region of conidia, sometimes from side of the conidia. Cleistothecia scattered to gregarious (75–)95–109(–13,5) µm in diameter, appendages sometimes dichotomously branched, (4–)5(–6,5) µm, in diameter, peridial cells irregular, (5–)9,5–11,7

A. Çelik · A. Karakaya (✉)
Faculty of Agriculture, Department of Plant Protection,
Ankara University,
Dışkapı,
Ankara 06110 Turkey
e-mail: karakaya@agri.ankara.edu.tr

S. Avcı · C. Sancak · S. Özcan
Faculty of Agriculture, Department of Field Crops,
Ankara University,
Dışkapı,
Ankara 06110 Turkey

Table 1 Powdery mildew species observed on *Onobrychis* spp. in Turkey. Herbarium numbers for the relevant specimen held at the GAZI herbarium are included in brackets

<i>Onobrychis</i> species	<i>Erysiphe trifolii</i>	<i>Leveillula taurica</i>
<i>Onobrychis alba</i> subsp. <i>laconica</i> (Orph. ex Boiss.) Hayek		X* (A. Karakaya 1037)
<i>Onobrychis altissima</i> Grossh.		X (A. Karakaya 1035)
<i>Onobrychis arenaria</i> (Kit.) DC.	X* (A. Karakaya 1040)	X* (A. Karakaya 1041)
<i>Onobrychis arenaria</i> subsp. <i>sibirica</i> (Sirj.) P. W. Ball	X* (A. Karakaya 1042)	X (A. Karakaya 1043)
<i>Onobrychis atropatana</i> Boiss. var. <i>grandiflora</i>		X* (A. Karakaya 1018)
<i>Onobrychis biebersteinii</i> Sirj.		X* (A. Karakaya 1045)
<i>Onobrychis chorassanica</i> Bunge ex Boiss.		X* (A. Karakaya 1044)
<i>Onobrychis cilicica</i> Kit Tan et Sorger.	X (A. Karakaya 1021)	
<i>Onobrychis cyri</i> Grossh.		X (A. Karakaya 1034)
<i>Onobrychis elata</i> Boiss et Bal.	X (A. Karakaya 1020)	
<i>Onobrychis fallax</i> var. <i>longifolia</i> Freyn. et Sint.	X (A. Karakaya 1019)	
<i>Onobrychis gracilis</i> Besser.	X (A. Karakaya 1014)	X (A. Karakaya 1015)
<i>Onobrychis hajastana</i> Grossh.	X (A. Karakaya 1028)	
<i>Onobrychis kachetica</i> Boiss. & Buhse		X (A. Karakaya 1038)
<i>Onobrychis kotschyana</i> Fenzl.	X (A. Karakaya 1027)	
<i>Onobrychis lasistanica</i> Boiss.	X (A. Karakaya 1016)	X (A. Karakaya 1017)
<i>Onobrychis megataphros</i> Boiss	X (A. Karakaya 1031)	X (A. Karakaya 1032)
<i>Onobrychis meschetica</i> Grossh.	X (A. Karakaya 1008)	X (A. Karakaya 1009)
<i>Onobrychis montana</i> DC. Boiss.		X* (A. Karakaya 1030)
<i>Onobrychis mutensis</i> Kit Tan et Sorger	X (A. Karakaya 1010)	X (A. Karakaya 1011)
<i>Onobrychis oxyodonta</i> Boiss.	X (A. Karakaya 1022)	
<i>Onobrychis oxyodonta</i> Boiss. var. <i>oxyodonta</i>	X (A. Karakaya 1023)	X (A. Karakaya 1024)
<i>Onobrychis oxyodonta</i> Boiss. var. <i>armena</i>	X (A. Karakaya 1025)	
<i>Onobrychis paupica</i> Bomm.		X (A. Karakaya 1013)
<i>Onobrychis pisidica</i> Boiss.	X (A. Karakaya 1003)	X (A. Karakaya 1002)
<i>Onobrychis podperea</i> Sirj.	X (A. Karakaya 1026)	
<i>Onobrychis ptolemaica</i> (Delile) DC.		X (A. Karakaya 1039)
<i>Onobrychis radiata</i> (Desf.) Bieb.		X (A. Karakaya 1012)
<i>Onobrychis sintenisii</i> Bomm.		X* (A. Karakaya 1033)
<i>Onobrychis stenostachya</i> Freyn subsp. <i>sosnowskyi</i> (Grossh) Hedge	X (A. Karakaya 1006)	X (A. Karakaya 1007)
<i>Onobrychis stenostachya</i> Freyn.	X (A. Karakaya 1004)	X (A. Karakaya 1005)
<i>Onobrychis tournefortii</i> (Willd.) Desv.		X (A. Karakaya 1001)
<i>Onobrychis vassilczenkoi</i> Grossh.		X (A. Karakaya 1036)

X* New for Turkey, previously reported from other countries

X New for Turkey and the world

(–15) μm . Asci, 3–11, sessile or shortly stalked, (45–)55–57(–67,5) $\times$ (27,5–)30–34(–40) μm . Ascospores 2–4, oval or ellipsoid (13,7–)16–17(–23,5) $\times$ (11–)12–14(–17) μm (Fig. 1).

First symptoms of *Leveillula taurica* were white, dense powdery patches on both sides of the leaves, gradually spread to leaves, leaf petioles, stem and floral receptacles. Hemiepidiophytic mycelium. Hyphae (3,5–)4–4,5(–6,5) μm wide. Conidiophores straight, unbranched (105–)122–129,5(–155) $\times$ (7,5–)8–9(–9,5) μm , foot cells (80–)85–87,5(–95) $\times$ (–7,5)8–9(–9,5) μm , followed by 1(–2) cylindrical

cells. Conidia produced singly at the apex of the conidiophore, Primary conidia lanceolate, secondary conidia ellipsoid to cylindrical, (37–)48–56,5(–67,5) $\times$ (12,5–)16,7–19,7(–25) μm , without fibrosin bodies. Germ tube with indistinct appressoria, longer than conidia length, arising from subterminal region of conidia. Cleistothecium (133–)148–197(–250) μm in diameter, often immersed in dense mycelium, appendages myceliod, straight, slightly rough, 3,5–5 μm wide, usually shorter than the diameter of cleistothecium. Peridial cells obscure, dark in color and irregular. Asci numerous, (60–)90–103,5(–125) $\times$ (30–)

Fig. 1 **a)** Symptoms **b)** conidiophores and conidia **c)** conidia, **d)** appressorium **e)** cleistothecium, peridial cells and appendages **f)** cleistothecium and appendage **g)** ascus and ascospores of *Erysiphe trifolii*. (Bar = 20 μ m)

40,5–48,5(–62,5) μ m. Ascospores 2 per ascus, ovoid-ellipsoid, (22,5–)37–46,4(–52,5) $\times$ (17,5–) 20–23(–28,5) μ m (Fig. 2)

Diseased plant parts are deposited in a herbarium at the Ankara University, Faculty of Agriculture, Department of Plant Protection, Turkey and in the Gazi University herbarium (GAZI), Ankara, Turkey.

Leveillula taurica has been reported from the former Soviet Union and Ukraine on *Onobrychis arenaria*, from Bulgaria on *Onobrychis arenaria* ssp. *lasioistachya*, from Romania on *Onobrychis biebersteinii*, from France on *Onobrychis montana*, from Spain, France and Romania on *Onobrychis viciifolia* (Braun 1995), from former Soviet Union on *Onobrychis atropatana* var. *grandiflora*, *Onobrychis sintenisii* and *Onobrychis pulchella* (syn: *O. alba* subsp. *laconica*) (Farr and Rossman 2011), from Iran on *Onobrychis viciifolia* (Sharifnabi and Banihashemi 1990)

from Iran on *Onobrychis viciifolia* (as *Leveillula leguminosarum*) (Ershad 1995), from Turkey on *Onobrychis viciifolia* (Karakaya 1998), on *Onobrychis hypargyrea* (Bremer et al. 1947), on *Onobrychis grandis* (Oran 1974), on *Onobrychis cappadocica* (Bahçecioğlu and Yıldız 2000). Khodaparast and Abbasi (2009), listed that *Leveillula taurica* has been reported from different regions of Iran on *Onobrychis* sp. (Sepahvand et al. 2002), on *Onobrychis galegifolia* (Bahçecioğlu et al. 2006, Ershad 1995), on *Onobrychis gaubae* (Kachooeian Javadi et al. 2006), on *Onobrychis chorassanica* (Tajik-Ghanbary et al. 2005) and on *Onobrychis montana* (Amano 1986). Khodaparast and Abbasi (2009) also reported that *Leveillula taurica* was common on *Onobrychis viciifolia* in Iran (Viennot-Bourgin 1958, Scharif and Ershad 1966; Mohammadi-Doustdar 1967; Daftari and Behdad 1968; Amano 1986; Sharifnabi and Banihashemi 1990; Ershad 1995; Sepahvand 2008).

Fig 2 a) Symptoms b) conidiophores and conidia c,d) conidia and appressorium e,f,g) asci and ascospores h) cleistothecium, asci, ascospores and hyphal appendages of *Leveillula taurica*. (Bar = 20 µm)

According to Braun (1995), *Erysiphe trifolii* (syns: *Microsphaera trifolii*, *Erysiphe martii*) has been reported from Greece to Turkey on *Onobrychis aequidentata*, from Bulgaria on *Onobrychis arenaria* ssp. *lasiostachya*, from former Soviet Union on *Onobrychis arenaria* ssp. *sibirica*, from Greece, Italy to Turkey on *Onobrychis caput-galli*, from Switzerland, France, Romania to Turkey on *Onobrychis montana*, from Romania on *Onobrychis petraea*, from Austria, Switzerland, former Czechoslovakia, Germany, Denmark, Spain, France, England, Hungary, Italy, Poland,

Romania, former Soviet Union, Turkey and former Yugoslavia on *Onobrychis viciifolia*. *Erysiphe martii* (syn: *Erysiphe trifolii*) has been reported from Turkey on *Onobrychis viciifolia* (Bremer et al. 1952; Karel 1958; Oran 1967), *Erysiphe communis* (syn: *Erysiphe trifolii*) on *Onobrychis arenaria* from Switzerland (Farr and Rossman 2011), on *Onobrychis aequidentata* (Öner et al. 1974; Tamer and Öner 1978), on *Onobrychis altissima* (Tamer et al. 1996), on *Onobrychis caput-galli* (Öner et al. 1974; Karaboz and Öner 1982). Bahçecioğlu and Yıldız (2000)

reported *Microsphaera trifolii* on *Onobrychis* sp. from Turkey. Khodaparast and Abbasi (2009) reported an *Oidium* sp. on *Onobrychis altissima* from Iran.

Acknowledgement We thank Professor Mecit Vural of Gazi University for his help during the preparation of the herbarium samples.

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