

ORIGINAL ARTICLE

## Identification of *Cercospora* species in southwestern Iran

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### Abstract

*Cercospora* species are associated with leaf spot symptoms on various host plants. In this research, nine species of the genus on some medicinal and economic crops were found in different locations in Kohgiluyeh and Boyerahmad Provinces (southwestern Iran) and examined according to morphological characteristics of stromata, conidiophores, conidiogenous cells and conidia. Results showed that *Cercospora* species on *Cichorium intybus* (*C. cichorii*) and *Nasturtium officinale* (*C. nasturtii*) are new for the mycobiota of Iran. However, characteristics of *Cercospora* on *Plantago lanceolata* are very similar to the description of *C. plantaginis*, but morphologically indistinguishable from *C. apii* s. lat. Other species have already been reported from other parts of Iran, but are new in southwestern Iran. Furthermore, *Rumex crispus* and *Trifolium resupinatum* are new hosts for *C. apii* and *C. zebrina* in Iran, respectively.

**Key words:** cercosporoid fungi, leaf spot, plant diseases, taxonomy

## Introduction

Species of the genus *Cercospora* Fresen. are considered to be destructive pathogens especially on economic crops. The fungus reduces the photosynthetic capacity as a consequence of necrotic leaf lesions, which results in reduced yield (Shane and Teng 1992). Bdliya (2007) found that crude fiber, crude protein, fat and dry matter content were negatively related to *Cercospora* leaf spot severity on *Arachis hypogaea* L., while ash, moisture content and nitrogen free extracts showed positive relationships with increasing disease severity. Recently Arzanlou *et al.* (2016) evaluated the inhibitory capability of bacterial antagonists inhabiting the rhizosphere of the sugarbeet against *Cercospora beticola* Sacc. and found three bacterial strains which significantly reduced the disease severity in laboratory and greenhouse assays.

*Cercospora* contains many species. Most of them are known only on the basis of their host plants and morphological features (Crous and Braun 2003). The genus *Cercospora* is distinguished from other similar genera by having acicular, hyaline and septate conidia with conspicuous hila produced on pigmented, unbranched, septate and smooth conidiophores with conspicuously thickened and darkened conidiogenous

loci (scars) (Crous and Braun 2003). To date, various morphologically identified records of *Cercospora* and *Cercospora*-like fungi have been published by Iranian and foreign mycologists (Ershad 2009). New records of cercosporoid and ramularioid fungi in Iran have been published in recent years by several mycologists who identified more than 50 cercosporoid fungi new for the mycobiota of Iran (Pirnia *et al.* 2012 a, b, c, d; Hesami *et al.* 2011, 2012; Khodaparast *et al.* 2012; Bicharanlou *et al.* 2013 a, b, c; Pirnia 2014; Behrooz *et al.* 2015 a, b). Numerous studies on *Cercospora* and allied genera in Iran have been done and have often led to the discovery of new records. The lack of information about *Cercospora* species in southwestern (SW) Iran encouraged the authors to collect and identify species of the genus and their host plants in this region.

## Materials and Methods

Specimens with leaf spot symptoms from different locations in SW Iran including Basht, Cheram,

Dehdasht, Gachsaran, Sisakht, Sough and Yasuj were collected during spring-autumn 2012–2013. Host plants were identified by botanists of Yasuj and Shiraz Universities. In infected leaves, stromata, conidiophores and conidia were picked up directly by a needle from leaf spots and microscopic slides were prepared in 50% lactic acid. Characteristics such as the presence or absence of stromata, pigmentation, shape, size and number of septa of conidia and conidiophores and structure of conidiogenous cells were used to identify the species (Chupp 1954; Ellis 1976; Crous and Braun 2003). Measurements of stromata, conidiophores and conidia were done using the Pixe LINKu scope program and drawings were made using a drawing tube attached to a microscope.

## Results and Discussion

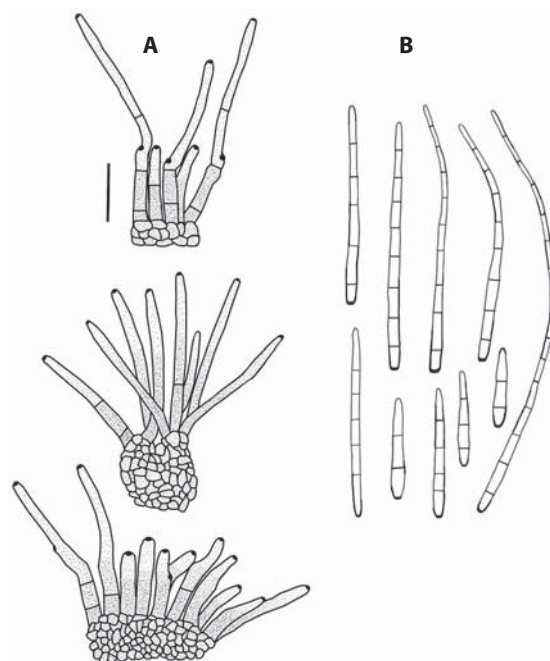
Two species, viz., *Cercospora cichorii* and *C. nasturtii*, found to be new for the mycobiota of Iran are treated in detail in this paper. Other species are new to Kohgiluyeh and Boyerahmad Provinces, SW Iran. *Rumex crispus* L. and *Trifolium resupinatum* L. proved to be new hosts for *C. apii* and *C. zebrina* in Iran. All specimens are deposited in the fungus reference of the Iranian Ministry of Agriculture “IRAN” at the Iranian Research Institute of Plant Protection.

***Cercospora cichorii*** Davis, Transactions of the Wisconsin Academy of Science 19 (2): 715 (1919)

Circular leaf spots with pale to gray center, 5–15 mm in diameter. Caespituli amphigenous, mostly epiphyllous. Stromata small, brown to pale brown, 8–45  $\mu\text{m}$  wide. Conidiophores fasciculate, 4–17 stalks, brown to pale olivaceous brown, erect, not branched, smooth, 0–3-septate, geniculate, 15–70  $\times$  (2–) 3–5  $\mu\text{m}$ . Conidiogenous loci conspicuous, terminal and lateral. Conidia solitary, acicular, hyaline, small conidia cylindrical, straight to slightly curved, smooth, thin, with 2–16 transverse septa, base truncate, tip subobtuse to subacute, (18–) 25–110 (–155)  $\times$  2–4 (–5)  $\mu\text{m}$ . Hilum thickened and darkened (Fig. 1).

Specimen examined: on *Cichorium intybus* L., Iran, Sisakhat, Kohkhedan, 12 October 2012 (IRAN 16529 F).

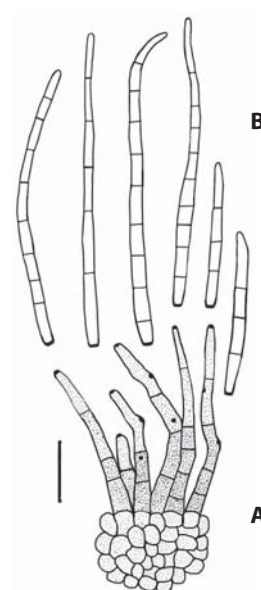
Note: *C. cichorii* is a common species on *Cichorium* spp. and characterized by having short conidiophores and conidia (Crous and Braun 2003). The species is new for the mycobiota of Iran.



**Fig. 1.** *Cercospora cichorii* on *Cichorium intybus*: A – stromata and conidiophores; B – conidia (scale bar: 20  $\mu\text{m}$ )

***Cercospora nasturtii*** Pass., Hedwigia 16: 124 (1877)

Circular leaf spots, center grayish white, 3–10 mm in diameter. Caespituli amphigenous, mostly epiphyllous. Stromata lacking or composed of a few pale brown cells, 15–40  $\mu\text{m}$  wide. Conidiophores fasciculate, 3–8 stalks, pale olivaceous brown and attenuated towards the tip, erect, not branched, septate, 1–3 times abruptly geniculate, 20–120  $\times$  (3–) 4–5 (–6)  $\mu\text{m}$ . Conidiogenous loci conspicuous, terminal and lateral. Conidia



**Fig. 2.** *Cercospora nasturtii* on *Nasturtium officinale*: A – stromata and conidiophores; B – conidia (scale bar: 20  $\mu\text{m}$ )

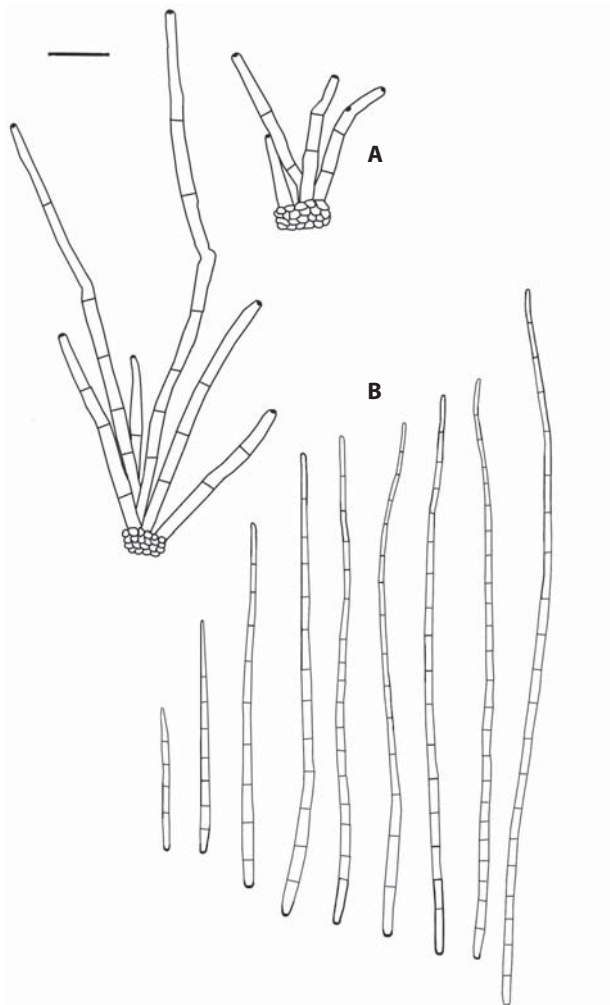
solitary, hyaline, obclavate to cylindrical or acicular, straight to slightly curved, smooth, thin, indistinctly multiseptate, base truncate, tip subobtuse, (25–) 40–110 (–135) × 3–5 (–6)  $\mu\text{m}$ . Hilum thickened and darkened (Fig. 2).

Specimen examined: on *Nasturtium officinale* R. Br., Iran, Cheram (Cheshme belgheis), 9 October 2012 (IRAN 16530 F).

Note: *C. nasturtii* has a wide host range and occurs on hosts of various genera belonging to Brassicaceae (Crous and Braun 2003). This is the first report of the species in Iran.

***Cercospora apii* Fresen., Beiträge zur Mykologie 3: 91 (1863)**

Specimens examined: on *Plantago lanceolata* L., Iran, Basht (Khan-Ahmad), 30 January 2013 (IRAN 16531 F), Iran, Cheram (Cheshmeh-Belgheis), 13 April 2012 (IRAN 16532 F). Iran, Sough, 14 April 2013 (IRAN 16533 F); on *Plantago major* L., Iran, Sisakht (Kohkhedan), 12 October 2012 (IRAN 16534 F); on *Rumex crispus* L., Iran, Cheram (Cheshmeh-Belgheis),



**Fig. 3.** *Cercospora apii* on *Rumex crispus*: A – stromata and conidiophores; B – conidia (scale bar: 20  $\mu\text{m}$ )

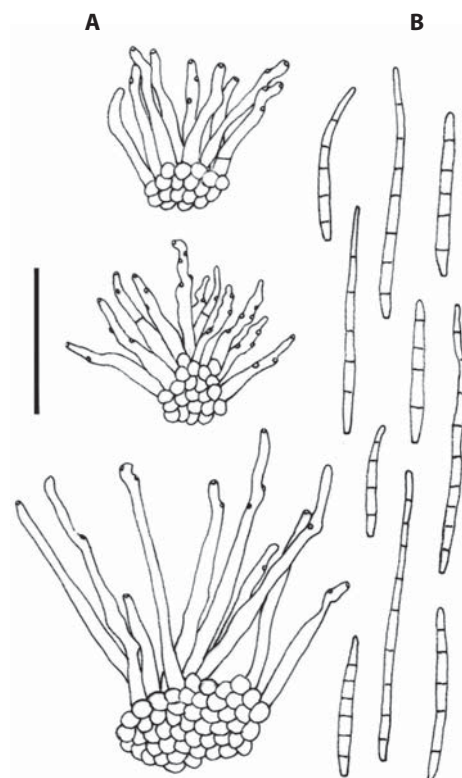
13 April 2012 (IRAN 16535 F); on *Rumex* sp., Iran, Basht, 13 October 2012 (IRAN 16542 F).

Note: The morphology of *Cercospora* on *P. lanceolata* from Iran is identical with the description of *C. plantaginis* provided in Chupp (1954). Crous and Braun (2003) linked 281 morphologically indistinguishable taxa on 83 host plant genera to *C. apii* s. lat. They also proposed to refer *C. plantaginis* to the *C. apii* species complex. Groenewald *et al.* (2006) showed that *C. apii* has a wider host range. Groenewald *et al.* (2013) carried out comprehensive molecular examinations of *Cercospora* spp. A culture of *Cercospora* sp. isolated from *P. lanceolata* in Romania clustered within *C. apii* s. str. confirmed that this species may infect *Plantago* spp. The first report of *C. apii* in Iran was published by Pirnia *et al.* (2010). *Rumex crispus* is a new host for *C. apii* in Iran (Fig. 3).

***Cercospora beticola* Sacc., Nuovo Giornale Botanico Italiano 8 (2): 189 (1876)**

Specimens examined: on *Beta vulgaris* L., Iran, Gachsaran, Imamzadeh Jafar, 10 April 2012 (IRAN 16536 F); Iran, Yasuj, Dasht Room 3 September 2012 (IRAN 16537 F).

Note: The species is characterized by having relatively short conidiophores and conidia and has previously been reported in Iran (Ershad 2009; Pirnia *et al.* 2010; Bicharanlou *et al.* 2013a) (Fig. 4).

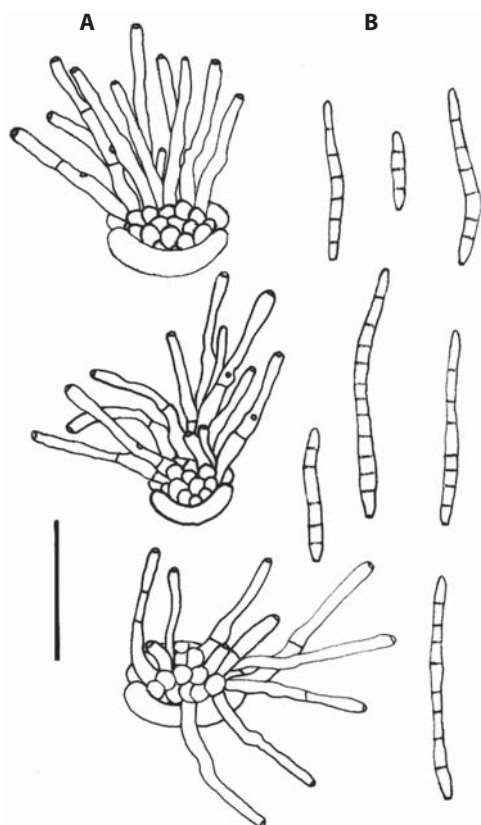


**Fig. 4.** *Cercospora beticola* on *Beta vulgaris*: A – stromata and conidiophores; B – conidia (scale bar: 50  $\mu\text{m}$ )

***Cercospora bizzozeriana* Sacc. & Berl.,  
Malpighia 2: 248 (1888)**

Specimen examined: on *Cardaria draba* L., Iran, Gachsaran, Imamzadeh Jafar, 10 April 2014 (IRAN 16539 F).

Note: The species has previously been reported in Iran without any description or illustration (Pirnia *et al.* 2012d). This is the first report of the species in SW Iran (Fig. 5).



**Fig. 5.** *Cercospora bizzozeriana* on *Cardaria draba*: A – stromata and conidiophores; B – conidia (scale bar: 50 µm)

***Cercospora peckiana* Chupp, A monograph  
of the fungus genus *Cercospora*: 449 (1954)**

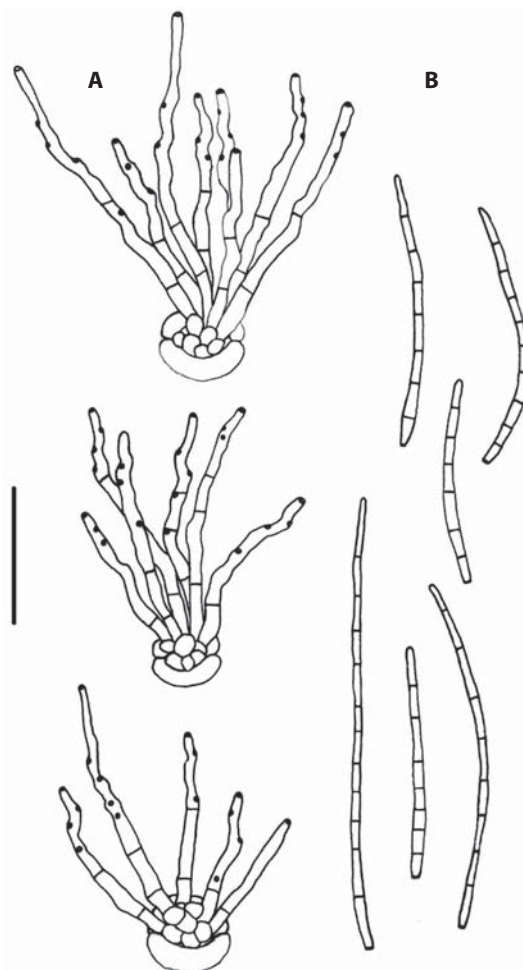
Specimens examined: on *Rumex crispus*, Iran, Cheram, 13 April 2012 (IRAN 16540 F), Basht, 13 October 2012 (IRAN 16541 F).

Note: This species was also reported in Iran without any description or illustration (Pirnia *et al.* 2012d), but its occurrence in Kohgiluyeh and Boyerahmad Provinces (SW Iran) is new (Fig. 6).

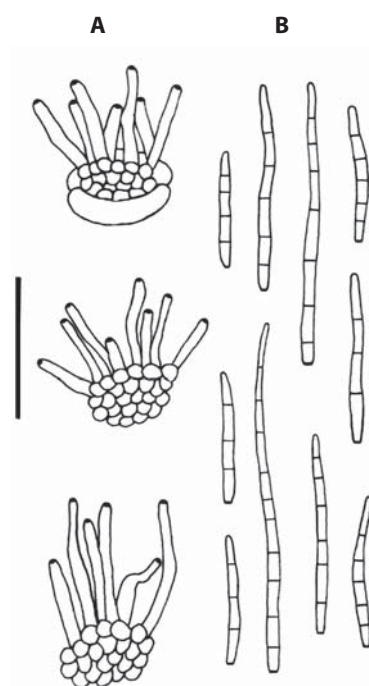
***Cercospora traversiana* Sacc., Annales  
Mycologici 2 (1): 18 (1904)**

Specimen examined: on *Trigonella foenum-graecum* L., Iran, Dehdasht, 8 July 2012 (IRAN 16543 F).

Note: The species is characterized by obclavate to cylindrical conidia (Fig. 7).



**Fig. 6.** *Cercospora peckiana* on *Rumex crispus*: A – stromata and conidiophores; B – conidia (scale bar: 50 µm)

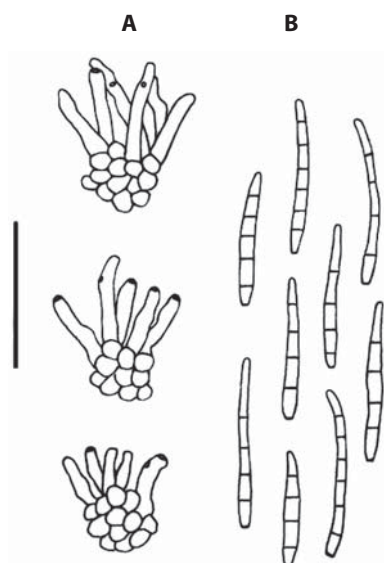


**Fig. 7.** *Cercospora traversiana* on *Trigonella foenum-graecum*: A – stromata and conidiophores; B – conidia (scale bar: 50 µm)

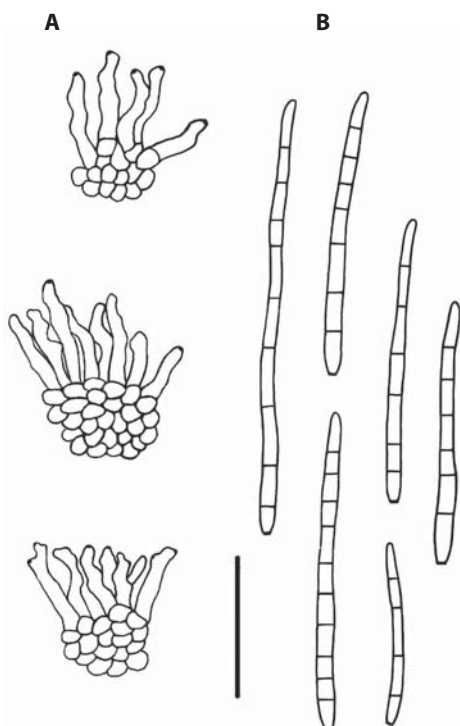
***Cercospora zebrina* Pass. Hedwigia**  
16: 124 (1877)

Specimens examined: on *Medicago sativa* L., Iran, Yasuj, Kakan, 11 July 2012 (IRAN 16545 F); Iran, Gachsaran, 8 October 2012 (IRAN 16546 F); on *Trifolium resupinatum*, Iran, Cheram, 13 April 2013 (IRAN 16548 F).

Note: *Trifolium resupinatum* is a new host for *C. zebrina* in Iran. This is the first report of the species in SW Iran (Fig. 8).



**Fig. 8.** *Cercospora zebrina* on *Medicago sativa*: A – stromata and conidiophores; B – conidia (scale bar: 50  $\mu$ m)



**Fig. 9.** *Cercospora zonata* on *Vicia faba*: A – stromata and conidiophores; B – conidia (scale bar: 50  $\mu$ m)

***Cercospora zonata* G. Winter, Hedwigia**  
23: 191 (1884)

Specimen examined: on *Vicia faba* L., Iran, Basht, Khan Ahmed, 8 April 2013 (IRAN 16549 F).

Note: This is the first report of the species in SW Iran (Fig. 9).

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