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Diyarbakır İli Buğday Tarlalarındaki Yabancı Otlar Üzerinde Gözlenen Mildiyö Türleri

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ÖZET

Çalışma, 2008-2009 yılları arasında Diyarbakır (Türkiye) ili ve ilçelerindeki buğday tarlalarının yabancı otları üzerindeki mildiyö hastalıklarını belirlemek amacıyla yapılmıştır. Sekiz farklı yabancı ot türü üzerinde sekiz farklı mildiyö fungus türü tespit edilmiştir. Bu mildiyö türlerinden üç tanesi Türkiye için yeni kayıttır. Mildiyö fungus türleri; *Hyaloperonospora parasitica* (Pers.) Constant., *Peronospora dianthi* de Bary, *Peronospora arborescens* (Berk.) De Bary, *Peronospora cephalariae* Vincens, *Peronospora lallemantiae* Kolymb., *Peronospora lamii* A. Praum., *Peronospora narbonensis* Gäum. ve *Peronospora sisymbrii-officinalis* Gäum. sırasıyla *Myagrum perfoliatum* L., *Agrostemma githago* L., *Papaver macrostomum* Boiss & Huet. ex Boiss, *Cephalaria syriaca* (L.) Schrad., *Lallemantia iberica* (Bieb.) Fisch. & Mey., *Lamium amplexicaule* L., *Vicia narbonensis* L. ve *Sisymbrium officinale* (L.) Scop. yabancı otu üzerinde gözlenmiştir. *P. dianthi* de Bary, *P. cephalariae* Vincens ve *P. lallemantiae* Kolymb. Türkiye için ilk kayıt niteliğindedir. Bu gözlenen mildiyö türlerinin morfolojik özellikleri bu çalışmada sunulmuştur. Tanımlanan mildiyö hastalık etmenleri, bu yabancı ot türlerine karşı potansiyel biyolojik kontrol ajanları olabilirler. Bununla birlikte, farklı yabancı ot türlerine karşı biyolojik kontrol ajanları olarak potansiyellerini keşfetmek için ayrıntılı çalışmalara ihtiyaç duyulmaktadır.

Anahtar Kelimeler: Buğday, Yabancı ot, Mildiyö fungusları, Diyarbakır, Türkiye

Downy Mildew Species Observed on Weeds of Wheat Fields in Diyarbakır, Turkey

ABSTRACT

This study was carried out to determine the downy mildew species affecting different weed species prevailing in wheat fields of Diyarbakır province and vicinities, Turkey during 2008-2009 growing season. Eight different downy mildew species were detected on eight different weed species. Three of the identified downy mildew species are new records for Turkey. The observed downy mildew species were; *Hyaloperonospora parasitica* (Pers.) Constant., *Peronospora dianthi* de Bary, *Peronospora arborescens* (Berk.) De Bary, *Peronospora cephalariae* Vincens, *Peronospora lallemantiae* Kolymb., *Peronospora lamii* A. Praum., *Peronospora narbonensis* Gäum. and *Peronospora sisymbrii-officinalis* Gäum. found on weeds *Myagrum perfoliatum* L., *Agrostemma githago* L., *Papaver macrostomum* Boiss & Huet. ex Boiss, *Cephalaria syriaca* (L.) Schrad., *Lallemantia iberica* (Bieb.) Fisch. & Mey., *Lamium amplexicaule* L., *Vicia narbonensis* L. and *Sisymbrium officinale* (L.) Scop., respectively. *P. dianthi* de Bary, *P. cephalariae* Vincens and *P. lallemantiae* Kolymb. are recorded for the first time in Turkey. The morphological characteristics of the identified downy mildew species are presented in this manuscript. The identified mildew species could be potential biological control agents against these weed species. However, detailed studies are needed to explore their potential as biological control agents against different weed species.

Key words: wheat, weed, downy mildews, Diyarbakır, Turkey

INTRODUCTION

Wheat is probably the most common cereal available all over the world, and is in even higher demand in recent years due to its abundant health benefits. Over the years, it has been proved as one of the most successful and sustainable cereal crops in the world (Anonymous, 2016a). Wheat has a long history of serving as an important food crop to mankind. It is a major source of energy through its carbohydrates, and supplies valuable proteins. This combination of carbohydrates and proteins gives wheat unique properties for making breads of different kinds and tastes (Belderok et al., 2000). Wheat is believed to be one of the most wholesome food item which ensures a diet rich of nutrients (Anonymous, 2016b). Wheat is produced in almost every region of Turkey, and is most popular food crop in the country. Wheat is being cultivated in Turkey from ancient times. According to some experts, wheat was first cultivated in the Mesopotamia. The world's first wheat landrace was evolved from the wild plants found in Turkey and the Middle East. Turkey is ranked 10^{th} in world wheat production (Anonymous, 2016c). In the recent decades, possibilities of irrigation have been raised in the country and wheat cultivation has been shifted to irrigated agriculture. The shift in production practices, climatic factors and weeds have been thought as hurdles in sustainable wheat production in the country. Weeds compete with wheat plants for water, nutrients and aeration; impair growth and development of wheat, offer difficulties in harvesting and decrease the quality of produce through weed seed contamination (Şin et al., 2016; Shahzad et al., 2016a, b).

Additionally, weeds also serve as alternative hosts for a number of diseases, thus negatively affect wheat production. Therefore, effective weed control in wheat is inevitable to sustain crop yield (Shahzad et al., 2016a, b). The farmers mainly rely on herbicides for weed control which have given rise to herbicide resistance problem in the country (Doğar, 2016, Doğar and Kadioğlu, 2016; Türkseven et al., 2016). Thus, adoption of alternative weed management practices is necessary to tackle the weed infestation in wheat to secure higher crop yields.

The use of biological control agents for weed control has attracted increased attention recently. The diagnosis of host weed species and their natural enemies is the foundation stone of a successful biological control program (Özaslan, 2016). Studies of phytopathogenic fungi and other microorganisms on weeds of agrophytocoenosis are important in terms of their potential as biological control agents. There are some reports highlighting the occurrence of fungal plant pathogens in Turkey (Göbelez, 1963, 1964; Erciş and İren, 1993; Uygur et al., 1993; Uygur, 1997; Özrenk and Tepe, 1999; Bahçecioğlu and Gjaerum, 2003; Kavak, 2003; Sert and Sümbül, 2003; Kırbağ, 2004; Sert, 2009; Tunalı et al., 2009; Erdoğdu et al., 2010; Özaslan, 2011; Ekici et al., 2012; Özaslan et al., 2013, 2015; Erdoğdu and Hüseyin, 2013; Özaslan, 2016). However, new pathogen records need to be explored on new weed species to establish a successful and sustainable biological control program against these species.

In this study, downy mildew fungi infesting the weed species prevailing in wheat crop were identified through mycological surveys. Furthermore, morphological characteristics of these species were determined and are presented in the manuscript. The results report interesting findings for the use of identified mildew species in future biological control programs in the country as well as in other parts of the world.

MATERIALS AND METHODS

Downy mildew species specimens were collected during periodical mycological surveys of wheat fields in Diyarbakır, Turkey, during 2008-2009. Any symptomatic observations of downy mildew species on the prevailing weed species were accepted as infected or infested. The frequency of a fungus species was calculated by observing a 500 m^2 area, chosen randomly and 10-20 weed samples were observed from this area. After identification of the fungal organism, arithmetic mean was calculated and the frequency of occurrence of the disease was computed. The distribution and frequency of downy mildew species was calculated by using the equations developed by Odum (1971) and Uygur (1997) as described below.

$$\text{Prevalence rate } (\%) = \frac{A}{B} \times 100$$

$$\text{Frequency of Occurrence } (\%) = \frac{C}{D} \times 100$$

Here;
A = the number of fields encountered fungal microorganism
B = the total number of fields sampled
C = number of plants infested with fungus
D = the total number of plants examined

Microscopic studies were carried out on slides prepared in distilled water. For microscopic examination and microphotographs, a Leica DM E light microscope was used. Spores were measured using a Leica DM E light microscope (objective 40x or 100x). Length and width of 30 spores were measured for each sample. The fungi were identified using the related handbooks and other publications (Ellis and Ellis, 1987; Mayor, 1962; Saccardo, 1972; Uljanishchev, et al., 1985; Vanev et al., 1993) by examining the lesions formed in the plant tissue, conidial structure, conidiophore branching, conidium structure, conidium shape, color and size of the resting organ. The host weed species' specimens were prepared according to established herbarium techniques. The weed species were identified using "Flora of Turkey and East Aegean Islands" (Davis, 1965–1985). Taxa, families, and author citations are spelled according to Kirk and Ansell (1992), and Index Fungorum (2016). All specimens are deposited in the Mycological Collection of Dicle University, Diyarbakir (Faculty of Agriculture, Department of Plant Protection).

RESULTS AND DISCUSSIONS

The downy mildew species with their host weed species, collection sites, coordinates, altitudes, dates, name and label specified by the collector (CÖ = Cumali Özaslan), place where determined for the first time in Diyarbakır province, distribution and frequency are presented as below;

OOMYCOTA

Peronosporales
Peronosporaceae
1. *Hyaloperonospora parasitica* (Pers.) Constant.

Specimen examined: In wheat crop, on living leaves of *Myagrum perfoliatum* L. (Brassicaceae), Turkey, Diyarbakır Province, Ergani District, 37°55'85" N, 42°16'59" E, 834m, 10 May 2009, CÖ 200937.

Hyaloperonospora parasitica infesting *Myagrum perfoliatum* was observed in wheat fields in Merkez, Bismil, Silvan and Ergani districts. Among the 80 fields surveyed, 5 were found to be infested with the fungus, while 43 out of 50 weed species observed were infested with the fungus (Table 1). *H. parasitica* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color.

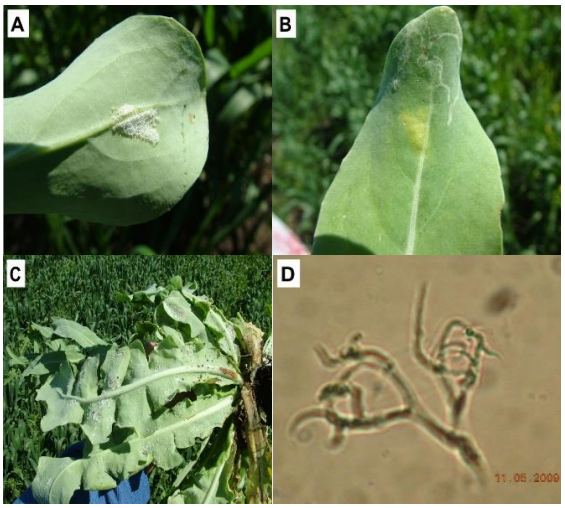

Figure 1: Symptoms (a, b and c) and sporangiophore (d) of *Hyaloperonospora parasitica* on *Myagrum perfoliatum*

2. *Peronospora dianthi* de Bary (recorded for the first time in Turkey)

Specimen examined: In wheat field, on living leaves of *Agrostemma githago* L. (Caryophyllaceae), Turkey, Diyarbakır Province, Ergani District, 38°22'93" N, 39°67'86" E, 957 m, 16 April 2009, CÖ 200943.

Peronospora dianthi infesting *Agrostemma githago* was observed in wheat fields in Merkez, Bismil, Silvan and Ergani districts. Among the 65 fields surveyed, 29 were found to be infested with the fungus, while 135 out of 290 weed species observed were infested with the fungus (Table 1). The infestation signs of *P. dianthi* were obvious in the field and growth of *A. githago* was retarded to certain extent. The main signs of fungus the fungus infestation on the infested plants are, burning of shoots and leaves, drying of buds and branches, discoloration and deformation. *P. dianthi* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These yellow regions turn to brown giving a look of necrosis and under suitable conditions these symptoms appear on whole plant.

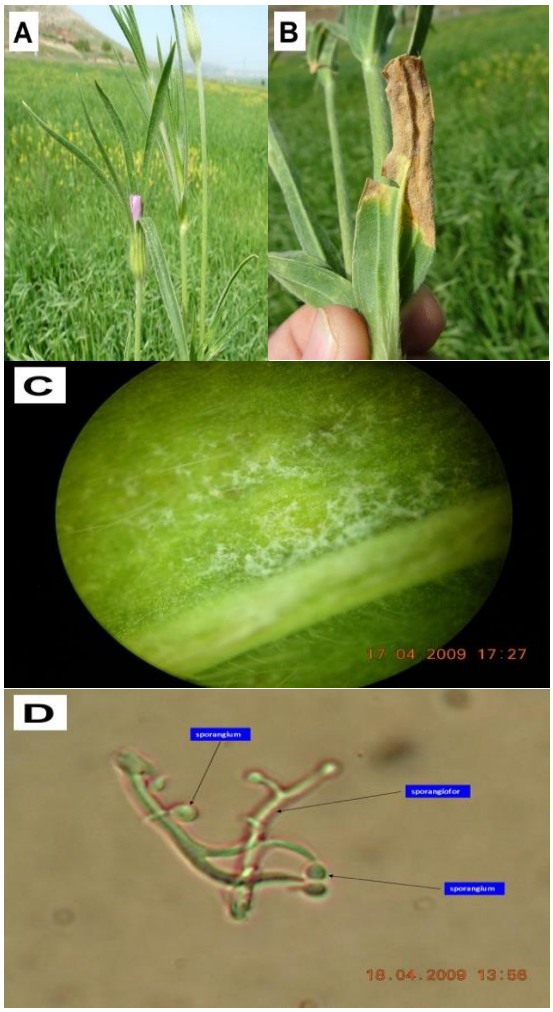

Figure 2: Symptoms (a, b and c), sporangiophore and sporangium (d) of *Peronospora dianthi* on *Agrostemma githago*

3. *Peronospora arborescens* (Berk.) De Bary

Specimen examined: In wheat field, on living leaves of *Papaver macrostomum* Boiss & Huet. ex Boiss (Papaveraceae), Turkey, Diyarbakır Province, Silvan District, 38° 7'6.60"N, 40°47'47.32"E, 767 m, 20 May 2008, CÖ 200849.

Peronospora arborescens found on *Papaver macrostomum* was only observed in Silvan district. Among the 20 fields surveyed, 6 were found to be infested with the fungus, while 52 out of 60 weed species observed were infested with the fungus (Table 1). *P. arborescens* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding

to the pile turns to yellow color. These lesions turn to brownish black color with time and infested leaves die.

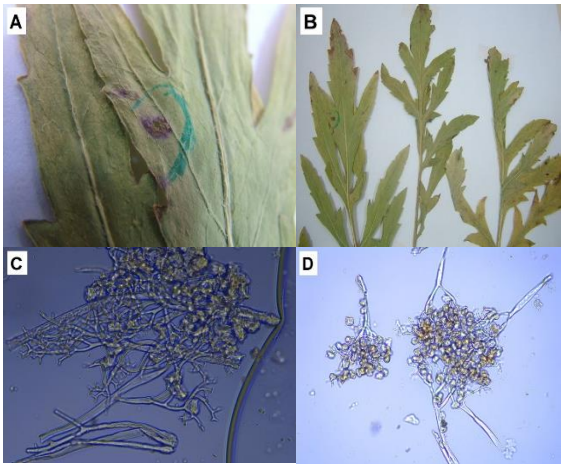

Figure 3: Symptoms (a and b), sporangiophore and sporangium (c and d) of *Peronospora arborescens* on *Papaver macrostomum*

4. *Peronospora cephalariae* Vincens (recorded for the first time in Turkey)

Specimen examined: In wheat field, on living leaves of *Cephalaria syriaca* (L.) Schrad. (Dipsacaceae), Turkey, Diyarbakır Province, Bismil District, 37°47'59.97"N, 40°44'19.20"E, 541 m, 29 April 2008, CÖ 200824.

Peronospora cephalariae found on *Cephalaria syriaca* was observed in the wheat fields of Merkez, Bismil, Silvan, Ergani and Çermik districts. Among the 91 fields surveyed, 85 were found to be infested with the fungus, while 593 out of 850 weed species observed were infested with the fungus (Table 1). The infestation signs of the fungus were obvious under field conditions. The fungus was more frequently observed in Silvan district and growth of the infested plants was retarded to certain extent. *P. cephalariae* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These lesions turn to brown color with time and infested leaves die.

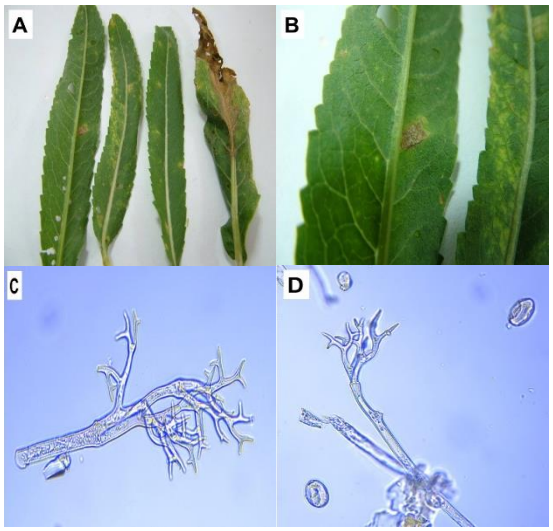

Figure 4: Symptoms (a and b), sporangiophore and sporangium (c and d) of *Peronospora cephalaria* on *Cephalaria syriaca*

5. *Peronospora lallemantiae* Kolymb. (recorded for the first time in Turkey)

Specimen examined: In wheat field, on living leaves of *Lallemantia iberica* (Bieb.) Fisch. & Mey. (Lamiaceae), Turkey, Diyarbakır Province, Silvan District, 38° 8'39.05"N, 40°55'40.72"E, 865 m, 28 April 2009, CÖ 200926.

Peronospora lallemantiae found on *Lallemantia iberica* was observed in the wheat fields of Merkez, Bismil and Silvan districts. Among the 65 fields surveyed, 27 were found to be infested with the fungus, while 169 out of 270 weed species observed were infested with the fungus (Table 1). The fungus was more frequently observed in Silvan district and growth of the infested plants was retarded to certain extent. *P. lallemantiae* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These lesions turn to brown color with time and infested leaves die.

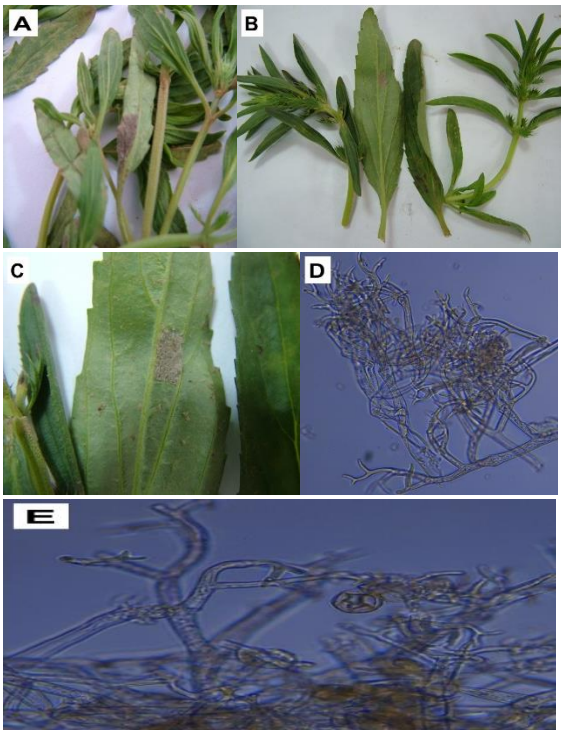

Figure 5: Symptoms (a, b and c), sporangiophore and sporangium (d and e) of *Peronospora lallemantiae* on *Lallemantia iberica*

Peronospora lamii found on *Lamium amplexicaule* was observed in the wheat fields of Silvan district only. Among the 20 fields surveyed, 3 were found to be infested with the fungus, while 7 out of 30 weed species observed were infested with the fungus (Table 1). *P. lamii* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These lesions turn to brown color with time and infested leaves dye. If the prevailing conditions favor the growth of fungus, it results in the mortality of whole plant.

6. *Peronospora lamii* A. Praum.

Specimen examined: In wheat field, on living leaves of *Lamium amplexicaule* L. (Lamiaceae), Turkey, Diyarbakır Province, Bismil District, 37°49'9.41"N, 40°30'55.19"E, 564 m, 28 April 2009, CÖ 200929.

Figure 6: Symptoms (a), sporangiophore and sporangium (b and c) of *Peronospora lamii* on *Lamium amplexicaule*

Table 1: Downy Mildew Species on weeds and their distribution and observation rates in wheat fields of Diyarbakir

Downy Mildew and Weed Species	P (%)	FO (%)
Hyaloperonospora parasitica (on *Myagrum perfoliatum*)	6.25	86.00
Peronospora arborescens (on *Papaver macrostomum*)	30.00	86.66
Peronospora cephalariae (on *Cephalaria syriaca*)	93.40	69.76
Peronospora dianthi (on *Agrostemma githago*)	44.62	46.21
Peronospora lallemantiae (on *Lallemantia iberica*)	41.53	62.59
Peronospora lamii (on *Lamium amplexicaule*)	15.00	23.33
Peronospora narbonensis (on *Vicia narbonensis*)	68.42	80.38
Peronospora sisymbrii-officinalis (on *Sisymbrium officinale*)	32.80	29.13

P = prevalence, FO = frequency of occurrence

7. *Peronospora narbonensis* Gäum.

Specimen examined: In wheat field, on living leaves of *Vicia narbonensis* L. (Fabaceae), Turkey, Diyarbakır Province, Silvan District, 38° 7'47.93"N, 40°45'7.95"E, 765 m, 10 May 2009, CÖ 200922.

Peronospora narbonensis found on *Vicia narbonensis* was observed in the wheat fields of Bismil Ergani, Çermik and Silvan districts. Among the 76 fields surveyed, 52 were found to be infested with the fungus, while 418 out of 520 weed species observed were infested with the fungus (Table 1). The fungus was more frequently observed in Silvan district and growth of the infested plants was retarded to certain extent. *P. narbonensis* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These lesions turn to brownish black color with time and infested leaves die. If the prevailing conditions favor the growth of fungus, it results in the mortality of whole plant.

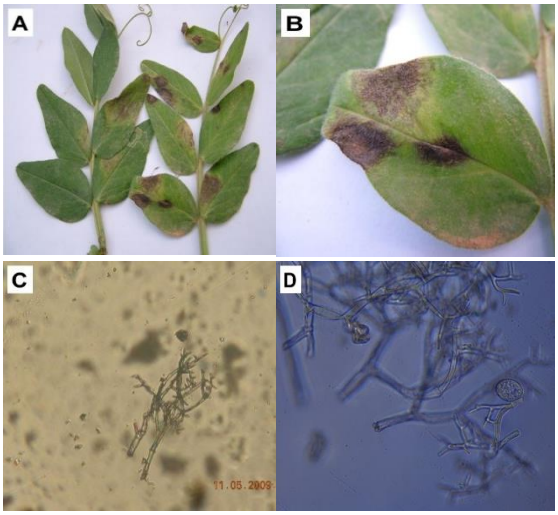

Figure 7: Symptoms (a and b) and sporangiophore (c) and sporangium (d) of *Peronospora narbonensis* on *Vicia narbonensis*

8. *Peronospora sisymbrii-officinalis* Gäum.

Specimen examined: In wheat field, on living leaves of *Sisymbrium officinale* (L.) Scop. (Brassicaceae), Turkey, Diyarbakır Province, Çınar District, 37°46'12.58"N, 40°21'51.12"E, 692 m, 5 May 2009, CÖ 200930. *Peronospora sisymbrii-officinalis* found on *Sisymbrium officinale* was observed in the wheat fields of Bismil, Silvan and Çınar districts. Among the 70 fields surveyed, 23 were found to be infested with the fungus, while 67 out of 230 weed species observed were infested with the fungus (Table 1). The fungus was more frequently observed in Silvan district and growth of the infested plants was retarded to certain extent. *P. sisymbrii-officinalis* usually brings up a pile of pods that are easily noticeable on the underside of the leaf of the host plant. The surface of the upper leaf corresponding to the pile turns to yellow color. These lesions turn to brown black color with time and infested leaves die. If the prevailing conditions favor the growth of fungus, it results in the mortality of whole plant.

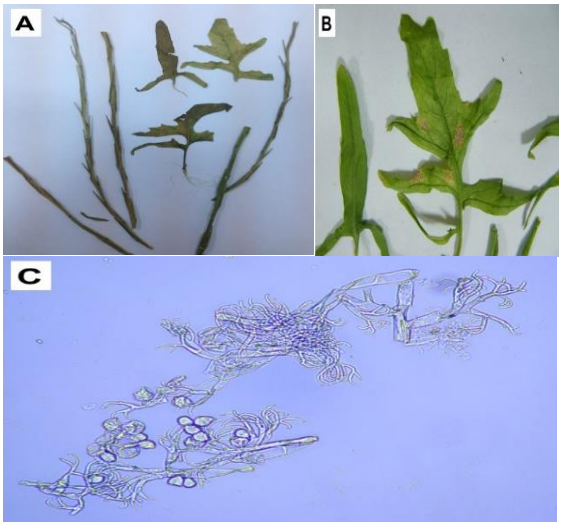

Figure 8: Symptoms (a and b) and sporangiophore and sporangium (c) of *Peronospora sisymbrii-officinalis* on *Sisymbrium officinale*

CONCLUSIONS

Eight different downy mildew species have been identified in the current study on eight distinct weed species (each mildew species infesting only one weed species).

Three of downy mildew species; *Peronospora dianthi* de Bary, *Peronospora cephalariae* Vincens and *Peronospora lallemantiae* Kolymb. are recorded for the first time in Turkey. These mildew species can be potential biological control agents of these weed species in the era of increasing concerns on environment safety and herbicide resistance. However, detailed studies on host specificity and potential of these species to damage/control needs to be explored in detailed studies.

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