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Full Length Research Paper

Two new records of powdery mildews with their effectiveness on three ornamentals in Turkey

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In this study, two new species of powdery mildews together with disease severities measured at four different growing stages were identified on three ornamental species in the Şanliurfa district of Turkey. Observations and measurements were made on natural and experimental stands. On natural stands, 15, 85 and 100% disease rates were determined on *Fuchsia regia, Calendula officinalis* and *Zinnia elegans*, respectively. Powdery mildews of *C. officinalis* and *Z. elegans* were identified as *Podosphaera xanthii* (*Oidium* subgenus *Fibroidium*). Disease symptoms were observed from early seedling to late maturing stages on *Z. elegans*, and from pre flowering to maturing stages on *C. officinalis*. The mildew pathogen of *Fuchsia regia* was identified as *Leveillula taurica*. This ornamental species appear to be resistant to this respected powdery mildew agent during summer, but somewhat susceptible in the early autumn. In addition, upper leaves were observed the only section displaying the disease.

Key words: *Podosphaera xanthii*, *Leveillula taurica*, ornamentals, disease severity.

INTRODUCTION

Powdery mildew is a general name of symptomatic appearance of some plant diseases caused by a group fungi species in the Erysiphales and Ascomycota. Most species in these biotrophic pathogens can infect too few plant species, for example, one or a several species, due to highly specialized to their hosts. However, due to less specialization to host, some mildew pathogen can cause disease in widely plant species. In the Erysiphales, the number of genera varies according to various taxonomists. At present, seven genera are commonly accepted (Zheng, 1985).

Many plant species may be affected from various species of powdery mildews. But, they do not all damage economically. According to Hirata (1986), it is estimated that 40, 000 species of flowering plants, most of them are dicotyledonous in the 40 order, are under attack of these pathogens. Different edible and ornamental species in the cultivated plants may be severely damaged as quantitatively and qualifiedly by the mildew pathogens (Alexopoulos et al., 2003). Ornamental species in different category of Plantae kingdom had great importance in the human life since prehistory eras. International curiosity has increased, particularly, after 16th century, and today, they have high economic share at the areas of national and international trades in many countries. The three genus of ornamental are *Fuchsia*, *Calendula* and *Zinnia*, with their many species and varieties.

Fuchsia regia (Onagraceae), *Calendula officinalis* and *Zinnia elegans* (Asteraceae) are only three species from them, respectively. They are commonly grown in parks and gardens in the Mediterranean and temperate regions of Turkey with pot plants in the harsh climatic regions for mainly purposes of decorative and cutting flower production. Exception of two species, *C. officinalis* was also produced as a medicinal herb in ancient cultures of Arabian, Indian, Greek, Turk, and Roman in addition to foods, cosmetics and a dye mater for fabrics (Khalid, 1995).

The aim of this study was to identify the species of powdery mildew on *F. regia, C. officinalis* and *Z. elegans*; and to determine the resistance levels of these ornamentals to their respected pathogens in natura and experimental plots in the Şanliurfa district of Turkey (South Eastern district).

MATERIALS AND METHODS

Surveys on natural stands, identification of pathogens and pathogenicity tests

Ornamentals, *F. regia*, *C. officinalis* and *Z. elegans*, were surveyed

Table 1. Rate of powdery mildew of three ornamentals in 20 different stands in centre of Şanliurfa city.

Ornamental species	Ornamental stands				Infection status	
	Park stands	Official stands	Home stands	Total stands	Infected stand numbers and %	Non-infected stand numbers and %
Fuchsia regia	10	5	5	20	3 to 15	17 to 85
Calendula officinalis	12	7	3	20	17 to 85	3 to 15
Zinnia elegans	7	5	8	20	20 to 100	0 to 0

in the Şanliurfa from early springs to late autumn of 2009. Surveys were conducted in 20 stands (ornamental planted areas) for each ornamental species, mainly in parks and home gardens. Related stands were visited at three times in different growth stages of plants to determine the disease frequency. Any plants, displaying clear symptoms of powdery mildew in a stand, were accepted as infected. Infected and non-infected stands and disease status were determined as percent. Plants with powdery mildew symptoms were collected in sufficient numbers. They were transported to the pathology laboratory and then identification was made immediately. Herbarium specimens were also deposited in sufficient numbers for later identification. Trends of the diseases during growing season and status of ornamentals against pathogens were also noted. Macroscopic symptoms of pathogens on their hosts were photographed. Microscopic morphologies were determined by compound of light, dissecting microscopes, and a SEM electron microscope.

Anamorphic and teleomorphic structures of the related pathogens were considered in the identification of pathogen species. Dimensions of conidia and conidiophores were measured, photographed and identified. Pathogenicity tests on three species and cross-inoculation tests between *C. officinalis* and *Z. elegans* were performed. Approximately, 1 x 10^5 per ml. conidial suspensions of mildews derived from the infected plants for each species were used together with mycelia on trials. On cross-inoculation tests, inoculum derived from *C. officinalis* was used in inoculation of *Z. elegans,* while inoculum derived from *Z. elegans* was used in inoculation of *C. officinalis*. Tests were made on twenty five days old seedlings grown in three and two replicates for inoculations and controls, respectively per species. On seedlings, inoculums were sprayed, and they were incubated in humidity chamber (80 to 95%) at 25ºC for 48 h. No spraying was made on controls. Then, plants were raised normally and irrigated when needed. Disease symptoms were screened on inoculated plants, daily.

Observation on experimental plots and measurements of disease severity

Reactions of these ornamentals to mildew pathogens were measured on experimental plots performed at the experimental fields of the Agricultural Faculty, Harran University. Experiments per species were constituted as three replicate in the randomized plots with 1 x 3 m dimension. Sowings were made on 2 June 2010. Plots were irrigated on demand from the surface. Powdery mildew infected plants, *F. regia, C. officinalis* and *Z. elegans* were used as inoculum sources for the plots associated with the same species. They were separated to small parts and dispersed among sown plots at the post emergence stages. Disease severities of species were measured at the following four stages; viz. seedling stage (3 to 4 leaves), pre flowering, pre seed formation and seed formation. Three plants, per species and per plots were selected randomly. In the measurement of disease severity, a previous method (Kavak, 2004), was used after minor modified. Clear infected areas covered by mildew colonies were estimated as percent for each leaf. A total of 36 leaves (3 replicate plots x 3 plants x 4 upper leaves) of each ornamental were used in this work. Then, the disease severity per species was measured as single percent value after arithmetic calculations were made from each specimen.

RESULTS AND DISCUSSION

Oidium anamorph of *Podosphaera xanthii* on *Z. elegans and C. officinalis*

First symptoms of powdery mildews on *Zinnia elegans* and *C. officinalis* were observed in natural stands in late May 2009, and in experimental plots, late June 2010. Plants in natural stands had been severely affected from the disease. In a short time, disease became very effective on many planted areas and spread to the other plants. These symptoms were also observed on new seedlings of *Z. elegans* in the beginning of November. The stands displaying symptoms were presented in (Table 1). The primer step of diseases started with the colony formation on true leaves. In a short time, both sides of leaves, and to some extent stems and calyxes of flowers were covered by dense coalesce colonies forming composed of dust like, breakable grayish conidia and mycelia (Figure 1a and b). Lesser symptoms were present on plant stems, and very rarely on calyx and petal leaves of flowers. Necrotic spots were also present on edges of older leaves as well as wilt signs and prematurely senescing. As seen in Table 2, in the experimental plots, first mildew symptoms together with different severities were observed at the early seedling stage on *Z. elegans*, and at the pre flowering stage on *C. officinalis*.

Microscopic morphology of powdery mildews on *C. officinalis* and *Z. elegans* had similar properties as described follow. Conidia were cylindrical to broadly cylindrical (ellipsoid-ovoid to doliiform) (Figure 1d), 22-46 x 13-20 µm (long and wide) in dimensions, produced in linear chains formed up to 5 matured cells. They were thin walled, smooth, colorless, and had a sinuous wrinkling pattern with fibrosin bodies. Germ tubes in conidia were short and broad. They consisted with fibroidium type, brevitubes subtype. Conidiophores were long (roughly 40-140 x 8-15 µm in dimensions), erect or slightly bent and having long cylindrical foot cell with strait

Figure 1. Powdery mildew infected ornamentals and their pathogen species. (a) Powdery mildew infected *Z. elegans* (b) Powdery mildew infected *C. officinalis* (c) Conidiophore in *P xanthii* (d) Conidia in *P xanthii* (e) Powdery mildew infected *F. regia* (f) Conidia (primer and seconder) and conidiophore in *L. taurica* (Arrow keys are pathogen colonies).

or twisted form (Figure 1c). Mycelia cells which branched at right angles were superficial, having mini nipple shaped appressoria and 25-100 x 5 x 10 µm in dimensions. In spite of screened until late October, no chasmothecia was detected. However, described characteristics were overlapped with Oidium subgenus *Fibroidium*, the anamorh of *Podosphaera*, and also were consistent with the *Podosphaera xanthii* (Braun, 1987; Cook and Braun, 2009; Braun et al., 2001). *Z. elegans*, seem as very susceptible to this powdery mildew in both spring and autumn seasons in Şanliurfa district. First mildew symptoms on test plants were observed 10 days after inoculation similar to natural stands. *P. xanthii* was reported on *C. officinalis* (Garibaldi et al., 2008) and on different host species, such as on *Medusagyne oppostifolia* (Pettit et al., 2010). In addition, *Erysiphe cichoracearum* was previously reported powdery mildew on *C. officinalis* and *Z. elegans* (Clare, 1964). However, no record was detected and to my knowledge, this is the first report of *P. xanthii* on *C. officinalis* and *Z. elegans* in Turkey.

Leveillula taurica on *Fuchsia regia*

During long period of summer in experimental plots and natural stands. *F. regia* remained symptoms free from powdery mildew. The stands only 15% were contaminated

Table 2. Estimated reaction levels of three ornamentals to powdery mildews at different growth stages in experimental plots.

	Disease severity	Disease severity	Disease severity	Disease severity
	Early seedling	**Pre flowering**	**Pre seed production**	**Seed formation stage (%)**
Calendula officinalis	Symptomless	10%	25%	54
Zinnia elegans (%)	5	16	42	75
Fuchsia regia	Symptomless	Symptomless	Symptomless	8

with this powdery mildew (Table 1). The early symptoms were in experiments and some natural stands were observed in the early October. Grayish symptoms of the powdery mildew were localized on cross section of leaves (Figure 1e). Infected areas of the leaves were dried and became necrotic as the disease progressed. Diseased areas forming mycelia, conidiophore and conidia were generally localized on the main leaves and to a lesser extent on small leaves on the highest section of plants. Same symptoms were observed on through main veins on some older leaves.

In the microscopic investigation, dimorphic conidia in short chains bearing from three to four septate's conidiophores (55 to 210 µm) were detected. The primary conidia were lanceolate (15-21 x 40-55 µm) and the secondary ones were cylindrical (15-20 x 45-60 µm) (Figure 1f). The teleomorph was not detected. However, the related criteria in the anamorphic morphology had characteristic properties of *Leveillula taurica* as described by Braun (1987). As similar to natural stands, first symptoms of this mildew were observed on test plants inoculated on pots 20 days after inoculation. *L. taurica* has been previously recorded on caper (Kavak, 2004b) and hollyhock (Kavak and Dikilitas, 2006) in Turkey, and on some ornamentals (Glawe et al., 2006; Koike et al., 2010) in different countries. However, this is the first report of *L. taurica* on *F. regia* in Turkey and other places. This species seem to be resistant to *L. taurica* during summer season, but susceptible to some extent in the later seasons.

On the evaluation of upper four leaves, the disease severity was estimated as 8% at the seed formation stage (Table 2). On the base of late occurrence of this disease, roles of climatic factors and position of planted areas were seen effective factors. As a property of autumn season, increase in temperature decreases and humidity increases, and these combined factors may become effective on disease development.

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