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SEVERE INFECTION OF FIGS BY FIG RUST PATHOGEN *CEROTELIUM FICI* IN MONTENEGRO

SUMMARY

In late summer and early fall of 2014, both in productive plantations and in nurseries in Montenegro, an important disease of figs was recorded. The leaves of diseased trees became twisted upwards with rusty and necrotic areas and then dried. Numerous yellow to brown coloured spots on the upper side and reddish-brown pustules on the lower side of the leaves were noticed. Almost all leaves with those symptoms prematurely fell down, leaving bare branches and unripe fruits. Microscopic observations in laboratory revealed that the disease is caused by the phytopathogenic fungus *Cerotelium fici*. The disease is favoured by humid and warm summer conditions as it was in 2014.

Keywords: fig rust, *Cerotelium fici*, Montenegro

INTRODUCTION

Fig (*Ficus carica* L.) originates from Near East and now is mostly grown in Mediterranean region. Turkey is the largest world producer of figs (30% of overall world production) followed by Egypt, Morocco, Spain, Greece, USA, Italy, Algeria, Syria etc. (Cizmovic et al., 2005).

Fig has been traditionally grown in the southern and central part of Montenegro for a long time. After Second World War in the southern parts of Montenegro, according to number of trees, fig was on the second place after olive. Since then, due to expansion of citrus and actinidia, its economic importance gradually decreased (Mijuskovic, 1999). Based on data from 1999, there were 225.390 yielding trees, with total year production of 2.434 t and average yield of 10.7 kg/capita in Montenegro (Cizmovic et al., 2005). Fig fruits are used in nutrition mainly as fresh and dried and have an important nutritive value.

Until recently, in Montenegro fig was not grown on large areas, mainly near houses and in gardens, so the intensity of certain diseases was not of extreme importance. However, in recent years fig plantations were set up (from several hundreds to over 1000 trees), and several diseases have been observed whose intensity threatens the cultivation of this crop and jeopardize the yield.

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In 2014 economically significant fig disease was recorded in Montenegro. Based on symptoms manifestation and microscopic observations in the laboratory it was revealed that the disease is fig rust caused by the phytopathogenic fungus *Cerotelium fici* (E.J. Butler) Arthur. The disease is favored by humid and warm summer conditions as it was in 2014.

Fig rust was already recorded a few times in last century in Montenegro (Mijuskovic, 1963).

MATERIAL AND METHODS

Several fig orchards and nurseries in Montenegro were visited during summer and fall of 2014. Since a lot of prematurely fallen leaves were noticed on the ground, we observed the trees and collected the diseased leaves. Samples were placed in plastic bags and transported to laboratory of phytopathology at the Biotechnical Faculty in Podgorica. After symptoms' observation and description, microscopic analysis of noticed pustules on leaves has been done using conventional techniques in order to reveal morphological features of the pathogen.

A hundred of the found spores were measured and observed in order to define their shape, color and dimensions. Their photos were made as well. For this purpose, Axioskop 2 plus Zeiss and AxioCam ERc5s Zeiss were used.

RESULTS AND DISCUSSION

During field trips to fig orchards and nurseries in Montenegro in 2014, a severe dropping of leaves from fig trees were noticed in late summer and early fall. Symptoms have manifested on the upper leaf surface as small yellowish spots at the beginning. As the disease progress they turn a reddish- brown color and become angular. However, upper surface of the leaves remains smooth (Fig. 1). Opposite of these spots, on the lower leaf surface a lot of dirty-orange, rusty to reddish-brown raised pustules were visible (Fig. 2). Angular spots often merge and form necrotic areas usually near the edges that make leaf curling upwards (Fig 3). This curling of leaves cause the reduction of assimilative surface required for optimal photosynthetic activity thus influencing on yield. In some cases it looked like the tree get burned (Fig. 4). Almost all leaves with those symptoms prematurely fell down, leaving bare branches and unripe fruits. Significant defoliation (Fig. 5) disables fruits to ripen fully. Thus the yield was quite affected. Symptoms on fruits, however, have not been recorded.

Similar symptoms on leaves caused by fig rust were reported by other authors as well (Mijuskovic, 1963; Ferrin & Overstreet, 2010; Verga & Nelson, 2014). Although some authors recorded *Cerotelium fici* not only on fig leaves but also on fruits (McKenzie, 1986; Verga & Nelson, 2014), we found the pathogen only on leaves. Also Mijuskovic (1963) have mentioned fig rust only on leaves and Ferrin & Overstreet (2010) stated that fig rust occurs only on the leaves and does not affect the fruit directly.

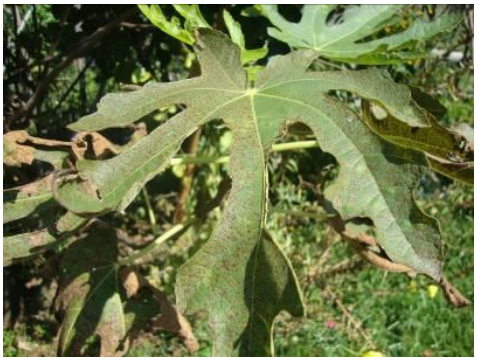

Fig. 1. Symptoms of fig rust on the upper leaf surface

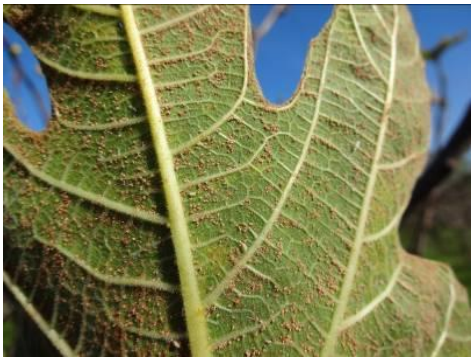

Fig. 2. Fig rust – pustules on the underside of the leaf

Fig. 3. Fig rust symptoms – necrosis and curling of diseased leaves

Fig. 4. Fig rust symptoms – seared appearance of a diseased tree

Fig. 5. Fig trees defoliated by fig rust bearing unripe fruits

Microscopic analysis revealed that the pustules on the lower leaf surface were actually uredinia that contain abundance of urediniospores. Urediniospores (Fig. 6) usually have wide-ellipsoid to polygonal or rounded shape. Interior of the spores is granulated and yellowish to faintly orange, framed with the thick, light brown, denticulate membrane. Size of uredioniospores varies 19.6 – 31.9 × 14.7 – 24.5 μm (average 24.5 × 20.0 μm). This description corresponds to those given by Mijuskovic (1963) and McKenzie (1986). According to Huseyin & Selcuk (2004), spermogonia and aecia are unknown, while, besides uredinia and urediniospores, telia appear as well on lower leaf surface (recorded on leaves of Ficus carica in Turkey). Telia are very small, whitish and scattered with teliospores in chains of 2-7 spores, angular-spherical or broadly-ellipsoid, 19-22 x 10-17 μm; spore wall is 1-1,5 μm thick, hyaline and smooth.

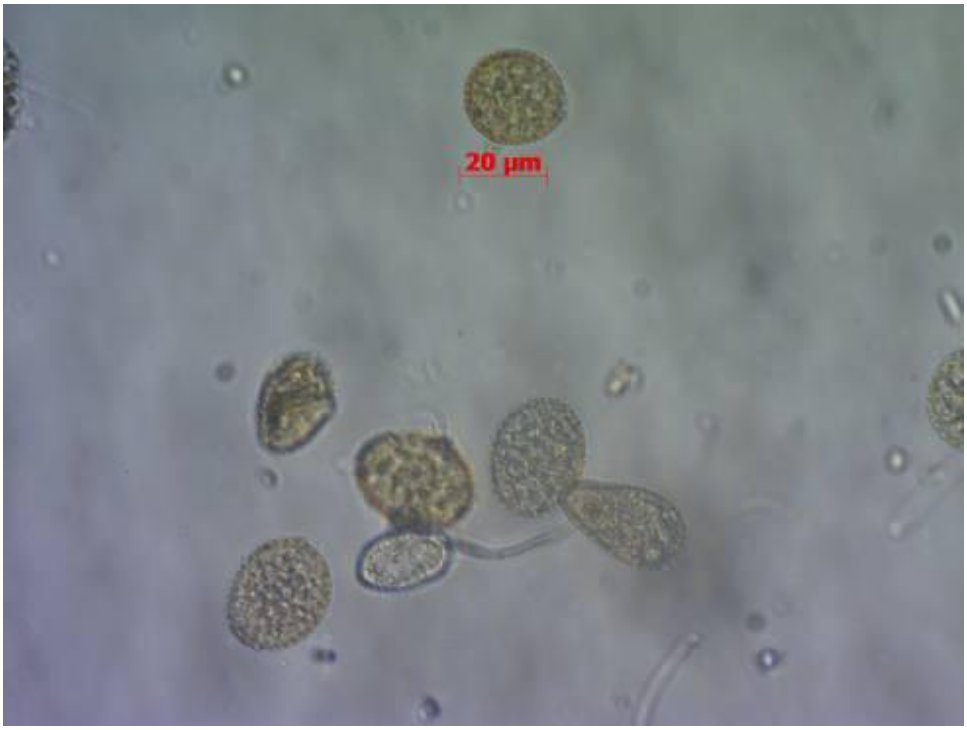

Fig. 6. Urediniospores of *Cerotelium fici*

Fig rust caused by *Cerotelium fici* (E.J. Butler) Arthur is a common disease on fig (*Ficus carica* L.). Rust on *Ficus elastica* has been discovered for the first time in 1961 in France and the disease was attributed to *Cerotelium fici* (Grouet, 1962). In Montenegro *Cerotelium fici* was recorded on ornamental nursery plants of *Ficus elastica* Roxb. in greenhouses during 2004 and 2005 (Vucinic et al., 2006). Other host plants from the family Moraceae are also susceptible to *C. fici* such as plants from genera *Maclura*, *Morus* and *Broussonetia papyrifera* (paper mulberry) (McKenzie, 2013).

Fig rust is widespread in tropical and subtropical areas throughout the world. It has been recorded in the southeastern U.S., in Bermuda, West Indies, Central America, Oceania etc. (Verga & Nelson, 2014; McKenzie, 2013). The disease has been known in Australia since 1904 while it has been recorded in New Zealand on *Ficus carica* in 1986 (McKenzie, 1986). It is also present in Turkey (Huseyin & Selcuk, 2004) and India (Desai, 1998). According to Mijuskovic (1963), fig rust usually doesn't cause significant damages in Mediterranean, but its appearance isn't rare however even in countries with arid climate, such as Tunis, Morocco, Israel, Italy, south France, Mediterranean islands etc.

In Montenegro, fig rust was noticed for the first time in 1949 in Herceg-Novi, when symptoms were present on several leaves and damages were insignificant. Then the disease was stated in 1952 along Montenegrin coast. However, intensive infections of figs with evident damages occurred in 1959 and 1963. Both years were distinguished by exceptionally heavy rains (Mijuskovic, 1963).

In 2014 in Podgorica surrounding area where fig plantations are mostly situated summer was quite rainy. Rainy summer is unusual for this area (summer is usually hot and dry) so it could be the most probable reason for the severe infection of figs caused by fig rust disease. According to meteorological data obtained from iMetos weather station located in this area, June, July and especially September 2014 had much higher rainfall in comparison to 2013 and 2012 when no fig rust was detected. Number of rainy days in period from April to September in 2014 was 82, while in 2013 and 2012 there were 60 and 47 rainy days, respectively. In the same period precipitation (mm) was 796,8 in 2014, while it was 551,4 and 613,4 in 2013 and 2012, respectively. Temperature conditions were very favorable for fig rust development in 2014. From April to September average monthly temperature was 19.5 °C while in 2013 and 2012 it was 20.8 and 21.6 °C, respectively. It can be concluded that slightly lower temperatures in 2014 can be attributed to the refreshment caused by rainfall. Better conditions for fig rust development were more obvious if we compared average monthly temperatures in June, July, August and September when we noticed quite higher temperatures especially in 2012 (for example average monthly temperature in July in 2012 was 27.5°C and in 2014 it was 22.9°C; in August 2012 it was 26.5°C and in 2014 it was 23.8°C; in September 2012 it was 21.1°C and in 2014 it was 18.4°C.

Fig rust is favored by warm and humid weather during vegetation period. In hot and dry conditions it doesn't cause significant damages in fig growing. The rust spores can be spread by wind and rain drops to other plants. Introduction of the disease in New Zealand has been related to its spread by windborne urediniospores from Australia (McKenzie, 1986). According to McKenzie (2013), when rust spores land on the surface of leaves they require at least 14 hours of continuous wetness to germinate. Several days after germination of spores and penetration of the fungus into leaf, small yellowish spots appear on

the upper leaf surface as the first symptoms of the disease. When the vegetation ends, rust spores on fallen leaves overwinter and serve as a source of inoculum for the next season (Verga & Nelson, 2014).

The disease can cause significant damages in areas with rainy summer conditions. It develops usually late in the summer when the infected trees can defoliate in a few weeks due to the disease fast spreading and short incubation period. Sometimes fig rust can appear early in the summer when it can be especially destructive since premature defoliation induce new growth on trees. This new growth can beat out the plant and cause that it come into winter unprepared and susceptible to low temperatures (Mijuskovic, 1963; Ferrin & Overstreet, 2010).

Control measures against fig rust should integrate cultural practices and, if required, chemical control. Cultural practices foresee gathering and destroying of infected leaves together with such a pruning of shoots that allows airflow through the canopy and drying the foliage. It is recommended to avoid sprinkler irrigation that wets the leaves. Irrigation water should be applied at the ground level directly to the soil in the morning (to avoid humidity and leaf wetness during the night). Weed control must be regularly done to reduce relative humidity in fig orchard. If defoliation appears, the trees should be additionally fertilized to stimulate new leaves as soon as possible. These measures are recommended by Verga & Nelson (2014) and Ferrin & Overstreet (2010) and can be recommended to fig growers in Montenegro. Fungicidal control usually is not necessary, especially in Montenegro where rainy summers are exceptional. However, if the disease is present every year, chemical control needs to be applied. Treatment with protective fungicide must be done before the disease appears. Bordeaux mixture, sulphur, zineb or maneb can be used (McKenzie, 1986). Results obtained by Desai (1998) in Karnataka, India showed that, among five applied fungicides, mancozeb (0.2%) was the most effective in controlling fig rust, but also the other fungicides such as tridemorph, wettable sulphur and chlorothalonil.

CONCLUSIONS

Fig is an important agricultural plant in Montenegro. Since fig growing tends to be enlarged and improved, certain diseases effect successful fig production significantly. In 2014 fig trees were attacked by fig rust that occurs in humid and warm conditions during the summer as it was the case in this year. Damages caused by the disease reflected in premature defoliation of trees that influenced on yield. Microscopic observation of infected leaves revealed that the causal agent is *Cerotelium fici* (E.J. Butler).

Since fig rust in Montenegro occurs only occasionally and depends on rainy season during the fig vegetation, chemical measures so far can be avoid and substitute by adequate cultural practices. However, if the disease continues to be a threat to fig growing in years to come, chemical treatment should be considered in the future.

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