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POTATO TUBER SPROUT ROT CAUSED BY *Fusarium sambucinum* IN TURKEY

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Abstract

Fusarium dry rot is one of the most important diseases of potato (Solanum tuberosum L.), affecting the tubers in storage and the seed pieces after planting. Fusarium sambucinum Fuckel - teleomorph Gibberella pulicaris (Fr.) Sacc. - is a common pathogen causing dry rot of stored tubers in temperate areas. To establish strategies for the control of this disease it should be made primarily a correct diagnosis and detection symptoms of disease caused by fungus on potato tuber. Natural infected tubers was exemined macroscopically and incubated in controlled environment chamber. Pathogenicity study carried out in vitro condition that showed both tubers and sprout were diseased and decayed by F. sambucinum. Consequently, the same symptoms were observed both on natural infected and artificially infected tubers. To our knowledge, this is the first report of F. sambucinum causing a sprout rot of developing sprouts on seed tubers in Turkey.

Key words: *Fusarium sambucinum, potato (Solanum tuberosum), sprout rot.*

INTRODUCTION

Potato (*Solanum tuberosum L.*) and its products are known to be the most important source of food for human beings. The annual yield losses of potato crop in the developing countries like Turkey was determined to be 32.4 % because of insect, weed and diseases. of this yield reduction, diseases were responsible of 21 .8 % (Eken et al., 2000). Losses associated with dry rot have been estimated to range from 6 % to 25 %, and occasionally losses as great as 60 % have been reported during long-term storage (Estrada et al., 2010; Secor and Salas, 2001). Thus, many studies have been conducted to decrease yield losses due to diseases and increase the quality and quantity of potato production in the world. Dry rot is caused by a number of *Fusarium* species. *Fusarium sambucinum* Fuckel- teleomorph *Giberella pulicaris* (Fr.) Sacc.- is the most common pathogen causing dry rot of stored tubers in The wold, but other *Fusarium* species are also known to cause dry rot, particularly *F. solani* (Mart.) Sacc. and *F. avenaceum* (Fr.) Sacc. (Boyd, 1972; Hanson et al., 1996; Eken et al., 2000; Borca and Carmen, 2013). In the previous studies, some researchers had identified some species like *Fusarium, Rhizoctonia*, *Helminthosporium*, *Penicillium* and *Doratomyces* from the samples of potato in Turkey. Pathogenicity studies showed that *Fusarium sambucinum*, *F. solani, F. culmorum, F. oxysporum* and *Pythium ultimum* were causing severe rots in potato tubers of three different commercial potato varieties such as cvs. Agria, Granula and Marfona (Eken et al., 2000). Acording to Wharton et al. (2006), *Fusarium sambucinum* was isolated from diseased sprout and tuber tissue from potato in Michigan. After made patohogenicity, Sprouts on inoculated tubers developed symptoms that were observed in the initially collected seed pieces. They highlihted that firs time this symptom had seen on seed tubers sprout in the United States.

To establish strategies for the control of this disease, it should be made primarily a correct diagnosis and identification of the pathogen on potato (Borca and Carmen, 2013). The identification of *Fusarium sambucinum* isolated from potato tubers is performed after obtaining a pure culture using the single spore technique and were made observations regarding the colony growth diameters on agar media (PDA). After an incubation for 10 - 14 days with a daily exposure to light and the microscopic morphology including shape and size of the macroconidia, the presence or the

absence of the microconidia and of the chlamydospores (Burgess and Liddell, 1983).
Also need to know how the disease occurs on the potato (Wharton et al., 2006). The pathogen transmission is correlated with it ability to sporulate underground on the seed tubers or on the stem bases, *Fusarium sambucinum* Fuckel sporulates on the stem (Adams and Lapwood, 1983; Choiseul et al., 2001). The pathogen enters the tuber causing the rot, often rotting out the centre. The rotted cavities are often lined with mycelia and spores of different colours from yellow, to white or even pink (Boyd, 1972).
The aim of this study was to determine new symptom of *Fusarium sambucinum* associated with potato tubers of cv. Lady Rosetta commercially grown in Turkey and a correct diagnosis and identification of the pathogen on potato.

MATERIALS AND METHODS

Examination of natural diseased tubers: Potato tubers of cv. Lady Rosetta (200 tubers) taken from storage in Afyon province in Turkey in 2014 for seed certification control. After all samples were washed with top water and dried in the laboratory, they were macroscopically examined for presence or absence of dry rot on the surface of tubers. Natural infected Uncut potato seeds were kept at 18-25 ^{o}C in dark and light conditions until they sprouted. After sprouting, they were taken on the water-soaked cloth into plastic boxes and incubated in the dark at 18 ^{o}C by 95 % relative humidity for 20 days in controlled environmental chamber. The pathogen isolation was made both from infected tuber and sprouted tissue, were incubated at 24 ^{0}C for 7 days.
The pathogenicity and Isolation : Pathogenicity was tested in Potato tubers of cv. Lady Rosetta with a single isolate collected from diseased sprouts and tubers. Tubers (5-7 cm in diameter) free from symptoms of dry rot and other diseases were selected for the experiments. and washed in running tap water, dipped in sodium hypochlorite (2 %) for 2 min, rinsed twice with double distilled sterile water (10 min each) and air-dried (Hide et al., 1977). For inoculum production, isolate obtained from diseased sprouts and was grown on PDA at 22-24°C for 14 days prior to inoculation. The isolate of fungi grown on the plates was prufied. Whole seed tubers with 5-8 mm long sprouts were cut in half longitudinally with a sterile knife to ensure that seed pieces had viable sprouts. The cut surfaces of seed pieces were spray inoculated with 200 ml of conidial suspension (1×10^4 conidia ml^{-1}) over the entire cut surface to give a final dosage of approximately 1 ml per seed piece (Wharton et al., 2006). Care was taken to limit inoculum spray to the cut surface so that sprouts were not inoculated. Seed pieces (15 per replicate × 4 replicates) were then placed in plastic boxes (40 × 20 × 10 cm) and incubated in the dark at 18°C and 95% relative humidity for for 4 weeks in a controlled environment chamber. As a control, cut seed pieces were spayed with sterile distilled water and incubated as above.
Identification : Identification of the pathogen was based on colonial - and conidial morphology (Booth, 1977; Gerlach and Nirenberg, 1982; Nelson et al., 1983; Hasenekollu, 1991; Leslie and Summerrell, 2006; Borca and Carmen, 2013). Firstly, the single spore technique was used to obtain a pure culture of *F. sambucinum* from diseased tuber and sprout samples. For microscopically identification of the pathogen the observations were made on shape and size of the abundant pink to salmon spores on PDA.

RESULTS AND DISCUSSIONS

Natural diseased tubers were macroscopically examined in laboratory and approximately 50 % of the tubers were found to be contaminated with dry rot. The first symptoms of dry rot were usually dark depressions on the surface of the tuber. In large lesions, the skin becomes wrinkled in concentric rings as the underlying dead tissue desiccates (Fig. 1). When diseased seed were cut in half, Internal symptoms are characterized by necrotic areas shaded from light to dark chocolate brown or black. This necrotic tissue is usually dry. The pathogen enters the tuber, often rotting out the center and rotted cavities are often lined with mycelia and spores of various colors from yellow to white to pink. The pathogen isolation was made from infected tuber tissue on to Potato Dextrose Agar (PDA), were incubated at 24 ^{0}C for 7

days. Eventually, *F. sambucinum* was isolated from all diseased potato.

It was observed that the disease had developed in tubers and sprouts during the waiting period in climate room. All tubers displayed typical Fusarium dry rot symptoms consisting of a brown, dry decay of tuber tissue with mycelia - lined cavities. Sprouts on infected tubers developed symptoms which were observed to cover with white mycelium and spores (Fig. 2). When diseased tuber with sprouts were cut in half, Brown and necrotic lesion could be seen expanding down the center of the sprout in vascular tissue and the base of the sprout in tuber tissue (Fig. 3). Pathogen isolations were made from diseased tuber tissue and infected sprouts on potato dextrose agar (PDA). In both cases, only *Fusarium sambucinum* was reisolated from diseased sprout and tuber tissue.

In pathogenicity study, the symptoms began to appear on tuber 72 hours after pathogen infected. Yellow-reddish symptoms occurred on tuber and they spread from the center to outward. The cracks and sunken were observed on tuber in later stages. After two weeks, the first symptom of disease appeared as brown black bruises on sprouts (Fig. 4). Reisolation has been performed from diseased sprout and tuber tissue. *Fusarium sambucinum* was only isolated.

For identification, it was firstly examined acording to colour change. The pathogen grew more rapidly on PDA plates, forming a thin, initially white mycelial colony turning from peach to orange later and crimson coloration of the colonies were observed from the upside and the underside of petri plate (Fig. 5, 6). For microscopically identification of the pathogen, the observations were made on shape and size of the spores. Conidia were rather uniform in type and size. Macroconidia were abundant, 3-6 septate with pointed apical cell and conspicuous food cell, measuring: 30-40 µm. Microconidia were rare, elliptical and 0-1 septate. None of the isolates formed chlamydospores (Fig. 7). According to Borca and Carmen (2013), the macroconidia have a falcate shape, are slender, comparatively short and usually rather uniform in size. The apical cell is pointed and the basal cell is foot shaped. The number of septa is 3 usually 6 septate. The microconidia are very rare, but found in the aerial mycelia when are present, they have an oval shape with 0 to 1 septate. The spores produced by the fungus culture on the surface of the agar media, vary in abundence. They are usually abundant in sporodochia which usually are orange and form in the center of the culture.

Previous studies have been demonstrated that *F. sambucinum* is important pathogen causing dry rot both in Turkey and the world (Boyd, 1972; Hooker, 1983; Hanson et al., 1996; Eken et al., 2000). According to the result of the study which carried out in USA, reported that the disease caused by the pathogen transmits from the tubers through to sprout (Hanson et al.,1996). However there is no such record in Turkey. This study have showed that the pathogen can kill developing sprouts outright in Turkey. In this case, potato tuber can result in delayed or non-emergence in field, so yield losses may more increase.

As a result, the same symptoms were observed both on natural infected tubers and artificially infected tubers. Since the sprouts of tubers were infected and spread towards the centre of seeds, it is assumed that infection of sprouts is systemic through the tuber (Fig. 3,4). In this case, when sprouts on potato seed affected heavily with *F. sambucinum,* it is thought that yield losses would more increase. To our knowledge, this is the first report of *F. sambucinum* causing rot on potato sprouts developing from seed tubers in Turkey.

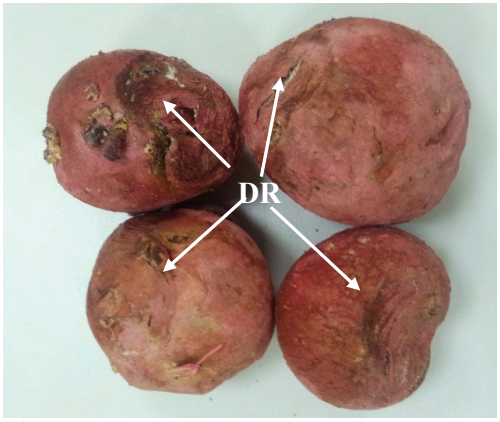

Figure 1. Dry rot symptoms on potato tubers. DR, dry rot

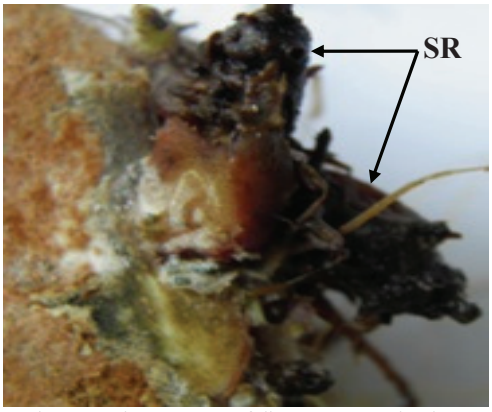

Figure 4. **T**he symptom of disease appeared as brown black bruises on sprouts. SR, sprout rot

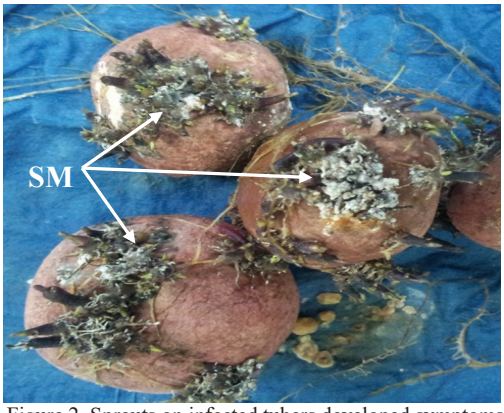

Figure 2. Sprouts on infected tubers developed symptoms to cover with white mycelium. SM, sprouts with mycelia

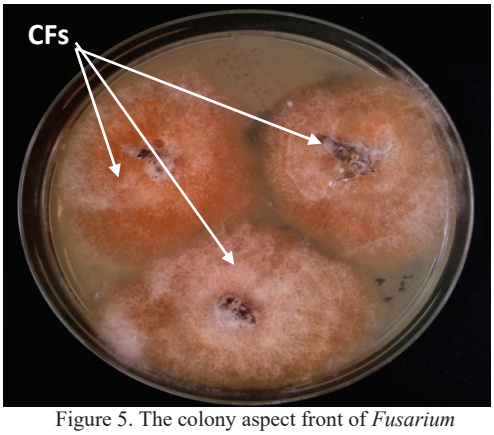

Figure 5. The colony aspect front of *Fusarium sambucinum* on culture media. CFs, Colonies of *Fusarium sambucinum*

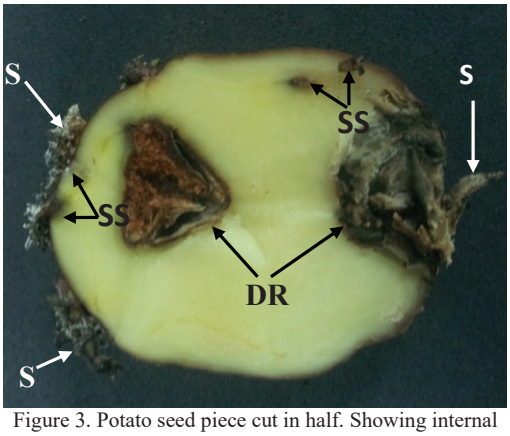

Figure 3. Potato seed piece cut in half. Showing internal symptoms of Fusarium dry rot in the tuber tissue and Fusarium sprout rot. DR, dry rot; S, sprout; SS, systemic symptom

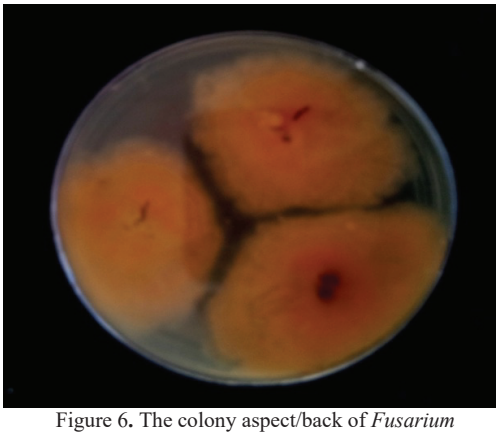

Figure 6**.** The colony aspect/back of *Fusarium sambucinum* on culture media.

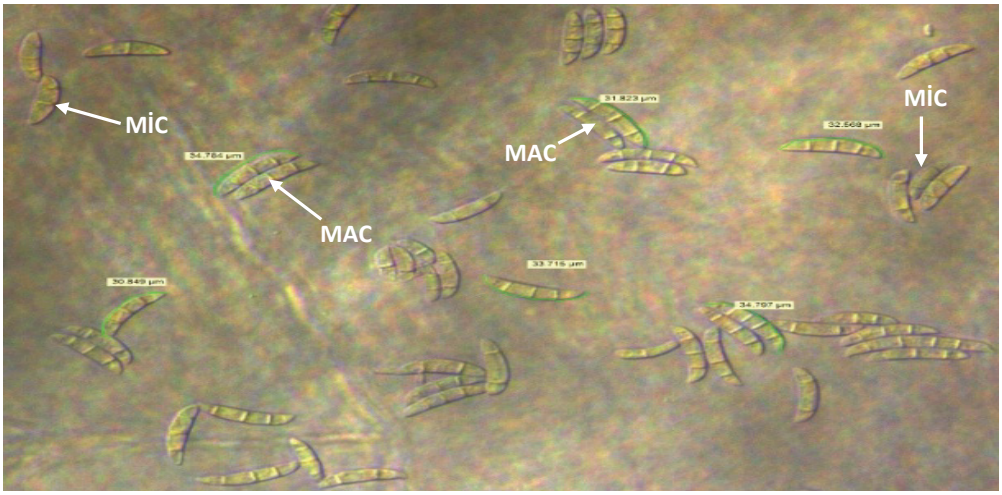

Figure 7. The microscopic view of *Fusarium sambucinum* macro-and microconidia, isolated from potato tubers. MAC, macroconidia; MİC, microconidia

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