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Determination of the Incidence and Severity of Stem Rot Disease of Rice in Samsun, Turkey and Evaluation of Some Rice Cultivars for Resistance

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ABSTRACT

Stem rot disease of rice has previously reported from Turkey many years ago. Since it did not cause severe damage on rice crop, was forgotten for years. Recently, rice growers in Samsun province (Turkey), complained about stem rot disease and *Sclerotium oryzae* was isolated from the diseased plants. In the present study, incidence and severity of the disease in the province and reactions of some rice cultivars against the disease were investigated. As a result of surveys, the disease was found to be common in all rice growing areas of Samsun with 75.1% mean incidence rate and 36.5% severity rate. Pathogenicity trial showed that 'Ribe' cultivar and 'Ergene' cultivars were highly resistant to the disease, while 5 other cultivars were moderately resistant or moderately susceptible. It was determined that stem rot disease with severity rate less than 30% did not significantly affect the heights and fresh weights of rice plants.

Key words: *Oryza sativa*, resistant variety, *Sclerotium oryzae*, Turkey

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important crops in Turkey with the total cultivation area of about 96 754 ha. Rice can be cultivated in the seven geographical regions of Turkey, but the main rice growing areas are Marmara, Thrace and Black Sea Regions. Samsun province, located at the middle of the Black Sea Region, is the third big rice producer province of the country after Edirne and Balıkesir provinces, with a total cultivation area of 9895 ha and production of 81 336 tons/year (Anonymous, 2009). As all agricultural crops, various diseases cause yield losses on rice crop. Most common diseases of rice are caused by fungi, mainly *Magnaporthe oryzae*, *M. salvinii*, *Cochliobolus myabeanus*, *Pythium* spp., *Gibberella fujikuroi*, *Rhizoctonia* group fungi, *Ustilaginoidea virens*, *Sarocladium oryzae* and *Tilletia barclayana* (Anonymous, 1992; Thind and Sharma, 2007).

DETERMINATION OF THE INCIDENCE AND SEVERITY OF STEM ROT DISEASE OF RICE IN SAMSUN, TURKEY AND EVALUATION OF SOME RICE CULTIVARS FOR RESISTANCE

Stem rot disease, caused by *Sclerotium oryzae* Cattaneo (sclerotial state of *Magnaporthe salvinii*. (Catt.) R. Krause & R. K. Webster) occurs in most rice-growing regions of the world. The stem rot pathogen is most often found in its sclerotial state; survives in soil or in crop residue as sclerotia and they serve as primary inoculum by floating on the water (Bockus et al., 1979; Citans and Webster, 2001; Hussain and Ghaffar, 1993). The initial symptoms of stem rot appear after mid-tillering as very small irregular black lesions on the outer leaf sheaths and progresses into the inner leaf sheaths forming bigger lesions. Damage caused by the fungus involves unfilled panicles, death of young tillers, chalky grain, and lodging. Stem rot is a serious disease causing yield losses (Ou, 1972; Krause and Webster 1973; Cother and Nichol, 1999).

It is known that blast caused by *Magnaporthe oryzae* B. C. Couch, brown spot caused by *Cochliobolus myabeanus* (Ito et Kurib.) Drechsl. ex Dastur and Bakanae caused by *Gibberella fujikuroi* (Saw.) Wollenw. are the main diseases of the rice cultivation areas of Turkey (Aktaş ve Tunalı, 1986; Sürek, 1995). Stem rot disease was previously reported from Tosya (Kastamonu) and Nallıhan (Ankara) districts (Bremer and Özkan, 1946). However, no detailed investigation was performed on the disease, till then. Recently, rice growers in Samsun started complaining about a disease causing yield losses. Examinations and isolations from the diseased plants continuously yielded stem rot fungus, *S. oryzae*. Thus, it was aimed in this study to determine; the incidence and severity of stem rot disease in Samsun province, and susceptibility of some cultivars against the disease.

MATERIALS and METHODS

Sampling and isolation of the pathogen

Surveys were performed in six districts of Samsun province having rice plantations (Alacam, Bafra, Carşamba, Ondokuz Mayıs, Tekkeköy and Terme) in 2006. Plants showing stem rot symptoms were searched when the fields were being drained for harvest (Cintas and Webster, 2001; Cother and Nicol, 1999). In order to determine stem rot incidence and severity, plant stems especially at the water line were examined in terms of lesions and sclerotia, and evaluated for disease severity by using a 0-9 scale, where 0= no incidence, 1=less than 1%, 3=1-5%, 5=6-25%, 7=26-50%, and 9=51-100% (Anonymous, 1996).

Rice plants showing stem rot symptoms were taken to the laboratory. Affected stems were washed under running tap water, surface-disinfected in 0.5% sodium hypochlorite (NaOCl) for 2-3 minutes, rinsed in sterile distilled water (SDW) and blotted dry on sterile paper towels. Stem pieces were then placed on 2% water agar (WA) in petri dishes. After incubation for a few days at 22±2ºC in the dark, hyphae were examined microscopically, and were transferred to plates containing potato dextrose agar (PDA; Oxoid Ltd, Basingstoke, UK). Cultures were maintained and stored on PDA slants at 5ºC (Erper et al., 2006).

Pathogenicity test

In order to determine the susceptibility of rice cultivars, pot assay was used in the pathogenicity test. Rice cultivars; 'Baldo', 'Ergene', 'Koral', 'Kral', 'Osmancık', 'Ribe' and 'Rocca', cultivated in the region and, one isolate of *S. oryzae* (Baf-55) obtained from an heavily infected plant in Bafra district were selected for the study. Baf-55 isolate was grown on PDA at 25°C in the dark. Ten seeds of each cultivar were planted in 30 cm diameter pots and thinned to five seedlings per pot, 11 days after sowing (DAS). Pots were fertilized with 1 g of ammonium sulfate $(NH_4)_2SO_4$ (equivalent to 200 kg /ha) and sufficiently watered 20 DAS. A 5 mm agar disc of the fungus was placed against each of randomly chosen four tillers of each plant, at water level, 64 DAS, and covered with parafilm. Each disc contained 14 to 40 (mean 26) sclerotia. The trial was performed in a randomized complete block design and three replications were used. Control plants were treated with agar discs without fungus (Cother and Nicol, 1999). Plants were grown to maturity, drained 135 DAS and harvested 145 DAS. Rice plants were cut longitudinally and plant heights and fresh weights were measured. Disease severity of the inoculated plants was rated by using 0-9 scale (Anonymous, 1996). All data were subjected to analyses of variance and significance of differences was determined according to the Duncan's multiple range test ($P \leq 0.05$). Resistance of the cultivars against the disease were evaluated according to their disease severity rates (1-10%: highly resistant, 11-20%: resistant, 21-30%: moderately resistant, 31-50%: moderately susceptible, 51-70%: susceptible, and 71-100%: highly susceptible) (Bhuiyan and Arai, 1994).

RESULTS and DISCUSSION

Incidence and severity of stem rot disease

Stem rot disease caused by *S. oryzae* has previously been reported from Ankara and Kastamonu provinces (Bremer and Özkan, 1946), but it was reported from rice plants grown in Samsun province for the first time. The present study showed that stem rot disease was common in all rice growing areas of the Samsun province, both in the eastern districts (Tekkekoy, Carsamba, Terme) and western districts (Alacam, Bafra, Ondokuz Mayis). The disease was found in all districts having rice plantations, with varying degrees. Mean disease incidence was 75.1% and disease severity was 36.5% in the province.

The highest disease incidence and disease severity were found in Alacam, Tekkekoy and Terme districts (Table 1). Since same cultivars has been grown and similar agricultural practices have been applied in the rice fields in the region, high incidence and severity of the disease can be attributed to the high inoculum level of the fields depending on the continuous rice cultivation. In addition, it was observed that most of the growers had left crop debris in the field after harvest. It is known that the

fungus survives as sclerotia for many years and management of crop debris is very important to minimize the inoculum (Bockus et al., 1979; Cother and Nicol, 1999).

Table 1. Rice growing areas and stem rot disease incidence and severity in Samsun province

District	Growing area (ha)[x]	Surveyed area (da)	Disease incidence (%)	Disease severity (%)
Alacam	1500	235	99.0	42.6
Bafra	5000	655	69.6	30.6
Carsamba	750	45	34.0	12.7
Ondokuz Mayıs	250	50	52.7	20.5
Tekkekoy	291	57	93.1	67.8
Terme	2000	420	90.5	56.2
Total	9791	1462		
Mean			75.1	36.5

[x]From the registrations of Samsun Directorate of Ministry of Agriculture and Rural Affairs, 2004

Cultural practices such as burning or deep burial of the debris, and winter flooding as an alternative are known to be effective against the disease (Cintas and Webster, 2001). It was also determined that potassium deficiency increased stem rot incidence and deep burial of rice straw returned the potassium in the residue back to the soil (Williams and Smith, 2001; Slaton et al., 2008). Thus, management strategies, such as potassium fertilization and burial of straw, are needed to be investigated in our region.

Susceptibility of rice cultivars against stem rot disease

In terms of disease symptoms, rice cultivars tested in this study indicated different degrees of susceptibility against stem rot disease (Figure 1). 'Rocca' cultivar was determined as moderately susceptible against stem rot disease with highest disease severity (Table 2).

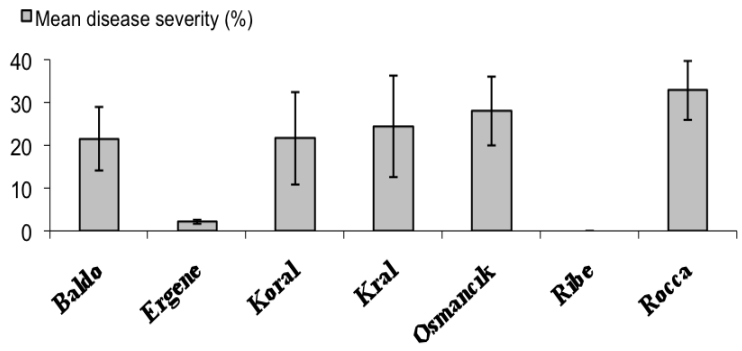

Figure 1. Stem rot disease severity (%) of rice cultivars inoculated with *Sclerotium oryzae*. Vertical lines represent standard errors of the means

'Ribe' was found to be the most resistant cultivar and according to the results of this study it can be decided as immune to the disease, that no symptoms were observed on it. But before the assignment of this cultivar as immune to the disease, it should be checked under different experimental conditions. 'Ergene' was also highly resistant to the disease and showed slight symptoms. According to the Duncan's multiple range test, it ranked between 'Ribe' and moderately resistant cultivars. Moderately resistant 'Osmancık' cultivar with 28% mean severity is known as the most common cultivar cultivated in the region. It is especially cultivated in the coastal areas, since it is known as resistant against rice blast disease. All other cultivars having slighter symptoms were not significantly different from each other. Determination of cultivars with better tolerance have mentioned as a practical approach to control stem rot disease (Carreres et al., 1995; Notteghem et al., 1995).

Table 2. Influence of *Sclerotium oryzae* inoculation on heights, fresh weights and disease severity rates of rice cultivars

Rice cultivars	Plant height (cm)		Fresh weight (g)		Mean disease severity (%)[z]
	Inoculated plants	Control plants	Inoculated plants	Control plants	
Baldo	64.93 AB[x] a[y]	68.67 A a	4.95 BC a	4.94 B a	21.53 BC
Ergene	63.44 AB a	60.92 A a	4.30 C a	4.33 B a	2.13 AB
Koral	57.55 B a	67.13 A a	3.84 C a	4.23 B a	21.62 BC
Kral	57.92 B a	60.93 A a	3.98 C a	4.05 B a	24.42 BC
Osmancık	68.60 A a	65.08 A a	5.90 AB a	5.26 B a	28.00 C
Ribe	67.00 A a	66.23 A a	6.87 A a	7.74 A a	0.00 A
Rocca	65.14 AB a	65.50 A a	4.90 BC a	4.98 B a	32.82 C

[x] Values represent the averages of potentially 15 plants. Mean values in columns marked by the same uppercase letter were not significantly different from each other according to Duncan's multiple range test ($p \leq 0.05$).

[y] Mean values of plant height and fresh weight in adjacent rows marked by the same lowercase letter were not significantly different from each other according to Student's t-test.

[z] Disease severity was assigned to each plant on a scale of 0-9, in which 0= no incidence, 1=less than 1%, 3=1-5%, 5=6-25%, 7=26-50%, and 9=51-100%. Data were subjected to an arcsin square root transformation before analysis and converted back to percentages for presentation.

No significant difference was found among the heights of non-inoculated rice cultivars, while slight differences occur when they were inoculated with stem rot fungus (Figure 2). Similarly, fresh weights of all cultivars except 'Ribe' were not significantly different from each other in control pots, but they slightly differed when inoculated (Figure 3). However, when the variables of each cultivar was analyzed by Student's t-test, it was found that stem rot disease had no effect on the height and fresh weights of rice plants, since those variables did not significantly differ with severity rates in the study. Identically, it was previously reported that disease severity was not correlated with the yield loss and infected tillers yielded higher grain weights than uninoculated tillers in some cultivars (Cother and Nicol, 1999).

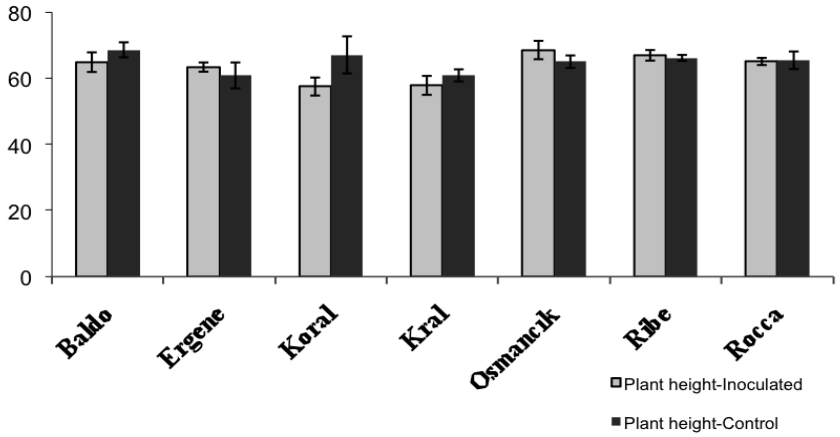

Figure 2. Influence of *Sclerotium oryzae* inoculation on the heights of rice cultivars. Vertical lines represent standard errors of the means

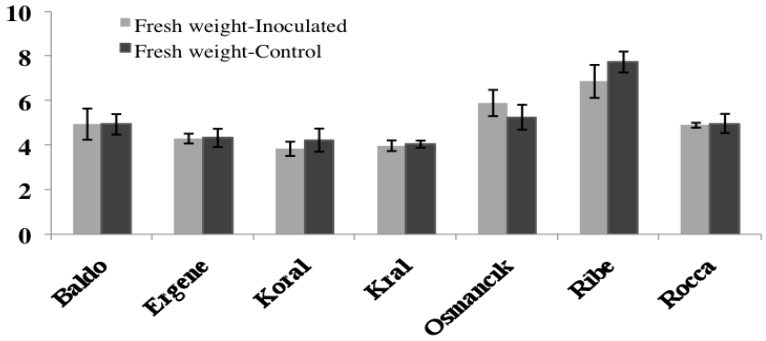

Figure 3. Influence of *Sclerotium oryzae* inoculation on fresh weights of rice cultivars. Vertical lines represent standard errors of the means

In this study, *S. oryzae* was reported from rice plants grown in Samsun province for the first time. Furthermore, incidence and severity of the stem rot disease was rather high in some rice growing areas in the province. Pathogenicity tests showed that 'Ribe' and 'Ergene' cultivars showed high resistance to the disease, while 5 other cultivars were moderately resistant or moderately susceptible. In addition, it can be mentioned that stem rot disease with severity rate less than 30% did not significantly affect the heights and fresh weights of the rice cultivars used in this study. Since disease severity rates in the fields in some districts were higher than those in the pathogenicity trial, it can be mentioned that the inoculum level of the pathogen in the fields was higher than the level that we used in the trial. Inoculation method used in the study was reported to be effective to cause severe disease on plants and could be used to test susceptibility

(Cother and Nicol, 1999). Fungal isolate used in the trial was obtained from a heavily infested plant, but maybe it's virulence was lower under trial conditions.

In conclusion, owing to the fact that rice has continuously been grown in the region and inoculum density of the pathogen has been increasing year by year, effective strategies to control stem rot disease should urgently be investigated. Firstly, cultivars seemed to be more resistant should be recommended to the rice growers and they should also be encouraged to use cultural practices controlling the disease.

ÖZET

ÇELTİK SAP ÇÜRÜKLÜĞÜ HASTALIĞININ SAMSUN'DAKİ YAYGINLIĞI, ŞİDDETİ VE BAZI ÇELTİK ÇEŞİTLERİNİN HASTALIĞA KARŞI DUYARLILIKLARININ BELİRLENMESİ

Çeltik sap çürüklüğü hastalığı Türkiye'de yıllar önce belirlendiği halde zararı çok düşük seviyede olduğu için önemsenmemektedir. Son yıllarda Samsun ilindeki çeltik üreticilerinden sap çürüklüğü hakkında şikayetler gelmiş ve hastalıklı bitkilerden *Sclerotium oryzae* izole edilmiştir. Bu çalışmada, hastalığın ildeki yaygınlığı ve şiddeti ile bazı çeltik çeşitlerinin hastalığa karşı duyarlılıkları incelenmiştir. Sörvey çalışmaları, Samsun ili çeltik alanlarında hastalığın % 75.1 yaygınlık oranı ve % 36.5 hastalık şiddeti ile yaygın olarak bulunduğunu göstermiştir. Patojenite denemeleri ise; 'Ribe' ve 'Ergene' çeşitlerinin yüksek derecede dayanıklı, diğer 5 çeşidin ise orta decede dayanıklı veya orta derecede hassas olduğunu ortaya koymuştur. Çalışmada ayrıca hastalık şiddeti % 30'dan daha az olduğunda çeltik bitkilerinin boy ve yaş ağırlıklarının önemli derecede etkilenmediği saptanmıştır.

Anahtar Kelimeler: dayanıklı çeşit, *Oryza sativa*, *Sclerotium oryzae*, Türkiye

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