ANASTOMOSIS GROUPS AND PATHOGENICITY OF *RHIZOCTONIA SOLANI* AND BINUCLEATE *RHIZOCTONIA* ISOLATES FROM BEAN IN ERZURUM, TURKEY

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SUMMARY

Two hundred twenty seven isolates of *Rhizoctonia* spp. were obtained from roots and hypocotyls of bean (*Phaseolus vulgaris*) grown in Erzurum, Turkey. Of these, 111 *Rhizoctonia solani* were identified as belonging to seven anastomosis groups (AG): AG-2-1 (0.9%), AG-3 (2.7%), AG-4 (47.8%), AG-5 (36.9%), AG-9 (8.1%), AG-10 (0.9%) and AG-11 (2.7%); 116 binucleate *Rhizoctonia* belonged to four anastomosis groups: AG-A (1.7%), AG-F (4.3%), AG-G (7.8%), and AG-K (86.2%). *In vitro* pathogenicity tests on bean cultivars showed that the highest disease severities were caused by AG-5 (B-1) and AG-4 (B-227) isolates, whereas AG-G (B-16, B-3) and AG-F (B-5) isolates were weakly pathogenic. On the other hand, the other anastomosis groups of *R. solani* (AG-2-1, AG-3, AG-9, AG-10 and AG-11), and binucleate *Rhizoctonia* (AG-A, and AG-K) were not pathogenic on the five tested bean cultivars. 'Şeker' was found to be the most resistant cultivar, and 'Terzibaba' was the most susceptible cultivar across all *Rhizoctonia* spp. tested. This is the first report of *R. solani* AG-2-1, AG-3, AG-9, AG-10, AG-11 and binucleate *Rhizoctonia* AG-F and AG-G on bean in Turkey.

Key words: *Rhizoctonia*, bean, anastomosis group, pathogenicity.

INTRODUCTION

Rhizoctonia solani Kühn [teleomorph: *Thanatephorus cucumeris* (Frank) Donk.] and binucleate *Rhizoctonia* (teleomorph: *Ceratobasidium* Rogers) are divided into anastomosis groups (AG) based on hyphal anastomosis reactions between isolates. *R. solani* is composed of 14 AGs designated as AG-1 through 13 and AG-bridging isolate (AG-BI) (Sneh *et al.,* 1991; Ogoshi, 1996; Carling *et al.,* 1999, 2002). Binucleate *Rhizoctonia* isolates are grouped into AG-A to AG-S (Sneh *et al.*, 1991).

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R. solani is a soilborne pathogen which attacks a wide range of plants (Ogoshi, 1996). In bean (*Phaseolus vulgaris* L.), *R. solani* can cause several types of damage, including hypocotyl rot, root rot and web blight (Galindo *et al.,* 1982, 1983a,b; Sumner 1985). AG-4 is the major AG worldwide, causing root rot in the bean. Additionally, other AGs (AG-1, AG-1-IB, AG-2-1, AG-2-2) have been reported on bean (Galindo *et al.,* 1982; Galindo *et al.,* 1983a,b; Sumner 1985; Bolkan and Ribeiro, 1985; Ogoshi, 1987; Muyolo *et al.,* 1993a; Echávez-Badel *et al.*, 2000). In Turkey, some *R. solani* AGs (AG-1, AG-4, AG-5) and binucleate *Rhizoctonia* (AG-A, AG-E, AG-I, AG-K) have been recognized on bean (Demirci and Döken, 1995; Demirci and Çağlar, 1998).

The objectives of this report were to determine the species and anastomosis groups of *Rhizoctonia* present in bean plants in Erzurum, and to evaluate their pathogenicity on several bean cultivars.

MATERIALS AND METHODS

Sampling, isolation and identification of *Rhizoctonia*. Bean plants were randomly collected from fields in seven districts (Center, Narman, Tortum, Pasinler, Uzundere, İspir and Oltu) of Erzurum during 1998 and 1999. Isolations were made from discolored or necrotic lesions on root and hypocotyl tissues. Affected bean tissues were washed under running tap water, surface disinfected in 0.5% sodium hypochlorite for 1 min and placed on 1.5% water agar containing 50 mg l^{-1} streptomycin sulfate (Demirci and Döken, 1993). After 48-72 h incubation at 20-25°C, hyphae from the margin of each developing colony were placed on water agar or potato dextrose agar (PDA). *Rhizoctonia* isolates were transferred to PDA slants and stored at 10°C.

The isolates of *Rhizoctonia* were identified on the basis of characteristics of their vegetative hyphae (Ogoshi, 1975), nuclear condition (Bandoni, 1979), requirement for thiamine (Rovira *et al.*, 1986), and hyphal anastomosis with known tester strains of *R. solani* and binucleate *Rhizoctonia* by using standardized techniques for anastomosis group determination (Parmeter *et al.,* 1969). Tester strains of *R. solani* (AG-1, AG-2-1, AG-2-2, AG-

3, AG-4, AG-5, AG-6, AG-7, AG-8, AG-9, AG-10, AG-11, AG-12, AG-13, and AG-BI) were provided by Dr. A. Ogoshi, Hokkaido University, Japan, Dr. D.E. Carling, University of Alaska Fairbanks, USA, Dr. S.M. Neate, CSIRO, Division of Soils, Australia, and Dr. D.A. Carter, University of Sydney, Australia. Tester strains of binucleate *Rhizoctonia* (AG-A, AG-Ba, AG-Bb, AG-C, AG-D, AG-E, AG-F, AG-G, AG-H, AG-I, AG-K, AG-L, AG-N, AG-O, AG-P, AG-Q, AG-J, AG-R and AG-S) were provided by Dr. A. Ogoshi, Hokkaido University, Japan, and Dr. M. Mazzola, Tree Fruit Research Laboratory, Western Ave., USA.

***In vitro* pathogenicity test.** Two isolates from each group having more than one isolate, twenty in total, were randomly selected for assessing their pathogenicity on the bean cvs Aziziye-98, Dermason, Şeker, Terzibaba, and Yakutiye. An agar plate assay was adapted from the method of Muyolo *et al*. (1993a). Seeds were surface disinfested in 1% NaOCl for 5 min, and air-dried before use. Ten seeds of each host were placed on 20 ml of sterile 1.5% water agar in 15-cm-diam. Petri dishes. The center of each dish was subsequently inoculated with a 10-mm-diam. mycelial disk from a 2-3-day-old colony grown on PDA. Cultures were incubated 4 days at 25±1°C in the darkness. Then the cultures were placed on a laboratory bench under 12 h light and 12 h dark. The experimental design was a randomized complete block with four replications. Disease severity was rated 10 days after inoculation using the following 1-5 scale: 1 = no symptoms, normal root development; 2 = localized tissue discoloration without necrosis, near-normal root development; 3 = localized lesions with extensive tissue discoloration, near-normal root development; 4 = nearly complete root necrosis, partially restricted root length; and 5 = complete root rot, root length severely restricted (Muyolo *et al.*, 1993b).

As all data showed normal distribution, they were directly analyzed by analysis of variance (ANOVA) with CoStat Version 6.2 software (CoHort Software, Monterey, CA, USA). Least significant differences (Fisher's protected LSD) were calculated following significant *F* tests.

RESULTS

***Rhizoctonia* species and anastomosis groups.** Of 227 isolates of *Rhizoctonia* spp. collected from bean, 111 were identified as *R. solani* and 116 were binucleate *Rhizoctonia* (Table 1). Isolates of *R. solani* were distinguished in seven anastomosis groups: AG-2-1 (0.9%), AG-3 (2.7%), AG-4 (47.8%), AG-5 (36.9%), AG-9 (8.1%), AG-10 (0.9%), and AG-11 (2.7%). Isolates of binucleate *Rhizoctonia* were distinguished in four anastomosis groups: AG-A (1.7%), AG-F (4.3%), AG-G (7.8%), and AG-K (86.2%).

Table 1. Number of isolates of *Rhizoctonia* species and anastomosis groups isolated from bean in Erzurum, Turkey.

Species and Anastomosis Groups (AGs)	Number of isolates
Rhizoctonia solani	
AG-2-1	1
AG-3	3
AG-4	53
AG-5	41
AG-9	9
AG-10	1
AG-11	3
Binucleate *Rhizoctonia*	
AG-A	2
AG-F	5
AG-G	9
AG-K	100
Total	227

Pathogenicity. Isolates of *R. solani* and isolates representing different anastomosis groups of binucleate *Rhizoctonia* varied in virulence (Table 2) and differences among the isolates were statistically significant. *R. solani* AG-5 (B-1, B62) and AG-4 (B-227, B-35) isolates were found to be the most virulent. AG-5 and AG-4 isolates caused more severe disease on hypocotyls than on roots. The AG-G (B-16, B-3) and AG-F (B-5) isolates were found to be weakly pathogenic, whereas isolates of the other anastomosis groups of *R. solani* (AG-2-1, AG-3, AG-9, AG-10 and AG-11) and binucleate *Rhizoctonia* (AG-A, and AG-K) were not pathogenic on the five bean cultivars tested. When the results with all the isolates were examined together, it was found that there were significantly statistical differences between the bean cultivars. 'Terzibaba' was found to be the most susceptible cultivar, while Şeker appeared to be much less susceptible than Aras-98, Dermason and Yakutiye (Fig. 1).

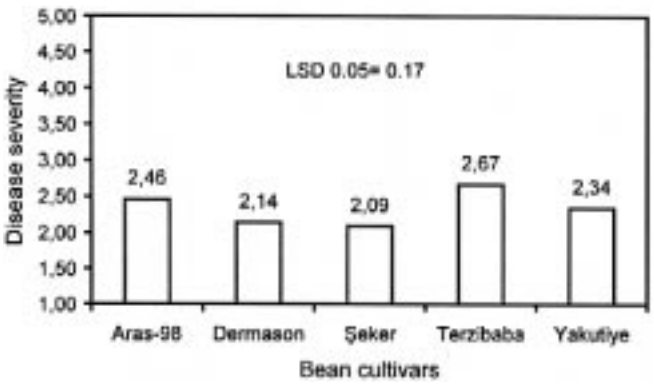

Fig. 1. Disease severity induced by *Rhizoctonia.*

Table 2. Pathogenicity of *Rhizoctonia solani* and binucleate *Rhizoctonia* on different bean cultivars.

Isolate	Bean cultivars and disease severity [a]					
	Aras-98	Dermason	Seker	Terzibaba	Yakutiye	Mean
Rhizoctonia solani						
AG-2-1 (B-87)	1.90	1.41	1.33	1.97	1.57	1.64
AG-3 (B-90)	2.53	1.95	2.09	2.37	2.37	2.21
AG-3 (B-49)	1.98	1.60	1.83	2.48	2.18	2.01
AG-4 (B-227)	3.92	2.89	3.27	3.90	3.53	3.50
AG-4 (B-35)	3.51	2.81	2.83	3.92	3.14	3.24
AG-5 (B-1)	3.80	3.79	3.63	4.22	3.78	3.84
AG-5 (B-62)	3.95	3.33	2.80	3.93	2.43	3.29
AG-9 (B-191)	1.94	1.72	1.46	1.95	1.37	1.69
AG-9 (B-169)	1.71	1.45	1.39	1.97	1.73	1.65
AG-10 (B-25)	1.62	1.14	1.26	1.76	1.57	1.47
AG-11 (B-107)	2.20	2.44	2.04	2.53	2.21	2.28
AG-11 (B-171)	2.07	2.23	2.09	2.49	2.18	2.21
Binucleate *Rhizoctonia*						
AG-A (B-30)	1.86	1.34	1.66	1.99	1.93	1.76
AG-A (B-54)	1.92	1.37	1.55	1.77	2.01	1.72
AG-F (B-5)	2.18	2.54	2.23	3.13	3.04	2.62
AG-F (B-29)	2.47	1.76	1.39	2.39	1.97	1.99
AG-G (B-16)	2.94	2.91	2.91	3.35	3.24	3.07
AG-G (B-3)	2.88	2.62	2.63	3.24	3.03	2.88
AG-K (B-183)	2.30	1.78	1.68	2.05	1.72	1.90
AG-K (B-145)	1.83	1.51	1.75	2.01	1.70	1.76
LSD [b]	0.95	0.51	0.59	0.96	0.82	0.34

[a] On a scale from 1 to 5, where 1 = no lesions and 5 = complete root rot.
[b] Means compared with Fisher's protected least significant difference (LSD) (P = 0.05).

DISCUSSION

Of all the *Rhizoctonia* isolates sampled from bean in Erzurum, 48.9% were *R. solani* (AG-2-1, AG-3, AG-4, AG-5, AG-9, AG-10 and AG-11), and 51.1% were binucleate *Rhizoctonia* (AG-A, AG-F, AG-G and AG-K). In a study carried out in Eastern Anatolia of Turkey, only *R. solani* AG-1, AG-4, AG-5, and binucleate *Rhizoctonia* AG-A, AG-E, AG-I, AG-K, were detected in bean (Demirci and Döken, 1995; Demirci and Çağlar, 1998). Hence, in the present study, AG-2-1, AG-3, AG-9, AG-10 and AG-11 of *R. solani* and AG-F and AG-G of binucleate *Rhizoctonia* were isolated from bean for the first time in Turkey.

Based on the results of pathogenicity tests, the highest disease ratings on bean seedlings were induced by the isolates of AG-4 and AG-5 of *R. solani*. Galindo *et al.* (1982) reported that isolates belonging to the AG-1, AG-2 and AG-4 were capable of infecting common bean leaves and hypocotyls in the greenhouse. AG-4 isolates obtained from soil, seeds and hypocotyls were pathogenic to leaves and hypocotyls of common bean and lima bean (Sumner, 1985; Bolkan and Ribeiro, 1985). Isolates of AG-4 have been reported as highly virulent to dry bean and soybeans (Phillips, 1991). However, Ogoshi (1996) reported that AG-5 isolates were weakly pathogenic or not pathogenic on plants. In contrast, Eken and Demirci (2003) reported that AG-4 and AG-5 were pathogenic to forage legumes. *R. solani* isolates belonging to AG-2-1, AG-3, AG-9, AG-10 and AG-11 were not pathogenic on all five bean cultivars tested. The isolates of binucleate *Rhizoctonia* AG-G and AG-F (B-5) isolates were weakly pathogenic on bean cultivars, whereas the other binucleate *Rhizoctonia* (AG-A, AG-K) were not pathogenic. Some AG isolates of binucleate *Rhizoctonia* have been reported as pathogenic, avirulent

or weakly pathogenic on cultivated plants (Sanders *et al.,* 1978; Burpee *et al.,* 1980; Hurd and Grisham, 1983; Sumner, 1985; Eken and Demirci, 2003).

In the present study, *R. solani* and binucleate *Rhizoctonia* isolates obtained from beans caused varying severity of root rot and hypocotyls lesions on bean cvs. Aras-98, Dermason, Şeker, Terzibaba and Yakutiye. Terzibaba was found to be the most susceptible bean cultivar. Our results indicate that there is potential for selecting bean cultivars resistant to *Rhizoctonia* by using agar plate assay methods. Muyolo *et al.* (1993a) reported that agar plate assays represent an acceptable preliminary method of assessing variation in virulence among anastomosis groups.

Rhizoctonia spp. are significant soilborne plant pathogens and cause diseases of roots and hypocotyls of bean crop in Erzurum, Turkey. Hence, suitable cultural practices, such as the use of resistant cultivars and the improvement of soil conditions, are highly recommended.

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