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Fungal Diseases and Their Prevalence in Bean Cultivation Areas of Türkiye

Sirel CANPOLAT[1,a,*], Senem TÜLEK[2,b], Abdulaziz YAĞMUR[3,c], Duygu MERMER DOĞU[4,d]

[1*] *Republic of Türkiye Ministry of Agriculture and Forestry, Ankara, Türkiye*
[2] *Republic of Türkiye Ministry of Agriculture and Forestry, Ankara, Türkiye*
[3] *Republic of Türkiye Ministry of Agriculture and Forestry, Ankara, Türkiye*
[4] *Republic of Türkiye Ministry of Agriculture and Forestry, Ankara, Türkiye*

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ABSTRACT

Türkiye has a significant position in legume production. According to 2023 data, Türkiye ranks 19th for dry bean production and 4th for fresh bean production worldwide. Due to the increase in fungal diseases, bean production and quality have recently shown a great reduction. One of the critical diseases affecting bean production is root and collar rots. In the study, the occurrence of fungal diseases causing root rot was investigated in nine different provinces of Türkiye, primarily in Eskişehir, Balıkesir, Kütahya, Bursa, Niğde, Nevşehir, Burdur, Karaman and Konya. Surveys were carried out in these nine provinces in 2018 and 2019 for the main production areas. During the surveys, plants showing damping-off, necrosis on the roots, yellowing on the leaves, discoloration on the vascular elements, wilting and drying symptoms were collected. From the diseased plants, 214 *Fusarium* spp., 83 *Rhizoctonia* sp., 32 *Macrophomina* sp., 12 *Alternaria* spp., 11 *Athelia* sp., 4 *Ceratobasidium* sp., 4 *Bionectria* sp., 1 *Trichoderma* spp. and 1 *Phythium* sp. isolates were obtained. The most common of these fungal genera was *Fusarium* spp. with a prevalence rate of 16.2%.

Keywords: *Phaseolus vulgaris*, root rot diseases, common pathogens

Türkiye'de Fasulye Ekim Alanlarında Görülen Fungal Hastalıklar ve Yaygınlıkları

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ÖZ

Türkiye, baklagil üretiminde önemli bir konuma sahiptir. 2023 üretim yılı verilerine göre, Türkiye 305 bin tonluk kuru fasulye üretimi ile dünyada 19. sırada; 519 bin tonluk taze fasulye üretimi ile de dünyada 4. sırada yer almaktadır. Son yıllarda fungal hastalıkların artması nedeniyle fasulye üretimi ve kalitesi büyük oranda düşmüştür. Fasulye üretimini etkileyen kritik hastalıklardan biri kök ve kök boğazı çürüklüğü olup, bu çalışma ile başta Eskişehir, Balıkesir, Kütahya, Bursa, Niğde, Nevşehir, Burdur, Karaman ve Konya olmak üzere Türkiye'nin 9 ilinde kök çürüklüğüne neden olan fungal hastalıklar araştırılmıştır. Bu dokuz ilde ana üretim alanları için 2018 ve 2019 yıllarında sürveyler yapılmıştır. Sürveylerde çökerten, köklerde nekroz, yapraklarda sararma, vasküler elemanlarda renk değişikliği, solgunluk ve kuruma belirtileri gösteren bitkiler toplanmıştır. Hastalıklı bitkilerden izolasyonlar yapılmış ve 214 adet *Fusarium* spp., 83 adet *Rhizoctonia* sp., 32 adet *Macrophomina* sp., 12 adet *Alternaria* spp., 11 adet *Athelia* sp., 4 adet *Ceratobasidium* sp., 4 adet *Bionectria* sp, 1 adet *Trichoderma* spp. ve 1 adet *Phythium* sp. izolatı elde edilmiştir. Bu fungal cinslerden en yaygın olanı %16.2 yaygınlık oranıyla *Fusarium* spp. olmuştur.

Anahtar kelimeler: *Phaseolus vulgaris*, kök çürüklük hastalıkları, yaygın patojenler

[a] *sirelozan_18@hotmail.com* *0000-0003-4595-6148*
[b] *senem.tulek@tarimorman.gov.tr* *0000-0002-7364-4750*
[c] *abdulaziz.yagmur@tarimorman.gov.tr* *0000-0003-0960-6714*
[d] *duygumermer@gmail.com* *0000-0003-4577-1741*

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Introduction

The common bean (*Phaseolus vulgaris* L.) is one of the most important legumes in the world and Türkiye, and is used in meals fresh and dry, as well as frozen, canned, and pickled. It is an important cultivated plant, being an indispensable legume in human nutrition due to its high protein and carbohydrate content. The bean, which is the most regularly distributed food source in the world, is the main staple legume, especially on the American continents (Sikora et al. 2018; FAO 2023). In Asia, which accounts for more than 50% of the world's bean production areas, India has 40.8% of the dry bean production areas and provides 22.1% of the production. European countries have only 2% of the world's planted area (Sikora et al. 2018). In the 2022-23 production season, the world produced approximately 27.4 million tons of dry beans. India, Myanmar and Brazil have had a significant influence on global dry bean production over the past five years. Türkiye ranks 19th globally with 305 thousand tons of dry beans and 4th with 519 thousand tons of fresh beans (FAO 2023). Among the countries exporting beans to the world in 2021, Türkiye ranked 5th with 110 thousand tons; however, its exports dropped by 22% to 7th place in 2022. There has been a notable surge in imports over the past five years, with Turkey ranking second among the nations with the largest increases in imports (170%), behind Iraq (294%), which has seen the largest increase (Anonymous 2023).

Although beans rank first in the world among cultivated edible grain legumes, they are in third place in our country after chickpeas and lentils. When Türkiye's dry bean planting areas are examined by geographical regions, in 2022, approximately 97.100 ha of the planting area consisted of 57.8% Central Anatolia (561 thousand decares), 20.7% Eastern Anatolia (201 thousand), 8.3% Black Sea (81 thousand), 4.3% Mediterranean (42 thousand), 4.6% Aegean (45 thousand), 4% Marmara (39 thousand) and 0.3% Southeastern Anatolia Region with approximately 3 thousand decares. In 2023, Niğde was in first place with 150 thousand decares in Türkiye's dry bean planting areas, while Nevşehir was in second place with 118 thousand decares, and Bitlis was in third place with 97 thousand decares (Anonymous 2023). Similar to other cultivated plants, beans have been reported to be susceptible to numerous disease agents that result in significant economic losses. Decreases in bean production are caused due to various biotic and abiotic factors. Approximately 200 pathogens have been reported to cause damage to beans, and it has been reported that 31 of the 61 pathogenic disease agents identified are caused by fungal pathogens (Hall et al. 2005). The most common agents causing root and crown diseases in beans are *Macrophomina*, *Rhizoctonia*, and *Fusarium* species, as well as *Sclerotinia*, *Sclerotium*, and *Pythium* species, which are also frequently determined pathogens.

The genus *Rhizoctonia* is a major soil pathogen all over the world and in our country. The fungus is a diverse, large, and complex group of fungi (Carling and Summer 1992). Due to its high level of environmental adaptation, it has spread throughout the world, and it causes an average annual crop loss of over 20% in over 200 economically significant plants worldwide (Clarkson and Cook 1983; MacNish and Neate 1996; Cromey et al. 2002). The agent is a soil-borne pathogen that causes lesions on the hypocotyls and roots of the plant. In severe infections, plant development stops or regresses, resulting in the plant's death before it can mature. In humid periods, the agent can also infect leaves, petioles, flowers and pods. When the agent infects the pods, the disease is also transmitted to the seeds, thus causing significant damage to both yield and quality (Hall 1994). Different researchers have reported that this agent causes disease in almost all vegetables and legumes, and causes problems in different parts of our country where beans are grown, and has a higher level of pathogenicity than other root pathogens (Demirci and Çağlar 1998; Karaca et al. 2002; Kırbağ and Turan 2006; Yeşil 2007; Akarca 2013; Yıldırım and Erper 2017; Canpolat et al. 2023).

One of the important fungal diseases affecting bean production is charcoal rot, caused by *Macrophomina phaseolina* (Tassi) Goid. *M. phaseolina* is a plant pathogenic fungus belonging to the family Botryosphaeriaceae, which causes damping-off, seedling blight, crown rot, stem rot, charcoal rot, basal stem rot, and root rot in many plant species. As one of the most harmful seed and soil-borne pathogens, *M. phaseolina* infects more than 100 of the nearly 500 plant species (Babu et al. 2007). Its hosts include peanuts, cabbage, peppers, chickpeas, beans, soybeans, sunflowers, sweet potatoes, alfalfa, sesame, potatoes, sorghum, wheat, and corn. It has been reported that the disease agent is widespread in our country in sesame, soybean, sunflower, cotton, melon, beans, tobacco, tomatoes, potatoes, apricots, and cucumbers (Maden and İren 1984; Arca and Yıldız 1990; Tezcan and Yıldız 1991; Kınay and Yıldız 1994; Baran and Kurt 2001; Sağır et al. 2009; Pekgöz and Tok 2018; Tok 2019; Anonim 2020; Lavkor and Onat 2021; Canpolat et al. 2022). Among the pathogens that cause disease in beans, different species of the genus *Fusarium* cause significant losses in bean-growing areas in our country, as in many countries where beans are grown worldwide. Among these species, *Fusarium oxysporum* f. sp. *phaseoli* causes wilting in beans, while *Fusarium solani* f. sp. *phaseoli* causes root rots (Montiel Gonzalez et al. 2005).

Ecological reasons, such as increased temperatures with drought, changes in precipitation, and sudden natural disasters (earthquakes, floods), directly or indirectly threaten plant health in the world. As a result of climate change, new agents and new pathogen species can be encountered. It should not be forgotten that fungal species can develop adaptations to the negative effects of global warming and significantly threaten plant health. Climate change can interfere with pathogens, which have an important place in plant protection, to spread to different locations, increase their frequency, cause epidemics, create new pathogen races that break plant resistance, and reach a point where no yield can be obtained in plant production. There is no detailed study showing the effect of climate change seen in recent years on fungal root diseases in the provinces where bean production is intense in our country.

This study aimed to determine the agents causing root rot disease in beans in recent years and the changes in the prevalence of these agents. For this purpose, surveys were conducted in 9 different provinces with significant bean production, including Eskişehir, Balıkesir, Kütahya, Bursa, Niğde, Nevşehir, Burdur, Karaman, and Konya, to determine

the fungal disease agents in 2018 and 2019. Their pathogenicity and prevalence were also determined.

Materials and Methods

The main material of the study consisted of 490 bean plants collected during surveys conducted in Eskişehir, Burdur, Kütahya, Balıkesir, Bursa, Niğde, Nevşehir, Konya, and Karaman provinces and isolates of pathogens obtained from these plants in 2018-2019.

Surveys

Surveys were conducted in 2018 and 2019 during the bean-growing seasons. Depending on the development of the plants, surveys were conducted in 9 different provinces, as mentioned above. In the surveys, the numbers of healthy and diseased plants were determined for each disease using the simple random sampling method. Evaluations were made on plants at 5 points if the field size was 1-5 da, at 10 points if it was 6-10 da, and at 15 points in fields larger than 10 da. The disease prevalence (%) in the production area was calculated based on the diseased plants. After the disease rates were determined in the production area, the prevalence at the district and province level was calculated according to the weighted average. During these surveys, in the areas where dry beans were grown most intensively in each province, diseased plants were collected by stopping every 5-10 km and walking in a "Z" shape towards the middle of the fields on the right and left sides of the fields. These plants were placed in paper bags and brought to the laboratory. Plant samples were stored in the refrigerator at 4°C until isolation.

Isolation

For the isolation process, plant pieces with a size of 0.2-0.5cm, including the diseased and healthy tissues, were cut from the diseased bean plants, immersed in 1% sodium hypochlorite (NaOCl) for 2-3 minutes for surface disinfection, and wassed through 3 series of sterile distilled water. Then, they were dried between sterile filter papers and placed onto the PDA and WA medium in petri dishes in sets of 5. These petri dishes were maintained for 7-10 days in an incubation room with a 12-hour light and 12-hour dark period at 23±1°C. Then, each of the developing fungi was purified by single spore isolation. The obtained fungus isolates were stored in cryo tubes containing 5% glycerin at -20°C and -80°C, in slanted agar containing PDA, and in eppendorf tubes on filter papers at +4°C.

Pathogenicity tests of some fungal isolates on petri dishes

For the preliminary pathogenicity tests of the isolates, they were inoculated into petri dishes containing PDA. After incubating at 25±2°C for 10-15 days, 4 discs were taken from each petri dish with the help of a 4mm diameter cork borer. Each disc piece was placed in a petri dish containing 2% water agar and incubated at 25±2°C for 48 hours. Bean seeds were submerged in 1% NaOCl for 3 minutes for surface disinfection and then rinsed three times with sterile distilled water. Then, 4 of these seeds were placed around the fungus discs in each petri dish. In other words, a total of 12 seeds were sown for each fungus, with 3 petri dishes and 4 seeds in each petri dish. In the control, a fungus-free water agar disc was placed in the middle of three petri dishes for each experiment, and 4 disinfected seeds were placed around it. All petri dishes were wrapped with parafilm and incubated in an incubator at 25±2°C (12 hours light/12 hours dark). The petri dishes were evaluated after 7-10 days. For this, the hypocotyls of the germinated seeds were examined, and disease was assessed using the 0-5 scale (Table 1) based on the size of the necrotic area on the hypocotyls (Ichielevich-Auster et al. 1985).

Table 1. 0-5 scale used for the disease evaluation of the isolates Rhizoctonia, Fusarium, Athelia, Alternaria, and Macrophomina species in the preliminary pathogenicity test (Ichielevich-Auster et al. 1985).

Scale Value	Diagnosis
0	Healthy plant
1	1-10 % hypocotyl infection
2	11-30 % hypocotyl infection
3	31-50 % hypocotyl infection
4	51-80 % hypocotyl infection
5	Dead plant (complete hypocotyl infection)

Diagnostic studies

The identification studies of the isolates found to be pathogenic in the pathogenicity experiments carried out in petri dishes were performed. The identification of the purified single spore cultures at the genus level, their morphological characteristics (colony development, color, spore shape and size) were examined under a stereomicroscope and a compound microscope, and the identification of the genera was determined by using the identification keys given in the literature. For the identification of *Fusarium* isolates, they were inoculated onto both SNA (Sentetik Nutrient Agar) medium, where their morphological structures were best formed, and PSA (Potato Sucrose Agar) medium, where the culture color was visible, and their identification was realized according to Booth (1971). The *Alternaria* isolates obtained from the isolations were identified according to Ellis (1971), and *Rhizoctonia* spp. was identified according to Sneh et al. (1994). *Macrophomina* sp. isolates were diagnosed according to Dhingra and Sinclair (1978) and Crous et al. (2006).

Results and Discussion

The scopes of the surveys

Isolations were made from plant samples observed to have disease symptoms in the surveys, and the preliminary pathogenicity tests of the isolated fungal agents were completed. As a result of the 2018 and 2019 survey studies, 214 *Fusarium* spp., 83 *Rhizoctonia* spp., 32 *Macrophomina* sp., 12 *Alternaria* spp., 11 *Athelia* sp., 4 *Bionectria* spp., 4 *Ceratobasidium* spp., 1 *Trichoderma* sp., and 1 *Phythium* sp. isolate were obtained from 490 diseased bean samples collected (Figure 1). The surveyed provinces and districts, the number of fields examined, the field area and the number of

samples collected for the years 2018 and 2019 were outlined in Tables 2 and 3.

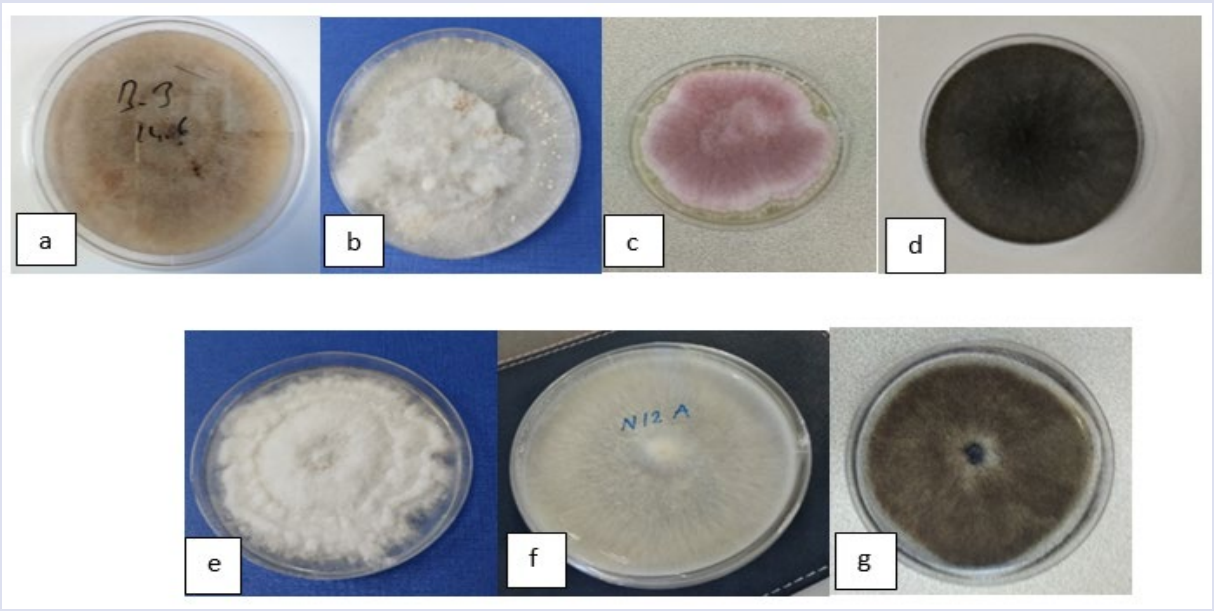

Figure 1. Isolated fungi a-f) Rhizoctonia, b) Athelia c) Fusarium, d) Macrophomina, e) Phythium, g) Alternaria

Table 2. Provinces, districts, number of fields examined, field area examined, and number of samples collected in 2018.

Province	District	Number of Examined Fields	Area (da)	Number of Collected Samples
Balıkesir	Merkez	2	6	4
Kütahya	Merkez	4	6	8
	Simav	5	21	15
Bursa	Osmangazi	4	9	12
	Yenişehir/ Yolören	4	88	10
	İznik	3	45	13
Eskişehir	Tepebaşı	10	300	24
Niğde	Merkez / Gölcük	3	12	6
	Merkez / Kiledere	2	40	2
	Merkez / Hasaköy	3	11	3
	Merkez / İnli	2	15	5
	Merkez / Aktaş	5	100	4
	Merkez / Ovacık	4	36	2
	Merkez / Konaklı	6	127	6
	Merkez / Orhanlı	4	43	7
	Merkez / Karatlı	2	16	5
	Ağcaşar	2	15	5
Konya	Çumra	6	200	10
	Kadınhanı	2	80	2
	Karatay	4	10	2
	Meram	5	15	3
	Altınekin	4	110	20
Karaman	Merkez	6	62	4
Burdur	Merkez / İnsuyu	7	51	15
Nevşehir	Merkez / Göre	6	107	13
	Merkez / İcik	4	80	11
	Kaymaklı	6	76	14
	Derinkuyu	8	122	19

GENERAL TOTAL		**244**

Table 3. Provinces, districts, number of fields examined, field area examined, and number of samples collected in 2019.

Province	District	Number of Examined Fields	Area (da)	Number of Collected Samples
Balıkesir	Merkez	2	6	4
Kütahya	Merkez	4	6	8
	Simav	5	21	15
Bursa	Osmangazi	4	9	12
	Yenişehir/ Yolören	4	88	10
	İznik	3	45	13
Eskişehir	Tepebaşı	10	300	24
Niğde	Merkez / Gölcük	12	336	8
	Merkez / Kiledere	3	20	4
	Merkez / Değirmenli	5	34	-
	Merkez / İnli	5	37	6
	Merkez / Değirmenli	4	34	-
	Merkez / Kayırlı	6	80	5
	Merkez / Ovacık	8	153	4
	Merkez / Konaklı	12	121	4
	Merkez / Orhanlı	5	32	7
	Merkez / Çamardı	3	15	-
	Merkez / Ağcaşar	4	84	11
Konya	Çumra	6	200	10
	Kadınhanı	2	80	2
	Karatay	4	10	2
	Meram	5	15	3
	Altınekin	4	110	20
Karaman	Merkez	6	62	4
Burdur	Merkez / İnsuyu	7	51	15
Nevşehir	Merkez / Göre	6	107	13
	Merkez / İcik	9	105	13
	Kaymaklı	6	90	10
	Derinkuyu	2	300	14
	Gülşehir	2	6	3
	Hacıbektaş	3	15	2
	Avanos	8	21	-
	GENERAL TOTAL			246

Preliminary pathogenicity studies

Preliminary pathogenicity tests were carried out with randomly selected isolates from similar colony-developing genera, and the disease severity of their agents was determined. Pathogenicities of 43 isolates of Fusarium, 18 isolates of *Rhizoctonia*, 17 isolates of *Macrophomina*, 8 isolates of *Athelia*, 7 isolates of *Alternaria*, 4 isolates of *Bionectria*, 2 isolates of *Ceratobasidium*, 1 isolate of *Phythium* and 1 isolate of *Trichoderma* sp. were tabulated in Table 4 and Figure 2.

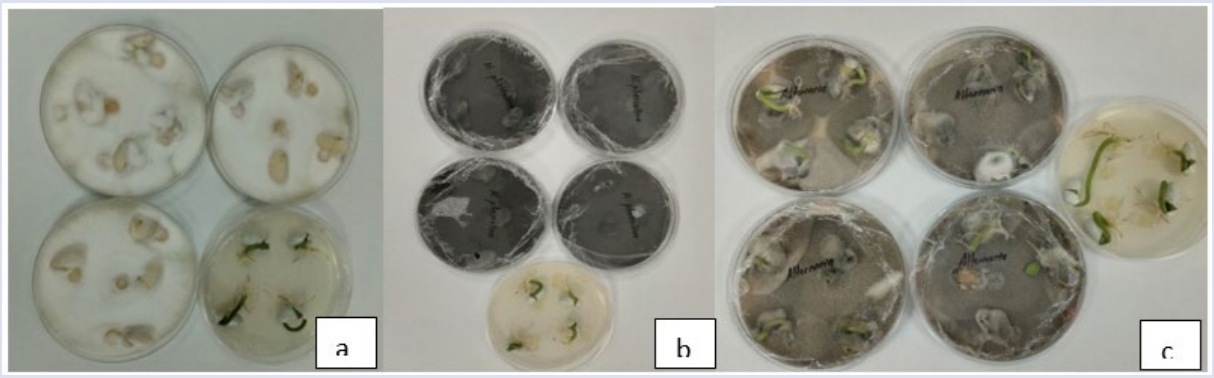

Figure 2. Preliminary pathogenicity tests performed with isolated fungi a) Fusarium, b) Macrophomina and, c) Alternaria

In the preliminary pathogenicity studies carried out in petri dishes, the disease severity values of *Rhizoctonia* isolates ranged from 15-100%, *Macrophomina* sp. isolates from 75-100%, *Fusarium* spp. isolates from 35-100%, *Alternaria* spp. isolates from 25-80%, *Athelia* sp. isolates from 70-100%, *Ceratobasidium* sp. isolates from 88-91%, *Bionectria* spp. isolates from 10-20%,

Trichoderma spp. isolate from 0%, and *Pythium* spp. isolate from 60%. (Table 4).

Table 4. Pathogenicities of some isolates obtained from bean fields carried on Petri dishes.

No	Isolates	No of isolates	Disease severity (%)
1	*Fusarium* sp.	29 B19 b	100
2	*Fusarium* sp	SABur11	100
3	*Fusarium* sp.	SABur21	100
4	*Fusarium* sp.	35 B19	100
5	*Fusarium* sp.	13 BU 19	100
6	*Fusarium* sp.	Ni 11 A.Ş.	100
7	*Fusarium* sp.	Ni 11 N	100
8	*Fusarium* sp.	N 3 BB	100
9	*Fusarium* sp.	N 6 OV	100
10	*Fusarium* sp.	SABur51	100
11	*Fusarium* sp.	SABur61	100
12	*Fusarium* sp.	SABur12	100
13	*Fusarium* sp.	SABur22	100
14	*Fusarium* sp.	SABur41	98
15	*Fusarium* sp.	SABur31	95
16	*Fusarium* sp.	N 3 6A	93
17	*Fusarium* sp.	SABur1	93
18	*Fusarium* sp.	SABur2	93
19	*Fusarium* sp.	SABur81	92
20	*Fusarium* sp.	N 14 Ca	92
21	*Fusarium* sp.	N 18 O	92
22	*Fusarium* sp.	SABur91	91
23	*Fusarium* sp.	3 B19a	91
24	*Fusarium* sp.	SABur71	90
25	*Fusarium* sp.	3 B19b	90
26	*Fusarium* sp.	N 14 B	90
27	*Fusarium* sp.	N 18 A	90
28	*Fusarium* sp.	N 3 6	90
29	*Fusarium* sp	N 25	86
30	*Fusarium* sp.	N 94	86
31	*Fusarium* sp.	20 Bu 19 a	86
32	*Fusarium* sp.	Ni 61	84
33	*Fusarium* sp.	Ni 66	84
34	*Fusarium* sp.	N 18 B	84
35	*Fusarium* sp.	20 Bu 19b	82
36	*Fusarium* sp.	40 B19 b	81
37	*Fusarium* sp.	40 B19 a	80
38	*Fusarium* sp	39 Bu 19	80
39	*Fusarium* sp.	N 18 AA	80
40	*Fusarium* sp.	N 14 Cb	80
41	*Fusarium* sp.	N 21 Bu	80
42	*Fusarium* sp.	33 B19	43
43	*Fusarium* sp.	31 Bu 19 b	35
44	*Rhizoctonia* sp..	31 Bu 19 a	100
45	*Rhizoctonia* sp.	26 Bu 19	100
46	*Rhizoctonia* sp.	30 Bu 19	100
47	*Rhizoctonia* sp.	5 Bu 19	100
48	*Rhizoctonia* sp.	9 BU 19	100
49	*Rhizoctonia* sp.	10 Bu 19	100
50	*Rhizoctonia* sp.	15 B 19	100
51	*Rhizoctonia* sp.	19 Bu 19	100
52	*Rhizoctonia* sp.	16 B 19	100
53	*Rhizoctonia* sp.	22 B 19	100
54	*Rhizoctonia* sp.	24 B19	100
55	*Rhizoctonia* sp.	38 B19 a	97
56	*Rhizoctonia* sp.	36 B19 b	96
57	*Rhizoctonia* sp.	36 B19 a	95
58	*Rhizoctonia* sp.	22 Bu 19	95
59	*Rhizoctonia* sp.	N 17 A	93
60	*Rhizoctonia* sp.	31 B19 b	80
61	*Rhizoctonia* sp.	15 B19	15
62	*Macrophomina* sp.	SMBrdr	100
63	*Macrophomina* sp.	SMEsk2	100
64	*Macrophomina* sp.	SMAnk	100
65	*Macrophomina* sp.	SMBu	100
66	*Macrophomina* sp.	SMBur	100
67	*Macrophomina* sp.	SMBrdr4	100
68	*Macrophomina* sp.	SMKut1	100

69	*Macrophomina* sp.	**SMKut3**	100
70	*Macrophomina* sp.	**SMBal**	98
71	*Macrophomina* sp.	**SMEsk3**	98
72	*Macrophomina* sp.	**SMIsp**	98
73	*Macrophomina* sp.	**SMBur2**	95
74	*Macrophomina* sp.	**N26 Bur**	95
75	*Macrophomina* sp.	**SMKon**	95
76	*Macrophomina* sp.	**SMKut2**	95
77	*Macrophomina* sp.	**N19 Bu**	85
78	*Macrophomina* sp.	**N22 Bu**	75
79	*Athelia* sp.	**SAA**	100
80	*Athelia* sp.	**SAK**	100
81	*Athelia* sp.	**24 Bu 19**	100
82	*Athelia* sp.	**SANi1**	100
83	*Athelia* sp.	**SABal**	95
84	*Athelia* sp.	**SAKar**	88
85	*Athelia* sp.	**SAKon**	79
86	*Athelia* sp.	**24 Bu 19d**	70
87	*Alternaria* sp.	**SAAnk**	80
88	*Alternaria* sp.	**SABur**	78
89	*Alternaria* sp.	**SAKüt**	76
90	*Alternaria* sp.	**SABal**	62
91	*Alternaria* sp.	**SAAks**	58
92	*Alternaria* sp.	**SABrdr**	48
93	*Alternaria* sp.	**SAKon**	25
94	*Bionectria* sp.	**7 B 19**	20
95	*Bionectria* sp.	**11 B 19**	18
96	*Bionectria* sp.	**N 18 BB**	15
97	*Bionectria* sp.	**36 B19**	10
98	*Ceratobasidium* sp.	**N 11 A**	91
99	*Ceratobasidium* sp.	**30 Bu 19**	88
100	*Pythium* spp.	**N 5A**	60
101	*Trichoderma* spp.	**8 B 19**	0

Prevalences of disease agents

The prevalence of 362 fungal disease agents on beans over two years was summarized in Table 5. As shown in Table 5, three pathogens, *Fusarium* spp., *Rhizoctonia* sp. and *Macrophomina* sp. were prevalent in all the provinces studied.

Table 5. Prevalence rate (%) of fungal agents in provinces.

Fungi	Prevalence of Disease Agents in Provinces (%)								
	Balıkesir	**Burdur**	**Bursa**	**Eskişehir**	**Karaman**	**Konya**	**Kütahya**	**Nevşehir**	**Niğde**
***Fusarium* spp.**	4,4	15.3	7.6	14.9	13	13.2	4.3	16.2	12
***Rhizoctonia* spp.**	4.3	11.3	5.8	4.9	5.6	10.9	3.7	8.2	7
***Macrophomina* spp.**	4.1	5	4.9	9.0	10.3	11	3.2	13.8	8.8
***Alternaria* spp.**	3.1	-	-	1.9	2.4-	-	-	3.1	1.6
***Athelia* spp.**	1.3	2.1	-	2.7	-	-	-	1.6	1.3
***Ceratobasidium* spp.**	-	1.1	-	2		1.7	1.5	-	-
***Bionectria* spp.**	0.9	-	-	0,3	-	-	-	0,6	0.3
***Trichoderma* spp.**	-	-	0.8		-	-	-	-	-
***Phythium* spp.**					0.3				

Fungal diseases are the most significant group of diseases limiting bean production worldwide, as well as in our country. One of these diseases is root rot caused by *Rhizoctonia* sp. This agent, which causes serious yield losses, is a soil-borne pathogen and can cause disease in all vegetables and legumes. Different researchers have reported that this disease agent is widely detected in almost every region of our country where beans are grown (Demirci and Çağlar, 1998; Karaca et al., 2002; Kırbağ and Turan, 2006; Yeşil, 2007; Akarca, 2013; Yıldırım and Erper, 2017; Canpolat et al., 2023). In the study, Rhizoctonia was detected in all surveyed provinces and caused root and crown rot in beans. Akber et al. (2023) reported that *Rhizoctonia solani* causes blight, damping-off and rot in legumes (alfalfa, soybeans, chickpeas, peas, lentils, beans and peanuts).

Another seed and soil-borne pathogen on beans is *Macrophomina* sp., which can infect more than 100 plant species (Babu et al. 2007). Its hosts include peanuts, cabbage, peppers, chickpeas, soybeans, sunflowers, sweet potatoes, alfalfa, sesame, potatoes, sorghum, wheat, and corn. In this study, the agent was detected in all surveyed provinces with a prevalence rate of 3.2-13.8% and a disease severity ranging from 75-100%. Bean charcoal rot disease, caused by *Macrophomina phaseolina*, caused yield losses of 20-40% in both survey years, depending on climatic conditions and disease severity. Similarly, the disease has been identified as the leading cause of soybean yield losses in eight of the largest soybean-producing countries (Wrather et al. 2010). It has also been reported by Luna et al. 2017 that Macrophomina charcoal rot is classified as the second most important disease of soybean in the USA, causing 2.0 million tons of yield loss between 2003 and 2012.

In the surveyed provinces, *Fusarium* spp. was identified in all provinces with a prevalence rate of 4.3-16.2% and a disease severity ranging from 43-100%, and this agent has been reported to be pathogenic in beans by different researchers both in our country and in the world (Mohammadi and Atashpanjeh, 2022; Hesami et al. 2021; Schneider et al. 2001; Abawi and Pastor-Corrales 1990). In our country, *Athelia* sp. in beans was first detected by Maden and İren (1984) and later by Avan et al. (2025). In this study, the agent was found in Balıkesir, Burdur, Eskişehir, Nevşehir, and Niğde with a prevalence rate of 1.3-2.7% and a disease severity ranging from 79-100%. *Alternaria* spp. was detected in Balıkesir, Eskişehir, Nevşehir, and Niğde with a prevalence rate of 1.6-3.1% and a disease severity ranging from 25-80%. In the study conducted by Demirci and Çağlar (1998), *Alternaria alternata* was the agent with the highest detection rate from diseased bean seeds, with a rate of 50.9%. Karonji et al. (2024) reported that *Alternaria alternata* causes a yield loss of more than 70% in beans, which is considered one of the most important legume plants in Kenya. It was also stated that the disease was detected in Croatia by Domijan et al. (2005) and caused significant damage to beans. *Ceratobasidium* sp. was detected in Burdur, Eskişehir, Konya, and Kütahya provinces with a prevalence rate of 1.1-2% and a disease severity rate of 88-91%. Rabago-Zavala et al. (2023) also reported that the disease causes a 35% yield loss in beans.

The genus *Bionectria* is a saprophytic soil microfungus that includes species used as biological control agents for some fungal plant pathogens, as well as other substrate relationships. It exhibits a high degree of ecological adaptability and is crucial for preserving the balance of soil microorganisms. Species in this genus are natural antagonists of insects and nematodes, and they also control phytopathogenic fungi through mycoparasitism and are effective biocontrol agents in agriculture. In this study, *Bionectria* sp. were obtained from four different provinces. *Trichoderma* sp. was also detected in Bursa province with a prevalence rate of 0.8% and a disease severity of 0%. *Pythium* sp. was obtained from Karaman province with a prevalence of 0.3% and a disease severity of 60%. *Phytium* spp. has been isolated from cabbage, tomato, mung bean, ginger, papaya, lettuce, bitter melon, and black-eyed peas worldwide (Yu and Ma, 1989; Lodha et al. 2004). It is a common pathogen in vegetable and tobacco nurseries in Türkiye and has also been reported to cause severe root rot in wheat and sugar beet plants (Hatat, 1995; Karabuğa and Karaca, 2011).

Conclusion

By analysing 490 diseased plant samples, surveys conducted in 2018 and 2019 during the bean-growing season in nine major bean cultivation areas of Türkiye revealed that root rots of beans are common in the country. As a result of the isolation work, the following isolates were obtained: 214 *Fusarium* spp. isolates, 65 *Rhizoctonia* sp. isolates, 32 *Macrophomina* sp. isolates, 12 *Alternaria* spp. isolates, 11 *Athelia* sp. isolates, 4 *Ceratobasidium* sp. isolates, 4 *Bionectria* sp. isolates, 1 *Trichoderma* sp. isolate, 1 *Pythium* sp. isolate. Late sampling, isolation media used, and many other factors may contribute to obtaining an isolate from Pythium. Preliminary pathogenicity tests were conducted with 101 randomly selected isolates that had similar colony structures, and their disease severity was determined. Furthermore, the fungal isolates from the dry bean production areas also provided material for our Institute's microorganism culture collection. With the isolates obtained from this study, it is necessary to perform further pathogenicity tests in pots and to carry out both morphological and molecular species identification of the pathogenic isolates. Additionally, the resistance of bean genotypes should be determined using the most common and aggressive isolates.

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