

Potato Fungal Diseases in the Kingdom of Saudi Arabia

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Abstract. The results of field survey of potato fungal diseases for two successive years in the six main potato producing regions in the Kingdom of Saudi Arabia proved the presence of fifteen pathogenic fungal genera. The isolated fungal genera were as follows, in a descending order: *Fusarium*, *Alternaria*, *Rhizoctonia*, *Stemphyllium*, *Cladosporium*, *Helminthosporium*, *Colletotrichum*, *Phytophthora*, *Pythium*, *Macrophomina*, *Phoma*, *Rosellinia*, *Verticillium*, *Cercospora* and *Sclerotium*. Eight out of the previously mentioned fifteen fungal genera i.e., *Cladosporium*, *Colletotrichum*, *Helminthosporium*, *Macrophomina*, *Phoma*, *Pythium*, *Rosellinia* and *Stemphyllium* were recorded for the first time on potato in Saudi Arabia. *Rhizoctonia solani* was the most frequent on tubers, while *Fusarium* spp. was the most frequent on roots and stem bases. The *Alternaria* spp. was most frequent genus on leaves.

Introduction

In the recent years, the production of potato crop in the Kingdom of Saudi Arabia has increased dramatically from almost nil in 1976 to more than 20,000 tons in 1985. There are many fungal diseases known to occur on potato throughout the world and some of them cause serious losses in production [1, 2]. In the Kingdom of Saudi Arabia, no attempts were made before to survey specifically the fungal diseases of potato and all previous reports were general except the survey which was done by El-Meleigi *et al.*; on diseases of marketable potato tubers [3]. In these general reports of plant diseases and pathogenic organisms in the Kingdom of Saudi Arabia, eight fungal genera were listed on potato. Those included *Alternaria* (especially *A. solani*), *Cercospora*, *Fusarium* (especially *F. equiseti*), *Leveillula* (*L. taurica*), *Phytophthora* (especially *P. infestans*), *Rhizoctonia* (*R. solani*), *Sclerotium* (*S. rolfsii*) and *Verticillium* (*V. albo-atrum* and *V. dahliae*) [4-7].

Early blight, caused by *Alternaria solani* Sorauer, is a major disease on potato in Saudi Arabia and it is worldwide in distribution. It causes foliage blight and tuber rot and it is sometimes a very serious disease [4, 6, 1, 8]. The fungus is a very good saprophyte and survives well in the soil [9]. Potato cultivars vary in the degree of resistance, but fungicide sprays are essential for high yield [10].

Fusarium dry rot caused by *Fusarium solani* (Mart.) App. & Wr. emend. Snyder and Hans. and other species of *Fusarium* are most frequently implicated in potato seed decay [5, 6, 1]. This fungus can survive in the soil for several years, but the primary inoculum is seed borne. Diseases caused by *Fusarium* sp. are probably the most common diseases in Saudi Arabia [3].

Rhizoctonia solani is typically seed and soil borne pathogen. It causes serious problems in potatoes and other crops [1]. Black scurf or "Rhizoctonia canker" caused by *Rhizoctonia solani* Kuhn is a very common disease on potato in Saudi Arabia [5, 6, 3]. It is primarily carried on potato seed tubers, which when grown, the pathogen extends to the stems and stolons [11] resulting in stolon necrosis and tuber malformation. Crop rotation and incorporation of crop residues in the soil proved useful in managing black scurf [12].

Verticillium wilt incited by *Verticillium albo-atrum* Reinke & Berth and *V. dahliae* Kleb. was also reported to occur on potato in the Kingdom of Saudi Arabia [5]. The disease is known to cause early killing of plants and tuber infection. Heavy losses of up to 50% may occur in heavy infested soil [13; 14].

Late blight (*Phytophthora infestans* (Mont.) de Bary) even though seen only once in Al-Kharj region of Saudi Arabia [15] is considered the most important disease of potato worldwide [1]. It is a destructive disease wherever potatoes are grown, except in warm, dry, irrigated areas. The causal fungus destroys foliage and decays tubers. Infected tubers and cull piles are the primary source of infection. Even though infection is favored by cool moist conditions, high temperature strains of the fungus have been reported.

Many other pathogens have been reported to occur occasionally on potatoes [2]. Some of these pathogens and sometimes new ones are found to be very serious [16].

The present study was conducted in order to survey and identify the fungal potato pathogens in the six main potato producing regions in the Kingdom of Saudi Arabia, during two consecutive years.

Materials and Methods

Eight field trips were made to survey potato fungal diseases in each of the six potato producing regions i.e. Qassim, Hail, Hofuf, Riyadh, Najran and Tabuk. Two trips were made each season (Autumn 1989, Spring 1990, Autumn 1990, Spring 1991). The first trip was made 30-50 days after potato planting. The second trip was made prior to the beginning of the harvesting time.

Samples from potato plant parts suspected of having fungal infections were collected, coded and placed in polyethylene bags. To maintain sample freshness until completion of the survey mission, all the samples were placed immediately in an ice chest. They were kept cool by placing them in refrigerators or by replacing the ice packs until transported to laboratories in Riyadh. For each sample, all necessary field informations were recorded in special data sheet.

The samples were re-examined in the laboratory. Subsamples were excised from infected tissues, labeled, and processed for fungal isolation. Some samples had mixed infection in roots, stems and/or leaves. Consequently, representative subsamples were taken.

In the fields, root infections were generally characterized by one or more of the following above ground symptoms: yellowing, curling of the leaves, stunting, rosetting and wilting. When the infected plants were pulled out from the soil conspicuous root rotting or decay, root canker, reduced root system, reddish, brown or black discoloration or root lesions were found. Sometimes external or shallow root lesions were observed.

The collected stem and crown samples from soil level or slightly below soil level were showing one or more of the following symptoms: cankers, lesions, or severe rot. Yellowing or necrosis of whole plant or branch was often noticed.

Collected leaves have leaf spots (concentric or not) that varied from minute 1-2 mm to large 1 cm or more. Other leaves had brown to black lesions with or without chlorotic margins. Some of the lesions were limited by veins while others were irregular in shapes. Some lesions had concentric rings, others did not. Lesions were brown to black with or without chlorotic margins. Some were limited by veins. Some had regular shape while others were irregular.

Infected tissues were rinsed in water, surface sterilized in 10% chlorox for 1 to 2 min, rinsed in sterile water, then cut into small sections, and plated on potato

dextrose agar (PDA) or nutrient agar (NA). Isolation procedures and media preparation were done using methods described by Tuite [17]. The plates were incubated in the dark at 25°C, and examined periodically for identification of the isolated fungi according to Hooker [1], Rich [2], Barnett and Hunter [18], Brenchley *et al.*, [19] and Webster [20].

Results and Discussion

Table 1 shows that the total number of collected infected samples during this survey was 717. During the two years of sampling, the number of samples that were collected during the Autumn season were generally more than the number collected during the Spring season. This may be attributed to the smaller areas of potato plantation in the Spring season as a result of the use of imported certified seed tubers for planting this season, compared to the use of locally produced potato tubers for planting the Autumn potato crop. The number of infected samples collected during the second trip of each season was more than that collected during the first trip. This was due mainly to the more foliage produced and the older plants which succumb easier to pathogens. The highest number of collected infected samples was from Gassim followed by Riyadh and Tabuk.

Table 1. Number of fungal-infected potato samples collected from different regions in The Kingdom of Saudi Arabia

Region	1st trip*					2nd trip**					Total
	A-89	S-90	A-90	S-91	T. ¹	A-89	S-90	A-90	S-91	T.	
Qassim	29	14	17	11	71	29	37	18	18	102	173
Hail	22	10	5	5	42	11	10	18	8	47	89
Hofuf	22	12	9	14	57	23	7	8	10	48	105
Najran	10	8	9	4	31	11	7	32	5	55	86
Riyadh	14	6	33	6	59	27	7	39	5	78	137
Tabuk	15	14	12	12	53	28	13	16	17	74	127
Total	112	64	85	62	313	129	81	131	63	404	717

* A-89, A-90: Autumn: November

S-90, S-91: Spring: April

** A-89, A-90: Autumn: December

S-90, S-91: Spring: May

¹. T.: Total

The isolation trials revealed the presence of 15 fungal pathogenic genera associated with infected tested samples. The most frequent are: *Fusarium*, *Alter-*

naria, *Rhizoctonia* and *Stemphyllium* (Table 2). Eight out of the obtained fifteen fungal genera i.e., *Cladosporium*, *Colletotrichum*, *Helminthosporium*, *Macrophomina*, *Phoma*, *Pythium*, *Rosellinia* and *Stemphyllium* were recorded for the first time on potato in the Kingdom of Saudi Arabia. *Rosellinia* spp. was recorded for the first time in the Kingdom of Saudi Arabia, and has not been previously found on any other plant. This fungus, although it is typically a root infecting fungus on woody plants, it was isolated from infected potato roots, stems and leaves that were collected from

Table 3. Regional distribution and frequency of fungal genera isolated during 1989/90, 1990/91 growing seasons in the Kingdom of Saudi Arabia

Fungi	Regions					
	Qassim	Hail	Hofuf	Najran	Riyadh	Tabuk
<i>Alternaria</i> spp. 3	165	90	96	49	53	104
<i>Cercospora</i> spp.	-	11	-2	-	-	1
<i>Cladosporium</i> spp.	6	12	7	13	4	25
<i>Colletotrichum</i> spp. 4	22	16	5	1	5	2
<i>Fusarium</i> spp.	149	80	123	62	81	78
<i>Helminthosporium</i> spp. 5	15	8	3	13	8	13
<i>Macrophomina</i> spp. 6	11	3	7	2	5	3
<i>Phoma andina</i>	12	8	-	3	1	3
<i>Phytophthora infestans</i>	5	2	-	-	1	-
<i>Phytophthora</i> spp.	6	15	2	9	5	4
<i>Pythium</i> spp. 7	6	6	17	2	3	5
<i>Rhizoctonia solani</i>	102	43	84	45	71	25
<i>Rosellinia</i> sp.	10	-	-	-	1	4
<i>Sclerotium rolfsii</i>	-	1	-	-	-	-
<i>Stemphyllium</i> spp. 8	24	31	4	8	11	42
<i>Verticillium</i> spp. 9	3	-	-	1	-	-
TOTAL	543	318	355	213	250	311

- 1: The number of fungi isolated in the region
- 2: The fungus was not isolated in the region
- 3: *Alternaria* spp., *A. alternata*, *A. solani*
- 4: *Colletotrichum* spp., *C. atramentarium*
- 5: *Helminthosporium* spp., *H. solani*
- 6: *Macrophomina* spp., *M. phaseoli*
- 7: *Pythium* spp., *P. ultimum*
- 8: *Stemphyllium* spp., *S. atrum*, *S. botryosum*
- 9: *Verticillium albo-atrum*, *V. dahlia*

Gassim, Riyadh and Tabuk regions. On the other hand, *Leveillula taurica*, the causal agent of powdery mildew in potato was the only fungus listed in previous reports [1; 15] but was not found in the present survey. The results in Table 2, also show that five fungal genera, namely, *Alternaria*, *Fusarium*, *Helminthosporium*, *Phoma* and *Rhizoctonia* were isolated from all the examined plant parts (tubers, roots, stems, and leaves), while *Sclerotium rolfsii* and *Cercospora* were isolated from roots and from leaves respectively.

Ten fungal genera were isolated from the six surveyed regions of the Kingdom, while one genus (*Sclerotium rolfsii*) was isolated once in Hail (Table 3). Also, thirteen fungal genera, out of 15 isolated, were found in Gassim and Hail.

The obtained data show that the number of fungal genera isolated from tubers were the lowest compared to the number of fungal genera identified on other parts of potato plants, the most frequently isolated were *Fusarium* spp. and *Rhizoctonia solani* (Table 2). Riyadh region showed the lowest number of fungi isolated from the infected tubers. Morphological differences in colony color and type and shape of spores of the fusaria obtained from infected root and stem samples suggests the presence of more than one species. Black scurf incited by *R. solani* was most common in potato plantations especially in Gassim region. Large proportions of tubers in this region were expressing symptoms of black scurf and sclerotia were abundant on tubers and stolons.

Field inspections show that the use of uncertified seed tubers gave weaker or virus infected plants with reduced yield, and make plants more vulnerable to attack by bacterial and fungal pathogens. The use of such tubers was particularly noticed in areas like Hofuf and Najran where potato is usually grown on small scale.

Fusarium spp. was the most frequent on roots and stems, followed by *Rhizoctonia solani* and *Alternaria* spp. On the other hand, *Alternaria* spp. was the most frequent fungus isolated from infected leaf samples followed by *Stemphylium botryosum*, *Fusarium* spp., *Cladosporium* spp. and *Helminthosporium* sp. (Table 2).

Field observations show that early blight caused by *A. solani* was more prevalent late in the spring season when the summer heat subsided and the relative humidity increased due to seasonal rain. Even though *A. solani* was much less abundant and severe in the autumn season compared to the spring season, it was very severe in some fields. Local outbreaks and severities were almost similar to the spring season in those fields. These cases were observed in some fields in Najran and Hofuf. The disease was very severe late in the season when infection reached 100% in many

Table 2. Frequency of pathogenic fungi isolated from the different parts of the infected potato plant during 1989/90, 1990/91 growing seasons at six locations in the Kingdom of Saudi Arabia

Fungi	Tissue from which the fungi were isolated				Total
	Tuber	Root	Stem & crown	Leaf	
<i>Alternaria</i> spp. 2	5	57	96	399	557
<i>Cercospora</i> spp.	-1	-	-	2	2
<i>Cladosporium</i> spp.	-	2	5	60	67
<i>Colletotrichum</i> spp. 3	-	24	18	9	51
<i>Fusarium</i> spp.	16	326	158	73	573
<i>Helminthosporium</i> spp. 4	1	8	11	40	60
<i>Macrophomina</i> spp. 5	-	23	4	4	31
<i>Phoma andina</i>	1	1	5	20	27
<i>Phytophthora infestans</i>	1	-	4	3	8
<i>Phytophthora</i> spp.	-	14	10	17	41
<i>Pythium</i> spp. 6	3	30	6	-	39
<i>Rhizoctonia solani</i>	49	217	98	6	370
<i>Rosellinia</i> sp.	-	10	3	2	15
<i>Sclerotium rolfsii</i>	-	1	-	-	1
<i>Stemphyllium</i> spp. 7	-	6	11	103	120
<i>Verticillium</i> spp. 8	-	2	1	1	4

1. The fungus not isolated from this plant part
2. *Alternaria* spp., *A. alternata*, *A. solani*
3. *Colletotrichum* spp., *C. atramentarium*
4. *Helminthosporium* spp., *H. solani*
5. *Macrophomina* spp., *M. phaseoli*
6. *Pythium* spp., *P. ultimum*
7. *Stemphyllium* spp., *S. atrum*, *S. botryosum*
8. *Verticillium albo-atrum*, *V. dahlia*

cases, but some fields had no or low percent infection. The occurrence of early blight is encouraged by the low temperatures in the early mornings. It is reported that the disease causes average annual losses exceeding those from late blight [2]. However, its impact on potato production in the Kingdom is unknown.

The high incidence of early blight could be explained partially by the effect of more than one factor notably the cultivar and treatments of the crop. That situation was noticed in the north eastern United States as it has been found that early blight

disease had increased in the potato crop which was attributed to the use of susceptible potato cultivars and the use of fungicides with action on other diseases such as late blight and that probably allowed diseases like early blight to have a more suitable and less competitive environment [21, 22].

The possible interactions between *Fusarium* spp. and *Rhizoctonia solani* that have been isolated from many infected roots and stem bases samples should be investigated further as it might have some effect on crop losses. The presence of more than one pest on the potato crop have been shown in some cases to decrease the overall damage when compared with the damage caused by each one pest alone. This has been found on potato when the amount of yield loss due to the infestations of potato by the potato leafhopper, early blight, and Verticillium wilt was less than combining the amount of losses when the plant infected by each pest alone [23].

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أمراض البطاطس الفطرية في المملكة العربية السعودية

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(قُدِّم للنشر في ١/٨/١٤١٤هـ؛ وقبل للنشر في ١٨/١/١٤١٥هـ)

ملخص البحث . أظهرت نتائج حصر الأمراض الفطرية التي تصيب نباتات البطاطس ولمدة عامين متتاليين في المناطق الست الرئيسية لزراعة البطاطس في المملكة العربية السعودية وجود خمسة عشر جنساً من الفطريات الممرضة . كان الترتيب التنازلي للأجناس الخمسة عشر حسب أعدادها كمايلي : *Fusarium* ثم *Helminthosporium*, *Cladosporium*, *Stemphyllium*, *Rhizoctonia*, *Alternaria*, *Rosellinia*, *Phoma*, *Mac-*
Sclerotium ثم الفطر *rophomina*, *Pythium*, *Phytophthora*, *Colletotrichum*, *Cercospora*, *Verticillium* . لقد سجلت ثمانية أجناس فطرية من الخمسة عشر جنساً السابقة الذكر لأول مرة على البطاطس في المملكة العربية السعودية وهي : *Helminthosporium*, *Colletotrichum*, *Cladosporium*, *Stemphyllium*, *Rosellinia* . الفطر من جنس *Pythium*, *Phoma*, *Macrophomina* كان الفطر الأكثر تكراراً على الدرنات في حين كان *Fusarium* spp. الأكثر تكراراً على الجذور وقواعد السيقان أما الفطر من جنس *Alternaria* spp. فكان الأكثر تكراراً على الأوراق .