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Survey of Wheat Pathogens Associated with Soil and Wheat Residues in Al-Qassim Fields Prior to the Sowing Season

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Abstract. Soil samples and wheat residues were collected from 51 wheat fields in the Al-Qassim region in Central Saudi Arabia prior to sowing wheat in the 1987 season. The texture of most soils was loamy sand, sandy loam or sandy. The salinity in fields along Hail, Eion El Gawa, Bakeria and Oniza roads was 9.5, 15.2, 8.7 and 5 m mhos/cm respectively. The pH of tested soils varied from 7.8 to 8.03 and was not related to fields and locations. Wheat cv. Yecora Rojo seedlings grown in autoclaved soils, non autoclaved soils, or wheat residues from wheat fields along Hail, Eion El-Gawa, Bakeria, and Oniza roads developed root or leaf spot symptoms at percentages of (13.7, 21.9, 23.4), (96.6, 36.6, 40.4), (13.9, 37.7, 38.2) and (6.3, 31.7, 32.1) respectively.

Bacteria belonging to 15 possible groups were isolated from seedling roots grown in wheat residues and fewer groups were isolated from wheat soil. *Aspergillus, Fusarium, Rhizoctonia, Pythium, Gaeumannomyces, Stemphilium, Helminthosporium, Cephalosporium* spp. and several unknown fungi were associated with tissues of diseased Yecora Rojo seedlings grown in wheat soil and/or residues.

Introduction

Wheat plants, in all stages of growth are subject to attack by many soil-borne pathogenic fungi. Species of *Fusarium, Helminthosporium, Gaeumannomyces, Rhizoctonia* and *Pseudocercosporella* are among the most common soil-borne fungi causing serious damage to spring wheat in many parts of the world [1, p. 106]. The survival of these fungi and other soil-borne root pathogens was reviewed by Garrett [2, p. 270].

Common (dry land) root and foot rots caused by species of *Fusarium* and *Helminthosporium* were described as the most serious diseases of spring wheat (*Triticum aestivum* L.) in Central Saudi Arabia [3,4] and in many other parts of the world [1,

p. 106]. The diseases are considered major problems in dry land wheat and are difficult to diagnose in their early stages in the field. However, the propagules of the pathogens are commonly isolated from wheat straw and infested soils. *H. sativum, F. culmorum* and *F. graminearum* are the most common species causing wheat root rot in warm soils [1, p. 106]. Serious leaf spots and leaf blotches of wheat are also induced by *H. sativum*. The competitive saprophytic ability of these fungi in wheat soil has been discussed [5].

There has been a great increase in wheat acreage in Saudi Arabia in the last few years. Wheat production increased from 300,000 tn. in 1975 to 1,400,000 tn. in 1984 [6]. Over 30% of Saudi wheat is cultivated in Central Saudi Arabia [7, p. 557].

Current productivity of wheat in Saudi Arabia is only 2.7 tn/ha. [8]. Several factors are, in our opinion, contributing to such low productivity including poor soil conditions, poor management and cultural practices and inadequate information on insects and diseases that affect wheat production. With the continuous cropping of wheat in the same fields, the population densities of soil-borne wheat pathogens are likely to build up causing serious economic losses in wheat yields.

The objectives of this study were to examine soil texture, pH and salinity in Al-Qassim (Central Saudi Arabia) wheat fields and to survey survival over the summer of potential wheat pathogens in soil and residues in several fields.

Materials and Methods

Fifty one fields cultivated to wheat in the last 1 to 4 years were selected for this study. These fields were separated by 5–10 km and scattered along the main roads in the region. Twenty fields were located along the Hail road, seven fields along the Eion El-Gawa road, 10 fields along the Bakeria road and 14 fields along Oniza roads (Fig. 1).

The soil samples were collected during September and October of 1986. Ten soil cores (10 cm diam. × 15 cm) were randomly taken from the upper 20 cm of soil in each field. Soil samples from each field were mixed and kept refrigerated during transfer to the laboratory.

Each composite soil sample was divided into two portions. The first portion of the soil was sieved and wheat straw debris placed in plastic bags and refrigerated until used in other experiments. The remaining sieved soil was divided into two halves. One half was autoclaved for 4 hr. and the other half was not autocalved.

The second portion of the soil was also used for determination of soil type, salinity and soil pH by the soil and water laboratory, College of Agriculture in Burydah.

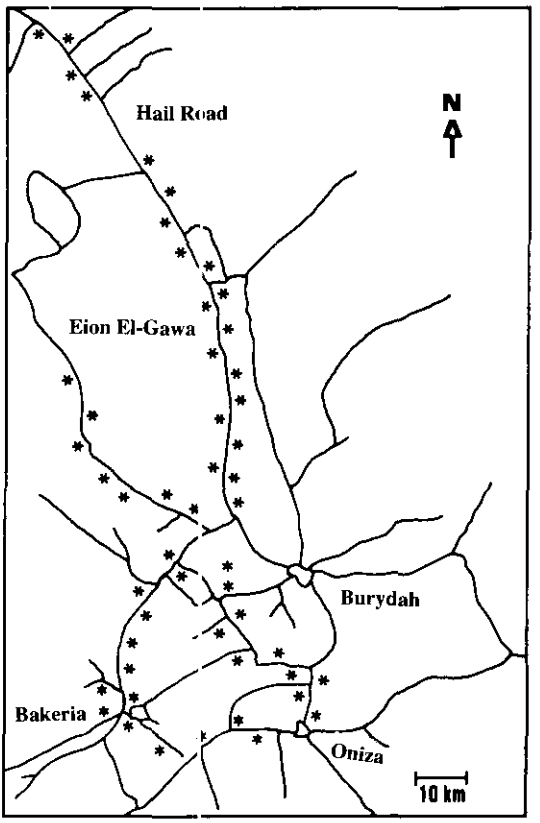

Fig. 1. Locations of wheat fields surveyed for soil borne wheat pathogens, soil texture, salinity and pH prior to sowing of 1987 in Al-Qassim region.

The fungi associated with wheat soil and residues were isolated from colonized seedling roots by the method of Wilkinson *et al.* [9]. Yecora Rojo wheat seeds with no visible disease symptoms were selected for this study. Plastic cups (8 cm diam. × 9 cm) were used to contain soil. The lower 5 cm of the cup was filled with vermiculite, and a 3 cm layer of non-autoclaved soil, wheat straw debris or autoclaved soil was placed on the surface of the vermiculite. Wheat seeds were surface treated with 0.5% NaOCl for 2 min, rinsed in sterilized distilled water and 10 seeds were placed on the surface of the soil or wheat straw and covered with vermiculite. Each treatment included 10 replicates. Seedlings were grown in a plant growth chamber at 18°C. After three weeks growth they were lifted and examined to determine the percentage of seedlings showing root rot or leaf spot symptoms. To isolate fungi, sections (1 cm) of the infected roots and crowns were surface treated in 0.5% NaOCl for 30 sec. and plated on acid potato dextrose agar (APDA) pH 5, corn meal agar (CMA), and on

a selective medium for the take-all pathogen [10, pp. 15–74]. The plates were incubated at 25°C until fungal colonies developed to isolate bacteria, 1 g of seedling root segments (1 cm long) was crushed in an autoclaved solution of 0.1 m Mg SO_4 and the suspensions were streaked on nutrient agar (NA), sucrose peptone agar (SPA) and King's medium B (KB) [11]. Plates were incubated at 27°C for 24–48 hr. *Pseudomonas* spp. were detected on KB media by viewing plates under UV light to enhance detection of fluorescent pigments. Isolates were subcultured on KB slants.

Results and Discussion

Most soils in wheat fields along the Hail and Eion El-Gawa roads were loamy sand. Soils in the Bakeria and Onaiza fields were loamy sand and sandy loamy, or sandy respectively.

The salinity varied considerably among wheat soils. The mean value of salinity in wheat fields along Hail road was 9.5 ± 7.7 m mhos/cm. In the Eion El-Gawa, Bakeria and Oniza fields salinity was 15.2 ± 31, 8.7 ± 7 and 5.0 ± 5 respectively.

The pH in various fields did not vary greatly and was on the alkaline side. The pH in the Hail, Eion El-Gawa, Bakeria and Oniza fields was 7.8 ± 0.3, 7.8 ± 0.3, 7.7 ± 0.2 and 8.0 ± 0.2 respectively.

Yecora Rojo wheat seedlings grown for three weeks were examined for the occurrence of disease symptoms. Root, foot rots and leaf spots were observed in non-autoclaved and wheat residue treatments. The percentage of seedlings with symptoms in autoclaved soil, non autoclaved soil and wheat residues obtained from various locations were as follows: Hail 13.7, 21.9 and 23.4; Eion El-Gawa 9.6, 36.6 and 40.4; Bakeria; 13.9, 37.7 and 38.2; Oniza 6.4, 31.7 and 32.1 respectively (Table 1). These results show that non autoclaved soils and wheat residues are important sources of inoculum for wheat soil borne pathogens. They also show a surprisingly high incidence of disease in the seedlings grown in the autoclaved soil.

Table 1. Disease incidence in Yecora Rojo wheat seedlings

Location	No. of fields surveyed	Percentage of root and foot rot		
		Autoclaved soil	Non-autoclaved soil	Wheat straw
Hail Road	20	13.7 ± 6	21.9 ± 1	23.4 ± 13
Eion El Gawa	7	9.6 ± 7	36.6 ± 15	40.4 ± 13
Bakeria	10	13.9 ± 8	37.7 ± 10	38.2 ± 9
Oniza	14	6.4 ± 8	13.7 ± 18	32.1 ± 10

Fungi isolated from surface sterilized infected seedlings tissues are listed in Table 2. The genera and species of most isolates were identified in our laboratory according to Wiese [1, p. 106], Asher and Shipton [12, p. 538], and Bessey [13, p. 791].

Table 2. Fungi associated with foot and root rot in Yecora Rojo wheat seedlings grown in wheat soil and residues from Al-Qassim wheat fields.

Fungi	Source		
	Autoclaved soil	Non-autoclaved soil	Wheat straw
Aspergillus flavus	–		+
Aspergillus niger	–	+	+
Alternaria spp	–	+	+
Fusarium graminearum	–	+	+
Fusarium globosum	–	+	+
Fusarium solani	–	–	+
Rhizoctonia spp	–	–	+
Pythium spp	–	–	+
Gaeumannomyces spp	–	–	+
Stemphylium sp.	–	+	+
Helminthosporium sativum	+	+	+
Helminthosporium specifera	–	–	+
Helminthosporium spp (2)	–	–	+
Unknown phycomycetes	–	+	–
Unknown Deuteromycetes (1)	–	–	+
Unknown Deuteromycetes (2)		–	+
Unknown Deuteromycetes (3)	+	–	–
Cephalosporium sp.	–	+	+

Three isolates each with different cultural characteristics of *Fusarium* and *Helminthosporium* were found. It is of interest that apart from unkown *Deuteromycetes*, the only fungus is isolated from seedlings in autoclaved soil was *Helminthosporium sativum*, a well-known seed-borne pathogen. *Gaeumannomyces, Pythium, Rhizoctonia* and *Cephalosporium* were isolated from infected seedlings but at lower frequencies than *Fusarium and Helminthosporium* sp.

Aspergillus, Alternaria and *Stemphilium* sp. were also commonly isolated from infected seedlings. Diverse groups of bacteria were isolated from roots of wheat seedlings grown in soil or in wheat residues. The isolated bacteria were placed into different groups according to their cultural characteristics and fluorescence. Groups of bacteria associated with seedling roots grown in wheat residues are presented in

Table 3. Most of the bacteria were *Pseudomonas* spp and more specifically fluorescent *Pseudomonas*.

Salinity is relatively high in most wheat fields in Al-Qassim. The concentration of salt in several fields was very high and well above 8 m mohs, the acceptable salt concentration for wheat growth. Salt tolerant crops such as barley, wheat grasses, sugar beet, rape and cotton may be grown where solutions from the root zone containing as much as 8 to 16 m mhos [14, p. 1118].

According to the values of pH in different soils, Al-Qassim wheat soils could be classified as mildly alkaline (pH 7.4–7.8), moderately alkaline (pH 7.9–8.4), strongly alkaline (pH 8.5–9.0) or very strongly alkaline (pH 9.1+) [14, p. 1118]. The majority of Al-Qassim soils are moderately alkaline.

Seedling root and crown rots and leaf spots were observed at relatively high percentages when non autoclaved soil or wheat residues were used as sources of inoculum regardless of wheat fields. This indicates that propagules of soil-borne wheat pathogens survive the hot summer of Central Saudi Arabia and may play a major role as sources of inoculum for root rots and leaf spot diseases. The occurrence of seedling damage in autoclaved soil at quite high levels indicates that seed borne fungi may also be important sources of wheat pathogens.

Most of the isolated fungi were in genera containing known wheat pathogens which induce serious wheat diseases. Leaf spots caused by *Helminthosporium* sp., crown and root rots caused by *Fusarium* spp., and take-all caused by *Gaeumannomyces* sp. were the most serious diseases reported in Al-Qassim wheat fields in 1985–86 [3].

Numerous bacteria were associated with wheat debris in the soil, including *Pseudomonas* spp. Wheat roots are usually colonized by diverse groups of bacteria [15, pp. 229–234]. On rare occasions wheat pathogenic bacteria such as *Xanthomonas translucens* f. sp. *undulosa* persist on plant residues in soil and cause black chaff disease in wheat [1, p. 106]. Other root colonizing fluorescent *Pseudomonas* suppress root disease when found in appropriate populations in the rhizosphere of wheat [16].

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Table 3. Description of bacteria isolated from Yecora Rojo wheat seedlings grown in wheat residues collected from wheat fields in Al-Qassim region before sowing in the 1987 season.

No.	Bacteria	Colony characteristics						Shape	Motility	Gram stain	Fluorescence
		Elevation	Edge	Surface	Optical features	Consistency	Color				
1.	Punctiform	Convex	Entire	Smooth	Opaque	Viscid	Light cream	Rod	+	–	–
2.	Circular	Pulvinate	Entire	Smooth	Opaque	Butyrous	Faint white	Short rods	+	–	+
3.	Circular	Pulvinate	Entire	Smooth	Opaque	Butyrous	Faint yellow	Rod	+	–	+
4.	Punctiform	Convex	Undulate	Smooth	Opaque	Viscid	Yellow	Rod	+	–	+
5.	Circular	Pulvinate	Entire	Smooth	Opaque	Butyrous	Cream	Rod	+	–	+
6.	Punctiform	Raised	Undulate	Smooth	Opaque	Butyrous	Cream	Rod	+	–	+
7.	Irregular	Raised	Entire	Smooth	Translucent	Membraneous	Light yellow	Rod	+	–	+
8.	Punctiform	Convex	Undulate	Rough	Translucent	Viscid	yellow	Rod	+	–	–
9.	Circular	Convex	Undulate	Rough	Opaque	Viscid	Faint yellow	Rod	+	–	–
10.	Circular	Pulvinate	Entire	Smooth	Opaque	Butyrous	Red	Rod	+	–	–
11.	Filamentous	Raised	Erose	Rough	Opaque	Membraneous	Yellow	Rod	+	–	–
12.	Circular	Convex	Entire	Smooth	Opaque	Butyrous	Faint white	Short roads	+	–	+
13.	Punctiform	Convex	Entire	Smooth	Opaque	Viscid	Cream	Rod	+	–	+
14.	Punctiform	Raised	Entire	Smooth	Translucent	Membraneous	Cream	Rod	+	–	+
15.	Punctiform	Raised	Entire	Rough	Translucent	Membraneous	Faint cream	Rod	+	–	+

References

[1] Wiese, M.V. *Compendium of Wheat Diseases.* Paul Minnesota: The American Phytopathological Society, St., 1977.

[2] Garrett, S.D. *Pathogenic Root-Infecting Fungi.* London and New York: Cambridge Univ. Press, 1970.

[3] El-Meleigi, M.A. "Fungal Diseases of Spring Wheat in Central Saudi Arabia." *Crop Protection Journal,* (1988) (In Press).

[4] Sharif, M. Wheat Diseases in Central and Eastern Regions of Saudi Arabia. Riyadh: *Ministry of Agriculture and Water Regional Research Center,* Saudi Arabia, 1983 .

[5] Coley-Smith, J.R. Survival of Plant-Pathogenic Fungi in Soil in The Absence of Host Plants: In: Schippers, B. and Gams, W. (ed.) *Soil-Borne Plant Pathogens.* New York: Academic Press, 1979, 39–57.

[6] Al-Shekh, A. "Wheat Production in Saudi Arabia. *Agriculture magazine, Ministry of Agriculture and Water Resources,* Saudi Arabia, **5** (1985), 4–10 (In Arabic).

[7] Ministry of Finance and Economy, *Statistical Year Book,* Kingdom of Saudi Arabia, 1983.

[8] Al-Akabawy, K.A. "Production of Grain Crops in Saudi Arabia." *Al-Sonbla,* 1 (1986), 42–43 (In Arabic).

[9] Wilkinson, H.T., Cook, R.J. and Aldredge, J.R. "Relation of Inoculum Size and Concentration to Infection of Wheat Roots by *Gaeumannomyces graminis* var *tritici." phytopathology,* **75** (1985), 98–103.

[10] Walker, J. Taxonomy of Take-all and Related Genra and Species. In: Asher, M.J. and Shipton, P.J. (ed.) *Biology and Control of Take-all.* New York: Academic Press, 1981.

[11] King, E.O., Ward, M.K. and Raney, D.E. "Two Simple Media for Determination of Pyocyanin and Fluorescein." *J. Lab. Clin. Med.,* **44** (1954), 301–307.

[12] Asher, M.J.C. and Shipton, P.J. *Biology and Control of Take-all.* New York: Academic Press, 1981.

[13] Bessey, E.A. *Morphology and Taxonomy of Fungi.* New York: Hafner Press, 1950.

[14] Martin, J.H., Leonard, W.H. and Stamp, D.L. *Principles of Field Crop Production.* New York: Macmillan Publishing Co. Inc., 1976.

[15] Van Vuurde, J.W.L., Kruyswyk, C.J. and Schippers, B. Bacterial Colonization of Wheat Roots in a Root-Soil Medel System. In: Schippers, B. and Gams, W. (ed.) *Soil Borne Plant Pathogens.* New York: Academic Press, 1979.

[16] Weller, D.M. and Cook, R.J. "Suppression of Take-All of Wheat by Seed Treatments with Fluorescent Pseudomonads." *Phytopathology,* **73** (1983), 463–469.

حصر للكائنات المرضة للقمح والمصاحبة للتربة وبقايا القمح في حقول القصيم قبيل الموسم الزراعي

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ملخص البحث. تم جمع عينات من التربة وبقايا القمح المصاحبة لها من ٥١ حقلاً في منطقة القصيم قبل زراعة موسم ١٩٨٧م. كان قوام التربة في غالبية الحقول سلتي رملي أو رملي سلتي أو رملي. كان متوسط الملوحة في الحقول على امتداد طريق حائل وعلى امتداد طريق عيون الجواء وطريق البكيرية وطريق عنيزة ٥ر٩ و ٢ر١٥ و ٦ر٨ و ٥ ملليموز على التوالي وكانت درجة الـ pH في هذه الحقول تتراوح بين ٨ر٧ إلى ٣ر٨ في المتوسط.

أصيبت بادرات القمح من الصنف يكورا روجو والتي زرعت في تربة معقمة أو غير معقمة أو في بقايا القمح بعفن الجذور أو تبقعات الأوراق بنسبة ٧ر١٣، ٩ر٢١، و ٤ر٢٣٪ في حقول طريق حائل و ٦ر٩ و ٦ر٣٦ و ٤ر٤٠٪ في حقول طرق عيون الجواء و ٩ر١٣ و ٧ر١٧ و ٢ر٣٨ في حقول طريق البكيرية و ٣ر٦ و ٧ر٣١ و ١ر٣٢ في حقول طريق عنيزة على التوالي. وجدت ١٥ مجموعة مختلفة من البكتيريا في جذور النباتات التي نميت في بقايا القمح بينما وجدت بكتيريا أقل في جذور البادرات المنماة في تربة غير معقمة أومعقمة. عزلت من بادرات القمح المصابة مجموعة من الفطريات الممرضة منها:

Rhizoctonia, Gaeumannomyces, Helminthosporium, Aspergillus, Fusarium, Stemphelium and Cephalosporium spp.