Special Report

Wheat Root Rotting Fungi in the "Old" and "New" Agricultural Lands of Egypt

Hanafy M. Fouly, Department of Natural Resources and Environmental Sciences, **W. L. Pedersen,** Department of Crop Sciences, **H. T. Wilkinson,** Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana 61801; and **M. M. Abd El-Kader,** Division of Plant Protection, National Research Center, Dokky, Egypt

ABSTRACT

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Surveys were conducted from November 1991 to June 1992 to identify fungi associated with wheat root rot in the Nile Valley, delta region, and new land areas of Egypt. A total of 1,024 fungal isolates were made from diseased roots and crowns of commercially grown spring wheat in Egypt. Thirteen different species were identified. The most frequently isolated fungi were *Fusarium culmorum, F. oxysporum, F. solani, Rhizoctonia solani* (AG)-4, *Macrophomina phaseolina,* and *Alternaria solani,* which represented 168, 134, 66, 221, 193, and 63 of the total number of isolates, respectively. The identification of *Gaeumannomyces graminis* var. *graminis* from the new lands is the first report of this pathogen in Egypt. *F. graminearum,* a *Helminthosporium* sp., *R. solani* (AG)-4, and *M. phaseolina* aggressively rotted roots of the most widely planted spring wheat cultivar, Sakha 69.

Spring wheat (*Triticum aestivum* L.) is cultivated on approximately 1.5 million ha in Egypt. Agricultural lands close to the Nile River and its delta in northern Egypt are referred to as "old" lands, and cultivation dates back many centuries. Wheat production on old lands is found in many small fields (<2 ha), most of which are irrigated by flood or furrow methods. Demand for increased agricultural production has resulted from a combination of a growing population and a need for greater agricultural exports. These demands have supported the expansion of farming into desert areas beyond the delta region, and these are referred to as "new" lands. For the past decade, soil from old lands, animal wastes, and water have been transported to these new agricultural lands. Overhead irrigation, larger fields (>10 ha), and more fertilization have increased not only production, but also the incidence and severity of plant disease. Because of the arid climate and use of irrigation, soilborne pathogens are the greatest potential limiting factor to production. Both the soil and the irrigation water for the new lands is taken from the old land areas and the Nile River system. El-Meleigi (8) reported that a *Gaeumannomyces* sp., a *Fusarium* sp., and a *Pythium* sp. were isolated from diseased roots of wheat cv. Yecora Rojo in Saudi Arabia. Beyond this, little has been reported on the pathogens or their potential to cause disease in either the old or new agricultural lands of Egypt. In the early 1990s, we observed wheat crops displaying patches of white heads. Crowns and roots of these plants were rotted. The identification of wheat root rotting pathogens, and the assessment of their potential to cause disease in old and new agricultural lands, was undertaken. Information from this program can be used to focus future research on the most important root pathogens of wheat in both old and new agricultural lands in Egypt.

Corresponding author: H. T. Wilkinson
E-mail: hwilkins@ux6.cso.uiuc.edu

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MATERIALS AND METHODS

Wheat plants with soil adhering to the roots were inspected and sampled at 45 different sites in six different locations in Egypt (Fig. 1). Samples from the old agricultural lands of the Nile River system and its delta were obtained from the governates of Beni-Suief, Giza, Al-Sharkia, Al-Dakahlia, and Kafr El-Sheikh. Representing the new agricultural lands beyond the delta region, plants in the governates of Ismailia and El-Beheira were observed and sampled. The wheat cv. Sakha 69 was being grown in all fields.

All field observations and samplings were made in 1991 to 1992. Each of the 45 fields was sampled at three times: the seedling, jointing, and seed-filling (heading) stages of growth. At each sampling date, the entire field was inspected for stunting, discoloration, thinning, and white heads. A sample of 12 to 24 plants displaying any of these symptoms was field inspected for root and crown disease symptoms. An additional 12 plants, from areas with evidence of root rotting (stunting or discoloration), were randomly selected, dug, placed in bags, and stored in an insulated container for transport to the laboratory for storage and evaluation.

All field plant samples were stored at 4°C. Loose soil adhering to roots was dislodged and discarded. Plant roots were washed for 15 to 20 min in running tap water and gently scrubbed to remove closely adhering soil. Roots and crowns of each plant were inspected for lesions, stunting, discoloration, adventitious branching, and fungal structures, as an aid in isolating and determining the causal agent. Sections of root and crown tissues displaying symptoms were excised, surface sterilized (2 min in 1% sodium hypochlorite), rinsed in sterile, distilled water, and blotted dry with sterile paper towels. Surface-sterilized samples were cut into pieces approximately 3 mm long and placed onto potato dextrose agar (PDA) acidified (pH 4.0) with 1.0 N HCl. Plates were incubated for 3 days at 25°C. All fungi egressing from tissue samples were transferred to a second petri dish containing acidified PDA and incubated for 3 days at 25°C. All cultures were stored at 4°C on PDA. All isolates were cultured on PDA under laboratory conditions and allowed to sporulate. The identification of *Fusarium, Rhizoctonia, Sclerotium, Trichocladium, Helminthosporium, Gaeumannomyces,* and other fungi was based on colony and spore morphology by means of the recommended keys and texts (1,7,11,13). The identification and frequency of isolation of each fungus was recorded.

The fungi were tested for pathogenicity on the wheat cv. Sakha 69. Wheat was assayed in 4 × 20.5 cm Cone-Tainers (Ray Leach Cone-Tainers, Stewe and Sons, Inc., Corvallis, OR) (14). The assay inoculum consisted of three plugs (0.5 cm^2 each) from 5- to 7-day-old PDA cultures. These were placed randomly on the surface of autoclave-sterilized vermiculite, and covered with a thin layer of the same material.

The vermiculite was autoclaved twice (0.124 M Pa, 121°C, 90 min); it was allowed to cool to room temperature for 24 h between autoclave treatments. Four surface-sterilized wheat seeds (5 min in 5% sodium hypochlorite) were placed onto the vermiculite surface above the inoculum and covered with an additional layer (1 cm thick) of vermiculite. Cone-Tainers were watered to maintain a moist root medium, and incubated with a 12 h per day light period (100 μE s^{-1} m^{-2}) at either 15 or 25°C, depending on the fungal species being tested. Three to 4 weeks after seeding, plants were observed for foliar symptoms resulting from root and crown disease. Diseased plants were then extracted from the Cone-Tainers, washed free of vermiculite, and inspected for root and crown symptoms. Root rot was recorded according to a 0 to 4 severity scale in which 0 = no symptoms, 1 = slight root discoloration, 2 = moderate root discoloration and small (<2 mm) lesions, 3 = severe rotting of roots and stem base with coalescing lesions, and 4 = roots completely rotted and plants necrotic. A mean disease rating was calculated by multiplying the number of plants in each category by their numerical rating, adding the ratings, and dividing by the total number of plants rated. Reisolations were made to confirm the identity of the causal fungus. Four replications were used, and all experiments were conducted twice.

RESULTS

Most fields inspected at the seedling stage had many patches of thin to bare areas. Brown spots were observed on subcrown internodes, secondary roots, and culms of seedlings at the margins of bare areas. At the jointing stage of growth, yellow patches were observed in the fields. Roots, crowns, lower nodes, and internodes of plants were brown in these patches. Cottony, pink mycelium was usually observed on the lower leaf sheaths. At the heading stage, many fields had plants with white heads and sooty molds. Aphids heavily colonized the green heads and produced abundant honey dew. Crowns and lower internodes were dark brown on diseased plants. In addition, late planted fields had severe powdery mildew, rust, and leaf spots.

A total of 1,024 fungi were isolated from diseased roots and crowns of commercially grown spring wheat (cv. Sakha 69) in Egypt. The total number of isolates from new and old lands was 500 and 524, respectively. Thirteen different species were identified (Table 1). The most frequently isolated fungi were *Fusarium culmorum* (Wm. G. Sm.) Sacc., *F. oxysporum* (Schlechtend.:Fr.), *F. solani* (Mart.) Sacc., *Rhizoctonia solani* (Kühn) (AG)-4, a *Trichocladium* sp., *Macrophomina phaseolina* (Tassi) Goidanich, and *Alternaria solani* Sorauer. The remaining fungi represented 1% of the isolates. The identification of *Gaeumannomyces graminis* var. *graminis* (Sacc.) Arx & D. Olivier from the new lands is the first report of this pathogen in Egypt (9).

Most of the fungal isolates tested were pathogenic on seedlings of Sakha 69 (Table 2). *Fusarium graminearum* Schwabe, *Bipolaris sorokiniana* (Sacc.) Shoemaker, *R. solani* (AG)-4, and *M. phaseolina* aggressively rotted roots, and some isolates of *F. oxysporum*, *R. solani*, and *M. phaseolina* were able to kill plants.

DISCUSSION

We conducted a detailed survey of commercial wheat fields in Egypt from the old lands of the Nile Valley and delta region and the new lands beyond the delta region. Poor cultural practices (manual planting, irregular applications of fertilizers), and seedling disease (pre- and post-emergent) may have been responsible for the bare areas and yellow patches seen in many fields that were sampled. Symptomatic plants had brown to dark brown spots on roots, crowns, and basal stems. *Fusarium* spp., *R. solani* (AG)-4, and *M. phaseolina* were frequently isolated from rotted roots. Most of the fungi shown in Table 1 have been previously reported as pathogens of wheat by Oswald (12), Cook (4), Hill et al. (10), and Wiese (13), but not in Egypt. In this study, *F. culmorum* was the prevalent species, followed by *F. oxysporum*, *F. solani*, *F. graminearum*, and *F.*

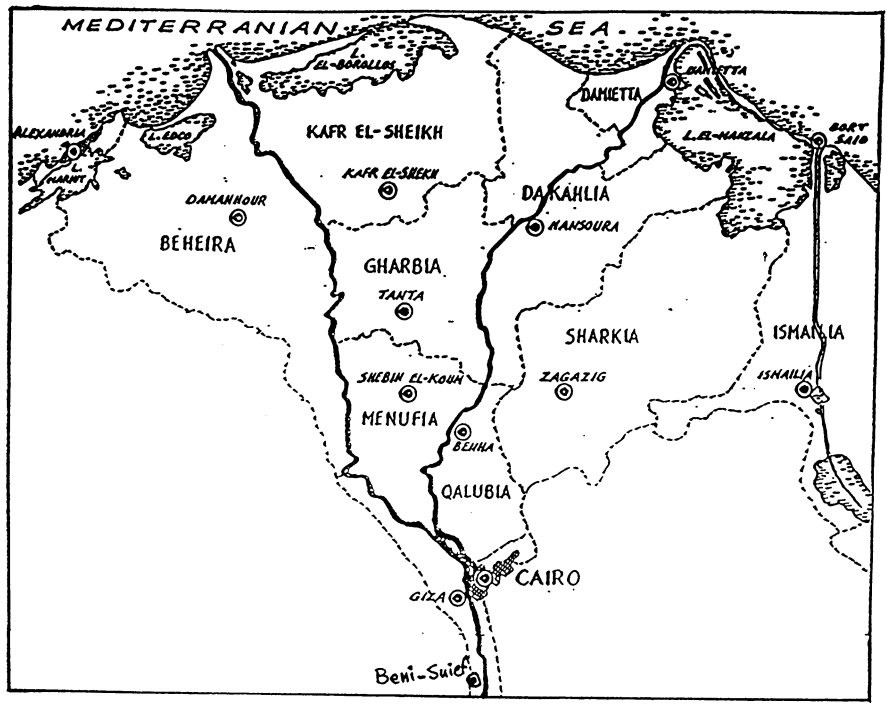

Fig. 1. Egyptian governates constituting the "new" (Ismailia and El-Beheira) and "old" (Beni-Suief, Giza, Al-Sharkia, Al-Dakahlia, and Kafr El-Sheikh) agricultural lands.

Table 1. Fungal isolations (1,024) from diseased wheat roots sampled from the "new" and the "old" agricultural lands of Egypt[a]

Fungus	Isolates from new lands (no.)	Isolates from old lands (no.)	Total isolates (no.)	Total isolates (%)
Fusarium solani	27	39	66	6%
F. culmorum	71	97	168	16%
F. oxysporum	50	84	134	13%
F. moniliforme	13	19	32	3%
F. graminearum	13	11	24	2%
Fusarium sp.	32	44	76	7%
Rhizoctonia solani (AG)-4	107	104	211	21%
Macrophomina phaseolina	144	49	193	19%
Alternaria solani	18	45	63	6%
Epicoccum nigrum (Link)	7	24	31	3%
Bipolaris sorokiniana	12	6	18	2%
H. spiciferum (Bainier) (Nicot)	2	2	4	<1%
Gaeumannomyces graminis	4	0	4	<1%

[a] "New" lands located in the governates of Ismailia and El-Beheira, Egypt; "old" lands located in the governates of Beni-Suief, Giza, Al-Sharkia, Al-Dakahlia, and Kafr El-Sheikh.

Table 2. Disease severity ratings of wheat cv. Sakha 69 inoculated with fungal isolates from "new" and "old" agricultural lands of Egypt[a]

Fungus	Isolates tested (no.)	Isolates scored in disease severity categories (%)[b]					Mean D.S.[c]
		0	1	2	3	4	
New lands							
Fusarium oxysporum	26	19	27	35	19	0	1.6
Fusarium sp.	20	0	15	60	25	0	2.0
Rhizoctonia solani (AG)-4	63	12	14	50	16	8	2.2
Macrophomina phaseolina	52	0	13	30	49	8	2.5
Old lands							
Fusarium moniliforme	10	0	50	40	10	0	1.7
F. oxysporum	49	10	21	49	18	2	1.8
F. culmorum	66	8	27	45	20	0	1.8
F. graminearum	10	0	20	30	50	0	2.2
F. solani	22	5	27	55	13	0	1.8
Fusarium sp.	23	8	22	46	24	0	2.0
Bipolaris sorokiniana	6	0	0	66	34	0	2.3
Rhizoctonia solani (AG)-4	74	9	22	48	21	0	2.0
Sclerotium bataticola	35	0	26	40	28	6	2.1

[a] New lands located in the governates of Ismailia and El-Beheirax; old lands located in the governates of Beni-Suief, Giza, Al-Sharkia, Al-Dakahlia, and Kafr El-Sheikh.

[b] Disease severity ratings scale: 0 = no symptoms; 1 = slight root discoloration; 2 = moderate root discoloration and small (<2 mm) lesions; 3 = severe rotting of roots and stem base, with coalescing lesions; 4 = root completely rotted, plants nectrotic.

[c] Mean Disease Severity. Disease severity ratings for all isolates of a single species. Means were based on four replications in each of two repeated experiments.

moniliforme J. Sheld. Cook (3) reported that *F. culmorum* and *F. graminearum* are the causal agents of root and foot rot of wheat in the U.S. Pacific Northwest. Both fungi are found in warm, dry climates of wheat-producing areas (2,5,6).

The prevalence of soilborne pathogens in the new lands was expected because of the transport of old soil and organic matter to this area. Yield losses due to soilborne pathogens of wheat were difficult to determine because of the poor cultural practices and variability among field management programs. Many of the commercial fields were planted manually with uncertified seeds, which require high seeding rates due to poor germination. As a result, many bare areas were replanted, and there are insufficient recorded data available on seeding rates, replanting, and grain yield.

The identification of *Gaeumannomyces graminis* var. *graminis* from the new lands is the first report of this pathogen in Egypt. Its low incidence suggests it is not causing significant yield reductions at this time. In this survey, *G. graminis* was not isolated from wheat roots in the Nile Valley. The identification of *G. graminis* in the new land region indicates a need for maintaining good crop rotation practices. The disease caused by this pathogen, "take-all," is generally more of a problem when wheat is cropped in monoculture without rotation. At present, take-all does not appear to be a problem. We conclude that soilborne pathogens are present in all of the growing areas in Egypt.

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