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Prevalence, Incidence and Severity of Soil-borne Diseases and Fungi of Wheat in Rice-wheat Cropping System of Punjab Province of Pakistan During the Cropping Season 1999

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Abstract: A survey was conducted to monitor foliar and root diseases caused by soil-borne fungi at the booting stage of wheat crop in main rice-wheat cropping areas of Sheikhupura, Gujranwala, Sialkot and Narowal districts of Punjab. Foliar and root samples were collected from twenty-one key locations of four districts for the assessment of prevalence, incidence and severity of root rot and foliar spots. The highest mean incidence of root rot was 100% in Narowal and Sialkot whereas the lowest of 95% was in Gujranwala. The highest mean severity was 2.2 in Narowal while the lowest 1.5 was in Sialkot. *Fusarium* spp., *Helminthosporium* spp., *Curvularia* spp., *Alternaria alternata*, *Macrophomona phaseolina*, *Coniothyrium* spp., *Mucor* spp., *Trichocladium* spp., *Rhizoctonia solani*, *Humicola* spp. and *Aspergillus* spp. were isolated from the plants showing root rot symptoms. In Narowal and Sialkot the prevalence of foliar spots was 100% and in Sheikhupura 66.66%. The highest mean incidence 21.25% of foliar spots was in Sialkot and the lowest 15% was in Narowal. The highest mean severity was 4.5 in Sialkot and lowest of 3.5 in Sheikhupura. *Alternaria alternata*, *Helminthosporium* spp, *Fusarium* spp. and *Chaetomium* spp. were isolated from leaves. During this survey it was concluded that root rot was more prevalent than foliar spots. Such types of survey should be conducted every year for the situation of diseases.

Key words: Rice-wheat cropping system, soil-borne diseases, Punjab, Pakistan

Introduction

Rice and wheat are two major cereals grown in Pakistan. In several parts of Pakistan notably in Sindh and Punjab provinces, rice and wheat are grown sequentially in the same field in the same farming year. During recent years, the rice growing areas of the central Punjab (Gujranwala, Sheikhupura, Narowal and Sialkot districts) have become increasingly important for wheat production.

Diseases, a major hazard in wheat production, cause losses through reduced yield and quality of grain. In general, these wheat diseases are caused by parasitic bacteria, fungi and viruses. Among these soil-borne fungal pathogens are considered to cause serious losses to wheat crop and agricultural economy in South and Southeast Asia (Mathur and Cunfer, 1993) including Pakistan. A number of pathogens have been identified from South and Southeast Asia (Kulkarni and Naragund, 1986). Soil-borne pathogens affect wheat by damage to seeds/seedlings, roots and lower leaves. Yields are lowered through reductions in emergence/stand density, plant vigour, tillering and photosynthetic area. Soil-borne fungal pathogens occur as complexes in rice and wheat, the nature of which is poorly understood and little quantified (Etienne, 2000-2001). Several soil-borne fungal pathogens such as *Cochliobolus sativus*, *Sclerotium rolfsii*, *Rhizoctonia solani*, *Fusarium* spp. and

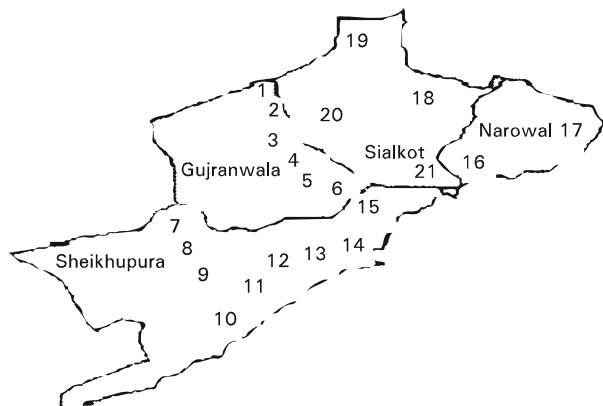
Gaeumannomyces graminis can cause root rot, crown rot and sheath blight of rice and wheat but these pathogens are unnoticed in Pakistan (Kishwar *et al.*, 1992). These pathogens may infect any of the underground parts. Typically, plants are not killed by fungal infection instead plants affected by root rot or sheath blight may reduce tillering, produce shriveled grains or small head depending upon time and severity of infection (Wisniewska and Chelkowski, 1999). *Cochliobolus sativus* is the major root rot causing fungus. The primary inoculum of the fungi comes from several sources such as weed hosts, soil, crop debris and uncultivated plants (Sharma *et al.*, 1996).

Although soil-borne diseases are considered limiting factors in crop production by small-scale farmers in rice-wheat production areas of South and Southeast Asia, the nature of these problems is not fully understood and little research has been conducted in Pakistan in context of the broader rice-wheat cropping system. In this paper the prevalence, incidence and severity of soil-borne diseases and associated pathogens of wheat, mainly the fungi, in rice-wheat cropping system present in some of the major wheat growing districts of Pakistan are described.

Materials and Methods

Areas surveyed: The survey was conducted at the

booting stage of wheat crop in main rice-wheat growing areas of Punjab in March, 1999. Gujranwala, Sheikhpura, Narowal and Sialkot districts were chosen for sampling. Sampling was carried out at twenty-one locations (Fig. 1),



- | | | |
|-----------------|---------------------|--------------------|
| 1. Poor plan | 2. Kot Ladha | 3. Qazi kot |
| 4. Attawa | 5. Kammonki | 6. MahayChatta |
| 7. Ajnianwala | 8. Jandiala | 9. Kakar Gill Form |
| 10. Kallar Pind | 11. Kala Shah Kakoo | 12. Muridke |
| 13. Sehnan | 14. Manga | 15. Addian |
| 16. Dhudiala | 17. Bhuda Dola | 18. Phatta |
| 19. Malomalhi | 20. Othian Wala | 21. Dara Wali |

Fig 1: Locations surveyed in main rice-wheat cropping areas of Sheikhpura, Gujranwala, Narowal and Sialkot districts of Punjab at the booting stage of wheat in March, 1999

of above four districts for the assessment of prevalence, incidence and severity of soil-borne diseases primarily root rot and foliar spots and their associated fungi. Additional information regarding planting date, previous crops, seed source, fertilizer, pesticides applications and yield were also recorded from the farmers in these locations.

Disease assessment: One farmer field was chosen randomly at each location. Disease assessment was done by an open quadrat (1x1 m²) from each corner and mid point of the field on an X configuration. In each quadrat, ten plants were selected to assess disease prevalence and disease severity. Disease prevalence was calculated with the help of following formula:-

$$\% \text{ Prevalence} = \frac{\text{Locations with disease symptoms}}{\text{Total locations}} \times 100$$

Incidence was recorded as percent plants showing foliar spots or root rot while disease severity was based on visual rating scales i.e. in case of root rot a 0-3 rating scale

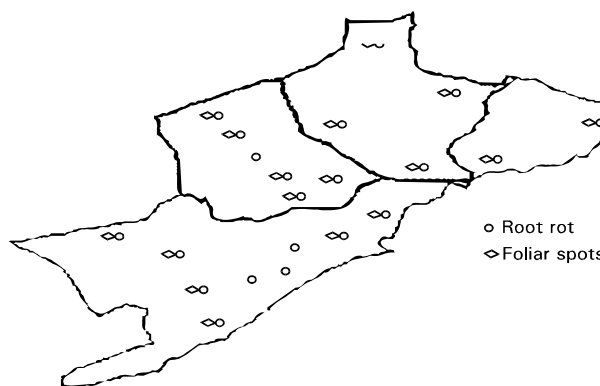


Fig. 2: Location showing the prevalence of foliar spots and root rot of wheat in rice wheat cropping areas of Punjab at the booting stage in March, 1999

was used; where: 0= clean, 1= slight, 2= moderate and 3= severe (Ledingham *et al.*, 1973) and for foliar spot 0-9 scale was used; where: 0= No symptoms, 1= Lesions covering 1% or less, 3= Covering 1-10% leaf area, 7= Lesions covering 26-50% leaf area and 9= Lesions covering 51% or more leaf area (Mayee and Datar, 1986). In case of foliar spots both incidence and severity was noted in field. Diseased samples were preserved in paper bags for further studies in the laboratory. In case of root rot, plants were uprooted with some soil and placed in polythene bags to carry to the laboratory for making assessment after washing.

Isolation of fungi from roots and foliage: Roots and foliar parts were separated and washed thoroughly in running tap water for 10-15 min and cut into pieces, surface sterilized by 1% clorox for 1 min, rinsed three times in sterilized distilled water, dried on sterile blotting paper and plated on Potato Dextrose agar (PDA) (Usmani and Ghaffar, 1982). The plates were incubated at 27°C for 3-4 days. The cultures of root and foliar fungi were purified and maintained on PDA slants at 27°C. Fungi were identified on the basis of their morphological, microscopic and growth characteristics using different keys (Gilman, 1945; Barnett, 1960; Domsch *et al.*, 1980).

Results

Prevalence of root rot and foliar spots: The prevalence of root rot was 100% in the four districts surveyed. Although foliar spots widely prevalent were lower than root rot and observed at all locations in Narowal and Sialkot, whereas in Gujranwala and Sheikhpura 83.33% and 66.66% locations, respectively had foliar spots (Fig. 2).

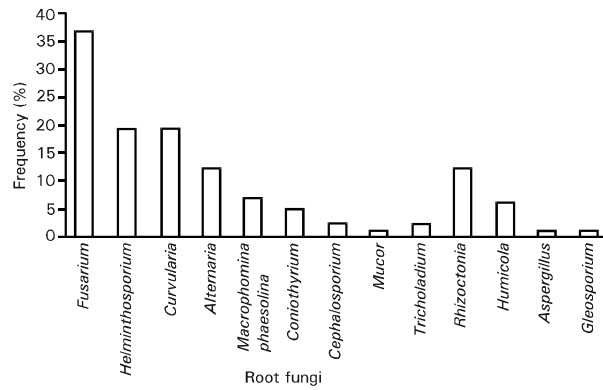


Fig. 3: Frequency percentage of different root fungi isolated from wheat of rice wheat cropping areas of Punjab

Table 1: Incidence and severity of root rot and foliar spots of wheat in main rice wheat cropping areas of Punjab

Areas	Foliar spots				Root rot			
	Incidence% plant infected		Severity (0-9) scale		Incidence % Plant infected		Severity(0-3)scale	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Gujranwala	0-40	18.33	0-7	4.1	80-100	95.00	0-3	2.1
Sheikhupura	0-50	18.88	0-7	3.5	98-100	99.77	0-3	1.8
Narowal	10-20	15.00	3-5	4.0	100	100.00	1-3	2.2
Sialkot	10-25	21.25	3-5	4.5	0-100	100.00	0-3	1.5

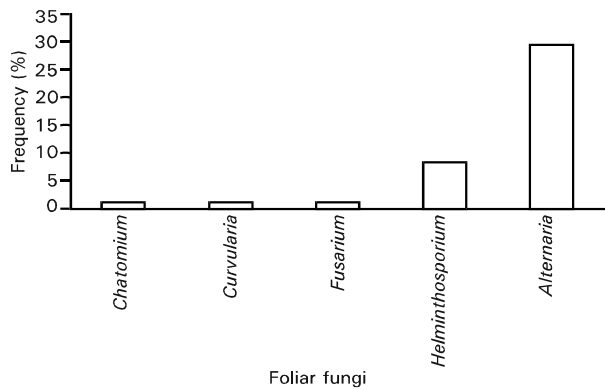


Fig. 4: Frequency percentage of different foliar fungi isolated from wheat of rice-wheat cropping areas of Punjab

Table 2: Fungi isolated from roots and leaves of wheat at the booting stage of wheat

Fungi	Roots	Leaves
<i>Fusarium</i> spp.	+	+
<i>Helminthosporium</i> spp.	+	+
<i>Curvularia</i> spp.	+	+
<i>Alternaria alternata</i> .	+	+
<i>Rhizoctonia solani</i> .	+	-
<i>Macrophomina phaesolina</i> .	+	-
<i>Corniothyrium</i> spp.	+	-
<i>Trichocladium</i> spp.	+	-
<i>Humicola</i> spp.	+	-
<i>Mucor</i> spp.	+	-
<i>Aspergillus</i> spp.	+	-
<i>Chaetomium</i> spp.	-	+

Disease incidence and severity of root rot and foliar spots: Highest mean incidence of root rot was 100% in Narowal and Sialkot with lowest 95% in Gujranwala (Table 1). The highest mean severity 2.2 was in Narowal and lowest 1.5 was in Sialkot. In case of foliar spots, the highest mean incidence was 21.25% in Sialkot while it was the lowest (15%) in Narowal. The highest mean severity 4.5 was observed in Sialkot while the lowest one 3.5 in Sheikhupura.

Isolation of fungi from roots: Most of the fungi isolated were identified to generic level (Table 2). Frequency percentage (Fig. 3) indicated that frequency of *Fusarium* spp. was the highest followed by *Helminthosporium* spp. as compared with other isolated fungi.

Isolation of fungi from leaves: *Helminthosporium* spp., *Curvularia* spp., *Alternaria alternata*., *Chaetomium* spp.

and *Fusarium* spp. were isolated from the wheat leaves of samples of surveyed areas (Table 2). Frequency percentage of different fungi isolated from wheat leaves (Fig. 4) showed that among twenty-one locations, *Alternaria alternata* and *Helminthosporium* spp. were more frequent than *Fusarium* spp., *Curvularia* spp. and *Chaetomium* spp.

Discussion

There are few published reports on the perception of small-scale farmers problems in Pakistan regarding soil-borne diseases and disease incidence or prevalence. The lack of information may be due to the difficulty of systematizing the diversity of cropping system, agroecological zones and crop species grown. With soil-borne fungal diseases, diagnosis is compounded by the diverse and subterranean nature of the causal agents acting to cause symptoms. In Punjab four districts (Sheikhupura, Gujranwala, Narowal and Sialkot) were chosen because in these districts most of the farmers practice rice-wheat cropping system and most of them intercrop with minor cereals, legumes and vegetables. Farmer's have land holdings of less than one ha and they have their own seed source. So after ever 10 km sampling was done and complete information was obtained. Farmers have less knowledge of soil-borne diseases (root rot and foliar spots) and pathogens.

Root rot was 100% prevalent in the rice-wheat cropping system of Punjab. Our observations are similar to Prasada and Prabhu (1962) because they also reported that root rot has been a prevalent disease of wheat in various parts of the world. In this survey incidence of root rot was 100% in Narowal and Sialkot under the range of severity scale of 1-3 and 0-3, respectively. Visual evaluation was confirmed by mycological technique. After the disease assessment small pieces of roots were plated on potato dextrose agar and different types of fungi were isolated (Table 2 and Fig. 3). The number of *Fusarium* species were more as compared to other fungi, suggesting that *Fusarium* may be responsible for root rot disease (Marasas *et al.*, 1988a,b; Klassen *et al.*, 1992). Elmer *et al.* (1997) reported that root rot a destructive disease and caused by *Fusarium* species in many parts of the world. Our findings are also similar to those of Wildermuth *et al.* (1997). Who reported that root rot was caused by *Fusarium* species and was a soil-borne disease of wheat. Foliar spots was also assessed and less prevalent as compared with root rot disease. Among the isolated fungi, dominant causal pathogens were *Alternaria alternata* and *Helminthosporium* spp. Tinline *et al.* (1975), Wiese (1987), Lamprecht *et al.* (1988) and Aftabuddin *et al.*

(1991) reported that the frequency of occurrence of *Helminthosporium* spp. was more than *Fusarium* spp. from the foliar spot of wheat. This indicates the similarity of findings. The present results are also similar to those of Singh *et al.* (1997) in India where foliar blight affected samples were found to be infected more by *Helminthosporium* spp., *Alternaria alternata* and *Cuvularia* spp. Similarly Joshi *et al.* (1978) analyzed 412 samples, collected from different states of India for foliar diseases of wheat and observed that *Alternaria* and *Helminthosporium* were the most common pathogens isolated from these infected samples.

Alternaria alternata, *Helminthosporium* spp. and *Fusarium* spp. were most important and prevalent pathogens in almost all the rice-wheat growing areas of Punjab. They can attack underground parts, leading to pre and post emergence death, damping off, seedling blight, root rot, leaf spot and leaf rot. These fungi can survive under high temperature, high relative humidity and free moisture, respectively (Saari, 1985). Many of the fungi isolated from plant suffering from root rot or foliar were also seed borne pathogens. This is the first report about the soil-borne diseases of wheat crop in rice-wheat cropping system. In this survey fungi are isolated, purified and preserved. Further studies will be done on these isolates in order to see their pathogenicity and genetic variability. In future, a major survey will be carried out in the main rice-wheat cropping areas of Punjab for the assessment of root and foliar diseases of rice. An additional survey will also be done again in wheat crop for the assessment of foliar diseases during coming season.

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