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A Study on Fungi and Soil Born Diseases Associated with Rice-wheat Cropping System of Punjab Province of Pakistan

Shazia Iram, [1]Iftikhar Ahmad and M. Ashraf
Department of Biological Sciences, Qauid-I-Azam University, Islamabad, Pakistan
[1]National Agricultural Research Center, Pakistan Agricultural Research Council,
P.O. Box 1031, Road, Islamabad, Pakistan

Abstract: The root and foliar diseases caused by soil-borne fungi of rice were assessed in main rice-wheat cropping areas of Punjab at the heading stage of the rice crop. Disease severity scales 0-3 and 0-5 were used for root rot and foliar diseases, respectively. The highest mean disease intensity of root rot was 58.88 in Sialkot and lowest 42.21 in Narowal. In case of foliar diseases brown spot, bacterial blight and sheath blight were 100% prevalent in Gujranwala whereas bakanae was present in traces in all four districts of Punjab. In Sheikhupura, blast was highly prevalent (20%) while in Gujranwala and Sialkot, it was absent. Sheath rot was only present in Narowal (16.66%). The highest mean disease intensity of brown spot (40), bacterial blight (44.66) and sheath blight (20) was in Gujranwala. Bacterial blight and sheath blight in Sheikhupura was 8 and 0, respectively. The highest mean disease intensity of blast was 4 in Sheikhupura and absent in Gujranwala and Sialkot. From root, foliar and soil samples *Fusarium* spp., *Nigrospora oryzae, Helminthosporium* spp., *Curvularia* spp., *Phytophthora megasperma, Aspergillus* spp., *Alternaria slternata* and *Trichocladium* spp. were isolated.

Key words: Soil born fungi, rice-wheat cropping system, Punjab, foliar diseases, root-rot

Introduction

Rice is one of the leading food crops of the world, an important staple food and cash crop of Pakistan. It contributes 15% to the foreign exchange earnings. Its area under cultivation 2,515 ha, production 5156 tons and yield 2,050 Kg ha^{-1} also indicate its importance. This crop is very suitable, while other crops are not supposed to be grown where kharif (summer) irrigation water supply is abundant (Cheema *et al.,* 1991). The rice growing areas of the Punjab centered in Gujranwala, Sheikhupura, Narowal, Hafizabad and Sialkot districts.

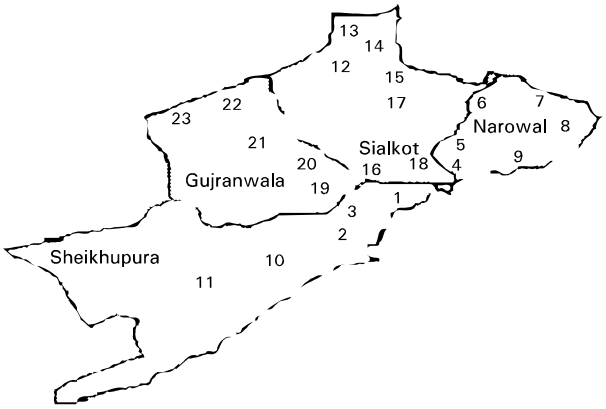
The rice crop is subjected to more than forty diseases, which is one of the factors, for low yield of rice in the world (including Pakistan). The diseases may appear at any stage of the growth and development of plant, attacking the seed sown, root system, foliage, stalk, leaf sheath, inflorescence and even the developing grain. The fungi, bacteria, nematode and virus cause different infectious diseases. There are numerous soil-borne fungi in rice. Which can cause various symptoms i.e. root rot, brown spot, blast, bakanae, bacterial blight, sheath rot and sheath blight (Blackie and Conroy, 1994; Schill *et al.,* 1994; Hillocks *et al.*, 1995). Root rot and bakanae diseases are caused by *Fusarium moniliforme,* sheath blight is caused by *Rhizoctonia solani* and other sheath diseases are caused by *Sclerotium oryza* and *Rhizoctonia oryzae.* Brown spot is caused by *Cocliobolus miyabeanus.* There are certain diseases, which have the potential to risk yield losses in rice-wheat cropping system. *Rhizoctonia solani* causes sheath blight in rice and is known to be responsible for foot rot of wheat (Sharma and Nagarajan, 1997). The soil-borne fungi perpetuate from season to season on host crop debris buried in soil (Ahmad and Raza, 1991). Soil borne fungi are difficult to eliminate since they produce resting structures like sclerotia, chlamydospores etc., which are well adapted to survive for long period under adverse environmental conditions (Ghaffar, 1988). Soil-borne diseases are limiting factors in still crop production by small-scale farmers. However, the nature of these problems is not fully understood and little research has been conducted in Pakistan in the context of the broader rice-wheat cropping system.

Materials and Methods

Farmer fields surveyed: Root, foliar and soil samples were collected from 29th September to 2nd October 1999 at the heading stage of rice. Twenty-three farmer fields were selected randomly from the four districts of Punjab six in each Gujranwala, Narowal and Sialkot district and five in Sheikhupura district. Sampling was done for the assessment of prevalence and disease intensity of soil-borne diseases primarily root rot, foliar diseases and their associated soil-borne fungi. From each field, 10 plants

with soil were collected at 10 points along a diagonal transect.

Soil was removed from each plant, mixed thoroughly and formed one composite sample. Additional information regarding planting date, previous crops, seed source, fertilizer and pesticides applications and yield were also obtained from the farmers (Fig. 1).



1. Shahzad Town	2. Dak Wahga	3.Borey Oat
4. Talwandi	5. Bagh	6. Didore
7. Class Goraya	8. Dharian Wala	9. Gharowal
10. Ayub Form	11. Patin Wala	12. DataZaidKa
13. Saho Wali	14. Poor Bucklain	15. Chicar Ali
16. Jaito Gill	17. Satra	18. Golian
19. Bari Wali	20. Sheikh Rajula	21. Rah Wali
22. Jandiala Dab	23. Khasre	

Fig. 1: Locations surveyed in main rice-wheat cropping areas of Sheikhupura, Gujranwala, Narowal and Sialkot districts of Punjab at the maturity stage of rice in September 1999

Assessment of root rot and foliar diseases: Root rot and foliar diseases were assessed with the help of disease rating scales. For root rot assessment, disease prevalence and disease intensity were determined by 0-3 rating scale[+], where: 0= clean, 1= slight, 2= moderate and 3= severe (Ledingham *et al.,* 1973). For foliar diseases, 0-5 scale was used where: 0= No symptoms, 1= 1-5% (few) spots on <50% of leaves, 2= 5-20% spots on <50% of leaves, 3= 5-20% spots on >50% of leaves, 4=20-50% spots on <50% leaves, 5= >50% spots on > 50% leaves (Anonymous, 1996).

Isolation of fungi from infected parts (roots and foliar) of rice: Roots and foliar parts were separated and washed thoroughly under running tap water for 10-15 min. Washed roots and foliar parts were cut into pieces, immersed in 1% chlorox for 1 min and rinsed three times in sterilized distilled water. Roots and foliar pieces were dried on sterile blotting paper and placed on potato dextrose agar (Usmani and Ghaffar, 1982). The plates were incubated at 27°C for 3-4 days.

Isolation of fungi from soil: Soil borne fungi were isolated from soil through soil dilution method (Waskman, 1992) at 10^{-3} dilution. The culture of fungi were purified and maintained on PDA slants at 27°C. Fungi were identified on the basis of their morphological and growth characteristics using different keys for identification of fungi (Gilman, 1945; Barnett, 1960; Domsch *et al*., 1980).

Results

Prevalence and disease intensity of root rot: The prevalence of root rot was 100% in the four districts of Punjab. Mean disease index 58.88 was higher in Sialkot and its range was 33.33 - 79.92. In Narowal, disease index mean was comparatively low 42.21 and its range was 33.33 - 66.66 (Table 1).

Prevalence and disease intensity of foliar diseases: In foliar diseases brown spot, blast, bakanae, bacterial blight, sheath rot and sheath blight were observed. Brown spot, bacterial blight and sheath blight were more prevalent (100%) in Gujranwala while in Sheikhupura prevalence of brown spot was 80% and bacterial blight was 40%. There was no sheath blight in Sheikhupura. Prevalence of blast was 20% in Sheikhupura while in Gujranwala and Sialkot it was absent. Bakanae disease was present in traces in all the four districts of Punjab (Fig. 2).

The mean disease index of brown spot was higher (40) in Gujranwala and it's range was 40 while lowest (20) was observed in Sheikhupura and Sialkot and its ranges were 0-40 and 0-40, respectively. In case of blast, the highest mean disease index (4) was recorded Sheikhupura and it ranged from 0 to 20. Blast was absent in Gujranwala and Sialkot. Bacterial blight disease index was higher (44.66) in Gujranwala and its range was 0-48, whereas lowest (8) was in Sheikhupura ranging 0-20. Sheath rot was only present in Narowal (3.333) and its range was 0-20. Sheath blight was comparatively higher (20) and it ranged from 8-40

Table 1: Disease index of root rot of rice in main rice-wheat cropping areas of Punjab

	Disease index	
Districts	Mean	Range
Gujranwala	55.53	19.98-99.99
Sheikhupura	46.66	33.33-66.66
Narowal	42.21	33.33-66.66
Sialkot	58.88	33.33-79.92

Table 2: Disease index of foliar diseases of rice in main rice-wheat cropping areas of Punjab

	Foliar diseases											
	Brown spot		Blast		Bakanae		Bacterial blight		Sheath rot		Sheath blight	
Districts	Mean	(Range)	Mean	(Range)	Mean	(Range)	Mean	(Range)	Mean	(Range)	Mean	(Range)
Gujranwala	40	(40)	0	0	0	0	44.66	(40-48)	0	0	20	(8-40)
Sheikhupura	20	(0-40)	4	(0-20)	0	0	8	(0-20)	0	0	0	0
Narowal	33.33	(0-60)	1.333	(0-8)	0	0	25.33	(0-40)	3.333	(0-20)	7.333	(0-20)
Sialkot	20	(0-40)	0	0	0	0	21.33	(0-48)	0	0	13.33	(0-40)

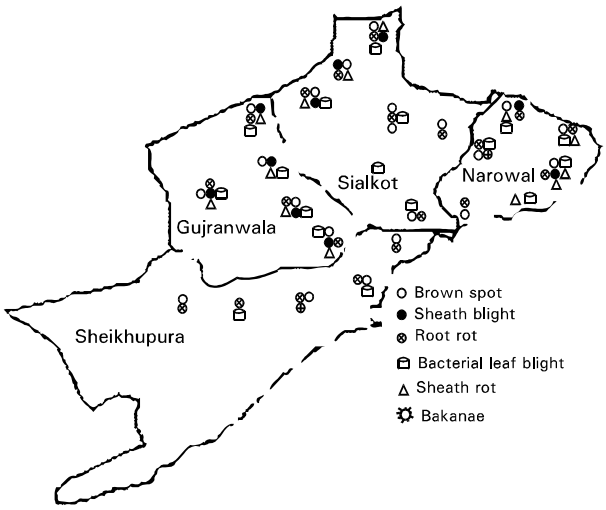


Fig 2: Locations showing the prevalence of root, foliar and sheath diseases of rice in rice-wheat cropping areas (Gujranwala, Sheikhupura, Narowal and Sialkot) areas of Punjab in September, 1999

while it was absent in Sheikhupura (Table 2).

Isolation of fungi from root, leaves and soil: Different types of fungi were isolated from rice roots of twenty-three key locations belonging the four districts surveyed. Frequency percentage of *Fusarium* spp. was the highest as compared to other root-isolated fungi (Fig. 3).

Nigrospora spp., *Curvularia* spp., *Helminthosporium* spp., *Stachybotrys* spp., *Fusarium* spp., *Alternaria* spp., *Aspergillus* spp. and *Trichocladium* spp. were isolated from the leaves of rice (Fig. 4). The frequency percentage of *Nigrospora* spp. was the highest followed by *Curvularia* spp., *Helminthosporium* spp. and *Fusarium* spp.

Different fungi were also isolated from the soil of rice of rice-wheat growing areas (Fig. 5). The colony-forming unit of *Cladosporium* spp. *was* higher than other fungi. *Aspergillus* spp., *Acremonium* spp., *Penicillium* spp., *Fusarium* and many other fungi were isolated from the soil and they were arranged according to their colony-forming units as shown in Fig. 5.

Discussion

Soil-borne fungi can cause various diseases of significant importance in rice crop i.e. root rot, blast, brown spot, bakanae, bacterial blight, sheath rot and sheath blight (Klassen *et al.,* 1992; Mareley and Hillock, 1993). However, 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. According to Hafiz (1986), Bhatti and Soomro (1996) and Jiskani (1999) brown spot, blast, stem rot, bacterial blight and false smut are sometimes considered important diseases at various parts of rice growing areas of Pakistan. Therefore, identification, management practices and some other relevant knowledge of the most important diseases of rice are very important, so that the growers may protect their crops from these diseases, research workers may decide their future strategies and extension workers may also to be alert.

During the 1999, survey of rice crop prevalence and disease intensity of root and foliar pathogens were estimated. Results of the twenty-three key locations of Punjab districts at the heading stage show that root rot was the most prevalent disease in all the four districts of Punjab. Among foliar diseases brown spot, bacterial blight and sheath blight were more prevalent diseases in all the locations surveyed. These results are somewhat similar to the results reported during the surveys of rice-wheat areas of Nepal and Haryana, India. In Nepal and Haryana; India blast, brown spot, bacterial blight and sheath rot were reported as the most important diseases of rice and potential threats for rice cultivation. (Batsa and Manandhar, 1997). In this rice survey species of *Fusarium, Nigrospora, Helminthosporium, Curvularia, Alternaria, Rhizoctonia* and *Sclerotium oryzae* were isolated from the root, foliar and soil samples. In India, Dodan *et al.* (1997) have produced results somewhat similar to our results because in India most important diseases were bacterial blight, blast, bakanae, stem rot, sheath blight and brown spot and the isolated fungi were *Helminthosporium* spp., *Sclerotium oryzae, Rhizoctonia solani, Fusarium* spp., *Alternaria* spp., *Curvularia* spp. and *Nigrospora* spp. (Batsa and

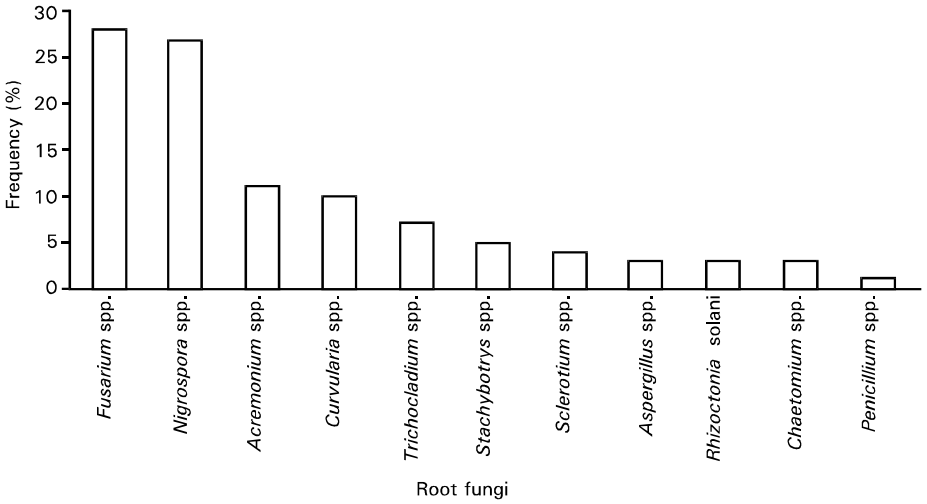


Fig. 3: Frequency percentage of different root fungi isolated from rice of rice-wheat cropping area of Punjab

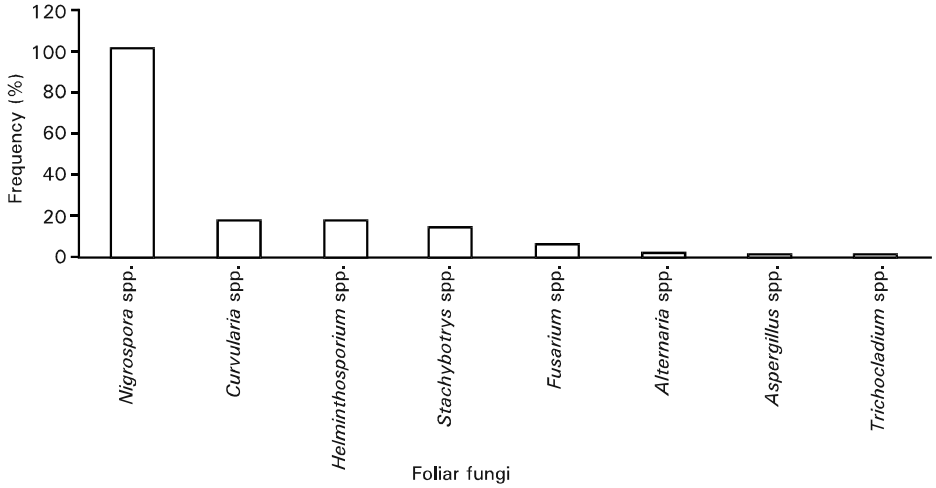


Fig. 4: Frequency percentage of different foliar fungi isolated from rice of rice-wheat cropping areas of Punjab

Manandhar, 1997). In Punjab, during the current survey *Rhizoctonia solani* was isolated from sheath blight affected samples. *Rhizoctonia solani* with sheath blight affected samples was also isolated by Cu *et al.* (1996) in Philippines and Vidhyasekaran *et al.* (1997) in India. Similarly, Zare and Frshad (1997) analyzed the rice samples and isolated nineteen species of *Fusarium.* The causal fungi of root, foliar and soil of rice were *Fusarium* spp. So the present results are also similar to Zare and Frshad because we also isolated various species of *Fusarium* from root, foliar and soil samples. Species of *Nigrospora* were also isolated from the roots, foliar and soil samples and in the Hokriku region for Japan reported the N*igrospora* sigmoidea. This fungus often found on various old dead parts of rice plants throughout the world and mainly occurring as saprophytes because when rice plants are weakened by nutritional either by climatic conditions or are suffering from other diseases or from the insect attack. This fungus may affect glumes, culms, leaves or various other parts of the rice plants. In present survey, rice plants were affected with root rot, brown spot, bacterial blight, sheath blight, blast, bakanae, sheath rot and insect attack. Insect attack was also noticed in farmer fields. A number of insects have been reported from China (Wei, 1957) and Vietnam (Roger, 1941-1942) but there is very little known about their role in other parts of the Asian Tropics.

This is the first report about the soil borne diseases of rice 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

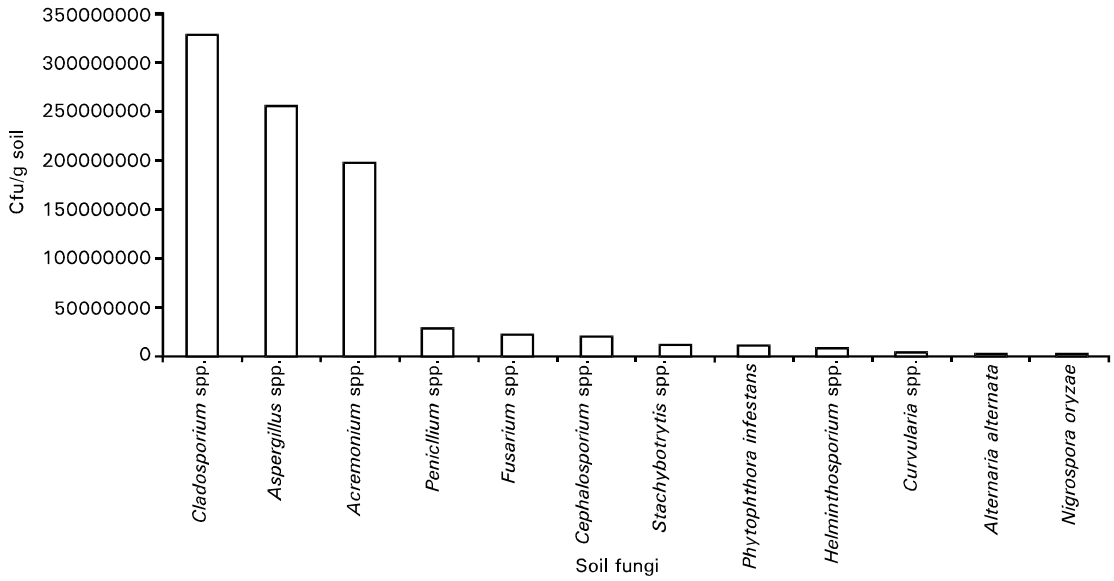


Fig. 5: Frequency percentage of different soil fungi isolated from rice of rice-wheat cropping areas of Punjab

pathogenicity and genetic variability. In past a major survey was carried out in the main rice-wheat cropping areas of Punjab for the assessment of root and foliar diseases of wheat. An additional survey will also be done again in wheat crop for the assessment of foliar diseases during coming season. Many of the fungi isolated from plant suffering from root rot or foliar were also seed borne pathogens. The most accessible means of controlling such disease is through selection of healthy seeds for planting.

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