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Incidence of *Helminthosporium* leaf blight of wheat and biochemical back-ground of disease resistance in the Eastern Gangetic Plains

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Abstract

***Helminthosporium* leaf blight (HLB) caused by *Bipolaris sorokiniana,* is a major disease of wheat grown under humid subtropical climates. Germplasm lines were evaluated for their response against foliar blight disease. Overall recovery of *B. sorokiniana* population was significantly higher than *A. triticina* population. Among five different varieties tested, all showed almost similar results. Assay of polyphenoloxidase and peroxidase enzyme activities showed that following infection, a substantial increase in PPO activity and in PO activity were recorded in resistant germplasms whereas the corresponding values were lower in susceptible germplasms.**

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Introduction

Helminthosporium leaf blight (HLB) caused by *Bipolaris sorokiniana* (Sacc.in Sorok) Shoem. has been a major disease of wheat (Triticum aestivum L.) grown under humid subtropical climates (Duveiller,2002, Rosyara *et al.*2009). Currently it has become major limitation for sustainable production of wheat in rice based cropping system in eastern Gangetic plains of India. Substantial economic losses are caused by HLB in this region (Singh *et al*., 1998). The yield losses due to HLB may be aggravated as a result of increased severity when abiotic stresses such as residual soil moisture, nutrient deficiency and high temperature occurs (Sharma and Duveiller, 2006). Although significant progress has been made in the breeding programmes, most of the cultivars grown in the warmer areas still posses relatively low levels of resistance against this disease (Sharma and Duveiller, 2004). The objectives of this report were to determine the causal organisms of foliar blight disease complex, its occurrence in Teesta and Gangetic Plains of West Bengal and also to investigate the biochemical mechanism of disease resistance.

Materials and Method

The experiment was continued during 2005-08 crop seasons. The leaf samples collected from different locations of Teesta and Gangetic alluvial soils of West Bengal were washed with mercuric chloride (0.1%) solution and dried. The leaf segments having typical blight symptoms were cut into small pieces (4mm2) and were placed on 9 cm diameter petri dishes having wheat bran extract sucrose agar medium and incubated at 250C ± 10C for seven days. The different pathogens were isolated and identified by comparing the respective isolate maintained in the Department of Plant Pathology. The pathogenecity was confirmed by detached leaf assay. Relative dominance of different pathogens were studied on wheat leaf samples of five varieties (HD 2329, Sonalika, Raj 4015, HW 2004 and K 9107) were collected from naturally infected plants at different growth stages of wheat, viz., Stage 34, 47, 55, 65, 73 and 83 according to Zadok's scale. The disease was visually scored using the double digit scale (00-99) developed by Eyal *et al.*(1987). AUDPC (area under disease progress curve) was calculated using the formula given by Das *et al.* (1992). The different biochemical parameters as total phenol and orthodihydroxy-phenol (Mahadevan and Sridhar, 1982), Polyphenoloxidase (PPO) activity (Jennings et a., 1969) and Peroxidase (PO) activity: Addy and Goodman (1972) in healthy and Bipolaris infected leaves of moderately resistant and susceptible genotypes were estimated.

Results and Discussion

The different pathogens viz,. *Bipolaris sorokiniana*, *Alternaria triticina*, *Drechslera gigantea, Curvularia lunata, Alternaria alternata, Pyrenophora tritici* –repentis were found to be associated with foliar blight. Of these, *B. sorokiniana, A. triticina* and *D. gigantea* were found to be pathogenic in this zone (Table 1). The pathogenecity of *D. gigantea* was confirmed earlier by Chowdhury *et al.*(2005). Maximum population of *Alternaria triticina* was obtained in 47th growth stage i.e. during flag leaf stage opening whereas Bipolaris sorokiniana and *Drechslera gignatea* showed significant continuous increase with the advancement of growth stages starting from stage 55 (Table 2). Overall recovery of B. sorokiniana population (73%) was significantly higher than *A. triticina* population (31.3%). Among five different varieties tested, all showed almost similar results.

Table 1 Pathogenecity of fungi associated with foliar blight in Teesta and Gangetic Alluvial soils of West Bengal

Fungi isolated	Pathogenecity
Bipolaris sorokiniana	++
Alternaria triticina	++
Drechslera gigantea	++
Curvularia lunata	-
Alternaria alternata	-
Pyrenophora tritici - repentis	NT

++: Pathogenic; -: Non pathogenic; NT: Not tested

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The results of the present study demonstrate that foliar blight complex is the most serious disease of wheat in teesta and gangetic alluvial region of West Bengal and caused by *B. sorokiniana*, *Alternaria triticina* and *Drechslera gigantea*. It is also observed that A. triticina appears at early growth stage whereas *B. sorokiniana* and *D. gigantea* appear late and cause considerable damage. Two germplasms collected from CIMMYT International programme, viz. Nepal 1 and RWP 40 are identified as resistant source of foliar blight disease.

Table 2 Occurence of Alternaria, Bipolaris and Drechslera in different growth stages of wheat in Teesta and Gangetic alluvial soils of West Bengal

Growth Stage	HD 2329	Sonalika	Raj 4015	HW 2004	K 9107
4th node (Stage 34)	A.t. (+)	A.t. (++)	A.t. (+)	A.t. (+)	A.t. (+)
Flag leaf sheath opening (Stage 47)	A.t. (++)	A.t. (+++)	A.t. (+++)	A.t. (++) B.s. (+)	A.t. (+)
One half of ear emerged (Stage 55)	A.t. (++) B.s. (+)	A.t. +++) B.s. (++)	A.t. (+++) B.s. (+)	A.t. (++)	A.t. (++)
Flowering halfway complete (Stage 65)	B.s. (++) D.g.	A.t. (++) B.s. (+++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.
Early milk (Stage73)	B.s. (++) D.g.	B.s. (+++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.
Early dough (Stage 83)	B.s. (++) D.g.	B.s. (+++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.	B.s. (++) D.g.

A. t.: *Alternaria triticina*; B. s.: *Bipolaris sorokiniana*; D. g.: *Drechslera gigantea*, +++: High recoverable; ++: Moderate recoverable; +: Trace recoverable

Table 3 Levels of total phenol and O – dihydroxyphenol in healthy and Bipolaris infected leaves of resistant and susceptible germplasms of wheat

Treatment	Total phenol (mg/g fresh weight)				O – dihydroxyphenol (mg/g fresh weight)			
	Resistant		Susceptible		Resistant		Susceptible	
	Nepal 1	RWP 40	Sonalika	HUW 234	Nepal 1	RWP 40	Sonalika	HUW 234
Healthy	3.54 ± 0.04	3.40 ± 0.01	3.02 ± 0.03	3.15 ± 0.04	0.29 ± 0.02	0.30 ± 0.04	0.28 ± 0.02	0.24 + 0.02
Infected*	3.93 ± 0.03	3.81 ± 0.04	2.88 ± 0.02	3.16 ± 0.02	0.33 ± 0.04	0.36 ± 0.01	0.25 ± 0.03	0.25 + 0.01

* Levels estimated after 48 hours of inoculation; +: SEM value

Table 4 Polyphenol oxidase and peroxidase activity in healthy and Bipolaris infected leaves of resistant and susceptible germplasms of wheat

Treatment	Polyphenol oxidase activity*				Peroxidase activity*			
	Resistant		Susceptible		Resistant		Susceptible	
	Nepal 1	RWP 40	Sonalika	HUW 234	Nepal 1	RWP 40	Sonalika	HUW 234
Healthy	13.01 ± 1.1	13.20 ± 0.9	12.20 ± 0.7	13.10 ± 1.1	14.40 + 0.8	14.21 ± 0.9	14.17 ± 0.9	14.16 ± 1.2
Infected**	16.60 ± 0.9	15.65 ± 0.7	13.56 ± 0.9	14.21 ± 0.7	17.50 + 0.7	18.40 ± 1.1	15.25 ± 0.8	15.91 ± 0.9

* Data is expressed as OD / g tissue / minute; ** Activity was estimated after 48 hours of inoculation; +: SEM value

A total of 550 numbers of germplasm were evaluated for their resistance against foliar blight disease. Of these two germplasm viz. Nepal 1 and RWP 40 were selected and their AUDPC ranged from 124 to 155, which suggested these genotypes are resistant to foliar blight in comparison to susceptible genotypes as Sonalika and HUW 234. The biochemical changes related to plant defense system were studied. Total phenol increased with infection (11%) in resistant germplasm whereas it was low in susceptible germplasm when compared with the healthy plants. The trend of ortho-dihydroxyphenol content showed the same way as that of the phenol content (Table 3).

Assay of polyphenoloxidase and peroxidase enzyme activities showed that following infection, a substantial increase (18-27%) in PPO activity and 21-29% in PO activity were recorded in resistant germplasms whereas the corresponding values were only 8-11% and 7-12% respectively in susceptible germplasms (Table 4). Similar observation was recorded by Tyagi *et al.*(2000) in wheat genotypes against *Alternaria triticina.*

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