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Pathogenic Variability of *Fusarium fujikuroi* Causing Bakanae Disease of Rice (*Oryza sativa* L.)

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Abstract

Bakanae or foot rot disease is one of the newly emerged diseases of rice in Kashmir. An extensive survey conducted during 2014 in two districts of south Kashmir *viz.,* Anantnag and Kulgam, revealed the prevalence of the disease in all the surveyed areas with varied levels of incidence which ranged from 0.6 per cent to 19.3 per cent. The fungus inciting the disease was identified as *Fusarium fujikuroi* Nirenberg [teleomorph*: Gibberella fujikuroi* (Sawada) Ito] on the basis of its morphological and pathological characteristics. Pathogenic variability study of 20 *F. fujikuroi* isolates collected from 17 diverse locations, on a set of seven putative rice differential lines, revealed the existence of variability in terms of pathogenicity of the isolates. The twenty test isolates discern into six pathogenic groups on the basis of similarity in reaction pattern of the differential lines against the test isolates. Two isolates from Block Larkipora (Ff13 and Ff15) shared a single group *i.e,* Group I and 5 isolates (Ff1, Ff2, Ff3, Ff4 and Ff5) from Larnoo block accommodated in Group II, Similarly, three isolates (Ff10, Ff12 and Ff17) from Block Qaimoh and three isolates (Ff6, Ff7 and Ff8) from block D.H.Pora shared group V and VI, respectively. Group III accommodated three isolates, 2 from Achabal block (Ff9 and Ff11) and 1 from Pahloo block (Ff16) and Group IV accommodated 4 isolates, 2 (Ff14 and Ff20) from Pahloo block, 1 (Ff18) from Achabal block and 1(Ff19) from Qaimoh block.

Key words: Bakanae, *Fusarium fujikuroi*, pathogenic, variability, *Oryza sativa*

Introduction

Bakanae or foot rot disease caused *Fusarium fujikuroi* Nirenberg [teleomorph: *Gibberella fujikuroi* (Sawada) Ito] is one of the important and widely distributed diseases of rice which considerably limit its yield potential (1-4). In India the disease is emerging as one of the major biotic stresses of rice and has been reported to cause moderate to severe yield losses ranging from 15-25 per cent from different states of India (5-7). The disease for the last few years has been noticed regularly affecting rice crop in Kashmir, inflicting heavy economic losses particularly on *Japonica* type of cultivars cultivated under high altitude conditions of Kashmir valley (8). The introduction of this disease in Kashmir through seed material is quite possible owing to its seed borne nature. The disease is reported to be both soil (9, 10) as well as seed-borne (11-13). Since, the disease is primarily reported to be seed-transmitted, seed dressing represents the first way to control the spread of the disease. However, seed treatment alone fails to prevent soil-borne infection after transplanting which results in poor management of the disease (14). Prevention of soil-borne infection after transplanting is always difficult due to prolonged saprophytic survival of the fungus and impracticality of chemical approach to eradicate soil borne inoculum. Morever, long term usage of fungicides has led to the resistance development in pathogens (15, 16) besides environmental consequences associated with their use (17). The most efficient and economical method to mitigate the menace of bakanae disease is therefore, the use of resistant varieties. Since, bakanae disease in Kashmir has been recently found affecting the rice crop, the breeding programme has never been targeted at bakanae disease resistance. The success of developing varieties with durable disease resistance largely depends upon identification of genotypes with resistance against range of virulence present in pathogen population prevalent in target locations. The study was therefore conducted to determine the extent of pathogenic variability present in pathogen population under Kashmir condition which shall guide plant breeders to develop varieties with durable resistance to bakanae disease.

Materials and Methods

Status of Bakanae Disease: Survey of the rice growing areas of two districts of Kashmir valley viz., Anantnag and Kulgam was carried out during July to August, 2014 to assess the status of the bakanae disease. Three representative villages were taken from each of the three blocks of the district and three random paddy fields selected from each village. Hundred random plants from each field were selected for recording observations on incidence of the disease. The per cent disease incidence was calculated by using the following formula:

$$\text{Per cent disease Incidence} = \frac{\text{No. of plants infected}}{\text{No. of plants examined}} \times 100$$

Collection, Isolation and Maintenance of Pathogen Isolates: Bakanae affected rice plants representing 8 rice genotypes and 17 diverse locations were collected during the course of survey and attempted for isolation of the causal pathogen. Twenty monoconidial cultures of *F. fujikuroi* (Table-1) were obtained using single spore isolation technique and maintained on Potato Dextrose Agar medium (PDA) for further studies. The pathogenicity test of the all the isolates of *F. fujikuroi* was established by confirming Koch' postulates on potted rice seedlings using their respective genotype from which they were isolated.

Pathogenic Variability: Virulence spectrum of twenty isolates of *F. fujikuroi* was characterized using seed dip inoculation technique on a set of seven putative differential rice lines *viz*., K-332, Pusa Basmati-1509, GS-88, SK-407, SK-423, Mushkbudgi and GSL-225. The differential rice lines were selected on the basis of consistency in their reaction type against the test isolates. Seeds of each differential line, collected from apparently healthy plots were sterilized and inoculated separately with twenty test isolates by soaking the germinated seeds in the concentrated spore suspension of *F. fujikuroi* for 12 hours. Twenty inoculated seeds of each differential line were then sown in plastic trays, filled with sterilized soil in such a way that the differential set inoculated with same isolate accommodated in one tray. Uninoculated checks in which seeds were treated with sterilized distilled water were also maintained for each test isolate. The trays were incubated in plant growth chamber at 30±2°C day and 25±2°C night temperature, 80±5 per cent relative humidity and alternate periods of 12 hour light and 12 hour darkness and kept under observation for a period of 30 days. The observation on per cent incidence of bakanae infected plants was recorded after 30 days of sowing to assess the level of resistance and susceptibility of each test entry according to disease rating scale as adopted by (18), where, lines up to 40 per cent disease incidence were treated as resistant and with more than 40 per cent disease incidence as susceptible.

Results and Discussion

Disease Status: Bakanae disease was found prevalent in all the surveyed rice growing locations (Table-2). Occurrence of this disease of rice has been reported from all over the world

Table 1. Sources of *Fusarium fujikuroi* isolates

Isolate	Location	District	Block	Rice Genotype
Ff1	MCRS*, SKUAST-Kashmir, Larnoo	Anatnag	Larnoo	GSL-64
Ff2	MCRS*, SKUAST-Kashmir, Larnoo	Anatnag	Larnoo	GSL-19
Ff3	Khreti	Anantnag	Larnoo	K-332
Ff4	Larnoo	Anantnag	Larnoo	K-332
Ff5	Drawa	Anantnag	Larnoo	K-332
Ff6	Nagam	Kulgam	DH Pora	K-332
Ff7	Khul Ahamdabad	Kulgam	DH Pora	K-332
Ff8	Mandgur	Kulgam	DH Pora	K-332
Ff9	Badoora	Anantnag	Achabal	China-1039
Ff10	Khudwani	Kulgam	Qaimoh	China-1039
Ff11	Thajwara	Anantnag	Achabal	China-1039
Ff12	Qaimoh	Kulgam	Qaimoh	Jehlum
Ff13	Kreeri	Anantnag	Larkipora	Jehlum
Ff14	Chatarpora	Kulgam	Pahloo	Jehlum
Ff15	Nowpora	Kulgam	Larkipora	Jehlum
Ff16	Gasren	Kulgam	Pahloo	K-39
Ff17	Bugam	Kulgam	Qaimoh	K-39
Ff18	Achabal	Anantnag	Achabla	K-78
Ff19	MRCFC** (SKUAST-K), Khudwani	Kulgam	Qaimoh	Pusa Basmati-1509
Ff20	Zangalpora	Anantanag	Pahloo	Local

*MCRS: Mountain Crop Research Station
**MRCFC: Mountain Research Centre of Field Crops

(1, 19) including India (20, 21, 22, 8). The disease incidence however, varied from location to location which ranged from 0.6 per cent to 19.3 per cent. While studying the incidence of bakanae disease (21) also recorded varied levels of disease incidence ranging from 3.8 to 13.6 per cent in Rajasthan. Similarly, (23) recorded 0.5 to 12.5 per cent bakanae disease incidence from Peninsular Malaysia and three provinces of Indonesia. The varied levels of disease incidence observed at different surveyed locations may be attributed to different cultural and management practices adopted by the farmers and above all the type of cultivar being cultivated by the farmers which vary in their level of susceptibility and resistance. Effect of different cultural practices on bakanae disease incidence has been reported earlier (24, 25). Bakane disease management in rice crop through delayed sowing has been reported by (25, 26), while as (24, 27) found higher levels of nitrogen and potassium suppressing the bakanae pathogen. The average disease incidence was higher (8.7%) in district Anantnag than district

Table 2. Incidence of bakanae disease of rice at different locations of Anantnag and Kulgam districts of Kashmir during 2014.

District	Block	Location	Varieties grown	Bakanae Incidence(%)*
Anantnag	**Achabal**	Achabal	China-1039, K-78	7.3
		Thajwara	China-1039, K-78	6.0
		Badoora	China-1039, Jehlum	5.3
		Mean		**6.2**
	Larkipora	Doru	Jehlum, K-78	0.6
		Kreeri	China-1039, Jehlum	4.3
		Nowpora	China-1039, Jehlum	6.6
		Mean		**3.8**
	Larnoo	Larnoo	K-332	19.3
		Drawa	K-332	12.6
		Khreti	K-332	17.0
		Mean		**16.3**
Overall mean				**8.7**
Kulgam	**DH Pora**	KhulAhamabad	K-332	5.3
		Nagam	K-332	4.6
		Mandgur	K-332	4.6
		Mean		**4.8**
	Qaimoh	Khudwani	China-1039, Jehlum, Local	8.3
		Qaimoh	China-1039, Jehlum	4.3
		Bugam	K-39, Jehlum	7.3
		Mean		**6.6**
	Pahloo	Chatarpora	China-1039, Jehlum	3.3
		Gasren	China-1039, Jehlum, K-39	5.0
		Zangalpora	China-1039, Local	5.6
		Mean		**4.6**
Overall mean				**5.3**

*Average of three sites

Kulgam (5.3%). Maximum disease incidence was recorded at Larnoo (19.3 %) location followed by Khreti (17.0%) and Drawa (12.5 %) areas of district Anantnag, while as the lowest disease incidence was recorded at Doru (0.6%) location of district Anantnag. The highest disease incidence observed at Larnoo may be attributed to the cultivation of susceptible variety K-332 and use of infected and untreated farmers own saved seed. However, the low disease incidence (4.8 %) in the same type of cultivar, K-332 at DH Pora of district Kulgam and lowest disease incidence at Doru location was attributed to use of treated seeds as revealed by the farmers. Effectiveness of fungicide seed treatment in disease management has been reported by various workers (8, 16).

Pathogenic Variability: Pathogenic variability study of 20 *F. fujikuroi* isolates collected from diverse locations was conducted on a set of

Table 3. Pathogenic grouping of *Fusarium fujikuroi* isolates using putative differential rice lines

Isolates	Reaction response of differential rice lines							Patho genic Group
	K-332	Pusa Basmati -1509	GS-88	SK-407	SK-423	Mushk budgi	GSL-225	
Ff13, Ff15	S	R	R	S	R	R	R	I
Ff1, Ff2, Ff3, Ff4, Ff5	S	S	R	S	R	R	R	II
Ff9, Ff11, Ff16	S	S	R	S	S	R	R	III
Ff14, Ff18, Ff19, Ff20	S	S	R	S	S	R	S	IV
Ff10, Ff12, Ff17	S	S	R	R	S	S	R	V
Ff6, Ff7, Ff8	S	S	R	R	S	S	S	VI

seven putative rice differential lines. The twenty test isolates discern into six pathogenic groups on the basis of 100 per cent similarity in the reaction pattern exhibited by rice differential lines against these test isolates (Table-3). Pathogenic variability in bakanae pathogen has been reported earlier by various workers (1, 27-31). Amatulli et al. (31) found considerable pathogenic variability among the 28 isolates of *F. moniliforme* using five paddy cultivars as differential host. Pathogenic variability in *F. fujikuroi* isolates in terms of variable symptom expression has been also observed (29, 31, 32). The pathogenic groups more or less related to their respective geographical regions of collection. Two isolates from Block Larkipora (Ff13 and Ff15) shared a single group *i.e,* Group I and five isolates (Ff1, Ff2, Ff3, Ff4 and Ff5) from Larnoo block accommodated in Group II, Similarly, three isolates (Ff10, Ff12 and Ff17) from Block Qaimoh and three isolates (Ff6, Ff7 and Ff8) from block D.H.Pora shared group V and VI, respectively. The region specificity of isolates in terms of their virulence can be attributed to non dispersal of infected seed through farmer to farmer exchange of seed material and very narrow cultivar diversity over large cultivated area. The similarity of the isolates representing the particular geographical region has been also found by (33). Group III accommodated three isolates, two are from Achabal block (Ff9 and Ff11) and one from Pahloo block (Ff16) and Group IV accommodated 4 isolates, two (Ff14 and Ff20) from Pahloo block, one (Ff18) from Achabal block and one (Ff19) from Qaimoh block. The sharing of common pathogenic group by isolates from different blocks may be ascribed to farmer to farmer infected seed sharing from one block to another and to the broad genetic diversity of cultivated rice varieties in these areas. The variability within the isolates of same district has also been reported (34).

Conclusion

Bakanae disease caused *Fusarium fujikuroi* is one of the important, newly identified and widely distributed diseases of rice which considerably limit its yield potential. The survey was conducted to assess the status and pathogenic variability of the bakanae disease in the southern Districts of Kashmir valley. The disease incidence was found prevalent in all the rice locations which were surveyed. Pathogenic variability study of *F. fujikuroi* isolates collected from diverse locations was conducted on a set of seven putative rice differential lines.

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