J. Mycopathol. Res. **41**(1) : 55-58 (2003)

Survival of *Fusarium moniliforme* in different sources

S. BISWAS AND S. N. DAS
Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia 741 252, West Bengal

Survival of *Fusarium moniliforme* Sheld, the causal fungus of Bakanae disease of rice, was studied in infested soil, stubble pieces and grains of paddy. The population of *F. moniliforme* in naturally infested field soil declined rapidly with increased storage period and the fungus survived up to three months from the date of collection of soil. The fungus survived in infected stubbles, kept in soil under natural environmental condition up to four months. Low temperature favoured the survival of the fungus in infected stubble-pieces. Rocovery percentage of the fungus declined rapidly with increasing temperature. The pathogen survived in infected rice grains, stored at room temperature, for considerably long period (ten months).

Key words : *Fusarium moniliforme*, rice, survival

INTRODUCTION

'Bakanae' disease, caused by *Fusarium moniliforme* Sheld. [Teleomorph : *Gibberella fujikuroi* (Sawada) Ito], is one of the important diseases of rice throughout the paddy growing countries of the world (Ou, 1985). The disease has been reported to cause moderate to severe losses which varied with regions and varieties grown (Heaton, 1965 ; Ou, 1985 ; Pavgi and Singh, 1964). In West Bengal the disease appears primarily on 'Boro crop' and has been reported to cause about 10% loss in yield under field condition (Biswas and Das, 2001). The pathogen is reported to be primarily seed-borne in nature but is also known to survive in soil (Ou, 1985). This paper reports the survival of the pathogen in different sources which is helpful for better understanding of the disease cycle as well as for effective control measures.

MATERIALS AND METHODS

Soil samples for studying the survival of the pathogen in field soil were collected from plough depth (upto 15 cm) of a farmer's rice field at Duttaphulia village near Ranaghat (Dist. Nadia) during April, 1997. Soil samples were collected from the rhizosphere of infected rice plants (variety Rasi–IEt 1444) immediately after harvesting, separately from 5 locations of the field, and pooled together in the laboratory, bulked, air dried, powdered and taken in plastic boxes (6 cm dia, height 8 cm) and stored under laboratory conditions. Small samples of soil were drawn at monthly interval. Sub-samples of 50 mg were weighed and distributed evenly over the surface of modified Czapek-Dox agar in petriplates for selective isolation of *F. moniliforme* (Sharma and Singh, 1973). Based on colony characters described by Sharma and Singh (1973) on this medium, colonies of *F. moniliforme* were counted in each plate after 5 days of incubation at 28±1°C and number of colony forming units (cfu) comprising of mycelial fragments and conidia were determined per gram of soil.

Survival of the pathogen in infected stubbles was conducted in earthen pots (dia 20 cm, height 30 cm). The inculated diseased plants (variety Rasi—IET 1444), after maturity, were cut almost from ground level, leaving the stubbles in the soil. Pots along with soil and stubbles were kept in the field under natural conditions. At monthly intervals stubbles were taken out from soil, washed throughly in running tap water for removing adhering soil particles and were chopped in approximately 1 cm in length. The stubble pieces were then surface sterilized with 2.5% NaOCI for 2 minutes, washed with sterilized distilled water and placed on

modified Czapek-Dox agar in petriplates. The stubbles showing colonies of the fungus were counted and per cent survival recovery was calculated.

Seeds of the susceptible variety Rasi (IET 1444), collected from heavily infested fields were cleaned, dried properly, filled in small cloth bags and stored at room temperature under laboratory conditions. Small samples of seeds were drawn at monthly intervals, surface sterilized with 2.5% NaOCl for 2 minutes and plated on modified Czapek (Dox) agar medium for selective isolation of the pathogen. Three plates were taken at a time and each plate contained 12 grains. The plates were incubated at 28±1°C for 5 days. The grains showing colonies of the pathogen were counted and per cent survival/recovery was calculated.

Lower 15 cm stem pieces from bakanae infected plants of rice variety Rasi (IET 1444), collected from farmer's field were dried under shade after thoroughly washing with tap water and chopped to appromixately 1 cm in length. The infected stem pieces were taken in small cloth bags and stored at different temperature conditions viz. 4°C (in a refrigerator), 28°C (in incubator) and room condition (temperature varied and average temperature given in the respective table under experimental results). Samples of stubble pieces from each temperature were drawn at monthly intervals, surface sterilized with 2.5% NaOCl for 2 minutes, washed with sterilized distilled water and plated on modified Czapek-Dox agar (Sharma and Singh, 1973). Three plates were kept per treatment and each plate contained 10 stubbles pieces. The plates were incubated at 28 ± 1°C for 5 days. The stubbles showing colonies of *F. moniliforme* were counted and per cent survival/recovery was calculated for each treament.

RESULTS AND DISCUSSION

The nature of perennation constitutes an important aspect of the life cycle of a pathogenic fungus, as successful perennation of the pathogen in some other sources during the offseasons, i.e. when the crop is not available, is reflected in its ability to resume pathogenic life when the suitable host is available. In the present studies, *F. moniliforme*, the causal fungus of bakanae disease of rice, was found to be able to perennate in several sources, namely, soil, infected crop residues and seeds for a considerable period, in absence of the host.

In the soil of an infested field, collected just after harvesting of rice (April, 1997) and kept under the laboratory conditions, it was observed that, the population of the causal fungus, *F. moniliforme* declined rapidly with increasing the storage period and beyond three months from the date of collection, the pathogen could not be recovered from the soil (Table 1). In earlier studies, Nyvall and Kommedahl (1966, 1968 and 1970) found that, the fungus survived in the soil for about four months in the form of thick-walled hyphae or macroconidia. These thick walled hyphae resemble chlamydospores but lack a double wall. Watanave (1974) reported that, rhizomorph like survival structures were observed when the fungus was grown on glass-slides kept in soil.

Table 1 : Survival of *F. moniliforme* in naturally infested soil.

Survival period (months)	Mean colony forming units (cfu) per gram of soil
April '97	213.3
May '97	93.3
June 97	26.6
July '97	6.6
August '97	0.0

The percentage recovery of the pathogen from infected stubble pieces, left in potted soil, after harvesting of the infected rice plants under natural environmental condition, declined rapidly with the increase of incubation period. Initially 100% of the stubble pieces yielded the fungus, however, it could be detected only for four months (Table 2). The rapid decline in the population of *F. moniliforme* in the infested stubble pieces left over in the soil might be attributed to the activities of the antagonistic microorganisms present in the soil or the decomposition of the stubble pieces. Grewal and (1988) stated that cool and dry condition favoured the survival of the pathogen in plant litter. Under natural conditions in Punjab, the pathogen survived in seeds and plant litter in the field and became the source of inoculum for the next crop. From the ob-

servations in the present studies on the survival of the pathogen in naturally infested soil and also in infected stubble pieces, kept in the potted soil under natural conditions, it may be concluded that *F. moniliforme* does not have very high competitive saprophytic survival ability in soil.

Table 2 : Survival of *F. moniliforme* in infested stubble pieces in soil

Survival period (months)	Precentage of infected stubble pieces yielding the fungus
April '97	100.0
May '97	96.6
June 97	73.3
July '97	46.6
August '97	16.6
September '97	0.0

Table 3 : *In-vitro* survival of *F. moniliforme* in infected stubble pieces at different temperatures (in the laboratory)

Survival period (months)	Precentage of infected stubble pieces yielding the fungus at different temperatures (°C)*		
	4°C	28°C	Room temperature (Average) (Max 35.46 Min. 23.17)
April '97	100	100	100
May '97	100	100	100
June 97	100	100	96.6
July '97	100	100	96.6
August '97	100	100	90.0
September '97	96.6	96.6	86.6
October '97	90.0	86.6	76.6
November '97	83.3	80.0	66.6
December '97	80.0	73.3	63.3
January '98	76.6	60.0	56.6
February '98	66.6	53.3	50.0
March '98	63.3	46.6	40.0
April '98	53.3	40.0	26.6
May '98	46.6	23.3	16.6
June '98	30.0	13.3	0.0

[* Experiment started from 28th April, 1997 and continued up to 21st June, 1998]

The survival of the pathogen in infected stubble pieces, on the other hand, when kept in the laboratory under different temperature conditions was much longer (at least 13 months) (Table 3). Temperature was found to have considerable effect on the survivability of the fungus in the infected stubble pieces. Low temperature favoured higher survivability of the pathogen. Thus, under low temperature condition, crop residues may serve as a major source of primary infection. At room temperature, the rate of decline of the population of the pathogen was maximum. Two factors may account for more rapid decline of the population of the pathogen in infected stubble pieces kept at room temperature than at a constant temperature in a refrigerator (4°C) or in an incubator (28°C). Firstly, with increase in storage period (starting from the month of April) there was an increase in atmospheric temperature (during the month of April-May) and secondly a fluctuation of daily temperature and also humidity under room conditions. Such fluctuation in temperature and humidity generally adversely affected the survival of a pathogen.

Table 4 : *In-vitro* survival of *F. moniliforme* in infected grains (stored at room temperature)

Survival period (months)	Precentage of infected seeds yielding the fungus*
April '97	66.6
May '97	60.0
June 97	60.0
July '97	60.0
August '97	56.6
September '97	53.3
October '97	46.6
November '97	40.0
December '97	33.3
January '98	23.3
February '98	13.3
March '98	0.0

[* Experiment started from 28th April, 1997 and continued up to 23rd March, 1998]

In infected rice grains, stored at room temperature, the pathogen could be recorded for considerably long period (ten months) (Table 4). Up to four months the percentage recovery of the pathogen in seeds remained more or less constant, after which it gradually declined, however, the pathogen could be recovered up to ten months. Sunder and Satyavir (1998) also found that the pathogen could survive for considerably longer period in infected grains and stubble pieces of paddy stored at room temperature, although it varied greatly with the varieties affected. The survival of the pathogen in grains and stubble pieces decreased with increased temperature and relative humidity.

From the preceding discussion, regarding the role of various sources on the perennation of *F.*

moniliforme, it may be broadly concluded that, infected seeds constitute the main sources of primary infection of the disease as the pathogen can survive in the seeds under natural condition after harvest till the next sowing season. On (1985) also suggested seeds to be the main primary source of infection of bakanae disease.

ACKNOWLEDGEMENT

The authors are grateful to Dr. P. K. Sengupta, Professor (Retd.), Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Naida for providing necessary help and technical counsel during the course of this investigation.

REFERENCES

Biswas, S. and Das, S. (2001). Incidence of bakanae disease of rice in West Bengal and spread of the causal fungus within the host. *Proceedings of the National Symposium on Tropical Mycology in the 21st century, Department of Botany, Calcutta University, 8-10 February, 2001.* (Abstract) pp 18-19.

Grewal, S. K. and Kang, M. S. (1988). Seasonal carry over of *Fusarium moniliforme* Sheld., causal organism of Sheath rot of rice. *Phytopathologia Mediterranea.* **27** : 36-37.

Heaton, J. B. (1965). A foot rot disease of rice variety Blue Bonnet in Northern Territory, Australia, caused by *Fusarium moniliforme* Sheldon. *Tropical Science.* **7** : 116-121.

Nyvall, R. E. and Kommedahl, T. (1966). Thickened hyphae as survival mechanism in *Fusarium moniliforme, Phytopathology,* **56** : 893.

Nyvall, R. E. and Kommedahl, T. (1968). Individual thickened hyphae as survival structures of *Fusarium moniliforme* in corn. *Phytopathology,* **58** : 1704-1707.

Nyvall, R. E. and Kommedahl, T. (1970). Saprophytism and survival of *Fusarium moniliforme* in corn stalk. *Phytopathology,* **60** : 1233-1235.

Ou, S. H. (1985). *Rice Diseases.* CMI, Kew, Surrey, U. K. 380 pp.

Pavgi, M. S. and Singh, J. (1964). Bakanae and foot root of rice in Uttar Pradesh, India. *Plant Disease Reporter,* **48** : 340-342.

Sharma, R. D. and Singh, R. S. (1973). A technique for selective isolation of *Fusarium moniliforme* from soil and plant tissues. *Indian Journal of Mycology and Plant Pathology,* **3** : 67-70.

Sunder, S. and Satyavir. (1998). Survival of *Fusarium moniliforme* in soil, grains and stubbles of paddy. *Indian Phytopathology,* **51** : 47-50.

Watanabe, Y. (1974). The possibility of soil transmission in bakanae disease and the contamination of seeds with causal fungus during the hastening process of seed germination. Bulletin of the *Tolai Kinki National Agricultural Experimental Station,* **27** : 35-41.

(Accepted for publication November 10 2002)