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SURVIVAL OF *BIPOLARIS SOROKINIANA* (SACC.) SHOEMAKER IN SOIL AND RESIDUE OF WHEAT

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Abstract

Off-season survival of *Bipolaris sorokiniana* (Sacc.) Shoemaker in sterilized and unsterilized soils, and in residues of wheat spread on soil surface were determined. Population of viable propagules of the fungus per gram of soil or residue was determined at monthly interval using dilution plate technique. It was found that the population of *B. sorokiniana* increased initially for two months in both soils and residues and declined thereafter. The decline was very sharp up to four months of survival and then onwards a gradual decline was observed. In case of free residue, a gradual decline in population was observed from the beginning of the pathogen survival. The pathogen could be recovered up to eight and ten months from the unsterilized and sterilized soil, respectively. It was not possible to recover the pathogen from the residues in unsterilized and sterilized soil after seven and eight months. The pathogen could survive for 12 months in free residue stored at room temperature.

Introduction

The fungus, *Bipolaris sorokiniana* (Sacc.) Shoemaker (syn. *Helminthosporium sativum* Pamm., King & Bakke) is principally a non-specific foliar blight pathogen, but it is also causal organism for seed rot or germination failure, crown rot, seedling blight, head blight and black point disease of wheat (Zillinsky 1983, Mishra *et al*. 2001). Asexual propagation of the fungus through conidial production is common in nature, and its teliomorph stage (*Cochliobolous sativus)* is only reported to occur in Zambia where two opposite mating types are found to exist (Raemaekers 1988). The sources of *B. sorokiniana* inoculum in nature are infected seeds, infected crop residues, collateral hosts, and free dormant conidia in the soil (Reis 1991). Knowledge on off-season inoculum survival of a pathogen in different sources is very essential to develop appropriate disease management strategy. Several workers have tried to determine the spore viability and the extent of survival of *B. sorokiniana* in soil and crop residues under different conditions (Mishra and Chourasia 1976, Reis and Santos 1987, Reis 1989, Reis *et al*. 1998a, Duczek *et al*. 1999).

Survival of *B. sorokiniana* in soil is accomplished by the ability of the fungus to colonize diseased wheat straw, and the inoculum density of the pathogen in soil is related to the amount of its sporulation occurring in crop residues (Burgers and Griffin 1968, Reis and Wunsche 1984). Tinline *et al*. (1988) stated that the intensity of common root rot and spot blotch severity at tillering, flowering and dough stages of wheat are closely related to the population density of *C. sativus* in soil. This necrotrophic fungus normally sporulates on the necrotic tissues throughout the growing season and reaches the heads, finally returning to seed, which ensures the most efficient mechanism for pathogen survival (Reis 1991, Reis *et al*. 1998b). When such seeds are sown in the field, the coleoptile readily gets infected resulting in seedling infection, which provides inoculum for the growing crop (Reis 1991). Mondal (2000) reported that infected seeds, and soils infested either with conidial suspension or colonized grains may serve as potential sources for the survival of *B. sorokiniana* resulting in germination failure, seedling mortality and

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spot blotch development in wheat. Recently, Pandey *et al*. (2002) from India reported that conidial germination of *B. sorokiniana* in wheat straw after five months of storage at room temperature falls below 0.5% suggesting the loss of pathogen viability. However, survival of this pathogen in soil and wheat residues under the agro-climatic conditions of Bangladesh is yet to be documented. The present study was, therefore, undertaken with the objective to determine the population of viable propagules of *B. sorokiniana* and the extent of its off-season survival in soil and crop residues of wheat.

Materials and Methods

Residues of wheat (cv. Kanchan) infected by *B. sorokiniana* were collected from the field after harvest in March, 2000. The residues were cut into 5 cm pieces and air-dried under shade for two days. Five kilograms of dried residues were then thoroughly mixed with upper 5 cm of soil in each of two 1×3 m beds in Bangabandhu Sheikh Mujibur Rahman Agricultural University campus, Gazipur. The residues were also evenly spread on the surface of the soil. The soil was silty loam and no manures or fertilizers were used. One of the beds was kept unsterilized and the other was sterilized with 2% formalin solution, 15 days before mixing the residues with soil. Samples of air-dried residues were also stored as free residue in brown paper bags at room temperature.

Soil samples were collected from the infested beds at monthly interval beginning from April 2000. Ten sub-samples were collected from each bed at 0-5 cm depth using an auger. The sub-samples were intermixed into a composite sample separately for sterilized and unsterilized soils. The composite samples were dried under shade, pulverized and screened through 20-mesh sieve to remove large particles and debris. Soil suspension of desired dilution was prepared with 10 g sample in 0.1% water agar at 45°C. A 1 ml aliquot was then pipetted into each Petri plate (9 cm) containing a selective medium (Reis 1983), and spread uniformly over the surface of the medium by gently tilting the plate. Compositions of the selective medium were: 35 g sliced potato, 5 g sucrose, 15 g agar, 5000 µg streptomycin and 250 µg benomyl in 1000 ml distilled water. Eight plates were used for each soil sample and were incubated for 5 days at 25 ± 2°C under 12/12 hr light and darkness period. After the incubation period, the colonies of *B. sorokiniana* were counted under a dissecting microscope and the number of propagules per gram of soil was determined by multiplying the plate count with the dilution factor (Reis 1983). During the sampling period from April to November, a 1:200 dilution was used while 1:100 dilution was used for rest of the sampling period.

Samples of infected residues were also drawn randomly from each treatment at monthly interval, chopped into 2-3 cm pieces and intermixed into composite sample. A 5 g composite sample was taken in a stoppered flask containing 100 ml of water and two drops of Tween-20 and shaken vigorously for 10 minutes after adding. Ten ml of this suspension was poured into 90 ml of water and stirred for 5 minutes. A 1 ml aliquot was then spread over the surface of the selective medium in each of eight plates and incubated at 25 ± 2°C under 12/12 hr light and dark cycle. After five days of incubation, the colonies of *B. sorokiniana* were counted and the number of propagules per gram of residue was determined.

Results and Discussion

The population density of *B. sorokiniana* increased initially for the first two months (May and June) in both sterilized and unsterilized soils and started to decline thereafter (Fig. 1, Table 1). The rate of decline in population of the pathogen was high up to August. The percentages of decline in population as recorded at the fourth month of survival were 67.6 and 67.8 in sterilized and unsterilized soil, respectively. From fifth month onward, a gradual decrease in population was

observed and the pathogen disappeared after eight and ten months from unsterilized and sterilized soil, respectively. Throughout the entire survival period, the population density of the pathogen was higher and the per cent decline in population was comparatively lower in sterilized soil than in unsterilized soil. Survival of *B. sorokiniana* in soil for different periods has also been reported by

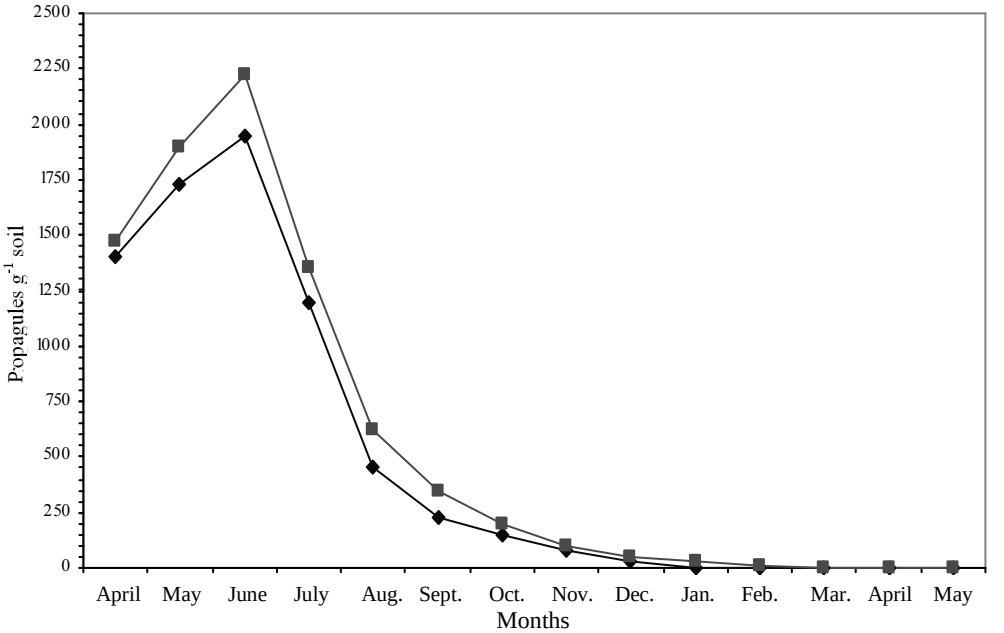

Fig. 1. Survival of *Bipolaris sorokiniana* in infested soil. --♦-- Unsterilized soil, --■-- Sterilized soil.

other workers from different countries. The survival of the pathogen in soil for 9-20 months depending on soil conditions has been documented by Chinn and Ledingham (1958) and Chinn (1965). Boosalis (1962) observed that the pathogen could survive in soil for more than 16 months

Table 1. Decline in population of *Bipolaris sorokiniana* during survival in soil and residue of wheat.

Survival period (month)	Per cent decline in population of *B. sorokiniana*				
	Unsterilized soil	Sterilized soil	Residue in unsterilized soil	Residue in sterilized soil	Free residue
April	0.0	0.0	0.0	0.0	0.0
May	– 23.2	– 28.8	– 37.7	– 37.0	4.0
June	– 39.3	– 50.8	– 63.3	– 64.8	12.2
July	14.3	8.5	2.0	1.8	22.8
August	67.8	67.6	66.0	63.0	38.2
September	83.9	76.3	79.6	77.8	50.4
October	89.3	86.4	88.8	85.2	61.8
November	94.6	93.2	94.9	94.4	74.8
December	98.2	96.6	100.0	96.7	89.0
January	100.0	98.3	100.0	100.0	95.1
February	100.0	99.1	100.0	100.0	98.0
March	100.0	100.0	100.0	100.0	99.2
April	100.0	100.0	100.0	100.0	99.2
May	100.0	100.0	100.0	100.0	100.0

at 22°C under 50% moisture holding capacity. Reis and Santos (1987) and Reis (1989) reported that free conidia of the pathogen can remain viable in field soil for up to 37 months under Brazilian conditions.

The trend in survival duration of *B. sorokiniana* in infected wheat residues was more or less similar to that observed in infested soils (Fig. 2, Table 1). However, the population density of the pathogen was always higher in infected residues compared to the infested soils during the entire period of survival. In residues spread on the surface of the soils (sterilized and unsterilized), the population of the pathogen declined after an initial increase during the months of May and June. In case of free residue (kept independently of soil at room temperature), a gradual decline in population was observed from the beginning of the survival period. The rate of reduction in population of the pathogen was higher in the residues spread on the soil than in free residues. The rate of reduction in survival of the pathogen was further higher with the residues in unsterilized soil than in sterilized soil. The pathogen associated with residues was not found viable after 7 and 8 months in unsterilized and sterilized soil, respectively but it survived up to 12 months in free residues stored at room temperature. Almost similar finding was reported in India by Mishra and Chourasia (1976). Under the field condition of southern Brazil, the pathogen can survive in infected wheat residue for 12-17 months depending on the rate of residue decomposition (Reis *et al*. 1998a). In Canada, conidial population of the pathogen may remain viable on residues of wheat and barley even after two successive winters (Duczek *et al*. 1999).

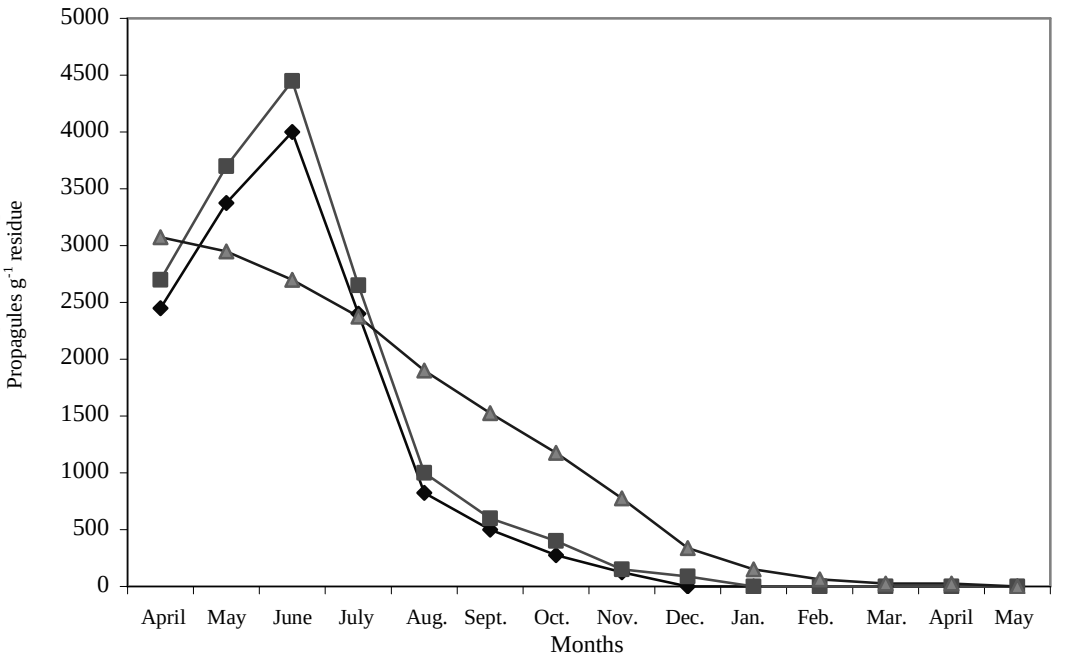

Fig. 2. Survival of *Bipolaris sorokiniana* in infected residue of wheat. --♦-- Residue in unsterilized soil, --■-- Residue in sterilized soil. --▲-- Free residue.

The variations in survival period of *B. sorokiniana* in Bangladesh as compared to other countries are possibly owing to variations in soil environment, especially temperature, moisture level and organic matter contents of the soils in different countries. When organic matters are available, the fungus colonizes them under suitable temperature and moisture content of soil. Under such active stage its population in soil may increase. Results recorded in the present study

are in support of this idea. The population of the fungus increased in the soil for the first two months of survival, especially when crop residue was added. The decline in population after two months and its disappearance after 8-10 months might be owing to exhaustion of organic matter in soil. Antagonistic organisms against *B. sorokiniana* might also play an active role to reduce population and survival period of the fungus.

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