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Efficacy of chemical fungicides against spot blotch (*Bipolaris sorokiniana*) disease management of wheat in northern part of West Bengal

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Abstract
The spot blotch disease caused by *Bipolaris sorokiniana* (Sacc.) Shoem is one of the most important foliage disease of wheat crop. This disease appears in almost all wheat growing areas of the world. In Northern part of west Bengal this disease causes severe yield loss every year. For the management of spot blotch disease of wheat five chemical fungicides was used. Plant disease intensity decreased with the application of different treatment over untreated control.The lowest AUDPC was recorded in T4 (Propiconazole@ 1ml/l)260.8 followed by T5 (Tebuconazole@1ml/l) 293.21 and T3 (Carbendazim+Mancozeb @) 2.5g/l) 376.54. Maximum AUDPC was recorded (563.27) under T1 (Untreated/control). Due to the application of Propiconazole, spot blotch disease reduce up to 60.18% and increase chlorophyll contain of the plant, increase different morphological traits of wheat crop as well as also ultimately increase yield up to 35.02%.

Keywords: Chemical fungicides, spot blotch, AUDPC, yield, wheat

Introduction
Among the important cereal crops of the world, Wheat is one of the most important cereal crop. Wheat is the basic stable food most of the civilization of the world, and a major source of nourishment. Wheat cultivation in India was started 5000 year ago (Feldman, 2001) [5] and its progress is remarkable. It provided nearly one third of grain of the total consumption in the world. Now, among the wheat producing countries of the world, India is the second largest wheat producer. This valuable impotent crop attacked by different types of biotic and abiotic factors. Among the biotic factors spot blotch disease is one of the most important devastating disease of the wheat caused by *Bipolaris sorokiniana* (Sacc.) Shoemaker syn. *Drechslera sorokiniana* (Sacc.) Subrm and Jain (syn. *Helminthosporium sativum* Pamm., King & Bakke), teleomorph *Cochliobolus sativus* (Ito &Kuribayashi) Drechsl. Ex Dastur (Acharya *et al.*, 2011) [1]. This fungus produce initially whiteand becoming brown to black in colour colony with sporulation. Mathre (1987) [9] reported that by *Bipolaris sorokiniana* produce 15-28 × 40-120 µm, straight to slightly curved, oblong, and fusiform to broadly ellipsoid, olive brown to dark brown, tapered towards the end conidia and have a prominent basal scar, smooth walled and having 3-10 thick walled transverse septa. Mathur *et al.*, (2000) [10] concluded that size of conidia was 40-120 × 17-28 µm. Singh *et al.*, (2013) [21] was also reported that size of conidia of kalyani, West Bengal isolates 20.35-90.30 × 11.95-23.43 µm. Conidiophores are 6-10 × 110-220 µm, fasciculate, geniculate, brown, erect, septate, simple, dark brown to olivaceous at the base and somewhat paler at the growing tip.

Initially chlorotic spots of light brown dots like symptoms appear (lesions are 1-2 mm long), latter lesions is extends very rapidly and developed typically elliptical, lens shaped, symptoms with brown necrotic areas show in center region, and this necrotic spot surrounded by chlorotic margin. These lesion collapses and ultimately whole becomes die (Mehta, 1981) [11].

Epidemiological factor is very important key factors for this disease development. Favorable weather for this disease development is 20°C to 30°C coupled with high humidity (90-100%) and long periods of leaf wetness (more than 12 to 18 hours) due to rainfall, irrigation, fog or dew. In the year of 1998, Meheta also reported that the conducive weather conditions i.e. continuous rain for 5-6 days followed by warmer temperatures (day average of 20-30 °C),

spot blotch epidemic can develop very rapidly. In Asian context, the severity of spot blotch at 28ºC than at lower temperature (Nema and Joshi, 1973 and Singh *et al.*, 1998) [13, 24].

Senthil in the year of 2004 has been reported that in Bangladesh 71%, 20-30% (but sometimes above 75%) in China, in Nepal 16.2-29% and 40% in Philippines reduce yield due to spot blotch disease. In India yield loss up to 18-22% due to this spot blotch disease (Singh *et al.*, 1997) [23].

This disease significantly occurs in Eastern Gangetic Plains (EGP) of South Asia. India, Nepal and Bangladesh also includes in this region (Joshi *et al*., 2007) [7].

In the year of 1998, Sarri has been reported that due to the rice-wheat cropping system of South Asia provides favorable environment for the survival and multiplication of spot blotch pathogens because riceserves as alternative host for the spot blotch fungi and rice stubble plays its role as a substrate for the fungi after rice harvest. Spot blotch disease is one of the most important disease of wheat in North eastern plains zone representing warm and humid climate in India. In this region different types of resistance verity have been used against this devastating disease but the level of resistance in popular varieties is stillnot sufficient to avoid losses in yield and quality of seed. Therefore to protect the crop, increasing yield and seed production fungicidal management against this disease has been attempted. In the year of 1998 Mehta [12], in Brazil, observed that foliar fungicides is effective in controlling spot blotch disease. He also reported that, Mancozeb, Propiconazole, Tebuconazole, Flutriazol, Procloraz, Triadimenol and Iprodione are the effective fungicide against spot blotch disease. Tewari and Wako (2003) [26] has been reported that Tebuconazole and Metacid are very effective against this disease. Rashid *et al.*, (2001) [15] observed that Propiconazole is very important foliar fungicide against spot blotch. Flusilazole, Prochloraz, Propiconazole and Tebuconazole effectively control spot blotch disease (Colson *et al*., 2003). According to Chandrashekhar, 2003 [2]; Ramachandra and Kalappanavar, 2004 [14], Propiconazole, Hexaconazole, Prochloraz and Quintal are the important fungicide against this devastating disease. Singh *et al*., 2011 [25] also reported that Propiconazole and Tebuconazole can significantly reduce this disease.

Materials and Methods

Experimental Setup: The present investigation for the evaluation of fungicide against spot blotch disease of wheat was conducted during the Rabi season of 2016-17, in randomized block design with four replications in Terai agro-climatic zone of West Bengal, at the experimental farm of Uttar Banga Krishi Viswavidyalaya, Coochbehar (26°19´86´N latitude and 89°23´53´´E longitude), West Bengal, India, with wheat genotype DBW-39. The Plot size was 5 X 4 with row to row spacing was 20 cm. Recommended management practices were done for raising a good crop. Total three irrigations, 21 days, 45 days, 60 days after sowing were given. During the sowing time 50% nitrogen and complete dose of phosphorus & potash @ 120:60:40 (N: P: K) were applied. Among the remaining 50% nitrogen, 25% were applied atthe time of 1st irrigation i.e. 21 days after sowing and remaining 25% at 2nd irrigation i.e. 45 days after sowing.

Pathogenicity test for the identification of the pathogen: Pathogen was isolated on Potato dextrose agar (PDA) media under the optimum temperature range of 28 ± 2ºC. Pathogen isolation was done from infected wheat leaf part. The pathogenicity was established by using *In vitro* detached leaf technique method. Healthy wheat leaves were first collected from the experimental field, after that surface sterilization was done by using 1% sodium hypochlorite solution. Then at one point of each leaf, a number of small injuries were made by a pin (pin prick method). After that point inoculation with fungal spore suspension (spore concentration of 1×10^6 conidia/ ml) was done and kept on moist blotting paper, in a 40×25 cm^2 plastic tray was used as conserve system (to conserve micro climate moisture level). Also absorbent cotton was rolled around the bottom of leaves. The whole system or tray was covered with transparent perforated polythene sheets (for aeration) and incubated at 28±2 ºC and 80-90% relative humidity in a growth chamber. After seven to eight days, the disease symptom was observed. Then again the pathogen was re-isolated from these infected leaves. After re-isolation, the pathogen was examined by using microscope, then compared with the original mother culture of the same pathogen and their identity was confirmed.

Pathogen inoculation: Large numbers of spores were generated by inoculating 5 mm mycelium plugs on processed wheat grains. Inoculated wheat grains were kept in incubator at 28 ± 2ºCfor 15 days to accelerate substantial sporulation. The sporulated wheat grains were filtered with muslin cloth in distilled water to harvest spores of *B. sorokiniana* and to prepare aqueous solution which was adjusted to spore density 104 mL-1. The experimental wheat field was uniformly inoculated before 7 days from booting stage.

Fungicide application: For the management of spot blotch disease ofwheat five systemic and non-systemic chemical fungicides i.e. Copper Oxychloride @ 2gm/l (T2), Carbendazim + Mancozeb @ 2.5g/l (T3), Propiconazole @ 1ml/l (T4), Tebuconazole @ 1ml/l (T5), Thiophanate methyl @ 1gm/l (T6) were used and T1 used as control. Fungicide application was started from booting stage at 10 days interval for three times.

Disease Assessment: Disease severity was visually scored by using double digit scale (00-99). The double digit scale was developed as a modification of Saari and Prescott's severity disease scoring scale. Disease severity was scored at 10 days interval for 4 times. First 3 disease data were recorded just before the fungicide sprayed and last disease data were recorded after 10 days of third spray. After that this disease data were further converted to percent disease index by using the formula {(D1/9 × D2/9) × 100)} (Duveiller *et al*., 2005) [4]. And finally from this percent disease index data, Area under Disease Progress Curve (AUDPC) was calculated by using a formula (Das *et al*., 1992; Sharma *et al*., 2007) [3, 20]. From this AUDPC we can clearly measure the amount of disease as well as the rate of progress.

Canopy Temperature: Along with disease scoring canopy temperature was also recorded for four times by using Hand-held infrared thermometer. From this canopy temperature data, the accumulated effect of a treatment in canopy formation was estimated as Area Under Canopy Temperature Progress Curve (AUCTPC) according to the formula given by (Rosyara *et al.*, 2009) [16].

SPAD Reading: Along with the disease scoring and canopy temperature reading, spad reading was also recorded for three

times with the help of Chlorophyll meter (model: KONICA MINOLTA SPAD – 502 plus). From this four spad value, Area Under Spad Value Decline Curve (AUSDC) was calculated by using the formula given by Rosyara *et al.*, 2007 [17]. From this AUSDC we can clearly measure the amount of chlorophyll contain, which indirectly indicated disease severity.

Biological Yield: For the study of the total biological yield, plant samples (only above ground part) from each replication was collected in harvesting stages. After that plant samples were dried in a hot air oven at 60ºC till constant weights were obtained.

Plant height: At the harvesting time, from the base of the plant or ground level to tip of the ear head (excluding awns) plant height was measured (centimeters). 10 numbers of plant form each replication was taken into consideration for recording plant height.

Spike length: Randomly 10 numbers of the spike form each replication was taken into consideration for recording spike length. Spike length (centimeters) was recorded from the base of the spike to the tip of the last spikelet, excluding awns.

Numbers of grains per spike (GPS): Number of grains per spike were counted and recorded from the randomly selected 10 number of spikes in each replication.

Thousand grain weight (TGW): Randomly selected 1000-grains were counted and weight was recorded in grams (g).

Grain yield: After harvesting, the crop was sun dried perfectly and threshed subsequently. Then the grains from each replication were sun dried, cleaned properly and weighed.

Data Analysis: The data collected was subjected to SPSS Software for statistical analysis of the data.

Results: The effects of chemical fungicides on plant growth and yield was observed by assessing the biological yield, plant height, spike length, grain per spike, 1000 gain weight, and yield of grain per plot.

Fungicidal effect against spot blotch (*Bipolaris sorokiniana*) disease management and related traits: In Table 1. represent the efficacy of different chemical fungicide against spot blotch disease management of wheat. The lowest AUDPC was recorded in T4 (260.8) followed by T5 (293.21) and T3 (376.54). Here efficacy of Propiconazole and Tebuconazole against spot disease management statistically equal. Fig. 1. represent % disease control, as compare to untreated plot. In T4 60.18% disease control was recorded as compared to T1, followed by T5 (56.64%) and T3 (42.48%). In Table 1. also represent Area Under Spad Value Decline Curve (AUSDC) Area Under Canopy Temperature Depression Progress Curve (AUCTPC). Here AUDPC with AUSDC have a corresponding negative effect, and AUDPC with AUCTPC have a corresponding positive effect. Highest chlorophyll contains was recorded in T4 (1207.63) followed by T5 (1113.13) and T3(1043.38) and lowest chlorophyll contain was recorded in T1 (801). In case of canopy temperature lowest canopy was recorded in T4 (602) followed by T5 (627) and T3 (641) and highest chlorophyll contain was recorded in T1 (769.25).

Table 1: Efficacy of various fungicides against spot blotch (*Bipolaris sorokiniana*) disease management and related traits

	Treatments	AUDPC	AUSDC	AUCTPC
T1	Contol	563.27^{a}	801.00^{e}	769.25^{a}
T2	Copper Oxychloride	489.20^{b}	896.25^{d}	693.00^{b}
T3	Carbendazim + Mancozeb	376.54^{c}	1043.38^{c}	641.50^{bc}
T4	Propiconazole	260.80^{d}	1207.63^{a}	602.88^{d}
T5	Tebuconazole	293.21^{d}	1113.13^{b}	627.13^{bc}
T6	Thiophanate methyl	412.04^{c}	990.88^{c}	670.88^{bc}
S.Em (±)		16.74	15.77	18.33
CD (<0.05)		50.46	47.52	55.24

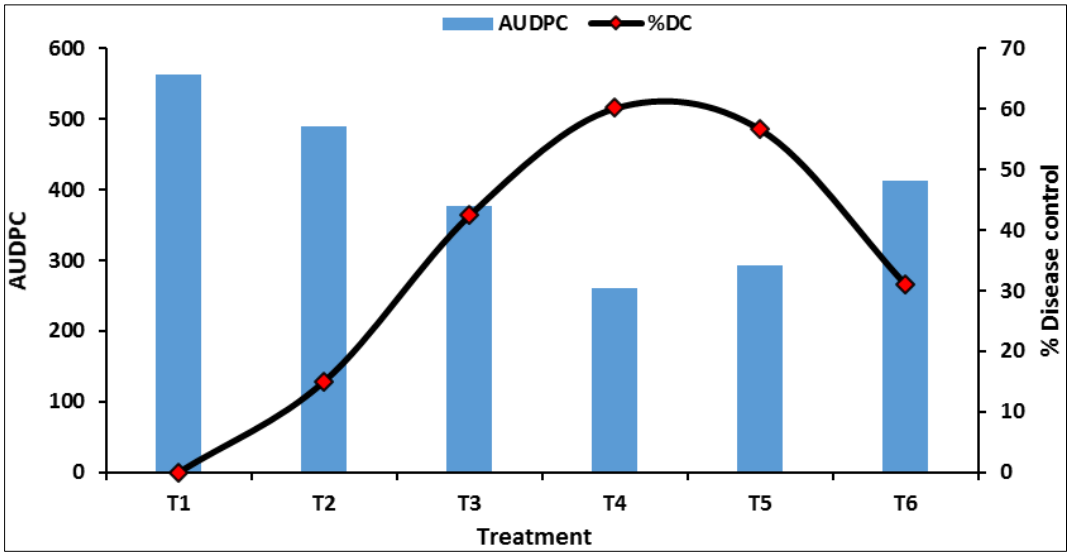

Fig 1: Effect of treatments on AUDPC & percent reduction of spot blotch disease on wheat

Fungicidal effecton morphological traits of wheat: The data on biological yield, plant height, spike length, grain per spike, and 1000 gain weight influenced by different chemical fungicides are presented in Table 2. In case of Biological yield, highest biological yield was recorded in T4 (31.66 kg/plot) followed by T5 (31.07 kg/plot) and T3 (30.38 kg/plot). In control plot (T1) 27.84 kg/plot biological yield was recorded. Statistically significantly highest plant height was recorded in T4 (98.74 cm), followed by T5 (95.73 cm) and T3 (93.27 cm). In untreated control plot (T1) statistically significantly lowest plant height (84.93 cm) was recorded. Spike length and grain per spike highest was also recorded in T4 (13.91 cm and 61.4) followed by T5 (13.46 cm and 59.41) and T3 (12.66 cm and56.46). Here in T4 and T5 spike length and grain per spike statistically equal. Statistically significantly lowest spike length and grain per spike was recorded in T1 (11.07 cm and 52.52). As compared to untreated plot highest 1000 grain weight was recorded in T4 (42.69g) followed by T5 (41.50 g) and T3 (40.73 g). In control plot 36.48g 1000 grain was recorded.

Table 2: Effect of different treatments on morphological traits of wheat

	Treatments	Biological Yield/Plot (kg)	Plant Height (cm)	Spike Length (cm)	Grain Per Spike	1000 grain Weight (g)
T1	Contol	27.84^{b}	84.93^{d}	11.07^{d}	52.52^{c}	36.84^{e}
T2	Copper Oxychloride	29.56^{b}	89.70^{c}	11.81^{c}	54.28^{bc}	$38.48d^{e}$
T3	Carbendazim + Mancozeb	30.38^{a}	93.27^{bc}	12.66^{b}	56.46^{b}	40.73^{bc}
T4	Propiconazole	31.66^{a}	98.74^{a}	13.91^{a}	61.40^{a}	42.69^{a}
T5	Tebuconazole	31.07^{a}	$95.73a^{b}$	13.46^{a}	59.41^{a}	41.50^{ab}
T6	Thiophanate methyl	29.88^{b}	90.66^{c}	12.01^{c}	55.66^{b}	39.21^{cd}
S.Em (±)		0.53	0.94	0.13	0.56	0.44
CD (<0.05)		1.60	2.84	0.40	1.68	1.32

Fungicidal effect on yield of wheat: The effect chemical fungicides on yield clearly presented in Table 3. As compared to untreated plot, significantly higher yield was receded in T4 (7.61 kg/ plot, 38.06 q/ha) followed by T5 (7.43 kg/ plot, 37.13 q/ha) and T3 (7.14 kg/ plot, 35.69 q/ha). In Fig. 2. represent % yield increase as compared to control plots. In T4 35.02% yield increase as compare to control plot followed by 31.07% in T5, and 26.60% in T3.

Table 3: Effect of different treatments on yield of wheat.

	Treatments	Kg/plot	q/ha
T1	Contol	5.64	28.19
T2	Copper Oxychloride	6.42	32.1
T3	Carbendazim + Mancozeb	7.14	35.69
T4	Propiconazole	7.61	38.06
T5	Tebuconazole	7.43	37.13
T6	Thiophanate methyl	6.68	33.39
S.Em (±)		0.11	0.53
CD (<0.05)		0.32	1.59

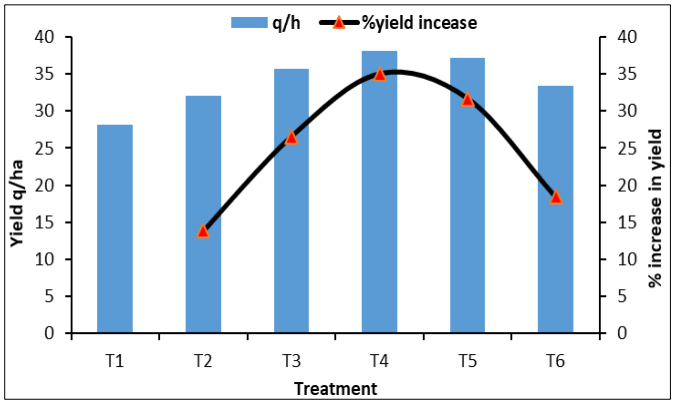

Fig 2: Effect of different treatments on percent increase in yield of wheat

Discussion

The present study showed that foliar application of different chemical fungicide can beeffectively reduced the severity of spot blotch disease as well as also increase different morphological and yield attributing characteristics of wheat. The result indicated that three time applications of Propiconazole @ 1ml/l followed by Tebuconazol @ 1ml/l from booting stage at 10 days interval gave the maximum decrease the incidence and severity ofspot blotch disease of wheat, and ultimately as well as also increase yield. Yadav *et al.*, in the year of 2015, has been reported that Propiconazole effectively reduced 50 to 62% disease incidence. Kumar *et al.*, in the year of 2018 also reported that Seed treatment with Vitavax 75 WP @ 2.5 gm /kg + 2 foliar sprays of Propiconazole @ 0.1% successfully control spot blotch disease. According to Verma, *et al.* (2018) Seed treatment with Vitavax Power @ 2.5g/kg of seed+ two sprays of Propiconazole @ 0.1%, followed by seed treatment with Vitavax Power @ 2.5g/kg of seed +two sprays of Tebuconazole @ 0.1% effectively reduced this disease. Gupta *et al.*, (2020) observed that under field condition, application of Propiconazole 25 EC @ 1.5 ml/l against spot blotch disease gave very successfully positive result. In the year of 2014 Singh *et al.* from their multi locations trial has been reported that Seed treatment with Vitavax powder+two sprays of tilt @ 0.1% or two sprays of tilt @ 0.1%, followed by two sprays of folicur @ 0.1% and Dithane M 45 three spray @ 0.25% effectively reduced spot blot disease in northern and southern part of West Bengal. Not only reduced the disease severity, but also increased the yield respectively.

Conclusion

For efficient management of spot blotch disease of wheat caused by *B. sorokiniana* use of chemical fungicides needs to be sincerely incorporated in the cultivation package of wheat crops. The findings from this study suggest that foliar application of chemical fungicides can be used to reduce the severity of spot blotch on wheat. The present investigation concluded that the chemical fungicides Propiconazole followed by Tebuconazole can be reduced from 56 to 60% disease severity

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