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EVALUATION OF PHYSIOLOGICAL TRAIT FOR SPOT BLOTCH (*BIPOLARIS SOROKINIANA*) RESISTANCE IN WHEAT GENOTYPE (*TRITICUM AESTIVUM)*

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ABSTRACT

Three wheat variety were evaluated for physiological trait and their involvement in spot blotch resistance under different date of sowing. Mean analyses revealed that sowing date has significant affect on physiological trait and yield. AUCTPC (207.15) and AUDPC (287.38) recorded significantly lowest in 5th November, HD-2967 (278.53) AUDPC was recorded less, though yield was found highest in 5th November (0.59g/m^2). Strong correlation between resistance and increased AUSDC has been recorded irrespective of variety. Relation between canopy temperature and disease was found positively related, whereas negative relation with stay green property. Yield and canopy temperature is negatively related with disease, the magnitude of the disease explain up to 59% variation of yield, similarly canopy temperature was also found negatively related with yield with R^2 value of 0.691. Green index of plant is only variables related positively with yield. Linear relationship was worked out and it was found that with increase in stay green property of crop there is decline in canopy temperature and it explains about 72% of the canopy temperature build up. Thus delayed planting increases the canopy temperature and decreases greenness index of crop and simultaneously there will be increase in disease and decrease in yield.

INTRODUCTION

Wheat the winter cereal of Indo – Gangetic plains, plays a major role in agricultural economy of India. Although the production has increased considerably, yet the productivity remains low in the Eastern Gangetic Plains. Among the reasons of yield disparity is poor disease management, particularly the foliar blight of wheat coupled with average high temperature are serious problems in eastern India. Among the different foliar blights, Spot blotch is gaining attention due to its fast spread and severity in the areas where it was not very important previously. Moderate to warm temperature (18ºC to 32ºC) favors the growth of *B. sorokiniana,* it imparts yield loss in the tune of 20-80 per cent and the extent of loss depends upon the severity of occurrence (Duveiller and Sharma. 2009). Thus the most economical and environmentally safe methods for sustainable disease control an integrated approach and use of resistant varieties is considered necessary (Biswas *et al.,* 2015). Joshi and Chand (2011) reported spot blotch of wheat has gained high interest due to losses caused by this disease in the 2nd largest wheat growing zone (NEPZ) of our country, similarly several authors Acharya *et al.*, 2011 and Iram and Ahmad 2005 also reported spot blotch as one of the most important pathogens. Hence the physiological traits have caught the attention of breeders due to limitations of conventional yield-based selections, particularly for stressed environments (Reynolds *et al.*, 2001). In recent years, researchers show that some physiological criteria such as stomatal conductance (Bahar *et al.,* 2009) canopy temperature depression (Bahar *et al.,* 2008) and chlorophyll content (Yildirim *et al.,* 2011) provide a gain on wheat, although longer leaf chlorophyll retention and canopy temperature depression indicated heat tolerant metabolism (Rees *et al*., 1993, Rahman 1996, Reynolds *et al*., 1997 and Al-Khatib and Paulsen, 1999). Under field conditions, late planting (resulting in heat stress) was found to increase spot blotch severity (Sharma and Duveiller, 2004) and higher yield loss at late sowing date is due to combined effect of higher temperature which favored spot blotch severity and terminal heat stress. In a study by Kshitiz K. P. *et al*., 2015, they reported that environment plays an important role in correlation. Development of resistance wheat cultivars has been identified as the best option to help million of subsistence farmers, where the cost of fungicides is prohibitive. Therefore the study was conducted with an objective to evaluate physiological traits and determine the association of this trait with disease progress and yield loss in wheat under different date of sowing.

MATERIALS AND METHODS

The experiment was conducted with three varieties, pathogen and environment following standard methods of recording and analysis at the experimental farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, India, during Rabi wheat growing season 2014-15.The site is situated at 26º19′86′′ Northlatitude and 89º23′53′′ East longitude with an elevation of 43 meter above mean sea level in the Terai agro climatic zone of West Bengal.

The soil at the experimental field was sandy loam to loam in texture, a true representative of West Bengal. The experiment material for study consists of three wheat varieties released for North Eastern Plain Zone. Among the varieties used are DBW-39, HD-2967 and HD-2733.

The trail was laid out in Split plot design with three replications and each three variety was sown in three different dates at an interval of 15 days i.e. 5th November, 20th November and 5th December. In each replication every variety was planted in a plot of two rows of 8m in length with a spacing of 25cm between rows. Total four irrigations were given, first being at 21^{st} days after sowing. The fertilizer were applied at the rate of 120:60:40 kg/ha (N: P: K). Whole of phosphorus and potash fertilizer were applied during sowing, while nitrogen was applied as split dose 50% at sowing time and remaining 25% at 1^{st} irrigation and 25% at 2^{nd} irrigation i.e. 65 days after sowing.

Physiological traits

Canopy temperature

The CTD trait was recorded using hand-held infrared thermometer; four measurements were taken per plot within a four days interval starting from 87^{th} day after sowing. Canopy temperature readings were not made two days after irrigation and rainfall. Measurements were done on cloudless, bright days. Ambient temperatures were measured using the handheld thermometer instantly after four readings in each plot.

Canopy Temperature Depression and Area Under Canopy Temperature Progress Curve (AUCTPC) was calculated by using the formula given by Rosyara. 2009.

CTD = Ambient Temperature (AT) – Canopy temperature (CT).

$$\text{AUCTPC} = \sum_{i=1}^{n-1} [(C(i+1) + Ci)/2]\,(T(i+1) - Ti)$$

where,

C i = CTD reading at date i

T i = date on which the CTD was scored

n = number of dates on which CTD was recorded

Spad reading

The chlorophyll content was recorded in Minolta company-defined SPAD values (model: KONICA MINOLTA SPAD – 502 plus). Four measurements were taken from flag leaf within a four days interval at different positions from tagged plant (starting from tip to base) and averaged (Rosyara *et al.*, 2007). Area under Spad Value Decline Curve (AUSDC) was calculated by using the formula given by Rosyara *et al.*, 2007.

$$\text{AUSDC} = \sum_{i=1}^{n-1} [(S(i+1) + Si)/2]\,(T(i+1) - Ti)$$

Where

Si = SPAD value on the ith date

Ti = ith day

n = number of dates of recording SPAD value

Disease assessment

Disease data were recorded when the first lesion appears on the leaf and continued thereafter at 7 days interval throughout the season (approximately 73-85 growth stage). The severity of the disease was visually scored employing double digit scale (00-99). The double digit scale was developed as a modification of Saari and Prescott's severity scale to score foliar disease of wheat plant (Saari and Prescott 1975).

Area Under Disease Progress Curve (AUDPC), measure the amount of disease as well as the rate of progress, was calculated by using formula (Sharma *et al.,* 2004). The double digit reading was further converted to percent disease index using the formula {(D1/9 x D2/9 x D3/9) x 100)} (Duveiller *et al.,* 2005).

The value of AUDPC was estimated using the midpoint rate or so called trapezoidal integration method. The AUDPC has no unit.

$$\text{AUDPC} = \sum_{i=1}^{n-1} [(Xi + Xi + 1)/2]\,(ti + 1 - ti)]$$

Where, x_i is the spot blotch severity on i^{th} date, the t_i is the i^{th} day and n is the number of scoring days.

Meteorological data was collected from Krishi Vigyan Kendra, Pundibari, Coochbehar adjacent to the experimental plot for further analysis.

Data analysis

The data collected was subjected to SAS software for statistical analysis.

RESULTS AND DISCUSSION

A great deal of variation in mean values range for AUSDC, AUCTPC, grain yield and Spot blotch severity (AUDPC) (normal and late sown) condition was recorded and presented in (Table 1). It has been clearly showed that date of sowing has significant affect on physiological trait and yield. Respective of date of sowing 5^{th} November (207.15) AUCTPC value was recorded lowest and later found to increases with every date of delayed sowing 5^{th} December (306.93), similarly AUDPC value was also recorded less in 5^{th} November (287.38) and tents to increase with delayed sowing 5^{th} December (564.12), thus it indicate that delayed sowing will result in poor performance of crop and create stress by spot blotch, it may be due to the influence of environmental condition, especially temperature and humidity , whereas this finding was in line of Duveiller *et al.*, 2005 and Pandey *et al.*, 2005 who also found that temperature is one of the factors associated with increased infection and disease development caused by *B. sorokiniana*. In HD-2967 AUDPC was recorded significantly less (278.53). Grain yield in respective of date of sowing and genotype interaction was recorded significantly high in 5^{th} November and it decreases with delayed sowing (5^{th} December). In a study by Sharma *et al.,* 2007 they also observed yield losses due to increase in temperature which resulted in spot blotch epidemic over the recent years. Among the genotype highest

Table 1: Effect of date of sowing on yield in relation to disease, canopy temperature and greenness index of wheat varieties

Varieties	Date Of Sowing	PDI 1	PDI 2	PDI 3	AUDPC	AUSDC	AUCTPC	YIELD (g/m^2)
DBW 39	5th November	7.82	12.35	28.81	260.08	362.67	214.50	0.630
	20th November	7.41	16.46	25.93	306.58	391.50	249.67	0.578
	5th December	17.28	20.58	46.09	522.63	155.20	308.40	0.408
HD 2967	5th November	5.76	8.64	20.58	213.17	360.93	205.95	0.590
	20th November	8.64	14.40	20.16	218.11	407.50	243.67	0.440
	5th December	16.05	19.79	28.81	404.30	161.93	307.40	0.290
HD 2733	5th November	7.00	17.28	25.93	337.45	352.93	201.00	0.539
	20th November	9.88	20.16	63.37	484.36	392.33	242.67	0.428
	5th December	23.46	31.69	66.26	765.43	160.67	305.00	0.252
	5th November	6.86	12.76	25.10	287.38	358.84	207.15	0.59
	20th November	8.64	17.01	36.49	319.20	397.11	245.33	0.48
	5th December	18.93	24.02	47.05	564.12	159.27	306.93	0.31
DBW 39		10.84	16.46	33.61	363.10	303.12	257.52	0.54
HD 2967		10.15	14.28	23.18	278.53	310.12	252.34	0.44
HD 2733		13.44	23.05	51.85	529.08	301.98	249.56	0.41
LSD		2.68	4.26	9.10	72.20	7.01	3.36	0.11

PDI: Percent disease index, AUDPC: Area Under Disease Progress Curve, AUSDC: Area Under Spad Decline Curve and AUCTPC: Area Under Canopy Temperature Progress Curve.

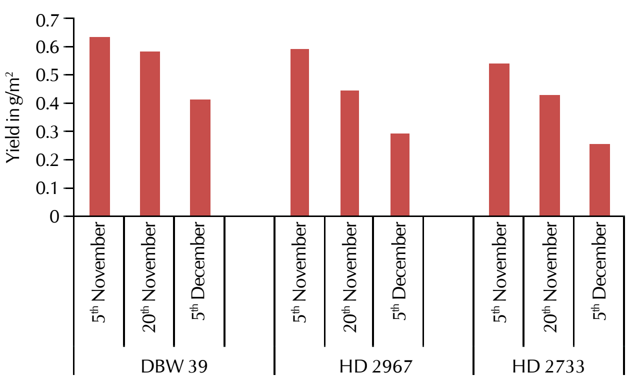

Figure 1: Effect of date of sowing on yield

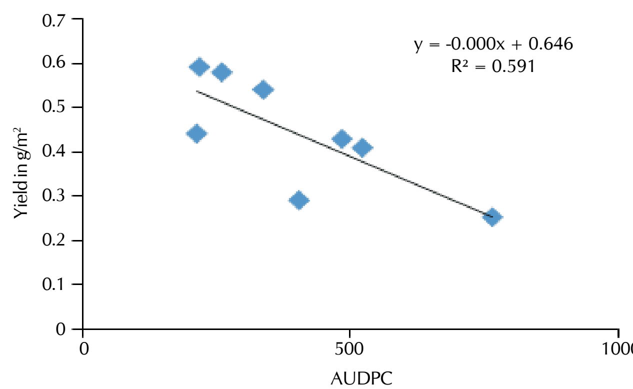

Figure 2: Relationship between yield and disease

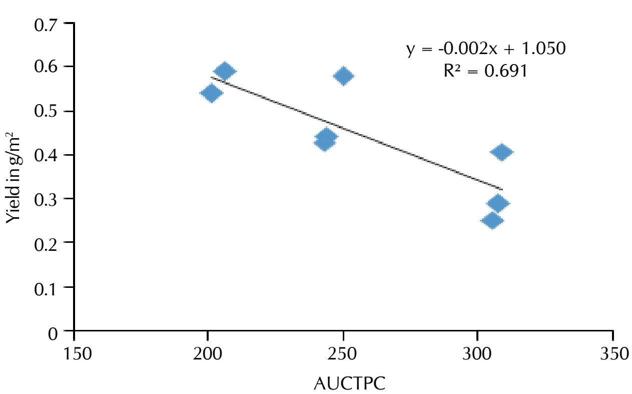

Figure 3: Relation between yield and canopy tempreature

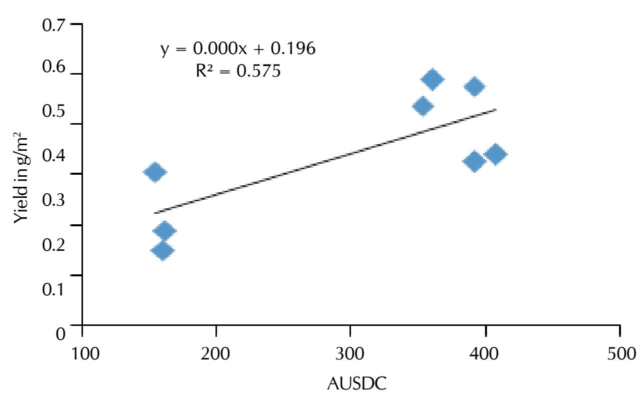

Figure 4: Relation between yield and greeness index

yield was recorded in DBW-39(0.54 kg) fallowed by HD-2967(0.44 kg) and HD-2733(0.41 kg). While 18.43% increase of AUCTPC value was recorded from 5th November to 20th November and 25.11% from 20th November to 5th December. The observations on canopy temperature in all the varieties have significant relationship with disease resistance which confirms the earlier observation of Rosyara *et. al. (*2008) reporting that cooler canopy temperature for disease resistance.

The assessment of Area Under Spad Development Curve (AUSDC) value respective of date of sowing AUSDC value was

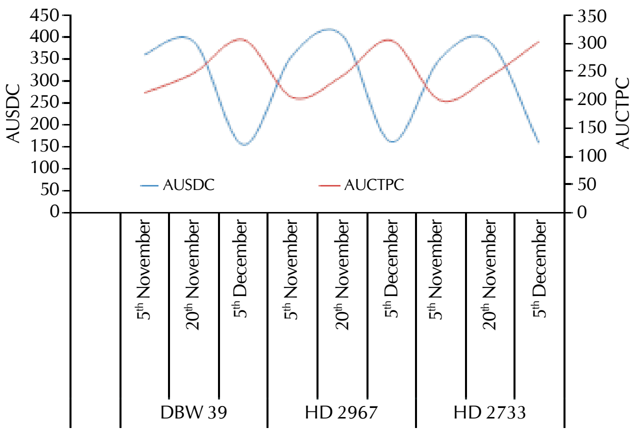

Figure 5: Canopy temperature and spad in three wheat variety at three date of sowing

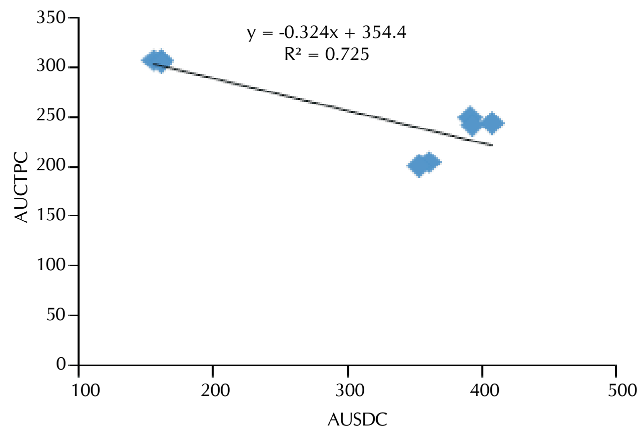

Figure 6: Interaction between canopy temperature and green index

found to be highly significant. However among the variety and date of sowing the highest AUSDC value was recorded in 5th November in DBW-39 (362.67) and in 20th November and 5th December it was in HD-2967(407.50 and 161.93). A low rate of chlorophyll decline has been reported to be associated with tolerance to other biotic and abiotic stresses (Limin and Fowler, 1993). Abiotic stresses have been reported to increase spot blotch severity (Sharma and Duveiller, 2004). Strong correlation between resistance and increased AUSDC has been recorded irrespective of any variety. This result confirms the earlier observation of Rosyara *et al.,* 2007. When a relation between canopy temperature and disease was drawn it was found to be positively related whereas same was found negative with stay green property. Interestingly a significant negative relation was found between canopy temperature and stay green property. It was observed that there was always rise in canopy temperature with lowering of greenness index given here as Area Under Spad Decline Curve (AUSDC).

In a study the yield reduction from a variety DBW-39 was recorded 7.94 % when sowing was delayed to 20th November and about 29.31% record when it was further delayed to 5th December. Thus reductions of 34.72% yield when sowing was delayed by 30 days *i.e.* from 5th November to 5th December in DBW-39. In HD-2967 (25.42%) yield loss when sowing was delayed to 20th November and 34.09% reduction in delayed sowing 5th December, an overall reduction of 50.84% was observed when sowing was delayed 30 days after first sowing. In HD-2733 there was 20.43% reduction from 5th November to 20th November, while 41.86% reduction from 20th November to 5th December and overall reduction of 53.70% was recorded when sowing was delayed from 5th November to 5th December. Yield reduction associated with delayed sowing is highest in HD-2733 and lowest yield reduction was recorded in DBW-39 (Fig. 1), with similar disease pressure probably DBW-39 may perform under varied environmental condition. When we go through the data of yield and disease progress in three varieties and three dates of sowing, it clearly indicates that yield declined with rise in disease progress. So further, an attempt was taken to find the relationship between disease, canopy temperature and chlorophyll content (stay green property) of the crop with yield of wheat. From the data it revealed that yield is negatively related with disease and the magnitude of the disease can explain up to 59% of variation of yield (Fig. 2). Similarly canopy temperature was also negatively related with yield, with R^2 value of 0.691 (Fig. 3), whereas among the variables only green index of plant is related positively with yield (Fig. 4). The findings are in line with Rosyara *et al.,* 2007, 2009. Negative correlation with disease was also observed by Hakim *et al.,* in 2012 and earlier by Singh *et al* in 1998. Canopy temperature depression has been associated with combine spot blotch and HLB resistance (Rosyara *et al.*, 2006) and post-anthesis heat stress tolerance (Rosyara *et al.*, 2008).

The observation on canopy temperature in all the varieties have significant relationship with disease resistance which confirms the observation of Rosyara *et al.*, 2008, indicating the cooler canopy temperature for disease resistance. CTD is an efficient parameter for stress diagnostic and selection of heat stress adapted genotypes (Manohar *et al.,* 2014).

When canopy temperature and greenness index was plotted together for different varieties at different dates of sowing (Fig. 5) there was a clean indication that with increase in chlorophyll content as measured by SPAD value and represented as Area Under Spad Development Curve (AUSDC) there was a sharp decline in canopy temperature represented here as Area Under Canopy Temperature Progress Curve (AUCTPC). Following this observation a linear relationship was worked out and it was found that with increase in stay green property of a crop there is a decline in canopy temperature and it explains about 72% of the canopy temperature build up (Fig. 6). The observation confirms the earlier observation by Guendouz *et al.,* 2013. A significant reduction in yield was observed in all the varieties. Yield reduction with delayed sowing maybe a function of its physiological performances in an altered environment which may lead to disease development. Delayed planting increase the canopy temperature and decreases the greenness index of the crop. Simultaneously an increase in disease is also evident. As mentioned in the results reduction in yield related to its physiological competence and disease scenario corroborates with the earlier observation by Rosyara, 2009 and Hakim *et al.*, 2012. While Kandel (2003) reported that disease increased with delayed sowing was due to confounding effect and/or enhancing effect of heat stress on *Helminthosporium* leaf blight development.

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