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Correlation of different traits of wheat with resistance to spot blotch disease

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Abstract
Spot blotch of wheat is caused by *Bipolaris sorokoniana* is one of the major disease of wheat which causes a considerable yield loss throughout the wheat growing areas in the world. Other than spot blotch this pathogen is reported to cause common root rot, foot rot, seedling blight and seed rot disease. Growing of resistant varieties and varieties with different phenological traits related with resistance to spot blotch disease can be an effective way of managing the disease. In this experiment different phenotypic traits for resistance to spot blotch were observed to explain the disease. Among the different phenotypic traits observed, phenological traits (onset of reproductive phase and maturity), symptomatological trait (lesion number), morphological trait (plant height), physiological trait canopy temperature (AUCTPC), chlorophyll content (AUSDC) and stay green property of the genotypes were found to explain 61 percent in the disease variation. Therefore these traits can be used as diagnostic traits for selecting spot blotch resistant wheat genotypes.

Keywords: *Bipolaris sorokoniana*, spot blotch, wheat, resistance, phenological traits.

1. Introduction
Wheat is a cereal grain which comes under the order Poales, family Poaceae, sub family Pooideae and have different species under the genus *Triticum*. Considering its nutritious value wheat is consumed throughout the world and looked as most important cereal crops in the world and occupies the largest area under cereal. In India it is the second most important staple cereal food after rice. Cultivation of wheat first started about 10,000 years ago, as part of the 'Neolithic Revolution', which leads to the shifting from gathering and hunting of food to well settled agriculture. Cultivation of wheat in India started around 5000 years ago (P. R. Shewry2009) [13]. In India wheat is grown as a rabi season crop. Being most important cereal crop wheat production and productivity are greatly challenged by different abiotic and biotic stress. Among the biotic stress Spot Blotch is gaining much importance and a major limiting factor for wheat productivity in warm and humid regions and more severe following rice wheat cropping system. The disease is caused by the pathogen *Bipolaris sorokinian* (Sacc.) Shoemaker (syn. *Helminthosporium sativum* teleomorph: *Cochliobolus sativus*). The occurrence of spot blotch disease was first reported by Mohy in the year 1914 but it was not regarded as an important pathogen in South Asia before the Green Revolution (Saari, 1998; Chaurasia *et al*., 1999) [11, 2]. Spot blotch pathogen is a hemibiotrophic phytopathogenic fungus and causes seedling blight, foliar blight/spot blotch, common root rot, head blight and black point in wheat, barley, other small cereal grains and grasses (Zillinsky, 1983; Wiese, 1998) [19, 16]. Global estimate indicates that 25 million hectares of wheat is affected by spot blotch (van Ginkel and Rajaram, 1998) [15], out of which India alone accounts for 9 million hectares, mostly in the rice wheat cropping system in the north eastern plain zone (Nagarajan and Kumar 1998) [9].Yield losses due to spot blotch of wheat are reported to range from 15.5 (Saari, 1998) [11] to 100% under severe conditions of infection (Mehta, 1993). Therefore the management of spot blotch disease is very important and the best approach to manage the disease can be obtain by developing resistant varieties. There are Reports of the presence of monogenic (Arney, 1951, Wilcoxson *et al.*, 1990) [1, 17] and polygenic (Griffee, 1925, Steffenson *et al.*, 1996) [4, 14] types of resistance to spot blotch disease. Different physiological, morphological, phenological and symptomatological traits has been reported to be related with resistant to spot blotch disease by different researchers which can be used in breeding for resistance.

2. Materials and methods

55 genotypes differing in genetic background, yield potential, maturity and level of Spot blotch resistance, including 8 susceptible checks were used in the experiment with three replication. The experiment was conducted in the experimental farm of Uttar Banga Krishi Viswavidyalaya, coochbehar, West Bengal. Different phenotypic traits were observed to explain the variation in disease. These traits are days to heading (number of days from sowing till heading), days to 50% flowering, days to physiological maturity, days to greenness, lesion number (randomly selecting the 40^2 cm area of the flag leaf using a sleet), lesion size using a pictorial scale and rating was given accordingly from 1 to 5, 1 as smallest lesion size and 5 as largest lesion size, leaf erectness (angle of flag leaf as erect, semi erect and drooping), leaf glaucosness (waxy layer on flag leaf) recorded using a pictorical scale from 0 to 10, 0 as no waxy layer and 10 as maximum waxy layer on flagleaf, lesion mimic (minute transparent spots on flag leaf), plant height, the Canopy temperature was recorded using hand-held infrared thermometer first at anthesis and remaining on four days interval which was later converted into Area Under Canopy Temperature Progress Curve (AUCTPC) using formula given by Rosyara *et al.*, (2009) [10], Area Under Spad Decline Curve (AUSDC) of flag leaf was recorded with the help of Chlorophyll meter (model: KONICA MINOLTA SPAD – 502 plus). Area under Disease Progress Curve (AUDPC), measure the amount of disease as well as the rate of progress, was calculated by using formula given by Sharma *et al* 2004 [12].

3. Results and Discussion.

Multivariate analysis performed with different traits (independent variables) i.e, Days to heading, 50% flowering, physiological maturity, days to greenness, lesion number, lesion size, erectness, leaf glaucosness, lesion mimic, plant height, Area Under Canopy Temperature Progress Curve (AUCTPC), Area Under Spad Decline Curve (AUSDC), Area Under Canopy Temperature Depression Curve (AUCTDC) to explain variation in disease in terms of AUDPC (dependent variable Y). However, before the regression the variables were correlated with each other to estimate the pair wise correlation and their significance was evaluated (table no.1). From the multiple correlation studies physiological maturity (crop duration), stay green property, number of lesion and size of lesion was highly correlated with disease severity (P=0.01), whereas, earliness in heading and flowering, Lesion Mimic and chlorophyll content (AUSDC) was also significantly correlated with disease (P=0.05). Among all the variables size of the lesion and lesion mimic was positively correlated and rest were negatively correlated. Then the data were subjected to step down multiple regression and the data obtained is presented in Table 2.

Table 1: Correlation matrix of the diagnostic traits for disease severity (AUDPC).

	DTH	FLR	PHM	DTG	L. NO	L. SIZE	LA	GLAUC	L. MIM	PL. HT.	AUCTPC	AUSDC	AUCTDC	AUDPC
DTH	1.0000	0.9626**	0.6533**	0.6650**	0.4815**	-0.4864**	-0.0293	0.2854*	-0.2654	-0.2485	-0.2188	0.3354*	0.2288	-0.3363*
50%FLR		1.0000	0.6813	0.6834**	0.4288**	-0.4453**	-0.0135	0.3636**	-0.2436	-0.2556	-0.1428	0.3723**	0.1612	-0.2974*
PH-M			1.0000	0.9578**	0.5908**	-0.5764**	-0.1486	0.1475	-0.3221*	-0.1024	-0.1123	0.1601	0.0860	-0.4998**
DT GREEN				1.0000	0.5692**	-0.5540**	-0.1276	0.1641	-0.3654**	-0.1298	-0.0877	0.2536	0.0479	-0.5584**
NO					1.0000	-0.9668**	-0.3374	0.0476	-0.4634**	0.0742	-0.1891	0.1927	0.2232	-0.6682**
SIZE						1.0000	0.3657	-0.0943	0.4422**	-0.0741	0.1948	-0.2352	-0.2246	0.6417**
ERECTNESS							1.0000	0.1064	0.1668	-0.0827	-0.0379	-0.1381	0.0220	0.2266
GLAUC-INDEX								1.0000	-0.2465	-0.3110*	0.2125	0.3981**	-0.1988	-0.0547
LESION MIMIC									1.0000	0.0271	-0.0344	-0.1935	0.0899	0.3312*
PLANT HEIGHT										1.0000	0.1835	-0.1638	-0.2046	0.1239
AUCTPC											1.0000	0.1338	-0.9334	-0.0227
AUSDC												1.0000	-0.1266	-0.3247*
AUCTDC													1.0000	-0.0088
AUDPC														1.0000

DTH = Days To Heading
50% FLR = 50% Flowering
PHM = Physiological Maturity
DTG = Days To Greenness
No = Lesion Number
Size = Lesion Size
Leaf Errectness
GLAUC-INDEX
LESION MIMIC
PLANT HEIGHT
AUCTPC = Area Under Canopy Temperature Progress Curve
AUSDC = Area Under Spad Decline Curve()
AUCTDC = Area Under Canopy Temperature Depression Curve
AUDPC = Area Under Disease Progress Curve
*Significant at P=0.05
**Significant at P=0.01

Table 2: Regression model for disease estimate using different diagnostic traits.

Parameter	Estimate	Parameter	Estimate
Intercept	3926.21	Intercept	2480.24
DTH	-5.17	DTH	0.00
50%FLR	10.98	50%FLR	6.35
PH-M	21.26	PH-M	23.16
DT Green	-37.02	DT Green	-37.45
Lesion Number	-14.46	Lession No.	-16.53
Size	6.25	Lession Size	0.00
Erectness	-6.83	Erectness	0.00
GLAUC-Index	6.35	GLAUC-Index	0.00
MIMIC TRAIT	-7.64	MIMIC TRAIT	0.00
Plant Height	3.05	PLANT Height	2.73
AUCTPC	-10.09	AUCTPC	-4.46
AUSDC	-1.13	AUSDC	-0.87

AUCTDC	-4.00	AUCTDC	0.00
DF	41.00	DF	47.00
MSE	3387.4438	MSE	3095.934
R^2	0.63	R^2	0.61

It was found that all these traits collectively explained 63 percent of the variation in the disease. Days to heading, days to greenness, lesion number, erectness, lesion mimic, Area Under Canopy Temperature Progress Curve (AUCTPC) and Area Under Canopy Temperature Depression Curve (AUCTDC) were shown to have negative correlation with the disease. Then by using step down regression methods some of the independent variables were dropped such as days to heading, lesion size, erectness, Glaucosness index, lesion mimic, and Area Under Canopy Temperature Depression Curve (AUCTDC) and considering only the most important parameters from phenological traits (onset of reproductive phase and maturity), symtomatological trait (lesion number), morphological trait (plant height), physiological trait (canopy temperature (AUCTPC), chlorophyll content (AUSDC) and stay green property of the genotypes were found to explain 61 percent in the disease variation. Thus some of these parameters may be utilized as the diagnostic traits in selection of resistant genotypes from a set of germplasm. Duveiller and Gilchrist, 1994 [3] also reported that taller plants are better able to escape the disease, as the upper part of their leaf canopy is far removed from the ground as the spot blotch pathogen is relatively weak, and tends to favour old or stressed leaves. However a very weak and negative correlation between plant height and spot blotch resistance was reported (Rosyara *et al* 2009) [10]. In resistant genotypes the colonization of the pathogen in the mesophyll cells is restricted and tries to penetrate from different sites which may result in numerous smaller lesion number where as in susceptible genotypes the colonization of the pathogen in the mesophyll cell is not restricted which may result in increasing lesion size which will later on coalesced with nearby necrotic lesion and form a bigger lesion size, thereby reducing the number of lesion (Kumar *et al*., 2002) [7]. Chlorophyll content has been reported to be correlated with tolerance to abiotic stress heat (Yang *et al.*, 2002) [18] and the spot blotch severity has also been reported to be increased by abiotic stresses (Sharma and Duveiller, 2004) [12].

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