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Effect of Different Dates of Sowing on the Incidence and Severity of Spot Blotch Disease of Wheat

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ABSTRACT: Spot blotch disease is quite prevalent in warmer region, and its sowing time play important role in its incidence and severity. The result of the experiment clearly showed that timely sown (11th Nov.) wheat have given the best results in terms of all aspects (double-digit scoring- 00, PDI- 26.67, DI %- 40.08 of V7- HD 3267) to late sown (16th Dec.) double-digit scoring- 14, PDI- 35.55, DI %- 47.05 of V7- HD 3267 and very late sown (7th Jan.) double-digit scoring- 15, PDI- 28.88, DI %- 76.22 of V7- HD 3267 respectively. Maximum disease severity was observed from V9- DBW 71 for all three different dates of sowing. V7 (HD 3267) has given the best result in terms of disease incidence and disease severity.

Keywords: *Bipolaris sorokiniana*, Genotype, Severity, Disease incidence, Percent disease index (PDI).

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered one of the most widely grown and consumed food crops in the world. Presently, it provides 20 percent of food calories to mankind in the world and it is a staple food for nearly 40 percent of the world population (Pingali, 1999). It is mostly used as wheat flour for the preparation of bread and cakes. It belongs to the order Poales and the family Poaceae. The cultivated wheat is hexaploid having 6 sets of chromosomes, 2n = 4x = 42. Wheat is believed to have originated in the southwestern region of Asia. Some of the earliest known remains of the crop have been found in Syria, Turkey, and Jordan (Feldman, 2001). In India wheat is considered as a winter crop i.e., *rabi* season crop. The sowing of wheat is done in autumn and harvested in summer. Generally, wheat is sown when the average daily temperature falls to around 22-23°C which happens only in November in most of the wheat-growing regions. Green revolution in India leads to the tremendous increase in total production of wheat due to the introduction of high-yielding dwarf varieties and extensive use of synthetic chemicals, but at the same time plants become more prone to insect pests which result in severe losses of the crop in the field. Among the different causes which lead to severe crop losses in the case of wheat are fungal, bacterial, and viral diseases. Commonly wheat crops get affected by many foliar diseases among them one fungal disease commonly known as spot blotch of wheat is considered as one of the most important diseases which is quite prominent in environments having high temperatures and high humidity (Ginkel and Rajaram, 1993). In recent years spot blotch disease has been emerged as a major constraint in the production of wheat due to the elimination of wild and traditional varieties and sudden increase in the cultivation of high-yielding varieties, which are good in yield but susceptible to biotic stress conditions. High temperature and high relative humidity favor the development and outbreak of the disease, particularly in South Asia's intensive 'irrigated wheat rice production cropping system (Kumar *et al.,* 2002). The Indian subcontinent has 10 million ha of spot blotch-affected land, out of which India alone has 9 million ha of affected land, most of which is in the rice-wheat cropping system (Nagarajan and Kumar, 1998). Mainly the Eastern Gangetic plain area of India comes under highly affected areas by this disease. The Rice crop serves as a host and after the harvest rice stubbles play the role of substrate for the spot blotch pathogen. The symptom of spot blotch are most prominent on leaves after heading and on lower leaves are more frequent and common, appearing as discrete, elongated, brown-black lesions. This pathogen can cause the disease on the whole-wheat plant (seedling blight, root rot, spot blotch lesions, and black point of the grain) and results in big damage in the quantity and quality of crop yield (Kumar *et al.,* 2018). For reducing

the wheat production losses caused by spot blotch pathogen, we need some better, cost-effective, and eco-friendly management practices, like cultural methods which include disease escaping by selecting the different date of sowing, it may be early sowing, late sowing, or very late sowing depending on the crop type and the disease or disease-causing pathogen. While going through the earlier research work, we find that only limited research has been conducted in the field of managing this disease by the cultural method. In recent years with the change in various environmental factors, the effect of this disease became more severe to the wheat crop, but no work has been conducted concerning the effect of different dates of sowing. Realizing the importance of the problem, the present study was carried out to identify the best disease-resistant genotypes with the objectives: To find the best time of sowing to escape spot blotch disease and to find out the incidence and severity of spot blotch at three different dates of sowing.

MATERIALS AND METHOD

The experiment was conducted at Bihar Agricultural University Farm, Sabour, Bhagalpur, having a plot size of 12.80 sq. m, one plot has 8 rows having a row to row spacing of 20 cm, and between the plots 1 m distance was maintained. Three different dates of sowing i.e. timely sown (11th November 2018), late sown (16th December 2018), and very late sown (7th January 2019) were selected for checking the effect of different dates of sowing on the performance of nine different wheat genotype i.e. HD 3249, DBW 187, HD 2733, HD 2967, DBW 39, HI 1621, HD 3271, PBW 757 and DBW 71. The statistical design applied for this experiment was a split-plot design. Table 1 shows the treatment details used in the field experiment.

Table 1: Treatments detail used in field condition.

Treatment	Timely sown	Late sown	Very late
Date of planting	11th Nov.	16th Dec.	7th Jan.
Plot size	12.80 m sq.	12.80 m sq.	12.80 m sq.
Spacing	20 cm	20 cm	20 cm
Cultivar used	HD 3249, DBW 187, HD 2733, HD 2967, DBW 39, HI 1621, HD 3271, PBW 757 and DBW 71	HD 3249, DBW 187, HD 2733, HD 2967, DBW 39, HI 1621, HD 3271, PBW 757 and DBW 71	HD 3249, DBW 187, HD 2733, HD 2967, DBW 39, HI 1621, HD 3271, PBW 757 and DBW 71
Replication	3	3	3
Design	Split plot	Split plot	Split plot

A. Preparation of fungal conidial suspension and Field inoculation by the pathogen

Four weeks after sowing i.e. after 30 days the plots were artificially inoculated with the spore suspension of *Bipolaris sorokiniana*. Fungus mycelium from the slants was inoculated on PDA plates and allowed to grow for 4-5 days, and then the active mycelium from the edge of the colony was cut into 3-4 bits of 5 mm with the help of a sterilized cork borer and transferred to the 250 ml conical flasks containing potato dextrose broth (PDB). The inoculated broth was incubated in BOD at 26±2°C for 7 days. 7 days after incubation the mycelial mat was developed on the PDB. The fully grown mycelial mat was harvested using blotter paper adjusted on a funnel and dried for 30 min. after drying the mycelia was crushed properly and diluted properly in distilled water. After that, the solution was sieved with the help of blotter paper. The conidial solution was adjusted at 1×10^6 conidia/ml for spraying. The volume of suspension was adjusted according to the treatment plot area.

B. Assessment of disease severity by double-digit scoring

Five plants showing uniform growth were selected from each genotype in each replication from all three different dates of sowing and tagged; plants from the border of the plots were not selected. All the data of disease severity, disease incidence, and percent disease index were recorded from that tagged plants with three replications for all treatments. For the assessment of disease severity double-digit scoring was taken. Double-digit scale (0-9) proposed by DWR (2001) was used for disease assessment; **score 0** = No blight, **1**= Up to 10% leaf area blighted, **2** = 11-20% leaf area blighted, **3** = 21-30% leaf area blighted, **4** = 31-40% leaf area blighted, **5** = 41-50% leaf area blighted, **6** = 51-60% leaf area blighted, **7** = 61-70% leaf area blighted, **8** = 71-80% leaf area blighted and **9** = >80% leaf area blighted. The left-hand side digit of the score represents the percent blighted area of flag leaf (F), whereas the right-side digit indicates the score of blight on one leaf below flag leaf (F-1). Firstly, the average score of data was calculated after averaging the figures of both flag leaf (F) and one leaf below flag leaf (F-1) separately.

C. Assessment of Disease incidence

The spot blotch disease was observed and disease incidence for all treatments at three different stages *viz*., (GS) on Zadok's scale: *viz.*, GS 55 (half of the inflorescences emerged), GS 75 (medium milk), GS 87 (hard dough). The progress of the disease in nine different genotypes was monitored and disease severity was recorded at the flowering, dough, and hard dough stage during the 2018-19 crop seasons.

The following formula was used for calculating Disease incidence (%):

Disease Incidence (%) =

$$\frac{\text{No. of infected plant}}{\text{Total no. of plant assessed}} \times 100$$

Disease incidence percent of all nine genotypes for three different dates of sowing with three replications were recorded.

D. Assessment of Percent Disease Index

The percent disease index (PDI) was calculated using the formulas of the Mckinney (1923)

Percent Disease Index =

$$\frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{maximum disease grade}} \times 100$$

E. Yield attribute

1000 grain weight was recorded after harvesting for all three different dates of sowing. 1000 seeds were counted manually and weighing was done by using an electronic weighing machine.

F. Statistical design

A split-plot design was used for conducting the field experiment with three replications. The results represented in the tables are the mean value of all three replications (*a = Date of sowing *b =Genotypes *c = Stage). The analysis was done with the help of the software OPSTAT (http://14.139.232.166/opstat/threefactor.htm). Further information about the experimental design and variety is presented in table 1.

RESULT

Spot blotch severity per plot was screened under field conditions against *B. sorokiniana*. The data of the double-digit score presented (Table 2) is the mean value of three replications, the mean value for flag leaf and one leaf below flag leaf (F-1) was calculated separately. At the hard dough stage, spot blotch severity ranged from 00 to 78 in dd scoring. HD 3271 was free from infection at timely sown (11th Nov. 2018) whereas, in the case of very late sown (7th Jan. 2019) highest double-digit score was recorded for DBW 71 (01 at flowering, 25 at dough, and 78 at hard dough stage) and lowest for HD 3271 (00 at flowering, 03 at dough and 15 at hard dough stage) followed by PBW 757 (01 at flowering stage, 23 at dough stage and 46 at hard dough stage) respectively.

Table 2: Effect of planting date on disease severity against *Bipolaris sorokiniana.*

Date of planting	Genotype	Leaf Blight Score (0-9dd)		
		Ist (Flowering)	IInd (Dough)	IIIrd (Hard dough)
11th Nov.	V1-HD 3249	00	01	02
	V2-DBW 187	00	01	02
	V3-HD 2733	00	01	02
	V4-HD 2967	00	01	02
	V5-DBW 39	00	00	01
	V6-HI 1621	00	01	02
	V7-HD 3271	00	00	00
	V8-PBW 757	00	00	01
	V9-DBW 71	00	01	02
16th Dec.	V1-HD 3249	01	03	25
	V2-DBW 187	00	13	36
	V3-HD 2733	01	03	25
	V4-HD 2967	01	03	37
	V5-DBW 39	00	14	37
	V6-HI 1621	01	03	24
	V7-HD 3271	00	02	14
	V8-PBW 757	01	13	24
	V9-DBW 71	01	14	69
7th Jan.	V1-HD 3249	01	14	46
	V2-DBW 187	01	14	48
	V3-HD 2733	01	13	46
	V4-HD 2967	01	24	58
	V5-DBW 39	00	13	46
	V6-HI 1621	01	14	58
	V7-HD 3271	00	03	15
	V8-PBW 757	01	23	46
	V9-DBW 71	01	25	78
*Mean value of three replication				

Percent disease index (Table 3) and disease incidence % (Table 4) were recorded at three different stages of the plant first at flowering stage, second at dough stage, and third at the hard dough stage. Percent disease index and Disease incidence (%) were lowest for timely sown treatment (11th Nov. 2018) as compared to late (16th Dec. 2018) and very late (7th Jan. 2019). At the flowering stage of timely sown (11th Nov. 2018) treatments, there was no disease appearance at the flowering stage that's why no PDI and DI % were recorded. At the hard dough stage, the PDI and DI % ranged from 8.90-26.67 (V7 lowest- V9 highest) and 40.08-47.10 (V7-V9) for D1 (11th Nov. 2018) respectively. The same pattern of the result obtained for both late and very late sown treatments i.e., lowest PDI and DI % obtained from V7 (35.55 and 63.70) and highest from V9 (77.77 and 95.62) respectively from late sown treatment and in case of very late sown treatments minimum PDI and DI % obtained were 28.88 and 76.22 (V7) whereas maximum were 80.00 and 96.88 (V9) respectively. All data related to disease severity were showing a similar pattern to V7 (HD 3271) and V9 (DBW 71) in which V7 was showing the best result with little or minimum disease severity and V9 was seems to be susceptible to spot blotch disease.

The results of the yield attribute i.e. 1000 grain weight were showing an irregular pattern of the result. From timely sowing treatments, maximum grain weight was 40.50 gm (V9) followed by 39.41 gm (V7) respectively. In the case of late sown and very late sown treatments maximum 1000 grain weight obtained was 37.71 gm (V8), and 30.54 (V7) followed by V7 (34.41 gm) and V8 (29.51 gm) respectively. With the increase in disease severity V9 has sown decrement in 1000 grain weight whereas V7 grain weight was more than 30 gm in both late and very late sown treatments.

Table 3: Effect of planting date on percent disease index (PDI) against *Bipolaris sorokiniana.*

Date of planting	Genotype	PDI		
		Ist (Flowering)	IInd (Dough)	IIIrd (Hard dough)
11th Nov.	V1-HD 3249	0.00	4.42	11.09
	V2-DBW 187	0.00	4.43	13.31
	V3-HD 2733	0.00	2.21	8.89
	V4-HD 2967	0.00	4.44	17.77
	V5-DBW 39	0.00	2.21	6.66
	V6-HI 1621	0.00	4.45	20.01
	V7-HD 3271	0.00	2.20	2.22
	V8-PBW 757	0.00	4.33	8.90
	V9-DBW 71	0.00	8.89	26.67
16th Dec.	V1-HD 3249	8.89	24.42	46.67
	V2-DBW 187	8.89	28.86	57.78
	V3-HD 2733	8.89	22.22	46.65
	V4-HD 2967	8.89	35.56	64.43
	V5-DBW 39	8.89	28.88	62.22
	V6-HI 1621	4.44	22.19	46.64
	V7-HD 3271	2.22	15.56	35.55
	V8-PBW 757	2.22	22.17	42.21
	V9-DBW 71	11.11	37.77	77.77
7th Jan.	V1-HD 3249	8.87	33.32	62.18
	V2-DBW 187	8.88	35.54	66.59
	V3-HD 2733	6.68	33.31	60.00
	V4-HD 2967	11.11	40.00	68.88
	V5-DBW 39	4.44	26.66	57.78
	V6-HI 1621	11.10	37.77	68.85
	V7-HD 3271	2.22	17.78	28.88
	V8-PBW 757	6.67	28.87	59.43
	V9-DBW 71	13.33	46.66	80.00
CD at 5 %	a=0.054 b=0.047 c=0.027 a × b=0.081 b × c=0.081 c × a =0.047 a × b × c=0.140			
CV %	0.390			
SEm (±)	0.050			
	*a = Date of sowing *b =Genotypes *c = Stage			
	*Mean value of three replication			

Table 4: Effect of planting date on percent Disease incidence (DI %) against *Bipolaris sorokiniana.*

Date of planting	Genotype	DI (%)		
		Ist (Flowering)	IInd (Dough)	IIIrd (Hard dough)
11th Nov.	V1-HD 3249	0.00	15.84	44.19
	V2-DBW 187	0.00	16.27	45.23
	V3-HD 2733	0.00	14.76	41.70
	V4-HD 2967	0.00	16.68	46.09
	V5-DBW 39	0.00	14.18	41.36
	V6-HI 1621	0.00	17.68	46.17
	V7-HD 3271	0.00	12.84	40.08
	V8-PBW 757	0.00	15.39	42.73
	V9-DBW 71	0.00	19.48	47.15
16th Dec.	V1-HD 3249	25.71	59.24	87.08
	V2-DBW 187	25.72	59.99	88.61
	V3-HD 2733	25.49	58.66	85.42
	V4-HD 2967	28.50	61.43	90.56
	V5-DBW 39	25.91	60.05	88.82
	V6-HI 1621	25.45	57.30	85.15
	V7-HD 3271	24.34	54.35	63.70
	V8-PBW 757	24.73	56.65	78.80
	V9-DBW 71	31.39	61.68	95.62
7th Jan.	V1-HD 3249	33.84	45.81	92.64
	V2-DBW 187	35.66	47.85	93.46
	V3-HD 2733	32.45	41.52	92.53
	V4-HD 2967	45.64	48.63	96.09
	V5-DBW 39	30.36	38.15	90.04
	V6-HI 1621	41.37	48.14	94.00
	V7-HD 3271	29.92	33.12	76.22
	V8-PBW 757	30.58	41.13	91.95
	V9-DBW 71	48.68	52.25	96.88
CD at 5 %	a=3.52 b=1.06 c=0.61 a × b=1.84 b × c=1.84 c × a =1.06 a × b × c=3.18			
CV %	4.43			
SEm (±)	1.14			
	*a = Date of sowing *b =Genotypes *c = Stage			
	*Mean value of three replication			

DISCUSSION

Bipolaris sorokiniana is an aggressive pathogen that causes spot blotch of wheat. Typically, the first foliar symptoms of spot blotch as small light brown blotches that develop into oval-shaped, light brown, necrotic lesions bordered. Early lesions are characterized by small, dark brown lesions 1 to 2 mm long without chlorotic margin. In susceptible genotypes, these lesions extend very quickly in the oval to elongated blotches, light brown to dark brown in color. When the spikelets are affected, it can result in shriveled grains. In case of severe infection, the grain may be completely discolored and shriveled. Similar symptoms were given by Zillinsky (1983); Schilder and Bergstrom (1993); Maraite *et al.*, (1998).

The predominance of spot blotch of wheat was reported especially in the north-eastern plain zone of Bihar and their adjoining states of India (Singh *et al*., 2001). Krishnendu *et al*., (2011) also observed that great yield losses occurred by the disease when the flag leaf and the leaf below the flag leaf became infected before the emergence of the ear head. Our findings are in complete agreement with Mahto *et al.*, (2002); Singh *et al.*, (2004) who also reported similar findings. Joshi *et al.*, (2002) also observed that spot blotch is the most concerning disease in warm and humid regions of India and other South Asian countries due to its widespread prevalence and increasing severity.

The presented above results were found to be in conformation with findings of Jahan and Adam (2015) who reported that November 14 sown wheat produced a maximum 1000-grain weight and there was a gradually decreasing trend with delayed sowing. The results are also in agreement with the previous reports (Subhan *et al.*, 2004; Shahzad *et al*., 2007). Jahan and Adam (2015) obtained statistically similar yields from November 14 and November 24 sown BARI Gom-25 but decreased significantly beyond the time of November 24. A decrease in grain yield of wheat due to delay sowing from November 20 onward was also reported by Singh and Uttam, (1999). Ansary *et al*.,

(1989); Shahzad *et al.*, (2007) also obtained lower yields with delay sown wheat. Regardless of varieties or cultivars, better yields were obtained when wheat was sown after November 15 and before November 30. Baloch *et al.,* (2010) recorded maximum grain yield when sown in November while minimum in December. Observations are following the findings of the numerous workers. Singh *et al.,* (1998), who reported that severe blights of wheat may occur for wheat sown after November 30. Wegulo *et al.,* (2009); Singh *et al.,* (2014) also reported spot blotch severity from flowering to watery milk stage in the case of wheat. Rosyara *et al.*, (2008); Gurung *et al.*, (2012) found increased disease severity in late sowing conditions. Similar results were obtained by Duveiller *et al.,* (2005).

Table 5: Effect of planting date on germination percent and 1000 grain weight (gm) against *Bipolaris sorokiniana*

Date of planting	Genotype	1000 Grain wt. (gm)
11th Nov.	V1-HD 3249	30.57
	V2-DBW 187	30.09
	V3-HD 2733	33.35
	V4-HD 2967	35.17
	V5-DBW 39	34.00
	V6-HI 1621	35.55
	V7-HD 3271	39.41
	V8-PBW 757	33.32
	V9-DBW 71	40.50
16th Dec.	V1-HD 3249	32.42
	V2-DBW 187	30.41
	V3-HD 2733	32.47
	V4-HD 2967	29.15
	V5-DBW 39	30.20
	V6-HI 1621	34.17
	V7-HD 3271	34.41
	V8-PBW 757	37.71
	V9-DBW 71	28.31
7th Jan.	V1-HD 3249	25.92
	V2-DBW 187	25.41
	V3-HD 2733	27.35
	V4-HD 2967	24.33
	V5-DBW 39	28.34
	V6-HI 1621	25.14
	V7-HD 3271	30.54
	V8-PBW 757	29.51
	V9-DBW 71	22.42
CD at 5 %		a=0.416 b=0.569 Factor(b)at same level of a=1.023 Factor(a)at same level of b=1.012
CV %		1.920
SEm (±)		0.342

CONCLUSION

An increase in disease severity of even resistant genotype might be due to the combined effect of heat stress and easily available inoculums (spores) from the first date sowing field. Moreover, the epidemiological condition might have favored the high disease on the second date of sowing. With the changing scenario of environmental factors (like temperature, rainfall) the spot blotch disease emerged as a serious problem for the warmer region and because of this, the losses that occurred due to this disease has been increased drastically. Concerning the recent situation, and the limited work conducted in recent years, it was important to check the proper time of incidence of spot blotch disease. This experiment provides proper information about the effect of different dates of sowing on the severity of spot blotch disease and favorable period for the incidence and infection of *B. sorokiniana,* and it will help to understand the behavior of the pathogen in terms of the sowing time, and the effect on growth and yield of the crop. With prospect, this exppperiment helps in understanding the effect of sowing time on the spot blotch pathogen. This helps the wheat cultivators to choose a proper time for sowing or if choose late to sow then to adopt preventive measures to manage the incidence of spot blotch disease. It also minimizes the usages of chemical fungicides, because from the very beginning for the management of *B. sorokiniana* uses of fungicide is the highly adapted

method that causes harmful effects on the environment, human health, soil health, and on other micro-flora and fauna, its is also due to lack of resistance variety against spot blotch pathogen so, mainly curative methods were used for the management. This finding of this experiment will help the farmers to adopt a safer method for management.

Ethics declarations

The authors declare that ethical standards have been followed and that no human participants or animals were involved in this research.

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Conflict of Interest. The authors declare that they have no competing interests and No potential conflict of interest was reported by the authors.

REFERENCES

Ansary, A. H., Khushak, A. M., Sethar, M. A., Ariam, N. A. & Emon, M. Y. M. (1989). Effect of sowing dates on growth and yield of wheat cultivars. *Pakistan Journal of Scientific and Industrial Research*, *32*: 39-42.

Baloch, M. S., Shah, I. T. H., Nadim, M. A., Khan, M. I., & Khakwani, A. A. (2010). Effect of seeding density and planting time on growth and yield attributes of wheat. *Journal of Animal and Plant Science*, *20*(4): 239-242.

Duveiller, E., Kandel, Y. R., Sharma, R. C., & Shrestha, S. M. (2005). Epidemiology of foliar blights (spot blotch and tan spot) of wheat in the plains bordering the Himalayas. *Phytopathology*, *95*(3): 248-256.

DWR (2001). Annual Report, Directorate of wheat research, Karnal, Haryana, pp. 98.

Feldman, M., (2001). The origin of cultivated wheat. In: The wheat Book, A. Bonjean and W. Angus (eds.). *Paris: Lavoisier Tech. & Doc.*, pp. 1-56.

Ginkel, V. M., & Rajaram, S. (1993). Breeding for durable resistance to diseases in wheat: Global additional perspective. Durability of disease resistance (Jacobes T, Parlevliet JE (eds) In: Jacobes T, Parlevliet JE) Kluwer *Academic Publishers, Dordrecht, Netherlands*, pp. 259-272.

Gurung, S., Sharma, R. C., Duveiller, E., & Shrestha, S. M. (2012). Comparative analysis of spot blotch and tan spot epidemics on wheat under optimum and late sowing period in South Asia. *European Journal of Plant Pathology*, *134*(2): 257-266.

Jahan, N. & Adam, A. M. M. G. (2015). Growth and yield responses of BARI Gom-25 in relation to sowing time. *Dhaka University Journal of Biological Sciences*, *24*(1): 99-102.

Joshi, A. K., Kumar, S., Chand, R. & Ortiz-Ferrara, G. (2002). Inheritance of resistance to spot blotch caused by *Bipolaris sorokiniana* in spring wheat. *Plant Breeding*, *123*: 213-218.

Krishnendu, A., Dutta, A. K., & Pradhan, P. (2011). *Bipolaris sorokiniana* (Sacc.) Shoem: The most destructive wheat fungal pathogen in the warmer areas. *Australian Journal of Crop Sciences*, *5*: 1064-1071.

Kumar, J., Schaer, P., Huckelhoven, R., Langen, G., Baltruschat, H., Stein, E., Nagarajan, S. & Kogel, K. H. (2002). *Bipolaris sorokiniana*, a cereal pathogen of global concern: cytological and molecular approaches towards better control. *Molecular plant pathology*, 3(4):185-195.

Kumar, S., Naresh, P., Kumar, V., Singh, R., & Biswas, S. K. (2018). Evaluation of different doses of fungicides and biocides against spot blotch of wheat caused by *Bipolaris sorokiniana*. International Journal of Current Microbiology, *Applied Sciences*, 7(12): 988-993.

Mahto, B. N., Singh, D. V., Srivastava, K. D., & Aggarwal, R. (2002). Mycoflora associated with leaf blight of wheat and pathogenic behaviour of spot blotch pathogen. *Indian Phytopathology*, *53*: 319-322.

Maraite, H., Zinno, Di. T., Longree, H., Daumerie, V., & Duveiller, E. (1998). Fungi associated with foliar blight of wheat in warmer areas. In: Proce. of the Internat. Workshop on Helminthosporium Diseases of Wheat: Spot Blotch and Tan Spot (Duveiller, E., Dubin, H. J., Reeves, J. and McNab, A., eds), *CIMMYT, El Batan, Mexico*, pp. 293-300.

McKinney, H. H. (1923). A new system of grading plant diseases. *J. Agric. Res*, *26*(2): 195-218.

Nagarajan, S., & Kumar, J. (1998). Foliar blights of wheat in India: germplasm improvement and future challenges for sustainable high yielding wheat production. Helminthosporuiumblights of wheat: Spot blotch and Tan spot (Eds. Duveiller E, Dubin HJ, Reeves J and McNab A). *CIMMYT, El Batan, Mexico, DF*, pp. 52-58.

Pingali, P. L. (1999). CIMMYT 1998-99 World Wheat Facts and Trends. Global Wheat Research in a Changing World: Challenges and Achievements. CIMMYT, Mexico. *Plant Disease Research*, *557*: 388-418.

Rosyara, U. R., Vromman, D., & Duveiller, E. (2008). Canopy temperature depression as an indicator of correlative measure of spot blotch resistance and heat stress tolerance in spring wheat. *Journal of Plant Pathology*, *90*: 103-107.

Schilder, A., & Bergstrom, G. C. (1993). Tan spot (*Pyrenoplwra tritici repentis*). In: S. B. Mathur and B. M. Cunfer (eds.) Seed Borne Diseases and Seed Health Testing of Wheat, pp. 113-122.

Shahzad, M. A., Din, W. U., Sahi, S. T., Khan, M. M., & Ehsanullah, A. M. (2007). Effect of sowing dates and seed treatment on grain yield and quality of wheat. *Pakistan Journal of Agricultural Scienc*e, *44*(4): 581-583.

Singh, D. P., Singh, A., Sonalki, I. S., Singh, S. P., Verma, J., Mahapatra, S., Viash, S.S., Mukhopadhaya, S. K., & Dutta, S. (2014). Management of spot blotch of wheat caused by *Bipolaris sorokiniana*in wheat using fungicides. *Indian Phytopathology*, *67*(3): 308-310.

Singh, R. N., Chauhan, A., & Singh, A. K. (2004). Foliar blight of wheat under rice wheat system in eastern. *Indian Journal of Mycology and Plant Pathology*, *31*(3): 339-342.

Singh, R.N., Singh, A. K., Singh, S. P. & Singh, B. N. (2001). Prevalence and distribution of foliar blight pathogens attacking wheat in India. *Indian Phytopathology*, *54*(2): 175-178.

Singh, R. V., Singh, A. K., Ahmad, R., & Singh, S. P. (1998). Influence of agronomic practices on foliar blight, and identification of alternate hosts in rice-wheat cropping system. In E. Duveiller, Dubin HJ, Reeves J, McNab A (Eds.), Helminthosporium blights of wheat: Spot blotch and tan spot. *Mexico DF: CIMMYT*, pp. 346-348.

Singh, V. P. N. & Uttam, S. K. (1999). Influence of sowing dates on yield of wheat cultivars under saline sodic conditions in Central Utter Pradesh. *Indian Journal of Agricultural sciences*, *38*: 64-68.

Subhan, F., Khan, M. & Jamro, G. H. (2004). Effect of different planting date, seeding rate and weed control method on grain yield and yields components in wheat. *Sarhad Journal of Agriculture*, *20*(1): 51-55.

Wegulo, S. N., Breathnach, J. A. & Baenziger, P. S. (2009). Effect of growth stage on the relationship between tan spot and spot blotch severity and yield in winter wheat. *Crop Protection*, *28*: 696-702.

Zillinsky, F. (1983). Common diseases of small grain cereals, a guide to identification. *CIMMYT, Mexico, DF*, pp.141.

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