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Estimation of yield loss at different disease levels of spot blotch of wheat in Bihar

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Abstract
Wheat (*Triticum aestivum* L.) is one of the oldest and most important cereal crop. It is the second important staple cereal food in India after rice and has played vital role in stabilizing the food grain production in the country. Wheat crop is affected by many fungal diseases. Spot blotch disease of wheat caused by *Bipolaris sorokiniana*, a hemibiotrophic, phytopathogenic fungus is one of them and prevalent in warmer and humid wheat growing regions. An experiment was conducted in field condition at University farm of Dr. Rajendra Prasad Central Agricultural University, pusa to estimate the yield losses due to spot blotch. Findings of present investigations revealed that yield loss due to spot blotch of wheat varies between 7 to 30 per cent and loss in 1000-grain weight between 3 to 23 per cent, depending upon the levels of disease in Bihar.

Keywords: *Bipolaris sorokiniana*, spot Bloch, wheat, yield loss, 1000-grain weight loss

Introduction
Wheat (*Triticum aestivum* L.) is one of the oldest and most important cereal crops. The world's major wheat producing areas are northern China, northern India, northern USA and adjoining areas of Canada, Europe, Russia, Latin America and Africa. Globally, total area under wheat production is 222.16 million hectare with production 752 million tonnes and productivity of 3380 kg/ha (USDA, 2017) [15]. Wheat is the second most important food crop of the India after rice and has played vital role in stabilizing the food grain production in the country.

The wheat cultivation in the warmer and humid region of North-eastern plain zone has extended significantly after green revolution, however, many new diseases and pest problems have been encountered by this crop that created significant yield loss. Wheat crop is affected by many fungal diseases and among these spot blotch has emerged as number one problem in hot and humid wheat cultivating regions (Van Ginkel and Rajaram, 1993). Spot blotch caused by *Bipolaris sorokiniana* is prevalent in warmer and humid wheat growing regions of the world and has special significance in the Eastern Gangetic Plains (EGP) of South Asia, which includes India, Nepal and Bangladesh (Joshi *et al*., 2007) [3].

Yield losses due to foliar blights are variable and in last two decades spot blotch has emerged as serious concern for wheat cultivation in the developing world. Spot blotch has been considered as a major constraint to wheat yields in South Asia due to reduction in 1000-grain weight and grain yield (Singh *et al.*, 2007) [12]. Annual yield loss of wheat due to this disease in South Asia is estimated to 15 to 20 per cent (Duveiller and Sharma, 2009) [2]. In India, losses due to diseases may be 10 to 50 per cent which can be devastating for farmers in the Eastern Gangetic Plains (EGPs) and depends on the level of resistance in a cultivar against leaf blight and weather conditions. The disease severity affects more than 10 million ha of wheat in gangetic plains (Nagarajan and Kumar, 1998) [4] and reduce grain yield up to 25 per cent in the affected areas (Saari, 1998) [8]. Narayan (2004) [5] reported that yield losses due to foliar blight of wheat at Pusa, Bihar, varied between 2 to 30 per cent and loss in 1000-grain weight between 3 to 26 percent depending upon the disease severity. Climate change has aggravated the disease scenario in India, which has led to increase in the incidence of spot blotch of wheat caused by the *Bipolaris sorokiniana* and now emerged as one of the serious production constraints in North-western region of India along with *Tarai* region of North-eastern plain zone (Singh and Srivastava, 1997) [13]. In 1990-91, the disease appeared in an epidemic form in some western districts of U.P. on wheat varieties HD 2329 and HD 2285 mainly due to late sowing and warm humid environment in the month of March (Singh *et al*., 1993).

Since then, this disease has emerged as a major problem in North-western as well as the peninsular India and has acquired the status of national importance instead of regional one.

Materials and Methods

A field trials in randomized block design with four replication were conducted during *Rabi* 2016-17 and 2017-18 at University Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa to estimate the loss in yield due to various level of spot blotch disease of wheat. Different levels of disease were created by giving different number of sprays of Indofil M-45 @ 0.25% at 7 days interval. First spray was given in all the plots except check, as soon as the disease was noticed in the field and 0 to 5 sprays of Indofil M-45 were given to different plots for creation of different levels of disease. For recording disease in field trials, Saari-Prescot 0-9 scale (Saari and Prescot, 1975) [9] and 0-9 double digit (dd) scale as adopted by the Directorate of Wheat Research Karnal were followed. Per cent Disease Index (PDI) was calculated by the following formula:

$$PDI = \frac{\text{Sum of all numerical rating x 100}}{\text{Total number of plants graded x Maximum grade}}$$

In each plot 10 randomly selected plants were scored. The recording of spot blotch was done in 0-9 double digit scale at dough stage. The scoring of the disease incidence was done on the top two leaves, i.e. flag leaf and one below it. Of two digits, while the first indicates the score of flag leaf, the second digit gives the score of next (flag-1) leaf. Assessment of disease severity as percentage of leaf area damaged at dough stage was done following the double digit score devised by Directorate of Wheat Research (DWR), Karnal. An average reaction was calculated after taking the mean of both digits separately. Harvesting and threshing was done manually. Crop of individual plots was harvested separately and bundled. Bundles from individual plots were threshed separately and grains obtained were weighted separately, to evaluate the yield of each plot. One thousand grain were counted from the produce of each plot and weighted to find out the 1000-grain weight. Data was analyzed statistically.

Results and Discussion

Data presented in Table 1 and illustrated in Figs. 1 and 2, reveals different levels of disease, i.e. PDI ranging from 25.53 to 78.80 and 30.70 to 80.00 per cent during *Rabi* 2016-17 and 2017-18, respectively, were created. Maximum Per cent Disease Index (PDI) of 78.80 and 80.00 per cent was observed during 2016-17 and 2017-18, respectively, in the plots where no fungicide was sprayed. Minimum PDI of 25.53 and 30.70 per cent was recorded in plots where five sprays of fungicide were given. Disease levels created in such a manner differed significantly from each other.

Data clearly indicates that minimum yield of 28.90 and 30.75 q/ha, respectively, in *Rabi* 2016-17 and 2017-18 were in unsprayed plots having 78.80 and 80.00 PDI, respectively. Maximum yields of 41.69 and 41.50 q/ha in *Rabi* 2016-17 and 2017-18, respectively, were recorded in plots where five sprays were given and PDI in these plots were only 25.53 and 30.70 per cent during *Rabi* 2016-17 and 2017-18, respectively. It clearly indicates that with the decrease in the PDI there was gradual increase in the yield.

Table 1. Effect of number of spray of Mancozeb on yield, 1000-grain weight and Per cent Disease Index (PDI) of spot blotch of wheat

No. of sprays of Mancozeb	Per cent Disease Index (PDI)*		Yield (q/ha)*		Yield loss (%)*		1000-grain weight (g)*		Loss in 1000-grain weight (%)*	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
0	78.80 (62.58)**	80.00 (63.44)	28.90	30.75	30.52 (33.36)	25.74 (30.31)	37.96	35.66	22.15 (28.02)	22.42 (28.18)
1	71.83 (57.92)	66.56 (54.65)	30.96	34.00	25.51 (30.05)	18.07 (24.94)	39.98	40.13	18.05 (25.04)	12.68 (20.31)
2	55.25 (47.99)	51.94 (46.09)	32.09	36.25	22.82 (28.25)	12.62 (20.60)	42.63	42.63	12.56 (20.52)	7.22 (13.54)
3	49.50 (44.69)	45.00 (42.11)	34.20	37.25	17.86 (24.78)	10.26 (18.36)	43.39	44.00	10.99 (18.71)	4.31 (9.44)
4	31.34 (34.01)	36.17 (36.95)	38.68	38.50	7.08 (14.08)	7.19 (15.28)	47.13	44.63	3.36 (10.14)	3.02 (9.25)
5	25.53 (30.33)	30.70 (33.62)	41.69	41.50	-	-	48.76	46.04	-	-
CD 5%	1.85	2.05	3.53	3.06	6.28	5.59	2.84	2.24	5.74	6.42
SE(m)	0.61	0.67	1.16	1.01	2.06	1.83	0.93	0.74	1.89	2.11

*Average of 4 replications

** Figure in parentheses are transformed (arc sin) value

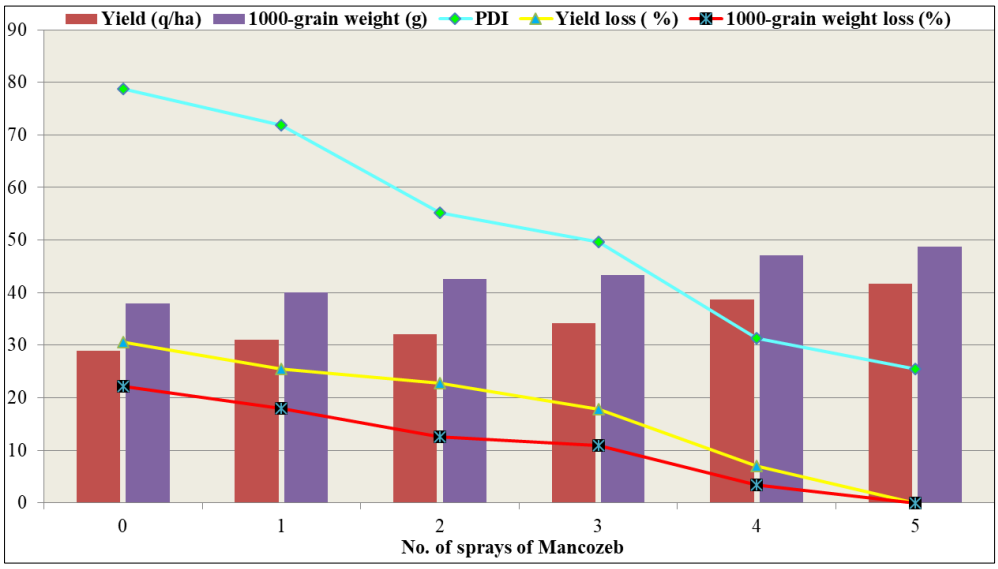

Fig 1: Effect of different disease levels of spot blotch on yield and 1000-grain weight of wheat during *Rabi* 2016-17

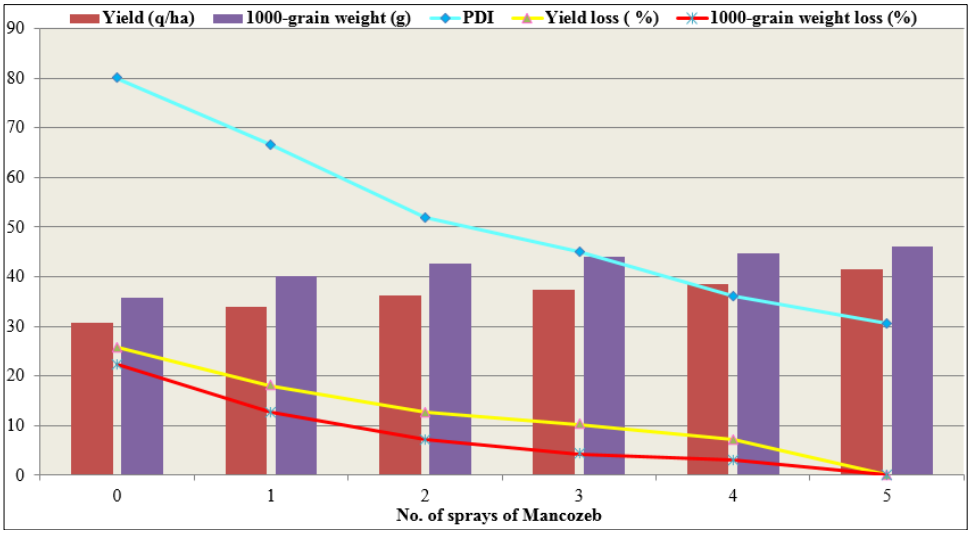

Fig 2: Effect of different disease levels of spot blotch on yield and 1000-grain weight of wheat during *Rabi* 2017-18

In 2016-17 maximum yield (41.69 q/ha) was recorded in plots given five sprays and it differed significantly from yield recorded in unsprayed plot as well as in plots which were given either 4, 3, 2, or 1 spray. Plot given 4 sprays recorded 38.68 q/ha yield which was significantly inferior than the yield obtained in plots given five sprays and significantly superior than those obtained in plots given 3, 2, 1 sprays or unsprayed plots. Yield of 34.20 q/ha and 32.09 q/ha recorded in plots given respectively, 3 and 2 sprays did not differ significantly from each other. However, these yields were statistically inferior than yields obtained in plots given 5 or 4 sprays. Yield of 32.09 q/ha obtained in plots given 2 sprays was statistically at par with those plots given 3 sprays on one hand and with those plots which were given 1 or no sprays of fungicides on the other hand. In 2017-18 also, highest yield of 41.50 q/ha was recorded in plots given 5 sprays, but this year it did not differ significantly from plots given 4 sprays; however, like previous year, it was significantly superior than yields of those plots which were given either 3, 2, 1 or 0 spray. Yields recorded in plots given 4, 3 and 2 spray were 38.50, 37.25 and 36.25 q/ha, respectively and they did not differ significantly from each other but differed significantly from unsprayed plot. Yield (34.00 q/ha) recorded in plot given one spray was significantly higher than unsprayed plot but was at par with that obtained in plots given 2 sprays. Minimum yield of 30.75 q/ha recorded in unsprayed plots was significantly inferior than yields of all other plots.

Yield loss due to spot blotch varied between 7.08 to 30.52 per cent in the year 2016-17 and 7.19 to 25.74 per cent in the year 2017-18 depending upon the level of disease. During the year 2016-17 losses were significantly more in unsprayed plots than plots given either, 3 or 4 sprays. Loss in yields recorded in plots given 0, 1 and 2 sprays and also 1, 2 and 3 sprays did not differ significantly from each other. Minimum yield loss, recorded in plots given 4 sprays was significantly less than losses of all other plots. During the year 2017-18 losses were significantly more in unsprayed plots than plots given either, 2 or 3 or 4 sprays. By enlarge in year 2017-18, losses were non-significant in between 0 and 1 spray, 1 and 2 sprays. Minimum yield loss recorded in plots given 4 sprays was at par with plots given 2 and 3 sprays.

Data presented in Table 1 also reveals that with decrease in the PDI value there was a gradual increase in 1000-grain weight and decrease in 1000-grain weight loss. Similar trend were observed in both the year. By enlarge in the year 2016-17, losses in 1000-grain weight did not differ significantly from each other if difference in number of sprays was only one, except plots given 3 and 4 sprays in which significant difference in 1000-grain weight loss occurred. In the year 2017-18, highest loss in 1000-grain weight recorded in unsprayed plot was significantly higher than plots given either 1 or 2 or 3 or 4 sprays. Next to unsprayed plot highest loss in 1000-grain weight occurred in plots given 1 spray and significantly higher than plots given 2, 3 and 4 sprays. Minimum loss in 1000-grain weight recorded in plots given 4 sprays which was at par with plots given 2 and 3 sprays. Present study clearly indicates that in Bihar yield loss due to spot blotch varies between 7 to 30 per cent and loss in 1000-grain weight between 3 to 23 per cent, depending upon the levels of disease.

A number of other workers have also reported variable yield losses depending upon the severity of the disease and variety (Sharma and Duveiller, 2006; Singh *et al.* 1997 and Razzaque and Hossain, 1991) [11, 14, 7]. Nema and Joshi (1971) [6] estimated 3 to 20 per cent losses in yield of wheat due to spot blotch under Indian conditions. Singh *et al*. (1995) reported 2.72 to 36.24 per cent loss under different agro-climatic conditions due to spot blotch. According to Saari (1998) [8] losses due to spot blotch are reported to be 16, 20, and 23 per cent repectively, in India, Nepal and Bangladesh. He also concluded that average loss due to leaf blight was around 20 per cent in South Asia. Bhandari *et al*. (2002) [1] reported that losses due to spot blotch of wheat (*Bipolaris sorokiniana*) varied from 24 to 27 per cent in highly susceptible cultivars. Yield losses to the tune of 30 per cent and 1000-grain weight loss upto 26 per cent depending upon the disease severity at Pusa (Bihar) were recorded earlier in the year 2000-01 and 2001-02 (Narayan, 2004) [5]. This clearly indicate that the losses due to spot blotch disease of wheat are still below 30% in Bihar.

Conclusion

In Bihar yield loss due to spot blotch varies between 7 to 30 per cent and loss in 1000-grain weight between 3 to 23 per cent, depending upon the levels of disease.

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