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Efficacy of fungicides as seed treatment and foliar application for managing leaf blight (*Bipolaris sorokiniana*) on wheat (*Triticum aestivum* L.)

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Abstract

Wheat leaf blight is emerging as one of the yield limiting factor in north eastern plains zone and also in north western plains zone. The chemical fungicides play a major role in controlling the leaf blight in India due to non availability of leaf blight resistant commercial varieties. To identify the suitable chemicals and method of application, various fungicides (captan 50%WP, carboxin 37.5% WP + thiram 37.5% WP, propiconazole 25% EC, tebuconazole 25% EC and mancozeb 75% WP) were evaluated either as seed treatment or foliar sprays and in combination under artificial epiphytotic field conditions for two crop seasons. The seed treatment with carboxin 37.5% WP + thiram 37.5% WP @ 1.5 g kg^{-1} seed followed by spraying with propiconazole 25% EC @ 0.1% at boot leaf stage resulted in best management of leaf blight in severe conditions. It was observed that the fungicide treatment not only controlled the blight severity and also the wheat grain yield.

Key words: Fungicides, wheat, leaf blight, *Bipolaris* and management

1. Introduction

Wheat (*Triticum aestivum* L.), the third largest produced cereal next to maize and rice , occupies 4.6 percent of total agricultural area in the world. During 2009-10, out of 217.31mha world wheat area, India was first holding 28.46 mha and from a total of 686.79 mt wheat production, 80.80 mt was contributed by India ranking second next to China. In India, wheat ranks second to rice among top ten commodities available for human consumption (FAOSTAT, 2014). During 2013-14, the wheat production reached 95.91 mt from 31.34 mha (Anonymous, 2014). Wheat leaf blight (spot blotch) caused by *Bipolaris sorokiniana* (Sacc.) Shoem. syn. *Drechslera sorokiniana* (Sacc.) Subrm and Jain (syn.*Helminthosporium sativum*, teleomorph *Cochliobolus sativus*), is an emerging problem in major wheat growing areas wherever the temperature is above 25°C and humid during crop season (Joshi *et al.*, 2002). *Bipolaris sorokiniana* is directly infecting wheat causing severe yield loss under favourable conditions ranging from 20-80% (Duveiller and Gilchrist, 1994). During 1990-91 there was leaf blight epidemic in western districts of Uttar Pradesh on wheat varieties HD2285 and HD2329 due to favourable environment (Singh *et al.,* 1993). In addition to yield losses, the grain quality also deteriorates depending on the level of susceptibility of a cultivar to the pathogen.

Unfortunately, the present day cultivars do not possess substantial resistance to leaf blight in India. Since leaf blight occurs in all the wheat growing agro-climatic zones, deployment of resistant cultivars remains the most effective strategy for the management of disease. The resistance source is not easily available and resistance is not stable due to development and the appearance of new/more virulent races of pathogens (Katasntones *et al.*, 2007). Though host resistance is most economical, fungicide treatment is also one of the effective control measures available for leaf blight management. The pathogen mainly survives as conidia in infected crop residues, on seeds, collateral hosts and in the soil (Reis, 1991). The better management will be accomplished both through reduction of soil inoculum by seed treatment and prevention of secondary spread by spraying fungicides. Due to non availability of disease tolerant genotypes, the use of chemical under high disease pressure is unavoidable

and evaluation of new fungicide molecules at different concentrations is required for effective management of leaf blight pathogen. Therefore in this experiment, the efficacy of fungicides as seed as well as foliar alone or in treatment combination was evaluated. In addition, the method of application and number of fungicidal sprays required were also evaluated for their effectiveness in wheat leaf blight management.

2. Materials and methods

Field trials were conducted at experimental farm of ICAR-DWR, Karnal, Haryana for management of leaf blight of wheat using chemical fungicides during 2012-13 and 2013-2014 crop seasons. The experiment was carried out in randomized block design (RBD) with three replications for each treatment on stripe rust resistant but leaf blight susceptible variety DBW14. For each treatment, there were six rows of five m length with row to row distance of 25 cm along with 1.25 m gap between replications and 75 cm gap between plots. The seed rate @ 125 kg ha^{-1} (per plot approx. 110 g) was adopted and sown on 30th Nov. 2012 during first year and on 25th Nov. 2013 during second year. The NPK fertilizer (120:60:40 $kgha^{-1}$) and FYM @ 2 tha^{-1} were applied. Three irrigations were assured at 20, 50 and 80 days and standard agronomic practices were followed. Untreated seed without any fungicide spraying was maintained as check. For maintaining uniform disease pressure in the field, the inocula of *Bipolaris sorokiniana* was artificially multiplied on sterilized wheat grains. Twenty days after inoculation, the conidial suspensions ($1x10^6$ conidia per ml) were sprayed on standing crop to ensure high disease severity for proper evaluation of fungicidal efficacy.

The efficacy of seed treating fungicides alone and in combination with foliar sprays was evaluated. There were treatments only with seed treatment (ST) of captan 50%WP @ 3 gkg^{-1} of seed or carboxin 37.5% WP + thiram 37.5% WP @ 2.5 gkg^{-1} of seed. In addition, there were treatments with carboxin 37.5% WP + thiram 37.5% WP @ 2.5 gkg^{-1} of seed as ST and single spraying of propiconazole 25% EC @ 0.1% at boot leaf or at the time of initiation of disease on Flag -1 leaf or seed treatment with carboxin 37.5% WP + thiram 37.5% WP @ 2.5 gkg^{-1} of seed and two sprays of propiconazole 25% EC @ 0.1 % at boot leaf or at the time of initiation of disease on Flag -1 leaf and second spray 20 days after interval. There were treatments using single spray of propiconazole 25% EC @ 0.1% or tebuconazole 25% EC @ 0.1% at boot leaf or at the time of initiation of disease on Flag -1 leaf or two sprays of propiconazole 25% EC @ 0.1 % or tebuconazole 25% EC @ 0.1 % at boot leaf or at the time of initiation of disease on Flag -1 leaf followed by second spray at 20 days interval. There was a treatment with three sprays of mancozeb 75% WP@ 0.25% at boot leaf or at the time of initiation of disease on Flag-1 leaf followed by second and third spray at 10 days intervals each. The foliar sprays were given on initiation of disease and in few treatments repeated after 15 days interval. First spray of fungicide was given at the initiation of disease followed by 2nd spray at 10 days interval whenever required.

The observations on seed germination at 20 days after sowing, foliar blight at flowering, dough and hard dough stages in DD (0-9) scale, 1000 grain weight and seed weight per plot were recorded. In each plot 50 plants were evenly tagged for observation of leaf blight and the per cent disease severity was calculated at flowering, dough and hard dough stages on flag and flag-1 leaf.

3. Results and discussion

Relative performance of different fungicides for the control of leaf blight of wheat is presented in Table 1.

The average seed germination in all non fungicide treated plots ranged from 82.88 to 84.58%). The seeds treated with captan 50%WP showed increased germination of 94.21% followed by seed treatment with carboxin 37.5% WP + thiram 37.5% WP (93.61%) (Fig.1)

This is due to suppression or elimination of soil borne pathogens and favouring the beneficial microorganisms surrounding the seeds in soil. Goulart *et al.* (1995) observed that spraying with tebuconazole, propiconazole 25% EC and Flutriafol on above ground parts of wheat controlled the leaf blight incidence of *B. sorokiniana*.

The leaf blight severity was observed on flag leaves and next to flag leaves during both years in all treatments. It was observed that the leaves below the flag leaf showed higher blight compared to flag leaves. This can be explained as enhanced infection rate due to conidia present in the soil and crop debris. During 2012-13, the leaf blight on flag leaf in untreated plot was 44.20 % and during 2013-14 the blight severity reached upto 56.67% due to favourable weather conditions. The plot having only seed treatment with captan 50%WP showed blight severity of 33.43 – 50.00%. However, the seed treatment with carboxin 37.5% WP + thiram 37.5% WP showed less disease severity (30.23- 36.67 %). This is due to the combined effect of systemic and non systemic effect of fungicides. There was high reduction of disease severity in case of seed treatment with carboxin 37.5% WP + thiram 37.5% WP along with single spray of Propiconzaole (26.68 %) and 26.70% in two sprayings of propiconazole 25% EC. It was observed that seed treatment with carboxin 37.5% WP + thiram 37.5% WP + thiram along with single spray of propiconzaole is as effective as that of two sprays. The same result was observed by Singh *et al.* (2011) on wheat variety HD 2329 with propiconazole 25% EC and tebuconazole 25% EC @ 0.1 under field conditions to control the spot blotch (65.80%).

Table 1. Effect of fungicides on wheat seed germination, per cent disease severity on flag and flag-1 leaves

Treatment	% Seed germination			% Disease severity on flag leaf			% Disease severity on flag leaf-1		
	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean
ST with captan 50%WP @ 2.5g/kg seed	93.87	94.54	94.21	33.43	50.00	41.65	49.00	56.67	53.34
ST with, carboxin 37.5% WP + thiram 37.5% WP @ 2.5g/kg seed	92.55	94.67	93.61	30.23	36.67	33.34	41.80	53.33	48.32
ST with, carboxin 37.5% WP + thiram 37.5% WP + propiconazole 25% EC spray @ 0.1%	94.65	94.68	94.67	27.37	26.00	26.68	32.23	40.00	36.65
ST with, carboxin 37.5% WP + thiram 37.5% WP + propiconazole 25% EC @ 0.1%- two sprays	91.42	94.65	93.04	26.93	26.67	26.70	30.43	43.33	30.00
propiconazole 25% EC spray @ 0.1% - one spray	82.55	86.21	84.38	30.43	26.67	30.00	37.60	43.33	36.70
propiconazole 25% EC @ 0.1% - two sprays	81.32	84.44	82.88	31.23	24.00	27.00	33.87	43.33	38.32
tebuconazole 25% EC spray @ 0.1% - one spray	82.35	84.26	83.31	30.53	27.33	28.67	43.53	43.33	43.32
tebuconazole 25% EC @ 0.1%- two sprays	83.03	85.91	84.47	26.90	27.33	27.02	43.90	40.00	41.65
mancozeb 75% WP@ 0.25% -three sprays	84.25	84.91	84.58	37.13	33.33	35.02	47.73	50.00	48.35
Untreated seed	84.17	84.98	84.58	44.20	56.67	49.99	54.37	73.33	63.32
CD (5%)	3.08	6.12		2.1	12.4		1.98	11.15	

Although foliar sprayings alone also had better effects than the untreated control but they are not as effective as that of ST along with foliar spraying of propiconazole 25% EC. On lower leaves same results were observed in both the years. In untreated plot the disease severity was up to 73.33 %. The seed treatment alone with captan 50%WP reduced the disease severity to 53.34% and carboxin 37.5% WP + thiram 37.5% WP seed treatment reduced to 48.32% (Fig. 1).

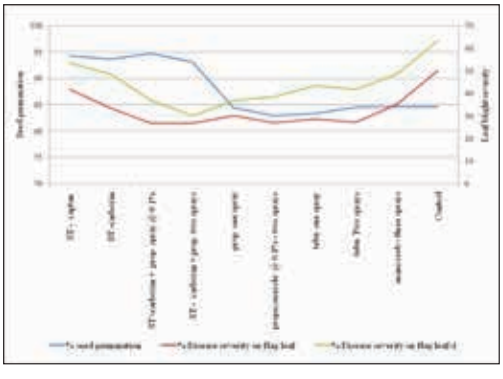

Fig. 1 Effect of fungicides on seed germination and leaf blight severity

However, the maximum reduction in disease severity was noticed when ST along with foliar spraying of tebuconazole 25% EC was applied (36.65 in case of single spray and 30.00% in two spraying. Though, other fungicidal spray also reduced blight severity they were not as significant as that of ST along with tebuconazole 25% EC sprays. Aminuzzaman and Hossain (2007) also observed that the fungicides benzothiodiazole, propiconazole 25% EC and azoxystrobin controlled leaf blight either alone or in their combinations significantly.

The mean grain yield was higher in all cases compared to untreated control (27.85 qha^{-1}). The highest grain yield was observed in ST with carboxin 37.5% WP + thiram 37.5% WP along with two sprays of propiconazole 25% EC (35.92 q/ha) followed by ST with carboxin 37.5% WP + thiram 37.5% WP + single spraying of propiconazole 25% EC (34.02) (Table 2).

Table 2. Effect of fungicides on 1000 grain weight and grain yield

Treatment	1000 grain weight (g)			Increase over Control (%)			Grain yield (q/ha)			Increase over Control (%)		
	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean
ST with captan 50%WP @ 2.5g/kg seed	36.80	37.00	36.90	3.66	3.85	3.75	21.75	36.39	29.07	9.85	1.36	5.61
ST with , carboxin 37.5% WP + thiram 37.5% WP @ 2.5g/kg seed	36.63	36.53	36.58	3.18	2.53	2.85	22.98	36.54	29.76	16.06	1.78	8.92
ST with , carboxin 37.5% WP + thiram 37.5% WP + propiconazole 25% EC spray @ 0.1%	37.47	37.40	37.44	5.55	4.97	5.26	31.38	36.66	34.02	58.48	2.12	30.30
ST with , carboxin 37.5% WP + thiram 37.5% WP + propiconazole 25% EC @ 0.1%-two sprays	37.92	38.80	38.36	6.82	8.90	7.86	33.38	38.46	35.92	68.59	7.13	37.86
propiconazole 25% EC spray @ 0.1% - one spray	37.03	36.77	36.90	4.31	3.20	3.75	20.37	38.49	29.43	2.88	7.21	5.05
propiconazole 25% EC @ 0.1% - two sprays	37.30	36.70	37.00	5.07	3.00	4.04	28.39	37.70	33.05	43.38	5.01	24.20
tebuconazole 25% EC spray @ 0.1% - one spray	36.67	36.77	36.72	3.30	3.20	3.25	23.85	38.44	31.15	20.45	7.08	13.76
tebuconazole 25% EC @ 0.1%-two sprays	36.63	36.37	36.50	3.18	2.08	2.63	27.10	38.87	32.99	36.87	8.27	22.57
mancozeb 75% WP@ 0.25% -three sprays	36.43	36.33	36.38	2.62	1.96	2.29	21.88	37.96	29.92	10.51	5.74	8.12
Untreated seed	35.50	35.63	35.57				19.80	35.90	27.85	0.00	0.00	0.00
CD (5%)	0.79	0.97					5.19					

The single spraying (31.15 qha^{-1}) and two spraying (32.99 qha^{-1}) of tebuconazole 25% EC also resulted in higher yield (Fig. 2).

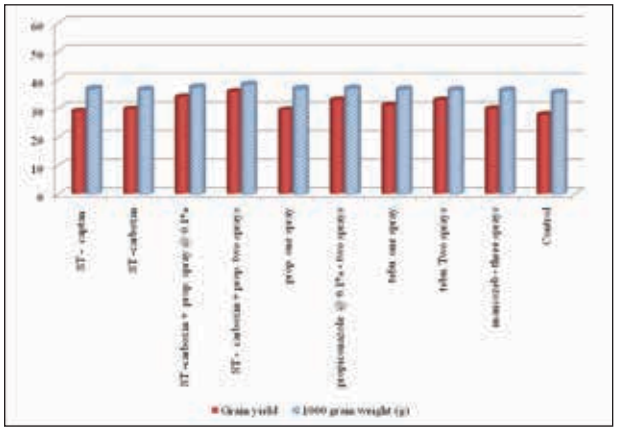

Fig. 2 Effect of fungicides on 1000 grain weight and grain yield

The increased 1000 grain weight was observed in all treatments ranging from (36.38 -38.36 g) compared to untreated check (35.57g). The same results were obtained by Alam *et al.* (1995) while spraying with propiconazole 25% EC @ 0.04% on wheat to control the leaf blight pathogen. Kabir and Hossain (2000) also observed the effect of different combinations of macronutrients (N, P, K, S) micronutrients (B, Cu, Zn), irrigation and tilt (2 sprays) in controlling Bipolaris leaf blight (BPLB), caused by *Bipolaris sorokiniana* (*Cochliobolus sativus*), in wheat cv. Kanchan. There was 102.56% higher than the national average yield of wheat. The experimental results will facilitate the plant pathologists and extension workers in suggesting wheat leaf blight management in disease prone areas.

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