Society for Advancement of Wheat and Barley Research
ICAR-Indian Institute of Wheat & Barley Research
Karnal - 132 001, India

Journal of Cereal Research
12(2) 137-141
Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Research Article

Efficacy and economics of some fungicides for the management of Banded Leaf and Sheath Blight in maize

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Article history
Received: 10 Jun., 2020
Revised: 07 Aug., 2020
Accepted: 21 Aug., 2020

Citation
Basandrai AK, A Mehta, VK Rathee, D Basandrai and BK Sharma 2020. Efficacy and economics of some fungicides for the management of Banded Leaf and Sheath Blight in maize . *Journal of Cereal Research* **12(2):** 137-141. http://doi.org/10.25174/2582-2675/2020/102256

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Abstract

Banded leaf and sheath blight (BLSB), caused by *Rhizoctonia solani* f.sp. sasakiiis, is a devastating disease, causing huge yield losses in maize growing areas throughout the world. In India, grain yield loss varied from 10-40% on various maize cultivars and most of the cultivated varieties, advanced breeding material and potential inbred lines are susceptible. Hence, fungicides are a viable alternative and an important component of integrated disease management. Keeping this in view, eight fungicides were evaluated as two foliar sprays for its management. The test fungicides were effective in reducing percent disease intensity (PDI) and increasing yield compared with the unsprayed check. According to Duncan's Multiple Range Test (DMRT), MDI and mean yield of 33.11 % & 34.63% and 53.14 & 36.13 q/ha were recorded during the years 2014 and 2016, respectively and the effect of years on disease intensity and yield was found to be significant. Amistar 250 SC sprayed @0.05% with mean disease control (MDC) of 63.18% over the unsprayed check plots was the most effective, resulting in mean yield of 46.62q/ha with 36.02 per cent increase over the unsprayed check (34.28 q/ha). It was followed by Valigan, Monoceren 250SC and Bavistin 50WP@ 0.1% resulting in PDI of 30.37, 31.19 and 31.72 with 54.68, 52.43 and 50.96 per cent MDC over the check. The highest mean grain yield (51.95 q/ha) was recorded in Valigan @0.1% with 51.55% increase over check, resulting in net profit of Rs. 27999 with cost: benefit ratio of 1:10.03, followed by 47.78 and 46.62 q/ha yield in two foliar sprays of Folicur 25 EC and Amistar 250 SC @0.1% with mean yield increase of 39.39 and 36.02% over the unsprayed check with net profit of Rs. 19710 and 16525 and corresponding cost: benefit ratio of 1:5.86, and 1:4.17, respectively. The identified effective fungicides may be used further in strengthening the plant disease management in maize against BLSB.

Keywords: Banded leaf and sheath blight, efficacy, fungicide, maize, *Rhizoctonia solani* f. sp. *sasakii.*

1. Introduction

Maize (*Zea mays* L.) is the third most important cereal crop in the world widely utilized as staple food, sustenance and domesticated animal fodder and as industrial material for various items i.e. starch, biofuel, etc. Maize ranks fourth in production and fifth in area among the major cereals in India (Kaur *et al.,* 2020) however, the productivity of the crop is very less. One of the main deterrents to high grain yield in maize is its susceptibility to large number of prevailing diseases i.e. bacterial stalk rot, turcicum leaf

blight, pre-flowering and post-flowering stalk rots, banded leaf and sheath blight (BLSB), etc. (Devi and Thakur, 2018) out of which BLSB caused by *Rhizoctonia solani* f.*sp. sasakii* Exner (Tu and Kimbrough, 1978) is a devastating disease (Kaur *et al.,* 2020; Malik *et al.,* 2018). In India, this disease was reported for the first time from Tarai region of Uttar Pradesh (Payak and Renfro, 1966) and later in the states of Haryana, Madhya Pradesh, Himachal Pradesh, Meghalaya, Rajasthan, West Bengal, Punjab and Assam (Rani *et al.,* 2013).The disease has the potential to inflict economic losses up to 100% (Sharma *et al.,* 2002) and has emerged as a potential threat in North Hill Zone and North Western Plain Zone during the rainy season crop. In India, most of the cultivated varieties, advanced breeding material, potential inbred lines are susceptible (https://iimr.icar.gov.in /wp-content/uploads/2020/05/ Kharif-2019.pdf). Under these circumstances, fungicides provide a viable short-term alternative and an important component of integrated disease management to curtail yield losses especially in high value seed production programs. Previously the use of fungicides was rare, But recently attempts have been made to manage BLSB by fungicides (Mishra *et al.,* 2005; Krishnam *et al.,* 2008; Singh and Singh 2011; Madhavi *et al.,* 2018). Fungicides with multiple effects on the pathogen like on sclerotial germination, mycelial growth inhibition and reduction of the disease spread would be most ideal. Keeping in view the present damaging status of the disease and increase in area under maize cultivation there is an urgent need to identify novel fungicides with different mode of actions and incidentally, several new fungicides representing varied groups are commercially available, hence the present studies were planned with the objective to determine the efficacy of such fungicides for the management of BLSB.

2. Materials and methods

The experiment was conducted at CSKHPKV, Hill Agricultural Research and Extension Centre, Dhaulakuan during the cropping season *kharif* 2014 to 2016 using susceptible varieties Hi-Shell and DKC-7074, respectively. During the Kharif season 2015, the experiment failed as plant stand was poor due to excessive rains. The trial was conducted in randomized block design (RBD) with three replications (plot size of $9m^2$) following recommended agronomical practices under irrigated conditions (http://www.hillagric.ac.in /extension/dee/pdf_files/Rabi_28-8-09.PDF). The fungicides (Table 1) were applied as foliar applications with the initiation of the disease. However, individual plants in each treatment were artificially inoculated 48h prior to the fungicidal application using the mass culture of pathogen multiplied on barley seeds as described by Hooda et al., (2018) with slight modifications. The subsequent spray was applied 15 days there after. Data were recorded on individual plants following modified 1-9 rating scale (Hoodaet al., 2018) and was used to work out percent disease intensity (PDI) by using the formulae given by Mckinney (1923):

Table 1: List of the fungicides used, their dosage and trade and technical names.

S.no.	Trade name (%)	Technical name	Concentration(%)
1	Score 250EC	Difenoconazole 25%EC	0.1%
2	Contaf 5SC	Hexaconazole 5%SC	0.1%
3	Bavistin 50WP	Carbendazim 50% WP	0.1%
4	Valigan	Validamycin 3% L	0.1%
5	Folicur25EC	Tebuconazole 25% EC	0.05%
6	Nativo75WG	Tebuconazole 50%+ Trifloxystrobin 25% w/w 75WG	0.05%
7	Amistar 250SC	Azoxystrobin 23.1% SC	0.05%
8	Monoceren 250SC	Pencycuron 22.9 % w/w	0.1%

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all disease rating}}{\text{Total no. of rating x maximum disease score}} \times 100$$

The data on plot yield were recorded after harvesting the crop and was given as yield q/ha. The data were subjected to analysis of variance using computer program CPCS 1 and statistical online packages. The data were also analyzed using Factorial Randomized Block Design (FRBD) to determine the effect of years, treatments and their interaction taking into consideration 2 levels of factors i.e. years (i.e. 2014 and 2016) and 9 levels of factor treatments i.e. Score 250 EC, Contaf 5 SC, Bavistin

50 WP, Valigan, Folicur 25EC, Nativo 75WG, Amistar 250SC, Monoceren 250SC and no spray control. Means between years & treatments and their interaction on percent disease intensity and yield were compared using Duncan's Multiple Range Test (DMRT) using IBM SPSS Statistics 22 software.

3. Results and discussion

All the fungicides resulted in significantly less PDI as compared with the unsprayed check i.e. 52.92 and 44.60 % during cropping season *Kharif* 2014 and 2016, respectively. The effect of years, treatments and their interactions on per cent disease intensity and yield (q/ha) are given in Table 2. DMRT was applied to compare the MDI and yield q/ha between the years, treatments and their interactions. MDI of 33.11% and 34.63% was recorded during the years 2014 and 2016, respectively and the effect of years on disease intensity was found to be significant (Table 2). All the treatments showed significantly less mean PDI as compared with no spray check (48.75%). It was observed that the least mean disease intensity of 27.01% was recorded in two sprays of Amistar 250SC @ 0.05% followed by MDI of 30.37, 31.19, 31.72 and 32.17 per cent in Valigan, Monoceren 250SC, Bavistin 50WP, Contaf 5SC @ 0.1%, respectively and it was at par with Monoceren 250SC @ 0.1%. Moreover, two sprays of Folicur 25 EC and Nativo75WG @ 0.05% showed MDI of 33.83 and 34.15 percent, respectively. Mean yield of 53.14 and 36.13 q/ha was recorded during the years 2014 and 2016, respectively and the effect of years on mean yield was significant. It may be due to the varied yield potential of susceptible varieties HiShell and DKC 7073, respectively. The treatments resulted in an increase of 8.97-17.67 q/ha in mean grain yields over the unsprayed check (Table 2). The maximum yield i.e. 51.95 q/ha was recorded in the plots treated with Valigan @ 0.1%. It was significantly more as compared with no spray check and all the treatments. It was followed by Folicur 25EC, Amistar 250SC @ 0.05%, Score 250EC and Monoceren 250 SC @ 0.1% with mean yield of 47.78, 46.62, 46.51 and 45.91 q/ha, respectively, and yield in these treatments was at par with each other. As has been observed in the present studies, Singh and Singh (2011) reported better performance of validamycin treatment than propiconazole and carbendazim as foliar spray and it resulted in higher grain yield. Similarly, Akhtar *et al.,* (2011) reported that foliar spray of carbendazim (0.1%) resulted in the least disease severity (25.78%) and the highest grain yield (31.50 q/ha). Furthermore, several workers (Dinakaran *et al.,* 2012; Lore *et al.,* 2012; Johnson *et al.,* 2013) corroborated the present studies that hexaconazole was highly effective against R. solani and increased the grain yield. The least mean yield i.e. 43.61, 43.24 and 41.84 q/ha was recorded in plots treated with Nativo75 WG @ 0.05%, Bavistin 50 WP and Contaf 5 SC @0.1%, respectively but it was more as compared to water spray check i.e. 34.28 q/ha. In case of yield, years and treatment interaction was significant indicating that effect of the treatments varied over the years.

The mean yield data during both the years was used to work out economics of fungicidal application. The highest mean grain yield of 51.95 q/ha was recorded in two sprays of Valigan @0.1% (Table 2) with mean increase of 17.67 q/ha in yield i.e. 51.55% over check. It resulted in net profit Rs. 27999 with cost: benefit ratio of 1: 10.03 (Table 3). It was followed by an increase of 13.50, 12.35, 12.24 and 11.63 q/ha yield in two foliar sprays of Folicur 25EC, Amistar 250SC @0.05%, Score 250EC and Monoceren 250SC @0.1%, respectively (Table 2) with corresponding 39.39, 36.02, 35.70 and 33.93% increase over the unsprayed check with net profit of Rs. 19710, 16525, 13583 and 16788 and cost: benefit ratio of 1:5.86, 1:4.17, 1:2.70 and 1:5.56, respectively (Table 3). As has been observed in the present studies, validamycin @ 2 ml/litre has been found effective (Saha and Dutta, 2007. Seed treatment with Pseudomonas fluorescens (10 g/kg) along with two sprays of 0.1% Propiconazole (Rajput and Harlapur, 2015), seed treatment with Bavistin@ 2.0 g/kg seed and two foliar sprays of Bavistin@ 0.1% (Devi and Thakur, 2018) were highly effective in reducing the disease intensity and increasing the yield as compared to no treatment control. The present results are also supported by the studies of Malik *et al.,* (2018) reporting that Validamycin at 0.1% and Trifloxystrobin 25 WG + Tebuconazole 50 WG at 0.05% were highly effective against BLSB.

4. Conclusion

The present study suggested that management of maize pathogens is considered very important in the present scenario because the prevalence and incidence of BLSB is increasing especially on the commercially grown hybrid cultivars resulting in a potential threat to maize cultivation in the country. All the test fungicides

References

Table 2: Efficacy of fungicides in the disease intensity of banded leaf and sheath and yield (q/ha) at Dhaulakuan during kharif 2014 and 2016 on var. HiShell and DKC-7074

SNo.	Common name	Technical name	Percent Disease Intensity*			Disease control (%)			Yield (q/ha)			Yield increase over check		
			2014	2016	Mean	2014	2016	mean	2014	2016	Mean	2014	2016	mean
1	Score 250 EC	Difenoconazole 25%EC @ 0.1 %	27.9 (31.84)	40.29 (39.38)	34.09^{e} (35.61)	56.12	18.34	39.67	60.30	32.72	46.51^{c}	19.97	4.5	12.24
2	Contaf 5 SC	Hexaconazole 5%SC @ 0.1%	29.43 (32.83)	27.33 (31.50)	28.38^{c} (32.17)	53.88	44.71	49.84	49.00	34.67	41.84^{b}	8.67	6.45	7.56
3	Bavistin 50 WP	Carbendazim 50% WP @ 0.1%	26.1 (30.68)	29.33 (32.77)	27.71^{c} (31.72)	59.10	40.59	50.96	49.40	37.08	43.24^{b}	9.07	8.86	8.97
4	Valigan	Validamycin @ 0.1%	24.9 (29.89)	26.33 (30.85)	25.61^{b} (30.37)	60.95	46.69	54.68	64.22	39.67	51.95^{d}	23.89	11.45	17.67
5	Folicur25 EC	Tebuconazole @ 0.05%	26.4 (30.90)	35.89 (36.78)	31.14^{d} (33.83)	58.58	27.29	44.89	59.66	35.89	47.78^{c}	19.33	7.67	13.50
6	Nativo75 WG	Trifloxystrobin 25% + Tebuconazole 50% @ 0.05%	22.7 (28.43)	41.14 (39.87)	31.92^{d} (34.15)	64.44	16.62	43.52	54.03	33.18	43.61^{b}	13.70	4.96	9.33
7	Amistar 250 SC	Azoxystrobin @ 0.05%	25.1 (30.06)	16.52 (23.96)	20.81^{a} (27.01)	60.54	66.61	63.18	47.70	45.54	46.62^{c}	7.37	17.32	12.35
8	Monoceren 250 SC	Pencycuron @ 0.1%	25.7 (30.42)	28.07 (31.96)	26.86^{bc} (31.19)	59.61	43.16	52.43	53.57	38.24	45.91^{c}	13.24	10.02	11.63
9	Untreated check (water spray)		63.7 (52.91)	49.33 (44.60)	56.50^{f} (48.75)		-		40.33	28.22	34.28^{a}		-	
		Mean (Years)	30.20 (33.11)	32.69 (34.63)	31.44	Mean (Yield)			53.14	36.13	44.63			
	LSD (0.05):	Years=0.60; Treatments=1.28 Year x Treatment=1.81				LSD (0.05):			Years=0.98 Treatments=2.09 Year x Treatment=2.96					

Means within a column having the same letters are not significantly different according to Duncan,s Multiple Range Test, (figures within the parenthesis are angular sign transformed values)

Table 3: Economics of fungicidal management of banded leaf and sheath and yield on var. HiShell and DKC-7074 at Dhaulakuan during 2014 and 2016

Sno.	Treatment	Technical name	% increase in yield over check			Total profit	Expenditure	Net profit	*C:B ratio
			2014	2016	Mean				
1	Score 250 EC	Difenconazole @ 0.1 %	15.93	49.52	35.70	21533.6	7950	13583	2.70
2	Contaf 5 SC	Hexaconazole @ 0.1%	22.83	21.50	22.06	13305.6	3200	10105	4.15
3	Bavistin 50 WP	Carbendazim @ 0.1%	31.38	22.49	26.16	15778.4	3900	11878	4.04
4	Valigan	Validamycin @ 0.1%	40.56	59.24	51.55	31099.2	3100	27999	10.03
5	Folicur25 EC	Tebuconazole @ 0.05%	27.16	47.93	39.39	23760	4050	19710	5.86
6	Nativo75 WG	Trifloxystrobin 25% + Tebuconazole 50% @ 0.05%	17.57	33.97	27.22	16420.8	7050	9370	2.32
7	Amistar 250 SC	Azoxystrobin @ 0.05%	61.34	18.27	36.02	21727.2	5202	16525	4.17
8	Monoceren 250 SC	Pencycuron @ 0.1%	35.50	32.83	33.93	20468.8	3680	16788	5.56

Labour cost= @ Rs. 260/ man day and 5 man days are required for one hectare, MSP maize @ Rs.=1760, *C:B= cost: benefit ratio, Rate of Score @ 5350, Contaf @ 600, Bavistin @ 1300, Validamycin @ 500, Folicur @ 2900, Nativo @ 8900, Amistar @ 5205, Monoceren @ 1080

i.e. Valigan @0.1%, Folicur 25 EC, Amistar 250 SC @0.05%, Score 250 EC and Monoceren 250 SC @0.1% showed significantly less intensity of BLSB and increase in yield and were highly effective for the management of the disease. These fungicides have different modes of action against the fungus i.e. demethylation inhibitors group containing triazole & imidazoles chemical families, succinate dehydrogenase inhibitors containing oxanthiins

& carboxamide families and quinine outside inhibitors group having strobilurins family. These may be used alternatively to avoid development of resistance in the pathogen against the fungicides. The fungicides are easily and readily available hence, may be judiciously used for the management of BLSB in maize crop.

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