

Original Research Article

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Integrated Evaluation of New Fungicides and Bioagents for the Management of Banded Leaf and Sheath Blight of Maize

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ABSTRACT

Biocontrol agents along with fungicides were evaluated in field condition to assess the most appropriate management strategy for management of banded leaf and sheath blight of maize caused by *Rhizoctonia solani* f. sp. *sasakii*. Two biocontrol agents and four fungicides viz., *T. harzianum*, *Pseudomonas fluorescens*, Carboxin 36.5% + Thiram 36.5% DS, Tebuconazole 50WG, Mencozeb 50% + Carbendazim 25% WS and Carbendazim 50 WP respectively were used as seed treatments and three new strobilurins fungicide such as Kresoxim-methyl 44.3 SC, Pyraclostrobin 23.6 EC and Pyraclostrobin 5 + Metiram 55 WG were used for twice foliar spray at 30 and 45 days after sowing. Seed treatment with *P. fluorescens* found effective against *R. solani* f.sp. *sasakii* with enhanced maize grain yield, fodder yield and 100 seed weight, followed by Carboxin 36.5% + Thiram 36.5% DS and Carbendazim 50 WP @ 2.5 g/ kg of seed (41.2%). All three strobilurins fungicides were found effective against *R. solani* f. sp. *sasakii*, where as Kresoxim-methyl found most effective as for foliar spray. Seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC found best management strategy against *R. solani* f.sp. *sasakii* which selected in enhanced maize grain yield, fodder yield and 100 seed weight followed by seed treatment with *P. fluorescens* @ 10 g/kg of seed and two foliar spray of Pyraclostrobin 23.6 EC.

Keywords

Foliar spray, Kresoxim-methyl, *Pseudomonas fluorescens*, *R. solani* f.sp., *sasakii* and seed treatment

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Introduction

Banded leaf and sheath blight (BLSB) of maize is a devastating disease in India. BSLB

is caused by *Rhizoctonia solani* f. sp. *sasakii* is a soil borne multi-host fungus. Due to several host range and high diversity, development of resistance genotype is very

difficult so unavailability of resistance genotype leads to application of chemical or biocontrol agent in management of BLSB disease (Rajput and Harlapur 2016). BLSB disease was economical important disease with nearly 50 percent of severity in North Karnataka especially in heavy rainfall area (Rajput and Harlapur 2014). Average 23.9 to 31.9 percentage of avoidable yield loss was reported in ten cultivars of maize in India (Lal *et al.*, 1980). The disease was well established in India and other part of world (Rajput and Harlapur 2015). Various biocontrol agents such as *Trichoderma viride* *T. harzianum* and *Pseudomonas fluorescens* found effective in management of *R. solani* f.sp. *sasakii* in both *in vitro* and *in vivo* condition (Rajput and Harlapur 2015 Rajput *et al.*, 2016a), where as propiconazole and carbendazim also found effective in both *in vitro* and *in vivo* condition (Rajput and Harlapur 2015 Rajput *et al.*, 2016b). Seed treatment with *P. fluorescens* (10 g/kg of seed) followed by application of propiconazole (0.1%) reduced BLSB disease severity by 68.90 percent as compared to control and increase grain and fodder yield by 40.72 % and 44.68 % (Rajput and Harlapur 2015). Seed treatment with carbendazim (2g/kg of seed) reduced BLSB disease severity by 68.00 percent as compared to control, where as foliar application reduced disease severity 25.70 percent as compared to control (Akhtar *et al.*, 2011). Mustard crop used as biofumigation of soil combined with seed treatment, soil drenching and foliar spray of *P. fluorescens* reduced BLSB disease severity and viability of inoculums (Madhavi and Devi, 2018). Foliar application of validamycin (0.2%) reduced BLSB disease severity and enhanced yield of maize as compared to control (Venkateswarlu and Beura 2020). Foliar application of validamycin (0.1%) and trifloxystrobin + tebuconazole (0.05%) were reduced the severity of BLSB and effectively manage the disease (Malik *et al.*, 2018). Ram (2016)

found Kresoxim-methyl as effective fungicide for management of *R. solani* in rice field. Similarly, Kumar and Ladha (2011) and Biswas (2012) also found foliar spray of Kresoxim- effective against *R. solani* in rice field. Since most of research tried strobilurins compound for rice crop rather than maize crop against *R. solani*. BLSB occurred in major maize growing area and cause economic impact of farmer, therefore a field experiment was conducted to evaluate the efficacy of new strobilurins fungicides along with bio-control agents as foliar spray and seed treatment agents for effective management of BLSB caused by *R. solani* f.sp. *sasakii* in maize.

Materials and Methods

Biological materials

To evaluate efficacy of new fungicide and biocontrol agents against management of BLSB of maize a maize hybrid DKC-8101 was selected which showed moderate resistance against BLSB of maize. *P. fluorescens* and *T. harzianum* cultures were obtained from Department of Microbiology, UAS, Dharwad. *R. solani* f. sp. *sasakii* was isolated from Saidapur Farm, Main Agricultural Research Station (MARS), Dharwad.

Field experiment

In split plot design new fungicides and biocontrol agents were evaluated at MARS, Saidapur farm, Dharwad during kharif season of 2012 with three replications. Maize hybrid DKC-8101 seeds were treated with two biocontrol agents and four fungicides viz., *T. harzianum* @ 10 g/kg of seed, *P. fluorescens* @ 10 g/kg of seed, Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed, Tebuconazole 50WG @ 1.5 g/kg of seed, Mencozeb 50% + Carbendazim 25% WS @ 2.5 g/kg of seed

and Carbendazim 50 WP @ 2.5 g/ kg of seed along with gum as sticker. Treated seed were dried in plain paper for four hours in shaded area and sown immediately after drying. The field experiment was conducted under irrigated condition under red soil with recommended dose of fertilizers, while insect management practices were followed as per recommendation of UAS, Dharwad. Maize hybrid DKC-8101 seeds were sowed in 6 rows with 60 cm × 20 cm in plot area of 9.0 m². Foliar spray of three fungicides viz., Kresoxim-methyl 44.3 SC @ 1 g/l of water, Pyraclostrobin 23.6 EC @ 1 g/l of water and Pyraclostrobin 5 + Metiram 55 WG @ 2 g/l of water were sprayed twice 30 and 45 days after sowing. *R. solani* f.sp. *sasakii* was multiplied on autoclaved sorghum grain and mixed with soil 400 gm of infected sorghum grain per meter square into top 5 cm of soil depth. Same 2-3 infected sorghum grain placed gently between rind and sheath blight in 30 days old plants.

Disease severity was observed at silk formation stage with 1-5 disease rating scale (Ahuja and Payak, 1983). Percentage Disease Index (PDI) was calculated with formula, $PDI = (\text{Sum of indivisula rating of leaves} \times 100) / (\text{number of leaves observed} \times \text{maximum scale})$, whereas percentage disease control was calculated based on disease observed in untreated control plot. Yield of grain and fodder was also calculated on basis of this enhancement in yield of both grain and fodder yield was also calculated, whereas 100 seed weight also calculated. The data was transformed to arc sine values and analyzed statistically.

Results and Discussion

Significant differences were observed among the treatments for PDI. The PDI was significantly different for seed treatment chemicals and bio-control agents and

chemicals of foliar applications (Table 1). PDI was ranging from 43.3% to 40.0% by using seed treatments. Minimum PDI was observed as 40.0% after seed treatment with *P. fluorescens* @ 10 g/kg of seed over the control (46.9%) followed by Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed (41.2%) and Carbendazim 50 WP @ 2.5 g/ kg of seed (41.2%). PDI was ranging from 37.14% to 34.84% by foliar application of new fungicides. Minimum PDI 34.8 % was observed after foliar application of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (61.1%) followed by Pyraclostrobin 23.6 EC @ 1 g/l of water (36.1%). PDI was significant differed for interaction effect of seed treatment and foliar spray also.

Minimum PDI 32.3 % was observed with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (65.4%) was statistically higher with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (33.5%), seed treatment with Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (33.8%) and seed treatment with Carbendazim 50 WP @ 2.5 g/ kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (33.8%). Maximum BLSB disease was reduce by seed treatment of *P. fluorescens* @ 10 g/kg of seed (38.91%) over than control (28.36%), where as foliar spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water (46.72%) was also reduced maximum disease over the control (Table 2). The interaction of seed treatments with foliar application, *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water reduce BLSB by 50.61% over the control (0.00%) followed by *P. fluorescens* @ 10 g/kg of seed followed by two spray of

Pyraclostrobin 23.6 EC @ 1 g/l of water (48.78%) over the control.

The grain yield of maize was also significantly different for seed treatment chemicals and bio-control agents and chemicals of foliar applications (Table 3). Grain yield of maize was ranging 70.54 q/ha to 58.60 q/ha after using either seed treatment or foliar application or both with fungicide or biocontrol agent or both. Seed treatment has significant difference on maize yield. Maximum maize grain yield was observed as 67.31 q/ha after seed treatment with *P. fluorescens* @ 10 g/kg of seed over the control (62.32 q/ha) followed by Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed (66.24 q/ha) and Carbendazim 50 WP @ 2.5 g/ kg of seed (66.99 q/ha). Grain yield of maize was ranging 68.13 q/ha to 66.01 q/ha by using foliar application one new fungicide. Maximum maize grain yield was observed as 68.13 q/ha after foliar application of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (59.47 q/ha) was statistically on par with Pyraclostrobin 23.6 EC @ 1 g/l of water (67.34 q/ha). Grain yield of maize was significant differed for interaction effect of seed treatment and foliar spray also. Maximum maize grain yield 70.54 q/ha was observed with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (56.15 q/ha) was statistically on par with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (69.75 q/ha), seed treatment with Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (69.04 q/ha). Maximum increased in maize grain yield was observed by seed treatment of *P. fluorescens* @ 10 g/kg of seed (19.87 %) over than control (10.98%), where as foliar spray of Kresoxim-methyl 44.3 SC @ 1 g/l of

water (21.33%) was also increased maize grain yield over the control (Table 3). The interaction of seed treatments with foliar application, *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water increased maize grain yield by 25.63 % over the control (0.00%) followed by *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (24.22%).

The yield of fodder was also significantly differed for seed treatment chemicals and bio-control agents and chemicals of foliar applications (Table 4). Yield of fodder were ranging 9.25 t/ha to 7.72 t/ha after using either seed treatment or foliar application or both with fungicide or biocontrol agent or both. Seed treatment has significant difference on fodder yield. Maximum fodder yield was observed as 8.76 t/ha after seed treatment with *P. fluorescens* @ 10 g/kg of seed over the control (7.68 t/ha) was statistically on par with Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed (8.21 t/ha) and Carbendazim 50 WP @ 2.5 g/ kg of seed (8.19 t/ha). Yield of fodder was ranging from 8.23 t/ha to 8.08 t/ha by using foliar application one new fungicide. Maximum fodder yield was observed as 8.23 t/ha after foliar application of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (7.85 t/ha) was statistically on par with Pyraclostrobin 23.6 EC @ 1 g/l of water (8.16 t/ha) and Pyraclostrobin 5 + Metiram 55 WG @ 2 g/l of water (8.08 t/ha). Yield of fodder was significant differed for interaction effect of seed treatment and foliar spray also. Maximum fodder yield was observed as 9.25 t/ha with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (7.33 t/ha) was statistically on par with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of

Pyraclostrobin 23.6 EC @ 1 g/l of water (8.69 t/ha), seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 5 + Metiram 55 WG @ 2 g/l of water (8.63 t/ha). Maximum increased in fodder yield was observed by seed treatment of *P. fluorescens* @ 10 g/kg of seed (19.54 %) over than control (4.74%), where as foliar spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water

(12.30%) was also increased fodder yield over the control (7.11%) (Table 3). In term of interaction of seed treatments with foliar application, *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water increased fodder yield by 26.19 % over the control (0.00%) followed by *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (18.55%).

Table.1 Effect of biocontrol agents and fungicides on PDI of BLSB disease as seed treatments (S) or foliar sprays (F)

Seed treatment	Foliar spray				Mean
	Kresoxim-methyl 44.3 SC	Pyraclostrobin 23.6 EC	Pyraclostrobin 5 + Metiram 55 WG	Untreated control	
<i>P. fluorescens</i>	32.3(34.65)	33.5(35.38)	34.6(36.05)	59.4(50.44)	40.0(39.22)
<i>T. harzianum</i>	35.9(36.83)	37.1(37.54)	38.2(38.19)	62.1(52.03)	43.3(41.18)
Tebucanazole 50 WG	34.1(35.75)	35.3(36.47)	36.4(37.13)	60.1(50.85)	41.5(40.11)
Untreated Control	39.5(38.96)	40.7(39.66)	41.8(40.30)	65.4(54.00)	46.9(43.22)
Carboxin 36.5 % + Thiram 36.5 %	33.8(35.57)	35(36.29)	36.1(36.95)	60.0(50.79)	41.2(39.97)
Carbendazim 50 WP	33.8(35.99)	35(36.29)	36.1(36.95)	60.0(50.79)	41.2(39.97)
Mencozeb 50% + Carbendazim 25%	34.5(35.57)	35.7(36.71)	36.8(37.37)	60.6(51.15)	41.9(40.36)
naeM	34.8(36.19)	36.1(36.91)	37.1(37.57)	61.1(51.43)	
For comparison of mean		Seed treatments (S)	Foliar Spray (F)	S × F	
S.Em ±		0.27	0.32	0.42	
C.D.at 5%		0.76	0.90	1.18	

Table.2 Effect of biocontrol agents and fungicides on percentage disease control of BLSB disease as seed treatments (S) or foliar sprays (F)

Seed treatment	Foliar spray				
	Kresoxim-methyl 44.3 SC	Pyraclostrobin 23.6 EC	Pyraclostrobin 5 + Metiram 55 WG	Untreated control	Mean
<i>P. fluorescens</i>	50.61	48.78	47.09	9.17	38.91
<i>T. harzianum</i>	45.11	43.27	41.59	5.05	33.75
Tebucanazole 50 WG	48.32	46.48	44.80	8.26	36.96
Untreated Control	39.60	37.77	36.09	0.00	28.36
Carboxin 36.5 % + Thiram 36.5 %	47.86	46.02	44.34	8.10	36.58
Carbendazim 50 WP	48.32	46.48	44.80	8.26	36.96
Mencozeb 50% + Carbendazim 25%	47.25	45.41	43.73	7.34	35.93
naeM	46.72	44.89	43.21	6.60	

Table.3 Effect of biocontrol agents and fungicides on grain yield (GY) of maize (q/ha) and increase grain yield (IGY) (%) of BLSB disease as seed treatments (S) or foliar sprays (F)

Seed treatment	Foliar spray									
	Kresoxim-methyl 44.3 SC		Pyraclostrobin 23.6 EC		Pyraclostrobin 5 + Metiram 55 WG		Untreated control		Mean	
	GY	IGY	GY	IGY	GY	IGY	GY	IGY	GY	IGY
<i>P. fluorescens</i>	70.54	25.63	69.75	24.22	68.42	21.85	60.53	7.80	67.31	19.87
<i>T. harzianum</i>	67.14	19.57	66.35	18.17	65.02	15.80	58.60	4.36	64.28	14.47
Tebucanazole 50 WG	67.74	20.64	66.95	19.23	65.62	16.87	59.55	6.06	64.97	15.70
Untreated Control	65.34	16.37	64.55	14.96	63.22	12.59	56.15	0.00	62.32	10.98
Carboxin 36.5 % + Thiram 36.5 %	69.04	22.96	68.25	21.55	66.92	19.18	60.75	8.19	66.24	17.97
Carbendazim 50 WP	68.74	22.42	67.95	21.02	66.62	18.65	60.65	8.01	65.99	17.52
Mencozeb 50% + Carbendazim 25%	68.34	21.71	67.55	20.30	66.22	17.93	60.05	6.95	65.54	16.72
naeM	68.13	21.33	67.34	19.92	66.01	17.55	59.47	5.91		
For comparison of mean			Seed treatments (S)			Foliar Spray (F)			S × F	
S.Em ±			0.32			0.48			0.67	
C.D.at 5%			0.90			1.34			1.88	

Table.4 Effect of biocontrol agents and fungicides on fodder yield (FY) of maize (t/ha) and increase fodder yield (IFY) (%) of BLSB disease as seed treatments (S) or foliar sprays (F)

Seed treatment	Foliar spray									
	Kresoxim-methyl 44.3 SC		Pyraclostrobin 23.6 EC		Pyraclostrobin 5 + Metiram 55 WG		Untreated control		Mean	
	FY	IFY	FY	IFY	FY	IFY	FY	IFY	FY	IFY
<i>P. fluorescens</i>	9.25	26.19	8.69	18.55	8.63	17.74	8.48	15.69	8.76	19.54
<i>T. harzianum</i>	7.93	8.19	7.81	6.55	7.74	5.59	7.59	3.55	7.77	5.97
Tebucanazole 50 WG	8.06	9.96	8.02	9.41	7.87	7.37	7.72	5.32	7.92	8.01
Untreated Control	7.52	2.59	7.98	8.87	7.88	7.5	7.33	0	7.68	4.74
Carboxin 36.5 % + Thiram 36.5 %	8.37	14.19	8.24	12.41	8.18	11.6	8.03	9.55	8.21	11.94
Carbendazim 50 WP	8.32	13.51	8.24	12.41	8.22	12.14	7.98	8.87	8.19	11.73
Mencozeb 50% + Carbendazim 25%	8.17	11.46	8.12	10.78	8.06	9.96	7.83	6.82	8.05	9.75
naeM	8.23	12.30	8.16	11.28	8.08	10.27	7.85	7.11		
For comparison of mean			Seed treatments (S)			Foliar Spray (F)			S × F	
S.Em ±			0.21			0.32			0.42	
C.D.at 5%			0.59			0.90			1.18	

Table.5 Effect of biocontrol agents and fungicides on 100 seed weight (g) of BLSB disease as seed treatments (S) or foliar sprays (F)

Seed treatment	Foliar spray				
	Kresoxim-methyl 44.3 SC	Pyraclostrobin 23.6 EC	Pyraclostrobin 5 + Metiram 55 WG	Untreated control	Mean
<i>P. fluorescens</i>	35.42	33.45	32.45	29.44	32.69
<i>T. harzianum</i>	30.92	28.95	27.95	24.04	27.97
Tebucanazole 50 WG	32.22	30.25	29.25	25.34	29.27
Untreated Control	28.72	26.75	25.75	22.60	25.96
Carboxin 36.5 % + Thiram 36.5 %	34.68	32.71	31.71	27.34	31.61
Carbendazim 50 WP	34.61	32.64	31.64	27.24	31.53
Mencozeb 50% + Carbendazim 25%	31.42	29.45	28.45	25.32	28.66
naeM	32.57	30.60	29.60	25.90	
For comparison of mean		Seed treatments (S)	Foliar Spray (F)		S × F
S.Em ±		0.51	0.67		0.89
C.D.at 5%		1.43	1.88		2.49

The 100 seed weight of maize was also significantly different for seed treatment chemicals and bio-control agents and chemicals of foliar applications (Table 5). Seed treatment has significant difference on 100 seed weight. Maximum 100 seed weight was observed as 32.69 g after seed treatment with *P. fluorescens* @ 10 g/kg of seed over the control (25.29 g) was statistically on par with Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed (31.61 g) and Carbendazim 50 WP @ 2.5 g/ kg of seed (31.53 g). 100 seed weight was ranging from 32.57 g to 29.60 g by using foliar application one new fungicide. Maximum 100 seed weight was observed as 32.57 g after foliar application of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (25.90 g) followed by Pyraclostrobin 23.6 EC @ 1 g/l of water (30.60 g). 100 seed weight was significant differed for interaction effect of seed treatment and foliar spray also. Maximum 100 seed weight was observed as 35.42 g with seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water over the control (22.60 g) was statistically on par with

seed treatment with Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water (34.68 g), seed treatment with Carbendazim 50 WP @ 2.5 g/ kg of seed followed by two spray of followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water (34.61 g), seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water (33.45 g).

Maximum maize grain yield (67.31 q/ha), fodder yield (8.76 t/ha), 100 seed weight (32.69 g) was obtained by seed treatment of maize with *P. fluorescens* @ 10 g/kg of seed with minimum PDI 40.0 %. Seed treatment with Carbendazim 50 WP @ 2.5 g/ kg of seed and Carboxin 36.5% + Thiram 36.5% DS @ 2.5 g/kg of seed also found excellent over the control. Similarly Rajput and Harlapur 2015 found that seed treatment with *P. fluorescens* @ 10 g/kg of seed also reduce BLSB severity by 49.95% over the control 38.97 %. Seed treatment with carbendazim (2g/kg of seed) reduced BLSB disease severity by 68.00 percent as compared to control (Akhtar *et al.*,

2011). Seed treatment with *Pseudomonas sp* @ 10 g/kg of seed also reduced BLSB disease severity by 27% over the control and enhanced yield of maize as compared to control (Venkateswarlu and Beura, 2020). Strain of *P. fluorescens* BNM296 was also reported to produce HCN and seed treatment reduces the damping off disease in soybean caused by *Pythium ultimum* (Leon *et al.*, 2009). Similarly, after co-inoculation of *P. aureofaciens* 63–28 with *R. solani*, PR protein such as b-1,3-glucanase (PR2), peroxidase (PR 9), chitinases (PR 3) were induced apart from several cell wall degradation enzymes (Jung *et al.*, 2007).

Maximum maize yield (68.13 q/ha), fodder yield (8.23 t/ha), 100 seed weight (32.57 g) was obtained by foliar spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water with minimum PDI 46.72 %. This result is accordance with Raji *et al.*, 2016, they found that foliar spray of Kresoxim-methyl inhibited growth on *R. solani* in field condition and reduce sheath blight severity with 39.76 %. Similarly, Ram (2016) also found Kresoxim-methyl as effective fungicide for management of *R. solani* in rice field. Kumar and Ladha (2011) also evaluate the fungicidal property of Kresoxim-methyl against sheath blight of direct seeded rice and found effective. Biswas (2012) also found similar effect as two foliar spray of Kresoxim-methyl along with Hexaconazole effective control *R. solani* in rice field and increase yield also.

Maximum maize yield (70.54 q/ha), fodder yield (9.25 t/ha), 100 seed weight (35.42 g) was obtained by seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Kresoxim-methyl 44.3 SC @ 1 g/l of water with minimum PDI 32.3% followed by seed treatment with *P. fluorescens* @ 10 g/kg of seed followed by two spray of Pyraclostrobin 23.6 EC @ 1 g/l of water. Integrate disease management is

best approach for managing BLSB disease of maize, biocontrol agent such as *P. fluorescens* reduce of soil borne disease caused by *R. solani* through various mechanisms such as DAPG antibiotic production, competition for organic nutrient, production of siderophore, chitinase enzyme, hydrogen cyanide induction of ISR (Rajput 2013). Need based foliar application of Kresoxim-methyl or Pyraclostrobin also manage BLSB disease by blocking transfer of electron in mitochondrial respiratory bc1 complex through attaching with ubihydroquinone oxidation protein (Herms *et al.*, 2002).

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