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Management of maize banded leaf and sheath blight with fungicides and biocontrol agents

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ABSTRACT

Management of banded leaf and sheath blight of maize caused by Rhizoctonia solani by using fungicides and biocontrol agents viz., benomyl, carbendazim, thiram, Trichoderma viride, Pseudomonas fluorescens and Bacillus subtilis as seed and soil treatment. Among all the treatments lowest disease severity index was observed in seed treatment with carbendazim and Trichoderma viride recorded lowest disease severity index i.e., 37.93% and 41.90% respectively, while the lowest per cent disease incidence was observed in seed treatment with carbendazim and thiram with per cent disease incidence 27.11 and 29.92.

Keywords: *Rhizoctonia solani*, Biocontrol agents, Fungicides

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INTRODUCTION

Maize is one of the important crops in India occupying fifth place in area and 3rd place in production. In India, maize is cultivated in an area of about 8.26 m.ha with the production of 19.73 million tonnes and productivity of 2295 kg/ ha [2]. Maize banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f.sp *sasakii (Thanatephorus cucumeris*) is considered as one of the most important disease and major constraint for low yields. In India the disease was first recorded in the Tarai (foot hill plain areas) region of Uttar Pradesh [7]. Yield losses vary from 11 to 40 per cent [8]. The banded leaf and sheath blight pathogen is soil-borne and its occurrence has also been recorded several maize growing areas. In view of increasing importance of banded leaf and sheath blight of maize, the present study was undertaken to investigate the efficacy of fungicides and biocontrol agents against the disease.

MATERIALS AND METHODS

The field experiment was conducted at college farm, College of Agriculture, Rajendranagar, Hyderabad during Rabi season 2010-11, using maize hybrid DHM-117. The experiment was planned using three biocontrol agents and three fungicides as seed treatment and soil application in three replications following randomized block design. The plot size was kept 2.6 x 2 m^2 with 6 rows at 45 cm apart. The seeds of maize hybrid DHM-117 were treated with fungicides and biocontrol agents with their recommended dosages using gum as sticker. The treated seeds were spread over a clean paper and dried in cool and shade place. Treated seeds were sown immediately after drying. Fungicides and talc based formulations of biocontrol agents were applied to the soil by mixing with the sand for uniform distribution before sowing of maize seeds in the field.

Inoculum Preparation
Sorghum grain was over soaked for 24 h and 50 gm of grain was transferred in to 250 ml flasks and sterilized and inoculated with culture of *R. soani*. The flasks were incubated at 28 ± 2^o C.

Leaf Sheath Inoculation Method
Plants were artificially inoculated 45 DAS by inserting 2 to 3 jowar grains covered with mycelial growth R. solani the rind and the leaf sheath. High humidity was maintained during disease development by frequent watering.

The data was recorded after 60 days after sowing. The following observations were recorded based on a standard 1-5 rating scale as suggested by [1]

1. Disease severity index (%) $= \dfrac{\sum \text{(rating number X no of plants in rating X 100)}}{\text{Total no of plants X highest rating}}$

2. Per cent disease incidence = $\dfrac{\text{No. of infected plants}}{\text{Total no of plants}} \text{ X 100}$

3. Plant height and Fresh weight and dry weight

RESULTS AND DISCUSSION

The results pertaining to the effect of seed and soil treatment with fungicides and commercial biocontrol agents on per cent disease severity index of banded leaf and sheath blight are presented in the Table 1 Among the treatments seed treatment with carbendazim recorded lowest disease severity index of 37.93% where as highest disease severity index of 63.23 was recorded in soil treatment with *Bacillus subtilis* while control recorded 88.96%. Seed treatment with carbendazim (37.93%) was followed by seed treatment with *Trichoderma viride* (41.90%), *Pseudomonas fluorescens* (43.03) and soil treatment with carbendazim (44.66%). The difference between these treatments were statistically on par. The differences among seed treatment with thiram (51.73%), soil treatment with carbendazim, seed treatment with benomyl (52.43%), soil treatment with *Trichoderma viride* (52.83), thiram soil treatment (54.66%), *Pseudomonas fluorescens* soil treatment (54.83%) and soil treatment benomyl (54.83%) were non-significant. Differences between seed and soil treatment with Bacillus subtilis were non-significant.

All the treatments significantly reduced the per cent disease incidence of banded leaf and sheath blight of maize and the per cent disease incidence ranged from 27.11 to 46.47 per cent compared to control with 76.96 per cent disease incidence. Among all the treatments seed treatment with carbendazim recorded the lowest per cent disease incidence (27.11) and soil treatment with Bacillus subtilis recorded highest per cent disease incidence. Among the biocontrol agents seed treatment with *T. viride* recorded lowest per cent disease incidence 31.7.

In case of soil treatment fungicide carbendazim, biocontrol agent *T. viride* soil application recorded lowest per cent disease incidence of 34.08 and 35.65 respectively.

The per cent disease incidence in seed treatment with carbendazim (27.11%), thiram (29.92%), *Trichoderma viride* (30.06%), Pseudomonas fluorescens (31.7%) and *Bacillus subtilis* (35.54%), soil treatment with carbendazim (34.08%), *Trichoderma viride* (34.09%) and *Pseudomonas fluorescens (34.9%)* were statistically on par. However the above treatments were significantly superior over soil treatment with thiram (39.03%), benomyl (39.83%) and *Bacillus subtilis* (46.47%). While the differences among these treatments were non significant.

The results are in agreement with the findings of [5], who evaluated the efficacy of disease control by most promising antagonist, *T. harzianum* against banded leaf and sheath blight disease in maize crop in comparison with fungicide carbendazim and it was evaluated as seed and soil application. The highest per cent efficacy of disease control was observed by carbendazim seed treatment (52.1) followed by *T. harzianum* seed treatment (49.2), whereas *T. harzianum* was used for soil application the disease control efficacy was 42.9 per cent. Soil drenching of carbendazim (0.1%) @ 500 ml/pot resulted in 51.3 per cent disease reduction over control.

Kitazin (0.05%) also showed effectiveness, resulting PDI 34.1 and 43.5 per cent efficacy in disease reduction over control [4] similary [9] reported that the efficacy of peat based *Pseudomonas fluorescens* formulation as seed treatment 16 and 20 g /kg of seed effectively controlled banded leaf and sheath bight disease. Soil application (2.5 kg/ha) of peat based formulation also controlled the disease effectively. The disease control may be to induced resistance by seed treatment with *Pseudomonas fluorescens* [10]

Plant Height 30DAS: It is observed from the data presented in the Table 2 Significant increase in plant height at 30 DAS in seed treatment with *P. fluorescens* and was found to be superior over other treatments.

Seed treatment with thiram, carbendazim, benomyl, *T. viride*, soil treatment with carbendazim, and thiram recorded 21.80, 21.20, 20.60, 19.93 20.26, and 19.90 cm plant height and were on par with each other.

Seed treatment with *B. subtilis* (19.63 cm), soil treatment with *P. fluorescens* (18.60 cm), benomyl (18.50 cm), *B. subtilis* (17.96 cm) and T. viride (17.93 cm) were statistically on par.

The plant height of different treatments at 30 DAS was found to be in the following order.

$T_5 > T_3 > T_2 > T_1 > T_8 > T_6 > T_9 > T_4 > T_{11} > T_7 > T_{10} > T_{12} > T_{13}$

Plant Height at 60DAS: The observations made with regard to the plant height at sixty days after sowing indicated that all the treatments were significantly superior to control. Seed treatment with *P. fluorescens* recorded the highest plant height of 108.33cm followed by thiram (99.00 cm) and P. fluorescens soil treatment (93.33cm) were on par with each other.

Seed treatment with carbendazim, *B. subtilis*, benomyl and *T. viride*, soil treatment with *T. viride*, benomyl, carbendazim, thiram and *B. subtilis* recorded 93.00, 83.66, 83.00, 82.00, 88.66, 88.33, 86.66, 85.00 and 79.66 cm plant height and were statistically on par. Control recorded a plant height of 63.66 cm.

The plant height of different treatments at 60 DAS was found to be in the following order.

$T_5 > T_3 > T_{11} > T_2 > T_{12} > T_7 > T_8 > T_9 > T_4 > T_1 > T_6 > T_{10} > T_{13}$

Fresh Weight in kg ha^{-1} at 60 DAS: The data collected after sixty days of sowing. The results pertaining to Table 3 showed that *P. fluorescens* seed treatment was the most effective treatment with 5796.23 kg ha^{-1} fresh weight and was on par with *T. viride* seed treatment (5740.68 kg ha^{-1}), thiram seed treatment (5240.68 kg ha^{-1}), carbendazim soil treatment (5166.61 kg ha^{-1}), thiram soil treatment (5129.57 kg ha^{-1}) and *T. viride* soil treatment (5066.61 kg ha^{-1}).

B. subtilis soil treatment, carbendazim seed treatment, *P. fluorescens* soil treatment, benomyl seed treatment, benomyl soil treatment and *B. subtilis* seed treatment recorded 4796.24, 4759.21, 4703.65, 4462.00, 4351.80 and 4259.21 kg ha^{-1}fresh weight respectively and were on par with each other when compared with control which recorded lowest fresh weight of 3537 kg ha^{-1} at 60 DAS.

The plant fresh weight of different treatments at 60 DAS was found to be in the following order.

$T_5 > T_6 > T_3 > T_8 > T_9 > T_{12} > T_{10} > T_2 > T_{11} > T_1 > T_7 > T_4 > T_{13}$

Dry Weight in kg ha^{-1} at 60 DAS: *P. fluorescens* seed treatment was the most effective treatment with 1333.31 kg ha^{-1}dry weight followed by *T. viride* seed treatment (1240.72 kg ha^{-1}). Thiram seed treatment (1092.58 kg ha^{-1}), carbendazim seed treatment (1085.17 kg ha^{-1}) and B. subtilis seed treatment (1077.76 kg ha^{-1}) were on par in recording the dry weight of maize.

The treatments that were followed in descending order of efficacy were carbendazim soil treatment, benomyl seed treatment, benomyl soil treatment, thiram soil treatment, *B. subtilis* soil treatment, *P. fluorescens* soil treatment and *T. viride* soil treatment with 1018.50, 999.90, 981.47, 955.54, 870.36, 870.36 and 870.36 kg ha^{-1} dry weight and were on par with each other. The least effective treatment was control with plant dry weight of 737.02 kg ha^{-1}.

The plant dry weight of different treatments at 60 DAS was found to be in the following order.

$T_5 > T_6 > T_3 > T_2 > T_4 > T_8 > T_1 > T_7 > T_9 > T_{10} > T_{11} > T_{12} > T_{13}$

Fluorescent pseudomonads are known to produce several siderophores and also promote plant growth. Further the root exudates of different crops release amino acids sugars and other substances. Among the amino acids released into the rhizosphere tryptophan is one of the important amino acid which the Fluorescent pseudomonads are known to convert into Indole acetic acid (IAA), which may be responsible for increased plant growth. The increase observed due to biological treatments may be due to the above phenomenon or due to growth promoting substances produced by themselves.

Two mechanisms have been advanced most frequently to explain the increased growth response induced by certain microflora. The first hypothesis was that enhanced growth of plants induced by antagonists might be due to biological control of plant pathogens in the soil. The other hypothesis was that a microbial agent produced growth regulatory metabolites. [11] demonstrated that a microbial agent produces growth regulatory metabolites, thus the plant length, shoot and root dry weights increased. [3] also reported that seed treatment with T. viride + P. fluorescens indicated maximum shoot length, root length, root length and dry matter production compared to control during their studies on damping off disease in chillies.

Plant growth promoting isolates of fluorescent Pseudomonads sp. EM85 and 2 bacilli isolates MR-11(2) and MRF, isolated from maize rhizosphere, were found to be strongly antagonistic to *F. moniliformae*, *F. graminearum* and *M. phaseolina* and also produced antifungal antibiotics (Afa), siderophore (Sid), HCN and fluorescent pigments besides exhibiting plant growth promoting traits like nitrogen fixation, phosphate solubilization, and production of organic acids and IAA. [6].

Efficacy of biocontrol agents in comparison to fungicides was evaluated in seed and soil application, lowest per cent disease incidence and disease severity index was observed by carbendazim seed treatment followed by seed treatment *T.viride* (Commercial). *T.viride* is known to act through mycoparasitism and is aggressive competitor to the pathogens through production of antibiotics. They showed good effect against banded leaf and sheath blight pathogen as equal to the fungicide hence the biocontrol agents need to be explored further because they are environmentally safe.

Table 1. Effect seed and soil treatment with fungicides and biocontrol agents on per cent disease severity index and per cent disease incidence

S. No	Treatment	Dosage	*Per cent disease severity index	*Per cent disease incidence
1	Seed treatment with benomyl	0.3 per cent	52.43 (46.39)	34.8 (35.99)
2	Seed treatment with carbendazim	0.3 per cent	37.93 (38.01)	27.11 (31.28)
3	Seed treatment with thiram	0.3 per cent	51.73 (45.99)	29.92 (33.10)
4	Seed treatment with Bacillus subtilis (Sri biotech.Ltd.)	0.4 per cent	62.13 (52.07)	35.54 (36.55)
5	Seed treatment with Pseudomonas fluorescens (Sri biotech.Ltd.)	0.4 per cent	43.03 (40.99)	31.7 (34.13)
6	Seed treatment Trichoderma viride (Sri biotech.Ltd.)	0.4 per cent	41.90 (40.33)	30.6 (33.56)
7	Soil application of benomyl	200 g/ acre	54.83 (47.77)	39.83 (39.11)
8	Soil application of carbendazim	200 g /acre	44.66 (41.93)	34.08 (35.64)
9	Soil application of thiram soil	200 g /acre	54.66 (47.67)	39.03 (38.61)
10	Soil application of Bacillus subtilis (Sri biotech.Ltd.)	5-7 kg /acre	63.23 (52.67)	46.47 (42.93)
11	Soil application of Pseudomonas fluorescens (Sri biotech.Ltd.)	5-7 kg /acre	54.83 (47.77)	34.9 (36.14)
12	Soil application of Trichoderma viride (Sri biotech.Ltd.)	2-5 kg /acre	52.83 (46.62)	34.19 (35.65)
13	Control		88.96 (70.75)	76.96 (61.31)
CD at 5% S.Em± C.V%			3.05 1.04 3.80	6.188 2.980 9.605
* Mean of three replications Figures in the parenthesis are angular transformed values				

Table 2. Effect of seed and soil treatment with fungicides and commercial biocontrol agents on plant height at 30 and 60 DAS

S. No	Treatments	*Plant height (cm) 30DAS	*Plant height (cm) 60DAS
1	Seed treatment with benomyl	20.60	83.00
2	Seed treatment with carbendazim	21.20	93.00
3	Seed treatment with thiram	21.80	99.00
4	Seed treatment with Bacillus subtilis (Sri biotech.Ltd.)	19.63	83.66
5	Seed treatment with Pseudomonas fluorescens (Sri biotech.Ltd.)	23.80	108.33
6	Seed treatment Trichoderma viride (Sri biotech.Ltd.)	19.93	82
7	Soil application of benomyl	18.50	88.33
8	Soil application of carbendazim	20.26	86.66
9	Soil application of thiram soil	19.90	85.00
10	Soil application of Bacillus subtilis (Sri biotech.Ltd.)	17.96	79.66
11	Soil application of Pseudomonas fluorescens (Sri biotech.Ltd.)	18.60	93.33
12	Soil application of Trichoderma viride (Sri biotech.Ltd.)	17.93	88.66
13	Control	17.50	63.66
CD at 5 %		1.98	15.18
S.Em$\pm$		0.68	5.2
C.V %		5.95	10.32

**Mean of three replications*

Table 3. Effect of seed and soil treatment with fungicides and biocontrol agents on fresh and dry weight of plants (kg ha^{-1}) at 60DAS

S. No	Treatments	*Fresh weight (kg ha^{-1})	*Dry weight (kg ha^{-1})
1	Seed treatment with benomyl	4462	999.9
2	Seed treatment with carbendazim	4759.211	1085.17
3	Seed treatment with thiram	5240.68	1092.58
4	Seed treatment with Bacillus subtilis (Sri biotech.Ltd.)	4259.21	1077.76
5	Seed treatment with Pseudomonas fluorescens (Sri biotech.Ltd.)	5796.23	1333.31
6	Seed treatment Trichoderma viride (Sri biotech.Ltd.)	5740.68	1240.72
7	Soil application of benomyl	4351.80	981.47
8	Soil application of carbendazim	5166.61	1018.5
9	Soil application of thiram soil	5129.57	955.54
10	Soil application of Bacillus subtilis (Sri biotech.Ltd.)	4796.24	870.36
11	Soil application of Pseudomonas fluorescens (Sri biotech.Ltd.)	4703.65	870.36
12	Soil application of Trichoderma viride (Sri biotech.Ltd.)	5066.61	1100.36
13	Control	3537	737.02
CD at 5%		957.56	265.93
S.Em $\pm$		328.05	91.1
C.V		11.7	15.62

**Mean of three replications*

CONCLUSION

Among all the treatments carbendazim recorded least disease severity index (37.93%) lowest per cent disease incidence 27.11 in both seed and soil treatments followed by seed treatment and soil treatment with T. viride.

Data revealed that P. fluorescens seed treatment was superior over the other treatments by recording 23.80 and 108.33 cm height at 30 and 60 DAS and also 5796.23 kg ha^{-1} fresh weight and 1333.31 kg ha^{-1} dry weight.

Seed and soil treatment with carbendazim reduced the disease severity index and per cent disease incidence in maize with an increase in plant height, fresh and dry weights and it is statistically on par with seed treatment with T. viride.

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