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Integrated Management of Maize Leaf Blight Caused by *Helminthosporium maydis*

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ABSTRACT

Leaf blight (Helminthosporium maydis Nisikado) is one of the most devastating diseases in maize. The innovative idea to manage crop diseases is the integrated method (chemical and bio-control agents), as it involves the least amount of fungicidal load in the environment. Thus, in the present study, the objectives were formulated to screen the different systemic and non-systemic fungicides against the mycelial growth of leaf blight pathogen under in vitro conditions and to investigate the effect of different fungicides and bio-agents against leaf blight disease under field conditions. Among fungicides, systemic fungicides viz., propiconazole, tebuconazole and hexaconazole were best (100%) and significantly superior in inhibiting the mycelial growth of the fungus at 0.1 per cent concentration. Mancozeb (0.2%) was recorded 92.78 per cent inhibition over control followed by propineb at 0.2 per cent (93.33%). In the field experiments, seed treatment (ST) with TNAU-Pf1 @ 10 g/kg seed + foliar spray of propiconazole (0.1%) and ST with TNAU-Pf1 @ 10 g/kg seed + foliar spray of tebuconazole (0.1%) at 40 DAS recorded the lowest incidence of leaf blight and maximum grain yield in maize.

Key words: Bioagents, fungicides, integrated management, leaf blight, *Pseudomonas*

INTRODUCTION

Maize is one of the important cereal crops and the third most important crop in India after rice and wheat. It has immense potential and is therefore referred to as a miracle crop and also as the “queen of cereals”. The crop is attacked by a number of fungal diseases, of which leaf blight caused by *Helminthosporium maydis* Nisikado [Telomorph = *Cochliobolus heterostrophus* (Drechs.) Drechs.] is an important disease affecting photosynthesis with severe reduction in grain yield to an extent of 28 to 91% (White, 1999). It is a serious fungal disease of maize throughout the world where maize is grown in warm and humid conditions. Earlier, the disease was considered as minor, but now it has assumed the status of major disease in India. Previously, the efficacy of different fungicides against maize leaf blight was evaluated under field conditions. Propiconazole spraying three times at weekly intervals was successful in reducing the rate of leaf blight in maize (Bowen and Pederson, 1988).

Begum *et al.* (1993) evaluated five fungicides for the control of artificial infections of *Exserohilum turcicum* on susceptible maize cultivars. All chemicals reduced disease intensity and increased grain yield, with mancozeb being clearly the most effective, followed by carbendazim, zineb, thiophanate methyl and finally copper oxychloride. Praveen Kumar *et al.* (2010) reported that the combinations of the mancozeb (0.25%) + *Trichoderma viride* (0.4%) + monopotassium phosphate (1%) + potassium silicate (1%) were found effective in reducing leaf blight. Seed treatment with *T. harzianum* (6 g/kg) followed by two sprays of mancozeb (0.25%) significantly recorded the lowest incidence of leaf blight and highest grain yield. Previous studies have shown that seed treatment and foliar application of *Pseudomonas fluorescens* prevented infection by the pathogen and reduced the disease incidence (Ramamoorthy and Samiyappan, 2001). Several researchers have reported the effectiveness of *Pseudomonas* in controlling diseases caused by various foliar pathogens (Rao, 2006; Anand *et al.*, 2010; Anand, 2021). Thus, an attempt was made to test the efficacy of *Pseudomonas* with different fungicides against leaf blight under field conditions.

MATERIALS AND METHODS

Fungicides and biocontrol agent

All the fungicides needed for these experiments were purchased from Private pesticide store, Veppanthattai, Perambalur District, Tamil Nadu and the talc-based

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formulation of *Pseudomonas fluorescens* (TNAU-Pf1) was obtained from the Department of Plant Pathology, Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India.

In vitro screening of different fungicides against *Helminthosporium maydis*

The required amount of individual fungicides was added separately on potato dextrose agar (PDA). Subsequently, 20 ml of the poisoned medium was poured into sterile Petri dishes. Mycelial discs of 8 mm in size from an actively growing fungus culture were excised with a sterile cork borer and one of these discs was placed in the centre of each agar plate. Control was maintained without adding any fungicides to the medium. Each treatment was replicated thrice. Subsequently, these plates were incubated at room temperature for seven days and the growth of the radial colony was measured. The efficacy of a fungicide was expressed as per cent inhibition of mycelial growth over control.

Field experiments

Two field experiments (2015-16 and 2016 -17) were conducted at Cotton Research Station Farm, Veppanthattai, Perambalur Dt. Tamil Nadu to assess the possibility of managing the leaf blight disease by combining different management measures. The experiments were conducted in Randomized Block Design (RBD) with eleven treatments and three replications with spacing of 60 x 25 cm using the maize hybrid. The individual plot size of 28 m^2 was maintained for each replication. The treatments of the experiment were

T_1. *Pseudomonas* (TNAU-Pf1) (Seed Treatment) + Mancozeb (0.2%) (Foliar Spray)
T_2. TNAU-Pf1 (ST) + Propiconazole (0.1%) (FS)
T_3. TNAU-Pf1 (ST) + Propineb (0.2%) (FS)
T_4. TNAU-Pf1 (ST) + Tebuconazole (0.1%) (FS)
T_5. TNAU-Pf1 (ST) + Carbendazim (0.1%) (FS)
T_6. TNAU-Pf1 (ST) + Copper oxychloride (0.25%) (FS)
T_7. TNAU-Pf1 (ST) + Hexaconazole (0.1%) (FS)
T_8. TNAU-Pf1 (ST) + Chlorothalonil (0.1%) (FS)
T_9. TNAU-Pf1 (ST) + Azadirachtin (0.1%) (FS)
T_{10}. TNAU Pf1 (ST alone) (FS)
T_{11}. Untreated control

Before sowing, the maize seed were treated with TNAU-Pf1 @ 10g/kg in all treatments. The fungicides were sprayed as per the treatment schedule at 40 days after sowing using a high volume backpack sprayer with a spray fluid volume of 500 l/ha. The data on Percent Disease Index (PDI was calculated before and after spray using the diseases scale given by Payak and Sharma (1983). The grain yield was also recorded in each treatment and expressed as quintal/ha.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using the IRRISTAT version 92-1 programme developed by the Biometrics Unit, International Rice Research Institute, The Philippines. Data on disease incidence were arc-sine transformed prior to analysis. The treatment means were compared using the Duncan's multiple range test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Data for systemic and non-systemic fungicides for inhibition of mycelial growth are presented in Table 1. There was significant difference among the systemic fungicides in inhibiting the growth of *Helminthosporium maydis* (Fig. 1 and 2). The triazoles like propiconazole, tebuconazole and hexaconazole were best (100%) and significantly superior in inhibiting the mycelial growth of the fungus at 0.1 per cent concentration. The effect of non-systemic/contact fungicides on the growth of *H. maydis* was also significant. Mancozeb (0.2%) was recorded 92.78 per cent inhibition over control and was followed by propineb at 0.2 per cent (93.33%) and coppper oxychloride at 0.25 per cent (62.22%). These results are in agreement with Wani *et al.* (2017) who evaluated twelve different systemic and contact fungicides and found that propiconazole was found best in inhibiting the mycelial growth of *Exerohilum turcicum* and mancozeb among non-systemic fungicides. Recently, Kumar *et al.* (2021) evaluated nine fungicides including systemic and contact against *H. maydis* and found that propiconazole was found highly effective and inhibited cent per cent of mycelial growth of *H. maydis* at all the tested concentrations.

Table 1: Effect of *Pseudomonas* and fungicides on maydis leaf blight and grain yield of maize under field conditions (Pooled mean of two seasons)

Treatments	Leaf blight (PDI)		Grain yield (Q/ha)	BCR
	Before spray	After spray		
TNAU-Pf1 (ST) + Mancozeb (0.2%) (FS)	1.25^{a}	5.77^{b}	55.90^{c}	3.70
TNAU-Pf1 (ST) + Propiconazole (0.1%) (FS)	1.94^{a}	2.97^{a}	58.72^{a}	4.06
TNAU-Pf1 (ST) + Propineb (0.2%) (FS)	1.32^{a}	5.88^{b}	55.95^{bc}	3.64
TNAU-Pf1 (ST) + Tebuconazole (0.1%) (FS)	2.16^{a}	3.26^{a}	57.85^{a}	3.98
TNAU-Pf1 (ST) + Carbendazim (0.1%) (FS)	0.98^{a}	11.67^{d}	48.92^{f}	2.11
TNAU-Pf1 (ST) + Copperoxychloride (0.25%) (FS)	1.15^{a}	6.87^{bc}	52.50^{d}	2.98
TNAU-Pf1 (ST) + Hexaconazole (0.1%) (FS)	0.89^{a}	5.22^{b}	56.32^{b}	3.71
TNAU-Pf1 (ST) + Chlorothalonil (0.1%) (FS)	1.26^{a}	7.49^{c}	51.85^{d}	2.88
TNAU-Pf1 (ST) + Azadirachtin (0.1%) (FS)	0.97^{a}	12.15^{de}	47.25^{e}	2.44
TNAU Pf1 (ST alone)	1.98^{a}	13.69^{e}	43.81^{f}	1.92
Untreated control	1.82^{a}	23.04^{f}	39.99^{g}	-

ST - Seed treatment; FS - Foliar spray
Values are means of three replications. In a column, means followed by a common letter are not significantly different at 5% level by DMRTs

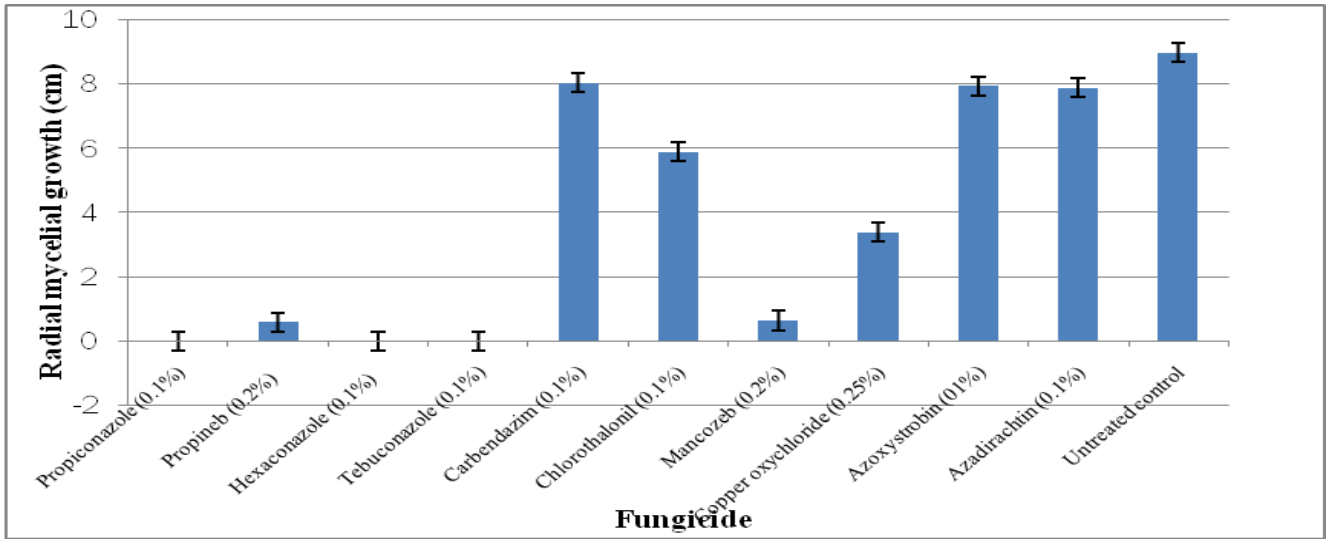
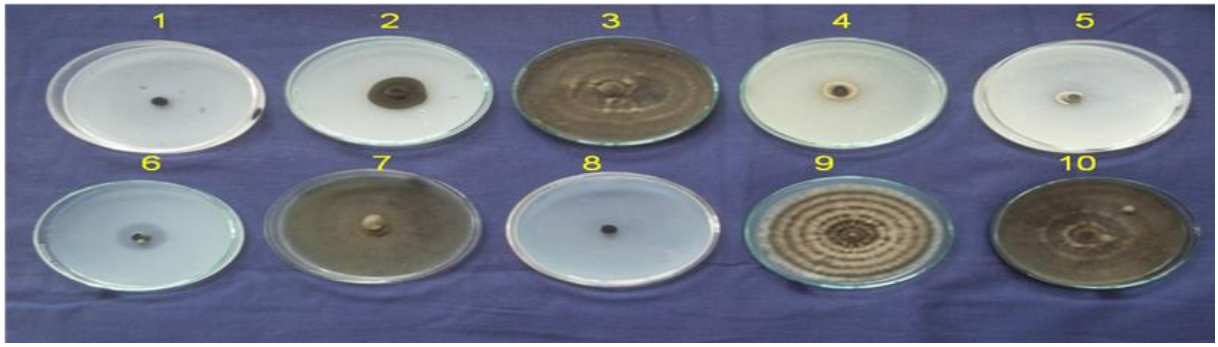


Fig. 1: Effect of different fungicide molecules on the mycelial growth of *Helminthosporium maydis*

In the field experiments, the results revealed that seed treatment (ST) with TNAU-Pf1 @ 10g/kg seed + foliar spray of propiconazole (0.1%) at 40 days after sowing (DAS) recorded only 2.97 PDI of leaf blight followed by ST with TNAU-Pf1 + foliar spray of tebuconazole (0.1%) (3.26 PDI) and were on par with each other. Whereas untreated control plots recorded 23.04 PDI of leaf blight (Table 1). Further, the treatments ST with TNAU-Pf1 + foliar spray of propiconazole and ST with TNAU-Pf1 + foliar spray of tebuconazole were recorded the maximum grain yield of 58.72 and 57.85 q/ha with highest BC ratio of 4.06 and 3.98, respectively.



1. Propiconazole (0.1%)
2. Chlorothalonil (0.1%)
3. Carbendazim (0.1%)
4. Mancozeb (0.2%)
5. Propineb (0.1%)
6. Tebuconazole (0.1%)
7. Azoxystrobin (0.1%)
8. Hexaconazole (0.1%)
9. Azadirachtin (0.1%)
10. Untreated control

Fig. 2: Effect of different fungicides on t the growth of *Helminthosporium maydis* under *in vitro* conditions

The results showed that ST with TNAU-Pf1 + foliar spray of propiconazole and ST with TNAU-Pf1 + foliar spray of tebuconazole was significantly superior over other treatments and can be recommended for the control of leaf blight disease under field conditions. The efficacy of the fungicides mancozeb, propiconazole and carboxin against leaf blight has also been reported by previous researchers (Singh and Gupta, 2000; Patil *et al.,* 2000; Wani *et al.*, 2017) in maize. Khedekar *et al.* (2006) and Wani *et al.* (2017) evaluated the effect of integration of fungicides and fungal antagonist on maize leaf blight. The maximum reduction in disease severity and incidence was recorded with seed treatment with *T. harzianum* (4-6 g/kg) followed by two sprays of mancozeb (0.25%). An integration of early sowing, seed treatment and foliar spraying with propiconazole 25 EC was the best combination to control maydis leaf blight and increase grain yield (Kumar, 2010). Recently, Carpane *et al.* (2020) reported that the application of trifloxystrobin + tebuconazole was increased the maize grain yield by decreasing the severity of Northern corn leaf blight.

CONCLUSION

The integrated approach using the bacterial bio-control agent and fungicide have the potential to suppress leaf blight disease in maize under field conditions. It can be concluded from studies that seed treatment with talc-based formulation of TNAU-Pf1 (10g/kg) plus two sprays of propiconazole (0.1%) or tebuconazole (0.1%) first at 40 days after sowing (DAS) can be effectively exploited for the management of leaf blight disease of maize.

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