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Field Evaluation of Fungicides for the Management of Banded Leaf and Sheath Blight of Maize and Their Effect on Yield Parameters

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ABSTRACT

Background: Maize is gaining importance among cereal crops as it is a good source of nutrition and phytochemical compounds. Among various pathogens attacking maize, banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f.sp *sasakii* is a very serious impediment for quality maize production. All the plant parts got infected with this disease under severe conditions. When this fungus completes its life cycle, it produces sclerotia on different plant parts which serve as inoculum for disease development in the upcoming season.

Methods: Keeping in view the economic value of the crop, occurrence and losses caused by this disease worldwide, the experiment on disease management was conducted to evaluate different fungicides under field conditions at Regional Research Station Uchani, Karnal of CCS Haryana Agricultural University, Hisar. The effects on yield parameters were also recorded.

Result: Results showed that all five fungicides were effective in controlling this disease and increasing yield as compared to the untreated checks. Azoxystrobin @ 0.1% foliar sprays twice at 30 and 45 DAS was found most effective in reducing the disease upto 73.54 per cent and increasing the grain yield (64.06 q/ha) by 77.30 per cent as compared to untreated control.

Key words: Banded leaf and sheath blight, Disease management, Maize, *Rhizoctonia solani* f. sp. *sasakii*, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is the world's most important cereal crop. It has a high yielding capacity and ranks third after wheat and rice in grain production. Maize is a rich source of nutrients; it contains about 72 per cent starch, 10 per cent protein and 4 per cent fat (Nuss and Tanumihardjo, 2010). Among all grain crops, maize has the highest genetic potential and is therefore considered the 'Queen of cereals'. Maize is widely used in many fields such as feed, alcoholic beverages, food additives, cosmetics, food, chemical products and ethanol production. About 50-60 per cent of all corn production is consumed as food and nutrition and the rest is consumed in the oil industry, starch industry and dry milling industries such as corn-bread, sattu, corn chips and Dalia (Sharma *et al.,* 2015). Maize ranks fifth in the area and third in production in India. Maize has wider adaptability, palatability, quick growing habit and it provides quality fodder also for livestock. Good quality of fodder is required for livestock production and to meet the demand especially in rural areas (Rajkumara *et al.,* 2020). In India, about 28 per cent of total maize production is consumed as food, 48 per cent for livestock and only 12 per cent is consumed in milling industries (Singh ans Misal, 2021). Handrid *et al.,* (2020) also reported that, with the increase of maize based industries there will be high demand of production, which can only be attained by controlling various diseases adversely affecting maize production worldwide. It has an area of about 9.70 million hectares having the production of about 30 million metric tons in 2020-2021 (USDA, 2021).

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Various pathogens such as fungi, bacteria, viruses and nematodes are collectively about sixty factors that cause diseases in maize and have adverse effects on the produce (Payak and Sharma, 1980). Outbreaks appear to be exacerbated during various stages of development. Among the various diseases of maize, banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* f. sp. *sasakii* Exner (*Thanatephorus sasakii*) is considered most destructive. The pathogen belongs to the kingdom Fungi, phylum Basidiomycota, class Agaricomycetes, order Cantharellales, family Ceratobasidiaceae and genus *Rhizoctonia*. De Candolle (1815) described this genus. *R. solani* f. sp. *sasakii* is highly pathogenic and has a very wide host range (Binder *et al.,* 2005). Symptoms of the disease begin to appear on the leaves and sheath in 40-50 days older plants and later stages when the infection increases, the ear can also be infected. The pre-flowering stage is most affected by the disease. The rings formed by lesions can be noticed on the lower leaves and sheath also. In the early stages of infection, the plant produces globular to elongated bands (1-3 mm thick in diameter) that appear as water-soaked lesions. Under favorable weather conditions, the symptoms may extend to silk, glumes and grains. Keeping in view the economic importance, occurrence and spread of disease worldwide, the main purpose of this experiment was to evaluate the effect of various chemicals to manage banded leaf and sheath blight of maize, so that losses can be minimized.

MATERIALS AND METHODS

Pathogen isolation

Sterilized potato dextrose agar (PDA) media was prepared by following the standard procedure (Yadav, 2019). It was poured in sterilized Petri plates having 90 mm diameter under aseptic conditions in a laminar air flow chamber and allowed to solidify for 15 minutes. Diseased leaves and sclerotia collected from the previous season were used for isolation of pathogen *i.e.*, *Rhizoctonia solani* f.sp. *sasakii*. The diseased portions of leaves along with some healthy portions were cut as 3-4 mm size bits and then dipped into sodium hypochlorite (0.1%) solution for 30-40 seconds followed by two times washing with sterilized water for surface sterilization. Similarly, sclerotia were cut into small bits and surface sterilized. These bits were placed in Petri plates having media under aseptic conditions. To facilitate proper growth, these Petri plates were placed in a BOD incubator at 28±1°C. Thus, pure culture of fungus was obtained and sub culturing was done after every 15 days and stored at 5±1°C in the refrigerator.

Sowing the crop in the field

Field trials were conducted during *Kharif* 2018 at Regional Research Station Uchani, Karnal. Maize cultivar CM 600 was used for this experiment. The experiment was laid down by following a randomized block design with a 3 × 3 m^2 plot size with the spacing of 75 × 20 cm and 3 replications for each treatment. The crop was raised by following package of the practice of Kharif crops of the Haryana state (Anonymous, 2017).

Artificial inoculation under field conditions

In addition to several ways of infecting the crop with BLSB pathogen under field conditions, plants were subjected to pathogen by following the standard procedure (Yadav, 2019). The artificial inoculations in the field were done twice at 30 days after sowing (DAS) and 45 DAS by incorporating a grain culture (using 4-5 barley grains) with the help of a needle directly from the Petri plate on the stem and the second or third internode on the plants. Diseased leaves and sclerotia collected from previous year's crop were also used for artificial inoculation. Sclerotia were crushed to a powder, the infected leaves were soaked in water for two days and the solution was sprayed on the healthy plants. To provide moist conditions and to facilitate infection, the crop was sprayed with water daily for a week. The crop showed distinguishing symptoms of infection and the pathogen was reisolated from infected plants.

Treatments

Fungicides *viz.,* Propiconazole (0.1%), carbendazim (0.1%), validamycin (0.1%), azoxystrobin (0.1%) and mancozeb (0.2%) were used as foliar spray twice at 30 DAS and 45 DAS after 24 hours of artificial inoculation under field conditions. The foliar sprays were done with the help of Knapsack sprayer by preparing desired concentrations in adequate amount of water.

Observations

The observations on per cent disease incidence and severity were recorded by following formulae given below:

Disease incidence was recorded and calculated by using the formula of Goswami *et al*. (2002).

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plant assessed}} \times 100$$

Disease severity was calculated by the formula given by AICRP on maize (Anonymous, 2016).

Per cent disease severity =

$$\frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{Maximum disease grade}} \times 100$$

Yield parameters

Yield parameters such as wet weight and dry weight of all cobs from each plot were taken. Grain weight of all cobs from each plot was taken after shelling for estimating yield (q/ha) of each treatment.

Statistical analysis

Statistical analysis of field experiments of the data was carried out using OPSTAT software from CCS HAU, Hisar, web site using appropriate programme as per requirement of the experiment. The critical difference (CD) was calculated at 5% level of significance for comparison of difference between the means of treatment (Sheoran *et al.,* 1998).

RESULTS AND DISCUSSION

Disease incidence (%)

It was found that, fungicides used in different treatments effectively reduced the disease incidence (Table 1). A minimum per cent disease incidence was found in plants treated with foliar applications of azoxystrobin @ 0.1% twice at 30 and 45 DAS. It was found most effective in reducing the disease with 23.10% disease incidence. Results with foliar spray with propiconazole @ 0.1% at same DAS was found effective next to azoxystrobin @ 0.1%, as it recorded 36.08 % disease incidence over the untreated check. Validamycin @ 0.1% followed by carbendazim @ 0.1% were also found effective and recorded disease incidence *i.e.,* 45.68% and 47.63%, respectively. Contrarily, foliar sprays of mancozeb @ 0.2% at 30 and 45 DAS were found least effective and disease incidence (54.05%) was maximum. Bhuvaneswari and Krishnam (2012) reported disease incidence of 27.06 per cent and evaluated that azoxystrobin 23 SC alone was effective in controlling disease caused by the *R. solani* pathogen. Malik *et al.* (2018) reported that validamycin @ 0.1% recorded minimum per cent index and gave 49.15 per cent disease control over untreated check and favors this study.

Disease severity (%)

It was found that, disease severity percentage was different in treatments with different chemicals used (Table 1) and their differences were statistically significant. The results of the experiment (Table 1, Fig 1) clearly showed that all the five fungicides tested significantly controlled BLSB disease and increased the grain yield. Azoxystrobin @ 0.1% foliar sprays twice at 30 and 45 DAS was found most effective in reducing the disease upto 73.54 per cent as compared to control (Plate 1). Results with foliar spray with propiconazole @ 0.1% at same DAS was found effective next to the above treatment, as it reduced the disease upto 49.52 per cent over the untreated check. Validamycin @ 0.1% followed by carbendazim @ 0.1% was also found effective in controlling disease. Two foliar sprays with mancozeb @ 0.2% at 30 and 45 DAS was found least effective in controlling disease (20.84%) as compared to control. The findings of In earlier studies, it was reported that carbendazim and validamycin are efficient in controlling R. solani pathogen (Ahuja and Payak, 1986; Sharma and Rai, 1999). Saxena (2002) also favored that propiconazole is an effective fungicide against the BLSB disease of maize. Whereas findings of Akhtar *et al.,* (2010) revealed that carbendazin and validamycin were effective in controlling BLSB disease in maize and supports our observation. Malik *et al.,* (2018) reported that application of validamycin @ 0.1% was found best in controlling BLSB disease, which favoured the results of this experiment.

Yield parameters

Significant differences in cob weight (fresh and dry) and grain yield were observed in different treatments (Table 2). Maximum fresh and dry cob weight (q/ha) were 106.94 and 77.13 and grain yield (q/ha) was 64.06, recorded from the treatment with azoxystrobin @ 0.1% and it increased grain yield by 77.30 per cent as compared to untreated control.

Table 1: Efficacy of different fungicides on BLSB incidence and severity under field conditions.

Treatment*	Disease incidence** (%)	Disease severity** (%)	% Disease control over check
T1= Propiconazole 25% EC @ 0.1%	36.08 (36.86)	43.40 (41.19)	49.52
T2= Carbendazim 50% WP @ 0.1%	47.63 (43.62)	57.06 (49.05)	33.64
T3= Validamycin 3% L @ 0.1%	45.68 (42.51)	54.73 (47.70)	36.35
T4= Azoxystrobin 25% SC @ 0.1%	23.10 (28.69)	22.75 (28.44)	73.54
T5= Mancozeb 75% WP @ 0.2%	54.05 (47.32)	68.06 (55.58)	20.84
T6= Control	82.45 (65.28)	85.98 (68.07)	
C.D. (p=0.05)	(3.95)	(3.78)	
SEm±	1.24	1.18	

Figures in parenthesis indicate angular transformed values.

*Two foliar sprays at 30 and 45 DAS after 24 hours of artificial inoculation.

**Mean of three replications.

Table 2: Effect of different fungicides on maize yield.

Treatment*	Fresh Cob weight** (q/ha)	Dry Cob weight** (q/ha)	Grain yield** (q/ha)	Increase in grain yield (%)
Propiconazole 25% EC @ 0.1%	98.61	69.23	56.12	55.32
Carbendazim 50% WP @ 0.1%	90.83	62.23	50.51	39.80
Validamycin 3% L @ 0.1%	94.04	64.56	52.81	46.17
Azoxystrobin 25% SC @ 0.1%	106.94	77.13	64.06	77.30
Mancozeb 75% WP @ 0.2%	86.24	56.38	45.82	26.82
Control	74.43	48.64	36.13	
C.D. (p=0.05)	4.51	2.83	3.02	
SEm±	1.41	0.89	0.95	

* Two foliar sprays at 30 and 45 DAS after 24 hours of artificial inoculation.

** Mean of three replications.

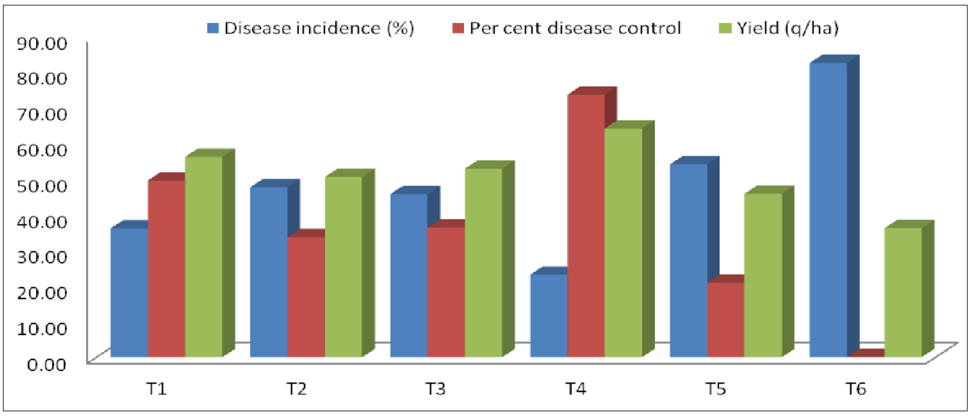

Fig 1: Effect of different fungicides in controlling BLSB disease and yield in maize.

(A)

(B)

Plate 1: (A) Best foliar treatment (Azoxystrobin 25% SC @ 0.1%) (B) Untreated check.

Results with foliar spray with propiconazole @ 0.1% at same DAS was found effective next to the above treatment, as it recorded grain yield 56.12 q/ha and increased grain yield upto 55.32 per cent over untreated check. Validamycin @ 0.1% followed by carbendazim @ 0.1% was also effective in increasing the grain yield. Contrarily, foliar sprays of mancozeb @ 0.2% at 30 and 45 DAS resulted in minimum grain yield among all chemical treatments and increased grain yield by 26.82% as compared to control. Batsa *et al.,* (2004) from his study also confirmed that highest yield was recorded in the treatment sprayed with validamycin. Akhtar *et al.,* (2010) revealed that, the treatments with carbendazin application attained highest yield among all treatments that favours our study. Malik *et al.* (2018) reported that validamycin @ 0.1% was most effective in controlling disease and produced the highest yield.

CONCLUSION

From the results of this experiment, it can be concluded that all the chemical treatments were effective against the disease and increased the yield. The most effective control in banded leaf and sheath blight disease (73.54%) and grain yield (64.06 q/ha) was recorded from the treatment with azoxystrobin @ 0.1% followed by propiconazole @ 0.1% at the same DAS. Foliar sprays with mancozeb @ 0.2% resulted in minimum disease control (20.84 %) and grain yield (45.82 q/ha) as compared to an untreated check.

Conflict of interest: None.

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