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Evaluation for Bio Efficacy of different Ecofriendly components of IDM for Charcoal Rot of Maize incited by *Macrophomina phaseolina* (Tassi) Goid

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ABSTRACT: Charcoal rot of maize is a widely distributed throughout the world causing sever economic losses and incited by the fungal pathogen *Macrophomina phaseolina.* The main objective of this experiment is toidentify the important IDM components to control charcoal rot disease of maizeunder field condition. Out of different componental treatments tested, the treatment invoving Soil application of Vermicompost enriched with *T. viride* (2 × 10^9 cfu/g)@250kg/ha was found to be the best treatment in terms of disease reduction (65 %) and increased grain yield (39%) with heighest C:B ratio of 1:1.35. However, the treatment involving foliar application of Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @0.1% at knee high stage was very closely follows in terms of disease reduction (56%) and grain yield improvement (29%) with C:B ratio of(1:1.34). Othar components like Chitosan and VAM also recorded significantly good results interms of disease reduction (54.5%, 49.4%) and grain yield improvement of (32.3%, 34.6%) indicating their potentiality to utilize them in integrated charcoal rot management of maize.

Keywords: Chitosan, *Macrophomina phaseolina*, Maize stalk rot, *Trichoderma viride.*

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop belonging to the grass family, Poaceae and is a native to South America. It is the third most important cereal crop next to rice and wheat in the world as well as in India. It is also considered as "Queen of cereal" due to its high production potential and wider adoptability (Ramesha and Krishna 2017). Maize is not only an important food source of human, but also a basic element of animal feed and raw material for producing many industrial products. The products include corn starch, corn oil, corn syrup, maltodextrins, and products of fermentation and distillation industries. In India, about 13% of maize produced is used for food purpose, about 13% as livestock feed, 47% as poultry feed, 14% in wet milling industry (*e.g.*, starch and oil production), Processed food (7%) and Export & other 6% (ICAR, 2020).

Globally 1162.7 MT of maize is being produced together by over 173 countries from an area of 201.8 mha with an average productivity of 5.75 t/ha. Globally, India stands the fourth largest acreage and fifth largest corn producer. In India, maize is cultivated in an area of 9.89 mha with production and productivity of 31.65 MT and 31.99 q/ha respectively (FAOSTAT, 2020).

Like many other cultivated crops, maize is also affected by various diseases that result into economic losses. It is reported nearly 61 diseases affect maize. Of these, post-flowering stalk rots (PFSR) are the most destructive diseases of corn (Payak and Sharma 1985). In India three bacteria and eight fungi were reported to cause stalk rots. Fungal diseases like Fusarium Stalk Rot (*F. verticillioides* (Sacc.) Nirenberg, *Syn. F. moniliformae*), Charcoal Rot (*M. phaseolina* (Tassi.) Goid) and Late Wilt (*Cephalosporium maydis*) are commonly associated with PFSR (Raju and Lal 1976). Among these charcoal rot (*M. phaseolina*) is a dominant one in southern India and also, the disease occurs as a complex along with *F. verticillioides* in some locations like Punjab, Rajasthan and Telangana that usually known as post flowering stalk rot (PFSR) disease.

In recent years yield reduction due to PFSR has been reported to be as high as 22.3 to 63.5 per cent. In Telangana state the disease incidence ranged from 27 to 76.8 per cent and caused by *F. verticillioides* and *M. phaseolina* (Mamatha *et al.,* 2020). The fungus survives on crop residues in the soil. Under favourable condition, it may infect roots as well as stalk and present throughout the life cycle of the plant (Headrick *et al.*, 1990). Control of this disease has become very difficult due to its soil borne and complex nature. Management of this disease through chemicals and by the use of resistant varieties are partly sucessful. But the hazardous impact of agrochemicals on the environment, development of resistant mutants, escalating cost of pesticides and breakdown of resistant varieties demands a sustainable and an alternative management strategy to manage this disease. Use of microbial agents, organic amendments, new molecules with less harm to environment and botanicals for disease management in agriculture is one of the most promising, effective and eco-friendly disease control strategy. In addition biocontrol agents are the best alternative for sustainable agriculture to overcome the problems of public concern associated with pesticides and pathogens resistance to chemical pesticides and eco-friendly (Akhtar and Siddiqui 2008). Recently, the application of chitosan and chitin in agriculture particularly in pest management is becoming a major focus of research. Since most chemical pesticides are highly toxic to humans and animals and not easily biodegradable, they often cause water and soil pollution.

Keeping the importance of the disease in view, the present investigation was planned with few new molecules possessing ecofrendly and bio control nature against charcoal pathogen of maize.

MATERIALS AND METHODS

All the experiments were carried out at Maize pathology section, Maize Research Centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad from 2019 to 2021. The details of the field experiment are as follow

Design: RBD

Replications: 3

Maize Hybrid used: Kaveri-50

Table 1.

T.No	Name of the treatment	Dose of treatment
T_1	Seed treatment with *Trichoderma viride*	10g/kg seed
T_2	Soil application of Vermicompost enriched with *T. viride*	*$2x10^9$cfu/g@ 250kg/ha*
T_3	Foliar application of humic acid	5ml/l at 35DAS and 45DAS
T_4	Foliar application of Chitosan	5ml/l at 35DAS and 45DAS
T_5	Foliar application of Azoxystrobin 18.2% w/w + Difenoconazole 11.4%	0.1% at 35DAS and 45DAS
T_6	Foliar application of Mancozeb 75WP	2.5g/l at 35DAS and 45DAS
T_7	Soil application of VAM (G.sp)	300kg/ha
T_8	Control (without treatment)	-

DAS: Days after sowing

The final observations on disease incidence was carried at 100 DAS and grain yield after harvesting. Percent disease incidence was carried using the formula

Per cent disease incidence =

$$\frac{\text{Number of plants affected}}{\text{Total number of plants observed}} \times 100$$

RESULTS AND DISCUSSION

In all the treatements during all the seasons there was a significant reduction in disease incidence and improvement in grain yield was observed in all the treatments imposed. In control plot the disease incidence recorded was as high as 45.0%. T_2, Soil application of Vermicompost enriched with *T. viride* ($2x10^9$cfu/g)@250kg/ha was found to be the best treatment in terms of disease reduction (65 %) and increased grain yield (39%) with heighest C:B ratio of 1:1.35. However, the treatment T_5 involving foliar application of Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @0.1% at knee high stage was very closely follows T_2 in terms of disease reduction (56%) and grain yield improvement (29%) C:B ratio (1:1.34). Chitosan and VAM also recorded significantly good results interms of disease reduction (54.5%, 49.4%) and grain yield improvement of (32.3%, 34.6%) indicating their potentiality to utilize them in integrated charcoal rot management of maize.

Meena *et al*. (2010) also reported similar effectively of native *Trichoderma* spp. against post flowering stalk rot of maize. Khokhar *et al*. (2014) revealed that combination of fungicides with bioagent or botanicals performed better than their individual application. The efficacy of *Trichoderma viride* in suppressing population of *Macrophomina, Fusarium* spp and other pathogens has been reported by other workers also in different crops (Jatav and Mathur 2003; Bohra and Mathur 2004). *Trichoderma* a commnly used biocontrol agent and is well known magical weapon against soil borne pathogens (Srivastava *et al*., 2015) and also known for its antagonistic mechanism for the control of fungal disease (Gomathinayagam *et al*., 2012) which was evident in the present study. In a similar study on management of tomato wilt caused by *F. oxysporum* f. sp. *lycopersici*, *Trichoderma* spp. was found highly effective against the pathogen and reduced the disease significantly (Sallam *et al*., 2019).

Patil *et al*. (2003) also reported that the seed treatment with *T. harzianum* (4kg seed) along with soil application of castor or neem cake (250 kg ha^{-1}) at 15 days prior to sowing gave more effective control of stalk rot disease and gave better cost benefit ratio. The study is in conformitywith Singh ***et al.*** (2015) who stated that in his works implementation of de oiled cakes alleviate the field fertility status and supplements by minimizing disease occurrence risk factors.

Successful growth suppression of *F. verticillioides (in vitro*) and its further exclusion from internodes of maize stem the field (*in vivo*) by strains of *Trichoderma pseudo-koningii* had been reported by Sobawale *et al*. (2005). Shekhar and Kumar (2010) reported the native iso-late of *Trichoderma harzianum* resulted in good plant health and reduced post-flowering stalk rot of maize. Monika *et al*. (2018) showed the antifungl activity of *Bacillus* strain B44 against *Fusarium oxysporum* f. sp. *lycopersici* and the isolate also showed 36% reduction in disease incidence in tomato plants under green house conditions. Kulkarni and Anahosur (2011) also reported the application of farm yard manure and Neemcake along with *T. harzianum* 15-20 days before sowing with two additional irrigation at tasselling and silking stage reduced the disease incidence from 70.08 to 13.24%.

T. polysporum was highly effective in suppressing melon wilt with highest efficacy to control and improve the fruit quality and yield under field conditions (Gava and Pinto 2016). Moreover, *Trichoderma* sp. have the capability to induce the antioxidant enzymes in plants under stress conditions after pathogen challenge as well as increased the plant fresh weight and seedling growth of tomato plants (Prabhukarthikeyan *et al*., 2014). Abden *et al*. (2013) observed that chitosan could cause complete inhibition of mycelia growth of various pathogens *viz*., *M. phaseolina*, *F. oxysporum. F. solani*, *Raularia* sp., and *Phoma* sp. at 4000ppm. Chatterjee *et al.* (2014) reported the minimum inhibitory concentration levels of water soluble s-chitosan for *M.phaseoloina* on PDA trough poisoned food technique.

Table 2: Pooled data on efficacy of different components in management of charcoal rot of maize from 2019 to 2021.

T. No.	Name of the treatment	Wilt incidence (DI%)	(%) Disease reduction over control	Grain Yield/ ha(kg)	(%) Grain Yield increase over control	C:B ratio
T_1	Seed treatment with *Trichoderma viride* @10g/kg seed	27.8	38.2	6091	25.5	1:1.24
T_2	Soil application of Vermicompost enriched with *T. viride* ($2x10^9$cfu/g)@ 250kg/ha	15.7	65.0	6746	39.0	1:1.35
T_3	Foliar application of humic acid @5ml/l at 35DAS and 45DAS	33.1	26.4	6070	25.1	1:1.23
T_4	Foliar application of Chitosan @ 5ml/l at 35DAS and 45DAS	20.5	54.5	6423	32.3	1:1.29
T_5	Foliar application ofAzoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @0.1at knee high stage	18.8	58.2	6690	37.9	1:1.34
T_6	Foliar application of Mancozeb 75WP @ 2.5g/l at knee high stage	32.6	27.5	6003	23.7	1:1.20
T_7	VAM (G.sp)@ 300kg/ha	22.8	49.4	6534	34.6	1:1.31
T_8	Control	45.0		4853		
	CD	3.9		131		
	SE(m)	1.3		42.91		
	CV	8.2			1.45	

CONCLUSIONS

The results from the experiment indicates that the components like soil application of vermicompost enriched with *T. viride,* foliar application of chitosan, soil application of VAM and foliar application of Azoxystrobin 18.2% w/w + Difenoconazole 11.4% are vital components that can play a very important role in integrated management of charcoal rot of maize.

Conflict of Interest. None.

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