Int.J.Curr.Microbiol.App.Sci (2017) *6*(9): 3546-3552

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 9 (2017) pp. 3546-3552**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.609.436

Management of Stalk Rot of Maize Caused by *Fusarium moniliforme* (Sheldon)

Mallikarjun Kenganal[1*], M.B. Patil[2] and Yusufali Nimbaragi[1]

[1]Department of Plant Pathology, University of Agricultural Sciences, Raichur
[2]Agricultural Extension Education Center, Koppal, India
**Corresponding author*

A B S T R A C T

Stalk rot in maize caused by *Fusarium moniliforme* has been a concern in majority of maize growing areas. There are no hybrids resistant to this disease. A study was conducted to identify the suitable strategies for effective mitigation of stalk rot. Biocontrol agents were tested by seed treatment and soil application in comparison with chemical seed treatment usually followed for soil borne diseases. Among the different treatments, seed treatment with *T. viride* and *P. fluorescens* at 2.5g each/kg of seed and soil application of 1.25kg/h each fortified with 250kg of FYM had lowest stalk rot of 6.07 per cent during 2014 and 8.13 per cent during 2015. The pooled disease incidence was 7.10 per cent. The treatment was statistically significant over other treatments which also recorded highest grain yield of 6044kg/h during 2014, 6067kg/h during 2015. The pooled yield was 6056kg/ha with a cost benefit ratio of 2.09. In untreated control stalk rot was 31.33 per cent during 2014, 42.10 per cent during 2015 and grain of 3378kg/h and 3444kg/h respectively during 2014 and 2015 with a pooled yield of 3411kg/h and cost benefit ratio of 0.78, the lowest among all. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (sprint) 1g/kg & 2g/kg and Thiram 75WP (1g/kg) had more disease compared to biocontrol treated plots. The results once again reconfirm the beneficial characters of *T. viride* and *P. fluorescensi* against the pathogenic microbes in soil. Their ability to parasitize the pathogens by starvation, encourage growth of the plants by acting as defense agents and adoptability to different kinds of climatic fluctuations makes them more suitable for engaging against the stalk rot of maize. These will be free from residue effects and low cost in adoption.

Keywords

Stalk rot, Maize, *Fusarium moniliforme*, Management.

Article Info

Accepted:
10 July 2017
Available Online:
10 September 2017

Introduction

Maize (*Zea mays* L) is popularly known as queen of cereals, cultivated throughout the world and has the highest production among all the cereals. Maize is also recognized by different synonyms such as zea, corn, silk corn etc. In Hindi it is called Makka and Barajovar. Maize is mother grain of Americans and is considered as the earliest cultivar of the new world. It is most widely distributed world's plant (Dilip Kumar and Aditya Narayan Jhariya, 2013). The worldwide production of maize was more than 960 million MT in 2013-14. In India during 2014-15 it stood at 24.17 million tone from an area of 9.23million hectare and productivity of 2.56 t/ha (Vinay Mahajan, 2016). It is an important staple food in many countries and is also used in animal feed and industrial applications. The crop has tremendous genetic variability, which enables it to thrive in tropical, subtropical, and temperate climates. It has highest genetic yield potential amongst the cereal crops. Its wide applications from food to fuel are driving its production. However, the cultivation is not free from constraints like in other crops. Diseases are one of the major hurdles in realizing the yield potential of maize. It suffers from a number of diseases such as turcicum leaf blight (*Exserohilum turcicum*), maydis leaf blight (*Drechslera maydis*), polysora rust (*Puccinia polysora*), brown stripe downy mildew (*Sclerophthora rayssiae* var *zeae*), sorghum downy mildew (*Peronosclerospora sorghi*), Rajasthan downy mildew (*Peronosclerospora heteropogoni*), banded leaf and sheath blight (*Rhizoctonia solani* f sp *sasakii*), bacterial stalk rot (*Erwinia chrysanthemi* pv *zeae*), post-flowering stalk rots (*Fusarium verticillioides*, *Macrophomina phaseolina*) and Curvularia leaf spot (*Curvularia lunata*) are the important constraints in globe responsible for yield losses (Khokhar, 2014). These diseases reduce the production, productivity and quality of grain (Sharma *et al*., 1993)

Maize production in India is dominated by Andhra Pradesh and Karnataka, majority of the area is covered by hybrid maize, production is supported by technologies for crop husbandry, crop protection and crop improvement. However, severe constraints in crop protection are faced since three years due to stalk rot caused by *Fusarium verticillioides* (Saccardo) Nirenberg (*Fusarium moniliforme* (Sheldon)).

The disease was first reported from United States of America by Pammel (1914) as a serious root and stalk diseases. Later Valleau (1920) indicated that *Fusarium moniliforme* was a primary cause of root rot and stalk rot of maize. In India *Fusarium* stalk rot was first reported from Mount Abu, Rajasthan (Arya and Jain, 1964).

It has been infecting maize in north and central Karnataka causing economic losses up to 85 per cent. As per earlier records the disease incidence ranged from 10 to 42% in Karnataka (Harlapur *et al*., 2002). Hooker and Britton (1962) estimated the reduction in grain weight by 5-20%, whereas the estimated loss due to *Fusarium* stalk rot has been reported as 38% in total yield (AICRP, 2014). Growers are not only worried of income but shortage of fodder which is starving the animals. Some are switching to alternate crops. Irrespective public and private bred hybrids all are succumbing to severe stalk rot. *Fusarium* stalk rot was observed in the plant age group of 55 to 65 days which coincides with tasselling and silking and immediately followed grain formation stage. At these stages the stem reserves are depleted and most of the carbohydrates are translocated to developing sinks and stalks are predisposed to the fungi (Desai *et al.*, 1992). The soil borne pathogen led to breakage of stalk, rotting, lodging and premature death of the infested plants. The plants expressed symptoms of drying from margin of leaves extending towards mid rib covering entire leaf lamina. Subsequent death of all leaves leads to drying of whole plant before seed set.

In other parts of world, it is a major disease of maize causing severe damage to the standing crop and may infect all types of corn (Renfro and Ullastrup, 1976). According to Sharma *et al.* (1993), maize production in India is severely limited due to the incidence of a soil borne disease commonly called Post-flowering stalk rot (PFSR) or stalk rot. Being a soil borne in nature, it has remained undeterred for many years. There are no resistant or tolerant hybrids against this disease. In order to overcome the losses due to stalk rot, the current experiment was conducted to develop an integrated disease management strategy suitable for adoption at low cost.

Materials and Methods

Stalk rot in maize caused by *Fusarium* is a soil borne pathogen and no chemical application or drenching are feasible. It is economically non viable for site application of chemicals which otherwise also harm the beneficial soil microfloara. The present experiment was undertaken to explore the potential of biocontrol agents widely used against many soil bore diseases. *Trichoderma viride* a fungal bioagent and *Pseudomonas fluorescens* a potential bacterial bioagent also a plant growth promoting rhizobacteria were employed in different mode of delivery. Among the chemicals only seed treatment by Mancozeb 50% + Carbendazim 25% WS (Sprint) 1gm/kg and Thiram 75WP 2gm/kg through seed treatment were tested. The experiment was laid out on field with severe stalk rot history during previous two seasons. Eight different treatments were laid out in three replications following complete randomized block design. *T. viride* and *P. fluorescens* were used alone and in combination for seed treatment and soil application fortified with Farm Yard Manure (FYM). Observations on percent stalk rot and grain yield were recorded in all the treatments. The experiment was conducted on the same plot for two years during 2014 and 2015. Data obtained were computed to get the average of two years and cost benefit ratio was calculated using average cost of cultivation and market price of two years to derive the conclusion.

Results and Discussion

Stalk rot in maize is usually noticed at the time of tassel emergence. The infection of plants begins from seed germination to tassel emergence, but symptoms will be visible later. The current experiment conducted was aimed to prevent early infection of plants after seed emergence by seed treatment and avoid proliferation of the pathogen by soil application of bioagents. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (sprint) 1g/kg & 2g/kg and Thiram 75WP (1g/kg) could able to reduce the seedling infection since earlier also seed treatment with Carbendazim or Captan gave effective control of late wilt of maize in India (Satyanarayana and Begum, 1996), but failed to prevent further infection at vegetative growth. Seed treatment with *T. viride* and *P. fluorescens* at 2.5g each/kg of seed and soil application of 1.25kg/h each fortified with 250kg of FYM had lowest stalk rot of 6.07 per cent during 2014 and 8.13 per cent during 2015 (Table 1). The pooled disease incidence was 7.10 per cent. The treatment was statistically significant over other treatments which also recorded highest grain yield of 6044kg/h during 2014, 6067kg/h during 2015. The pooled yield was 6056kg/ha with a cost benefit ratio of 2.09 (Table 2). The control treatment had stalk rot of 31.33 per cent during 2014, 42.10 per cent during 2015 and grain of 3378kg/h and 3444kg/h respectively during 2014 and 2015 with a pooled yield of 3411kg/h and cost benefit ratio of 0.78, the lowest among all.

The seed treatment of either chemical or biocontrol agent would certainly act against the seedling infection but more impact would be visible after their spread and multiplication in rhizosphear and acting against pathogens. In addition biocontrol agents are a good alternative for sustainable agriculture to overcome the problems of public concern associated with pesticides and pathogens resistance to chemical pesticides and to become eco-friendly (Akhtar and Siddiqui, 2008). The biological control activities are exerted either directly through antagonism of soil-borne pathogens or indirectly by eliciting a plant-mediated resistance response.

Table.1 Effect of different treatments on incidence of stalk rot of maize and its yield

Sl. No.	Treatments	Stalk rot incidence (%)			Yield (kg/plot)			Yield (kg/h)		
	Year	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
1	T1. Seed treatment with *Trichoderma* 5g/kg	20.57 (26.92)	22.43 (28.22)	21.50 (13.65)	5.83 (13.95)	5.33 (13.33)	5.58 (27.59)	3556	3889	3722
2	T2. T1 + soil application at 2.5kg/ha fortified with 250kg FYM	11.23 (19.46)	10.77 (19.11)	11.00 (16.59)	8.17 (16.58)	8.17 (16.58)	8.17 (19.34)	5444	5444	5444
3	T3. Seed treatment with *Trichoderma* + *Pseudomonas fleurosense* 5g/kg	17.40 (24.57)	21.53 (27.60)	19.47 (14.21)	6.03 (14.18)	6.07 (14.24)	6.05 (26.15)	4044	4022	4033
4	T4. T3 + soil application at 2.5kg/ha fortified with 250kg FYM	6.07 (14.15)	8.13 (16.50)	7.10 (17.52)	9.10 (17.54)	9.07 (17.50)	9.08 (15.43)	6044	6067	6056
5	T5. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (Sprint) 1gm/kg	14.93 (22.67)	18.43 (25.30)	16.68 (15.41)	7.13 (15.41)	7.03 (15.31)	7.08 (24.08)	4689	4756	4722
6	T6. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (Sprint) 2gm/kg	11.40 (19.62)	16.87 (24.18)	14.13 (15.67)	7.47 (15.84)	7.17 (15.51)	7.32 (22.05)	4778	4978	4878
7	T7. Seed treatment with Thiram 75WP 2gm/kg	16.23 (23.70)	20.37 (26.77)	18.30 (14.89)	6.87 (15.16)	6.37 (14.59)	6.62 (25.31)	4244	4578	4411
8	T8. Control	31.13 (33.88)	42.10 (40.43)	36.62 (13.05)	5.17 (13.11)	5.07 (12.99)	5.12 (37.20)	3378	3444	3411
	CD 5%	4.35	3.87	1.35	1.99	1.72	2.63			
	SE (m)	1.42	1.26	0.44	0.65	0.56	0.85			

Table.2 Cost benefit analysis of management of stalk rot of maize by different treatments

Sl. No.	Treatments	Yield kg/ha	Gross returns (Rs.)	Net returns (Rs.)	Cost benefit ratio
1	T1. Seed treatment with *Trichoderma* 5gm/kg	3722	50994	24734	0.94
2	T2. T1 + soil application at 2.5kg/ha fortified with 250kg FYM	5444	74589	47754	1.78
3	T3. Seed treatment with *Trichoderma* + *Pseudomonas fluorescens*5gm/kg	4033	55257	28997	1.10
4	T4. T3 + soil application at 2.5kg/ha fortified with 250kg FYM	6056	82961	56126	2.09
5	T5. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (Sprint) 1gm/kg	4722	64694	38429	1.46
6	T6. Seed treatment with Mancozeb 50% + Carbendazim 25% WS (Sprint) 2gm/kg	4878	66826	40546	1.54
7	T7. Seed treatment with Thiram 75WP 2gm/kg	4411	60432	34172	1.30
8	T8. Control	3411	46732	20482	0.78

The mechanisms involve antibiosis, parasitism, competition for nutrients and space, cell wall degradation by laytic enzymes and induced disease resistance (Singh, 2014). Thus both the biocontrol agents were competitive enough to fight against the pathogens than chemicals used for seed treatment. The soil application of these biocontrol agents would add to their population.

Often soil amendment with chemical application are not suitable, they are costly, hazardous and threaten the microflora, under such circumstances naturally available biocontrol agents are most promising. *Trichoderma* a widely used biocontrol agent is well known magical weapon against soil borne pathogens (Srivastava *et al.*, 2015) and also known for its mycoparasitic and antagonistic mechanism for the control of fungal disease (Gomathinayagam *et al*., 2010) which was evident in the present study. Majority of *Fusarium* wilts and rots are being controlled using *Trichoderma* spp. In the current study also the disease caused by *F. moniliforme* was found suppressed due to the application of *Trichoderma* along with *P. fluorescens.* 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 (Sundaramoorthy and Balabaskar, 2013). The beneficial use of *P. fluorescens* found in the present study was also reported against the growth of *Sclerotina sclerotiorum* (Vishal Kumar Deshwal, 2011). It was effective against the bacterial wilts such as *Ralstonia solanacearum* in brinjal (Gargi Chakravarty and Kalita, 2012). The bacterial biocontrol also induces plant growth and disease suppression in sustainable agriculture production systems which might have helped in boosting the grain yield in our experiment. Effectiveness of this novel bioagent were also recorded against six fungi viz. *Pyricularia oryzae Fusarium oxysporum*, *Aspergillus niger*, *Aspergillus flavus*, *Alternaria alternata* and *Erysiphe cruciferarum* (Shanker Kumer Pandey and Shyam Chandra Roy Chandel, 2014). Both the biocontrol in the study showed consistence performance over the years and could be used against the stalk rot of maize without any concern of residual issues. Even these biocontrol agents were proved superior against the foliar diseases also. In a study conducted on use of *T. viride* and *P. fluorescens* against *Phytophthora infestans* showed reduction of the disease compared to the untreated check (Zegeye, 2011). The experiment gave a sound strategy for management of stalk rot in maize without harming the environment and adding much to the cost of cultivation.

References

Akhtar, M.S and Siddiqui, Z.A. 2008. Arbuscular mycorrhizal fungi as potential bioprotectants against plant pathogens. *Mycorrhizae: Sustainable Agriculture and Forestry*, 61–97.

Arya, H. C. and Jain B. L. 1964. *Fusarium* seedling blight of maize in Rajasthan, *Indian Phytopathol.* 17: 51-57.

Dilip Kumar and Aditya Narayan Jhariya. 2013. Nutritional, Medicinal and Economical importance of Corn: A Mini Review. *Research J. of Pharmaceutical Sci.* 2(7): 7-8.

Desai, S., Hegde K. K. and Desai S. 1992. Identification of suitable method and time for artificial inoculation of maize with stalk rotting fungi. *Indian Phytopa*thology. 45(3): 381-382.

Gomathinayagam, S., Rekha, M., Sakthivel Murugan S. and Jagessar J. C. 2010. The biological control of paddy disease brown spot (*Bipolaris oryzae*) by using *Trichoderma viride* in vitro condition. *J. of Biopesticides* 3(1): 93 – 95.

Gargi Chakravarty and M. C. Kalita. 2012. Biocontrol potential of *Pseudomonas fluorescens* against bacterial wilt of Brinjal and its possible plant growth promoting effects. *Ann. of Biol. Res.* 3 (11): 5083-5094.

Harlapur, S. I., Wali, M. C., Prashan, M. and Shakuntala, N. M. 2002. Assessment of yield losses in maize due to charcoal rots in Ghataprabha Left Bank Canal (GLBC) Command area of Karnataka. *Karnataka J. Agric. Sci* 15: 590-91.

Hooker, A. L. and Brirton, M. P. 1962. The effect of stalk rot on corn yield in Illinois. *Pl. Dis. Reptr.* 46: 9-13.

Khokhar, M. K., Hooda, K. S., Sharma, S. S. and Vimla Singh. 2014. Post Flowering Stalk Rot Complex of Maize - Present Status and Future Prospects, *Maydica* 59; 226-242.

Pammel, L. H. (1914). Serious root and stalk diseases of corn. IOWA Agriculturist. 15: 156-158.

Renfro, B. L Ullstrup, A.J. 1976. A comparison of maize diseases in temperate and tropical environments. PANS 22:491-498.

Satyanarayana E and Begum H, 1996. Relative efficacy of fungicides (seed dressers) and irrigation schedule for the control of late wilt in maize. Current Res Uni Agri Sci Bangalore 25(4): 59-60.

Singh, H. B. 2014. Management of Plant Pathogens with Microorganisms, *Proc Indian Natn Sci Acad* 80 (2): 443-454.

Shanker Kumer Pandey and Shyam Chandra Roy Chandel. 2014. Efficacy of *Pseudomonas* as biocontrol agent against plant pathogenic fungi. *Int. J. Curr. Microbiol. App. Sci.* 3(11): 493-500.

Sharma, R. C., Carlos De Leon and Payak M. M. 1993. Diseases of maize in South and South-East Asia: problems and progress. *Crop Protection*, 12 (6):414-422.

Srivastava, M., Sonika Pandey, Mohammad Shahid, Vipul Kumar, Anuradha Singh, Shubha Trivedi and Yatindra Kumar Srivastava, 2015. *Trichoderma*: A magical weapon against soil borne pathogens. *Afr. J. Agric. Res* . 10(10): 4591-4598.

Sundaramoorthy, S. and Balabaskar, P. 2013. Biocontrol efficacy of *Trichoderma* spp. against wilt of tomato caused by *Fusarium oxysporum* f. sp. *lycopersici. J. of App. Bio. & Biotechnol.*. 1 (03): 36-040.

Valleau, W. D. 1920. Seed corn infection with *Fusarium moniliforme* and its relation to the root and stalk rots. *Ky. Agric. Expt. Statn., Res. Bull.* 226: 51.

Vishal Kumar Deshwal. 2011. *Pseudomonas aeruginosa* as biological control agent against plant pathogenic fungus *Sclerotina sclerotiorum, Int. J. of Pl., Animal and Env. Sci.* 2 (1): 14-17.

Vinay Mahajan. 2016. Directors review, Annual Maize Workshop, UAS, Bangalore 10-12, April p. 3-7.

Zegeye, E. D., Amutha Santhanam, Dereje Gorfu, Mesfin Tessera and Bekele Kassa, 2011. Biocontrol activity of *Trichoderma viride* and *Pseudomonas fluorescens* against *Phytophthora infestans* under greenhouse conditions. *J. of Agric. Tech.* 7(6): 1589-1602.

How to cite this article:

Mallikarjun Kenganal, M.B. Patil and Yusufali Nimbaragi. 2017. Management of Stalk Rot of Maize Caused by *Fusarium moniliforme* (Sheldon). *Int.J.Curr.Microbiol.App.Sci.* 6(9): 3546-3552. doi: https://doi.org/10.20546/ijcmas.2017.609.436