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Management of *Macrophomina* stem blight and dry root rot diseases in pigeonpea caused by *Macrophomina phaseolina* (Tassi) Goid

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ABSTRACT: In recent years *Macrophomina* stem blight and dry root rot diseases have become major constraints in successful and profitable cultivation of pigeonpea caused by *Macrophomina phaseolina* (Tassi) Goid. Increasing dry spells and droughts during pigeonpea cultivation has widen the scop for infection and spread of these diseases very rapidly than ever. There are no resistant cultivars available for cultivation among the cultivated gene pool. In such cases, suitable management become very essential. In absence of host resistance, the efficacy of different fungicides and bioagents was evaluated in field during *kharif*-2022 for management of both stem blight and dry root diseases. Among the tested treatments, T_9 consisting of seed treatment, soil drenching and foliar spray with *Trichoderma asperellum* + *Pseudomonas fluroscence* (5gm/kg, 5gm/lit) recorded significantly lowest mean disease incidence (2.77 %) followed by T_4, ST + foliar spray and drenching with Carbendazim 12WP + Mancozeb 63WP (5.85 %) whereas, T_8 (ST + foliar spray and drenching with Carbendazim 50WP)and T_6 (ST + foliar spray and drenching with Thiophanate methyl 70WP) recorded on par mean disease incidence. Maximum per cent disease incidence was observed in untreated control (34.39 %) followed by T_2, ST + foliar spray and drenching with copper oxychloride 50WP (19.13 %) plot. Benefit cost ratio was derived for the treatments evaluated and results revealed that highest BCR was observed in T_9 (2.24) followed by T_4 (1.90). Lowest benefit cost was obtained from T_5 (0.12) followed by control (0.18). After calculating the benefit-cost ratio for each of the treatments under consideration, the findings showed that T9 had the greatest BCR (2.24), followed by T_4 (1.90), while T5 had the lowest benefit cost (0.12), with control coming in second (0.18).

Keywords: Bio-controls, fungicides, *Macrophomina* stem blight, Dry root rot, Disease management.

INTRODUCTION

Pulses are considered as impoverished man's meat and are a significant source of additional protein for vegetarian diets. Other important constituents include minerals, riboflavin, vitamin C, phosphorus, and vital amino acids. Cereals are lower in iron and calcium than pulses. Pigeonpea is one of the protein rich legume crops grown in tropical and subtropical regions of the world. It is the second most important pulse crops of India after chickpea. In many states it is mostly eaten as split pulse, or "dal" or as fresh vegetable (de-hulled split peas); in other areas, it is consumed as a green vegetable. The deep root system of pigeonpea helps in extracting the nutrients and moisture from deeper soil layers and helps in breaking the hard soil surface (Ade *et al*., 2018), which improves the soil structure by penetrating its tap roots deep inside and spreading its lateral roots horizontally. Hence, it is called as "Biological plough" (Singh *et al*., 2018; Geeta *et al.*, 2021). The crop can fix atmospheric nitrogen and has the flexibility to solubilize fixed phosphorus (Ae *et al*., 1990; Fossou *et al*., 2016; Mhango *et al*., 2018). The heavy shedding of leaves adds considerable organic matter to the soil system.

Numerous biotic (fungal infections, insects, and storage pests) and abiotic (drought, temperature, photoperiodism, mineral deficiencies) factors can impact pigeonpea and prevent them from reaching their full potential in terms of productivity. In pigeonpea, *Fusarium* wilt (*Fusarium udum* Butler) and sterility mosaic were the most known diseases affecting the crop in its potential performance. However, in recent years, Phytophthora blight (*Phytophthora drechsleri* f.sp. *cajani*) and *Macrophomina* stem blight (MSB) and dry root rot (DRR) have become the most devastating diseases of pigeonpea since 2020. The MSB & DRR are influenced by mono-cropping, very closer spacing, severe drought. Under these disease favourable conditions, yield loss ranging from 10-100 per cent were reported by Smita *et al*. (2015). In Karnataka during 2020 and 2021 pigeonpea was affected by MSB and DRR across the Northern region known as pulse bowl of the state. Due to lack of resistant cultivars, the current investigation was undertaken to find suitable management practices using new fungicide compounds and bio-controls.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* 2022 at ZARS, Kalaburagi for management of *Macrophomina* stem blight and dry root rot diseases in pigeonpea onTS-3R cultivar. All the treatments had seed treatment with carboxin 37.5 + thiram 37.5 DS in common except in control and bio-controls followed by spraying and drenching with fungicides and bio control agents twice, once immediately after noticing signs of wilting in control and second time at 15 days later.

Ten days after treatments imposing, the disease incidence was recorded and the final observation was taken a week before harvest.

The per cent disease incidence was recorded for wilt due to dry root rot and *Macrophomina* stem blight as below

$$\text{Per cent disease incidence} = \frac{\text{Number of plants wilted}}{\text{Total number of plants examined}} \times 100$$

Treatment details

Treatment	Chemical	Trade name	Concentration
T_1	ST + foliar spray and drenching with carboxin 37.5 + thiram37.5%	Vitavax power	1g/lit
T2	ST + foliar spray and drenching with copper oxychloride 50WP	Blitox 50 W	1g/lit
T_3	ST + foliar spray and drenching with Mancozeb 75WP	M-45	2g/lit
T_4	ST + foliar spray and drenching with Carbendazim12WP + Mancozeb 63WP	Saaf	2g/lit
T_5	ST + foliar spray and drenching with Chlorothalonil 50WP	Kavach	2g/lit
T_6	ST + foliar spray and drenching with Thiophanate methyl 70WP	Topsin M	1g/lit
T_7	ST + foliar spray and drenching with Propiconazole 25 EC	Tilt	1g/lit
T_8	ST + foliar spray and drenching with Carbendazim 50WP	Bavistin	1gm/kg
T_9	ST + foliar spray and drenching with *Pseudomonas fluroscenes* +*Trichoderma asperellum*	-	Soil application 2.5kg/ha enriched in 100kg of FYM and foliar spray 5 gm/lit
T_{10}	Control	-	-

ST: Seed treatment with carboxin 37.5+thiram 37.5% @ 2g/kg seeds except in T9 and T10 plots.

RESULTS AND DISCUSSION

The field studies revealed that maximum disease reduction at 10 days after first spray and drenching was noticed in treatment T_9 (1.07%) followed by T_4 (4.5%) and T_8 (5.12 %), The treatment T6 also showed on par wilt incidence (5.55%) as of that T_8. Highest wilt incidence was found in control (26.84 %) followed by T_2 (16.30 %).

Further at 10 days after 2nd spray and drenching, significant least disease incidence was recorded in T9 (3.14%) plot followed by T_4 (5.46 %) plot. In T8 (6.22%) and T_6 (6.19%) plots on par disease incidence was observed. In control, highest Per cent Disease Incidence (PDI) (31.97 %) was observed followed by T_2 plot (18.01 %). The observations recorded a week before harvest showed similar trend in PDI among the treatments as that of earlier two observations. The least wilt incidence was recorded in T_9 plot sprayed and drenched with *Trichoderma asperellum*+ *Pseudomonas fluorescence* (4.10 %) followed by T_4 (7.61 %), T8 (8.22%) and T_6 (8.50%). Highest wilt incidence was found in control (44.67 %) followed by T_2 plot (23.09 %) presented in Table 1.

Significantly lowest mean per cent disease incidence was recorded in T_9 (2.77 %) followed by T_4 (5.85 %) whereas, T_8 and T_6 recorded on par mean disease incidence. Maximum per cent disease incidence was observed in untreated control (34.39 %) followed by T_2 (19.13 %) plot.

The results are an eye opening to understand necessity of undertaking both foliar spray and soil application of control measures instead of foliar spray alone or soil application. In an earlier effort by Chikkanna, (2014) for management of *Macrophomina* stem canker in pigeonpea, seed treatment, foliar spray of fungicides and biocontrol agents were evaluated and found that *Trichoderma viride* could have least (9.87) per cent disease incidence compared to check (34.55%) and any fungicides evaluated. However, further no effort was made in this regard and is the first study focusing control of soil inoculums responsible for dry root rot along with stem blight disease. Both foliar spray and soil drenching of biocontrol agents showed promising results in reducing the wilt incidences compared to fungicides tested.

Thombre and Kohire (2018) also reported carbendazim 12WP + mancozeb 63WP very promising in maximum reduction of mungbean blight caused by *M. Phaseolina* in both pot (83.35%) and field (67.07%) conditions over control. Invariably the biocontrol agents have the dual advantage of inhibiting the pathogens and protecting and promoting the growth of plant root system. In chickpea dry root rot management (Lokesh *et al.*, 2021) seed treatment with *Trichoderma harzianum* @ 10g/kg seed showed cent per cent reduction of disease compared with chemical fungicides seed treatment indicating the superiority of biocontrol agents over fungicides.

Table 1: Field efficacy of different fungicides and bio controls on management of wilt in pigeonpea due to stem blight and dry root rot caused by *Macrophomina pheasolina* during *kharif* 2022.

Sr. No.	Treatments	Dosage	Per cent disease incidence				Yield (q/ha)
			10 days after 1st spray	10 days after 2nd spray	Week before harvest	Mean	
1	ST+ foliar spray and soil drenching with carboxin37.5+thiram37.5%	1gm/kg	6.28 * (14.51)**	8.37 (16.82)	10.56 (18.96)	8.40 (16.85)	8.60
2	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with copper oxychloride 50WP	1g/lit	16.30 (23.01)	18.01 (25.11)	23.09 (28.72)	19.13 (25.94)	5.2
3	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Mancozeb 75WP	2g/lit	9.82 (18.26)	11.52 (19.84)	15.35 (23.07)	12.23 (20.24)	7.24
4	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Carbendazim12WP+Mancozeb 63WP	2g/lit	4.5 (12.27)	5.46 (13.52)	7.61 (16.01)	5.85 (14.0)	12.4
5	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Chlorothalonil 50WP	2g/lit	10.92 (19.30)	12.56 (20.76)	16.38 (23.88)	13.28 (21.37)	6.0
6	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Thiophanate methyl 70WP	1g/lit	5.55 (13.62)	6.19 (14.40)	8.50 (16.95)	6.74 (15.05)	10.0
7	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Propiconazole 25 EC	1g/lit	7.39 (15.77)	8.86 (17.32)	12.39 (20.61)	9.54 (17.99)	10.0
8	ST with carboxin37.5+thiram37.5% + foliar spray and drenching with Carbendazim 50WP	1g/lit	5.12 (13.07)	6.22 (14.44)	8.22 (16.66)	6.52 (14.79)	10.1
9	ST + foliar spray and drenching with *Trichoderma asperellum* + *Pseudomonas fluroscenes*	5g/lit	1.07 (5.93)	3.14 (10.21)	4.10 (11.40)	2.77 (9.46)	13.1
10	Control	-	26.84 (31.20)	31.97 (34.33)	44.38 (41.77)	34.39 (35.27)	4.34
	S.Em. ±		**0.77**	**0.74**	**1.06**	**1.08**	**0.67**
	C.D. at 5%		**2.27**	**2.19**	**3.14**	**3.20**	**1.98**
	C.V		**15.65**	**12.63**	**13.50**	**17.55**	**14.8**

*Original value **Arc sine transformed value

In the present field study bio control agents were found superior to others in reducing the disease incidence. In other crops like black gram, dry root rot was very effectively controlled by *T. viride* in the pot experiment and increased the root and shoot length of the plant (Tetali *et al.*, 2016). In mungbean *M. Phaseolina* disease incidence was reduced up to 79.23 per cent with least disease incidence (13.50%) and maximum grain yield (14.8 q/ha) in treatment of *T. harzianum* and Rhizobium as seed treatment and soil application (Kumar *et al*., 2021).

Pigeonpea yield was significantly higher in all the treatments involving fungicides and bio agents against *Macrophomina* stem blight and dry root rot causing wilt compared to untreated control plot. Maximum yield was recorded in T_9 (1312 kg/ha), followed by T_4 (1240 kg/ha). Lowest yield of 520 kg/ha was recorded in the T_2 but it was found to be significantly superior over untreated control (434 kg/ha). These results are in concurrence with the reports of Thombre and Kohire (2018) who also recorded maximum grain yield of mungbean while management of *Macrophomina* blight by foliar spray with carbendazim 12 WP + mancozeb 63WP (530 kg/ha) followed by *Trichoderma harzianum* (480 kg/ha). Paramasivan *et al*. (2022) also reported that seed treatment with *Pseudomonas fluorescens* (10g/kg), *T. asperellum* (4g/kg) recorded maximum reduction in root rot with disease incidence of 8.49 and 8.63 per cent respectively over control (34.63%). Further, soil applications of biocontrol agents fortified with FYM *viz.*, *Trichoderma asperellum* and 2.5kg+FYM @ 200kg/ha and 2.5kg *Pseudomonas fluorescens* + FYM @ 200kg/ha decreased the root rot incidence of groundnut (80.67 %) and (79.27%) over control and recorded higher yield of 1176 and 1155 kg/ha respectively.

Benefit Cost Ratio (BCR)

In the present study benefit to cost ratio of various fungicides and biocontrol agents tested was calculated. Highest BCR was observed in T_9 (2.24) followed by T_4 (1.90). Lowest benefit cost was obtained from T_5 (0.12) followed by control (0.18) shown in Table 2.

In our study, soil drenching and foliar spray with biocontrol agents and fungicides were found useful in reducing the wilt incidence and increase the yield compared to control (untreated) except in T_5 based on benefit to cost ratio analysis. Seed treatment, foliar application, and soil drenching of *Trichoderma harzianum* + *Pseudomonas fluorescence* foliar spray two times at an interval of 15 days from the first appearance of disease symptoms was found promising to control the wilting incited by *M. phaseolina* and dry root rot with increased grain yield and highest cost-benefit ratio, followed by foliar spray and soil drenching of carbendazim 12WP + mancozeb 63WP. The outcomes of our study are consistent with the conclusions made by Mahalakshmi and Devi (2021) who reported highest B:C ratio by seed treatment and Soil application of *Trichoderma harzianum* and *Pseudomonas fluorescence* in sesame root rot management during *kharif* 2016 and 2017 with a B:C ratio of 2.6 and 1.5 respectively, they also reported similar B:C ratio for seed treatment and soil drenching with carbendazim 50WP.

Table 2: Benefit cost ratio for management of wilt in pigeonpea due to stem blight and dry root rot caused by *Macrophomina pheasolina* during *kharif* 2022.

Tr. No.	Treatments	Yield (q/ha)	Treatment Cost (ha^{-1})	Cost of cultivation (ha^{-1})	Gross returns (ha^{-1})	Net returns (ha^{-1})	B:C ratio
1.	carboxin + thiram	8.6	2485	27485	58480	30995	1.13
2.	Copper oxy chloride	5.2	2445	27445	35360	7915	0.29
3.	Mancozeb	7.2	2930	27930	49232	21302	0.76
4.	Carbendazim +mancozeb	12.40	4040	29040	84320	55280	1.90
5.	Chlorothalonil	6.0	11370	36370	40800	4430	0.12
6.	Thiophanate methyl	10.08	2270	27270	68544	41274	1.51
7.	Propiconazole	10.04	4225	29225	68272	39047	1.34
8.	carbendezim	10.1	1190	26190	68680	42490	1.62
9.	*Trichoderma asperellum* + *Pseudomonas fluroscence*	13.12	2550	27550	89216	61666	2.24
10.	Control	4.35	00	25000	29580	4580	0.18

General view of management plot.

Control plot **Bio-controls treated plot**

Fig. 1. *In-vivo* management of *Macrophomina* stem blight and dry root rot diseases of pigeonpea.

CONCLUSIONS

The findings of the present study are very promising in reducing the wilt incidence caused by stem blight and dry root rot. The seed treatment with biocontrol agents protected the seeds against fungal pathogen infections during seed germination and seedling stage. Further foliar spray of biocontrol agents prevented the fresh infections by the target pathogens on stem and on roots until the crop is harvested.

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Interest of conflict. Authors have declared that no competing interests exist.

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