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Management of stem rot of groundnut through seed dressing fungicides and bio agent in natural and artificial inoculated condition

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Abstract
Pot trials were carried out in net house of Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh during *Kharif* 2017. Eight seed treatments *viz*., seed treatment (ST) with carbendazim 50% WP 2 g kg^{-1}, ST with tebuconazole 2 DS 1.5 g kg^{-1}, ST with mancozeb 75% WP, ST with carboxin 37.5% + thiram 37.5% DS, ST with carbendazim 12% WP + mancozeb 63% WP, seed treatment with *T. harzianum*, ST with *T. harzianum*+ soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} 10 g kg^{-1} at 30 DAS, ST with *P. fluorescens* + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS and a control were tested as a seed treatments against *S. rolfsii* in natural and artificial inoculated condition. Results revealed that seed treatment with *Trichoderma harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 days after sowing were recorded minimum stem rot incidence in natural (26.67%) and artificial (40%) condition and minimum disease severity in natural (22.67%) and artificial (39.33%) condition.

Keywords: Seed dresser, management, fungicides, bio agents, stem rot, natural and artificial condition

Introduction
Groundnut is an important annual oilseed crop. In India, it is cultivated in the area of 41.52 million ha with 70.77 lakh tones production and yield of 1704 kg ha^{-1}. In Gujarat, it is cultivated in the area 16.25 lakh ha with production of 30.54 lakh tones production and productivity is 1879 kg ha^{-1} (Anon., 2018) [1]. A large number of diseases attack groundnut in India. Among them, groundnut stem rot caused by *S. rolfsii* is found throughout groundnut producing areas of the world and causes the severe damage during any stage of the crop growth with greatest yield losses up to 80% in severe conditions (Saraswathi and Ravuri, 2015) [7]. Different chemical fungicides were used to control the stem rot disease. However, these chemical fungicides were found hazardous to our ecosystem. Thus, other alternative for disease management were considering among which biological control approaches promising. The present work was undertaken to test the efficacy of bio agents and chemicals as seed treatment for management of stem rot of groundnut in the pot condition.

Materials and Methods
Pot trials were conducted in net house of Department of Plant Pathology, Junagadh Agricultural University, Junagadh during *Kharif* -2017. The trial was taken in naturally stem rot infected and artificially inoculated soil in pot. In case of natural condition pots filled with naturally infected soil while in artificial condition they were inoculated with *S. rolfsii*. Eight seed treatments *viz*., seed treatment (ST) with carbendazim 50 % WP 2 g kg^{-1}, ST with tebuconazole 2 DS 1.5 g kg^{-1}, ST with mancozeb 75% WP, ST with carboxin 37.5% + thiram 37.5% DS, ST with carbendazim 12% WP + mancozeb 63% WP, seed treatment with *T. harzianum*, ST with *T. harzianum*+ soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} 10 g kg^{-1} at 30 DAS, ST with *P. fluorescens* + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS and a control were imposed to know efficacy of test fungicides and antagonist against *S. rolfsii*. Completely randomized design with three replication was adopted in both the trials. Mass multiplication of test fungus was prepared on half boil sorghum media, sterilized, followed by inoculating 4 days load culture of *S. rolfsii* and put in BOD incubator after seven days of incubation for further use. One set of 24 pots

(25 cm width x 24 cm depth) was filled with soil and mass inoculums of test fungus thoroughly mixed in pots soil @ 40 g kg^{-1}. Other set was maintained without inoculation of test fungus. One stet (three pots) inoculated with test fungus and other set un-inoculated maintained as control in each trial. Ten seed of groundnut variety GG - 20 were sown at 5 cm depth in each pot. The irrigation and other agronomical practices were adopted as and when required. Seed dressing of various fungicides and biocontrol agents used in pot culture studies along with various concentration described earlier.

Per cent incidence was calculated using formula given by Kokalis-Burelle *et al*. (1997) [5]. Periodical observations were recorded by using 1-5 rating scale as per rating 1: healthy, 2: lesion on stem only 3: Up to 25% of the plant symptomic (wilt, dead or drying), 4: 26-50% of the plant symptomic, 5: >50% of the plant symptomic given by shokes *et al.,* (1996) [8]. Disease severity (Ds) was carried out using formula given by Filion *et al*., (2003) [3].

Results and Discussion

Pot experiments were conducted to study the efficacy of different fungicides and bio control agents as seed dresser for the management of stem rot of groundnut caused by *S. rolfsii*.

The results presented in Table 1 revealed that the significantly minimum 26.67% disease incidence was recorded in seed treatment (ST) with *T. harzianum* 10 g kg^{-1} seed + soil application of *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, ST with *T. harzianum* 10 g kg^{-1} seeds, tebuconazole 2 % DS, ST 1.5 g kg^{-1} seed and mancozeb 75% ST 3 g kg^{-1} seed with 30.00, 30.00, 33.33 and 36.67%, respectively. They were remained statistically at par. Other fungicides *viz*., ST with carboxin 37.5% + thiram 37.5% DS 3 g kg^{-1} seeds (43.33%), ST with carbendazim 12% WP + mancozeb 63% WP ST 3 g kg^{-1} seed (46.67%) and ST with carbendazim 50% WP 2 g kg^{-1} seed (50.00%) found inferior in reducing stem rot disease. Maximum (53.33%) disease incidence was noted in control treatment.

Looking to the per cent disease incidence reduction, maximum of 49.99% disease incidence reduction was recorded in ST with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS. It was followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS (43.75%) and ST with *T. harzianum* 10 g kg^{-1} seed (43.75%). ST with tebuconazole 2 % DS 1.5 g kg^{-1} seed (37.50%) and ST with mancozeb 75% 3 g kg^{-1} seed (31.24%) were recorded moderately reduction in disease incidence. Less than 20% disease incidence reduction was found ST with carboxin 37.5% + thiram 37.5% DS 3 g kg^{-1} seed, ST with carbendazim 12% WP + mancozeb 63% WP 3 g kg^{-1} seed and ST with carbendazim ST 2 g kg^{-1} seed.

Similar trend, for stem rot disease severity were noted in groundnut pot trial. Significantly minimum 22.67% disease severity was recorded in ST with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS. It was followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS (24.67%), ST with *T. harzianum* 10 g kg^{-1} seed (24.67%) and ST with tebuconazole 2 % DS 1.5 g kg^{-1} seed (28.67%). They were found statistically at par. Remaining other treatments recorded disease severity in the range of 34.00 to 43.33%. Maximum disease severity was noted in control (49.33%).

Maximum per cent disease severity reduction was 59.33% in ST with *T. harzianum* 10 g kg^{-1} seed + soil application of *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS followed by ST with *P. fluorescens* 10 g kg^{-1} seeds + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, ST with *T. harzianum* 10 g kg^{-1} seed and ST with tebuconazole 2 % DS 1.5 g kg^{-1} seeds with 49.99, 49.99 and 41.88 per cent, respectively. Minimum 12.16% disease severity reduction over control was found in ST with carbendazim 2 g kg^{-1} seeds.

In artificial inoculated condition, the data presented in Table 2 revealed that the significantly minimum 40.00% disease incidence was recorded in seed treatment (ST) with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, ST with *T. harzianum* 10 g kg^{-1} seed, ST with tebuconazole 2% DS 1.5 g kg^{-1} seed, ST with mancozeb 75% 3 g kg^{-1} seed and ST with carboxin 37.5% + thiram 37.5% DS 3 g kg^{-1} seed with 43.33, 46.67, 50.00, 53.33 and 56.67 per cent incidence, respectively. They were found statistically at par. Highest disease incidence of 80.00 per cent was recorded in control.

Maximum 50.00% disease incidence reduction was noted in ST with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS and ST with *T. harzianum* 10 g kg^{-1} seed with 45.84 and 41.66 per cent, respectively. Moderate disease incidence reduction over control was recorded in ST with tebuconazole 2 % DS 1.5 g kg^{-1} seed, ST with mancozeb 75% 3 g kg^{-1} seed with 37.50 and 33.34 per cent, respectively. Minimum disease reduction was found in ST with carbendazim 2 g kg^{-1} seeds (12.50%). All the treatment reduced disease severity as compared to control.

Significantly minimum 39.33% stem rot severity was recorded in ST with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, ST with *T. harzianum* 10 g kg^{-1} seed, ST with tebuconazole 2 % DS 1.5 g kg^{-1} seed and ST with mancozeb 75% 3 g kg^{-1} seed with 40.67, 42.67, 48.00 and 49.33 per cent, respectively. They were remained statistically at par with each other. ST with carboxin 37.5% + thiram 37.5% DS 3 g kg^{-1} seed (56.00%) and ST with carbendazim 12% WP + mancozeb 63% WP 3 g kg^{-1} seed (59.33%) were found moderately disease severity. Maximum 75.33% disease severity was recorded in control.

All the treatments showed disease severity reduction over control. Maximum 47.79% disease severity reduction were recorded in ST with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS followed by ST with *P. fluorescens* 10 g kg^{-1} seed + soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS, ST with *T. harzianum* 10 g kg^{-1} seed and ST with tebuconazole 2% DS 1.5 g kg^{-1} seed and ST with mancozeb 75% 3 g kg^{-1} seed with 46.01, 43.36, 36.28 and 34.52 per cent, respectively. ST with carboxin 37.5% + thiram 37.5% DS 3 g kg^{-1} seed (25.67%) and ST with carbendazim 12% WP + mancozeb 63% WP 3 g kg^{-1} seed (21.24%) were found mediocre in disease severity reduction. Minimum 7.97% disease severity reduction over control was noted in carbendazim ST 2 g kg^{-1} seeds.

These results are in conformity by the findings of Biswas *et al*. (2000) [2] and Jadav (2006) [4] who demonstrated good control of *S. rolfsii* by seed treatment of *T. harzianum*. Manjula *et al*. (2004) [6] recorded seed treatment *P. fuorescens* and *T. harzianum* were significantly effective for control of stem rot of groundnut.

Conclusion

It can be concluded from the above studies that, in natural condition, seed treatment (ST) with *T. harzianum* 10 g kg^{-1} seed + soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS was recorded minimum stem rot incidence and severity with 26.67% and 22.67%, respectively. In artificial condition, same bio control agent treatment also exhibited minimum stem rot incidence and severity with 40% and 39.33%, respectively.

Table 1: Effect of different fungicides and bio control agents on stem rot disease incidence and severity in pot trial with natural condition

S. No	Treatment	Dosage (g kg^{-1})	Disease Incidence@ (%)	Reduction in disease incidence (%)	Disease Severity@ (%)	Reduction in disease severity (%)
1.	ST with carbendazim 50% WP	2	7.08 (50.00)*	6.24	6.60 (43.33)	12.16
2.	ST with tebuconazole 2 % DS	1.5	5.80 (33.33)	37.50	5.39 (28.67)	41.88
3.	ST with mancozeb 75% WP	3	6.08 (36.67)	31.24	5.85 (34.00)	31.08
4.	ST with carboxin 37.5% + thiram 37.5% DS	3	6.61 (43.33)	18.75	6.33 (40.00)	18.91
5.	ST with carbendazim 12% WP + mancozeb 63% WP	3	6.80 (46.67)	12.49	6.45 (41.33)	16.22
6.	ST with *T. harzianum*	10	5.52 (30.00)	43.75	5.00 (24.67)	49.99
7.	ST with *T.harzianum*+ Soil application *T. harzianum* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS	10	5.19 (26.67)	49.99	4.80 (22.67)	59.33
8.	ST with *P.fluorescens*+ Soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS	5	5.47 (30.00)	43.75	5.00 (24.67)	49.99
	Control	-	7.33 (53.33)	-	7.03 (49.33)	-
	S. Em. ±	-	0.38	-	0.35	-
	CD at 5%	-	1.12	-	1.03	-
	CV %	-	10.50	-	10.32	-

@It is average of three replication

* Data within parenthesis are original value (square root transformed values + 0.5 added)

Table 2: Effect of different fungicides and bio control agents on stem rot disease incidence and severity in pot trial by artificial inoculated condition

S. No	Treatment	Dosage (g kg^{-1})	Disease incidence@ (%)	Reduction in disease incidence (%)	Disease Severity (%)	Reduction in disease severity (%)
1.	ST with carbendazim 50% WP	2	8.38 (70.00)*	12.50	8.34 (69.33)	7.97
2.	ST with tebuconazole 2 % DS	1.5	7.08 (50.00)	37.50	6.94 (48.00)	36.28
3.	ST with mancozeb 75% WP	3	7.33 (53.33)	33.34	7.03 (49.33)	34.52
4.	ST with carboxin 37.5% + thiram 37.5% DS	3	7.56 (56.67)	29.16	7.5 (56.00)	25.67
5.	ST with carbendazim 12% WP + mancozeb 63% WP	3	7.99 (63.33)	20.84	7.71 (59.33)	21.24
6.	ST with *T. harzianum*	10	6.86 (46.67)	41.66	6.54 (42.67)	43.36
7.	ST with *T.harzianum*+ Soil application *T. harzianum*2.5 kg enriched in 250 kg FYM ha^{-1}10 g kg^{-1} at 30 DAS	10	6.33 (40.00)	50.00	6.20 (39.33)	47.79
8.	ST with *P.fluorescens*+ Soil application *P. fluorescens* 2.5 kg enriched in 250 kg FYM ha^{-1} at 30 DAS	5	6.58 (43.33)	45.84	6.38 (40.67)	46.01
	Control	-	8.96 (80.00)	-	8.69 (75.33)	-
	S. Em. ±	-	0.35	-	0.42	-
	CD at 5%	-	1.03	-	1.25	-
	CV %	-	8.07	-	10.02	-

@It is average of three replication

* Data within parenthesis are original value (square root transformed values + 0.5 added)

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