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Management of stem rot by chemical fungicide, bioagents and organic amendments in groundnut

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Abstract
The Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds recorded the lowest stem rot incidence (9.14%) and highest pod yield (466 kg/ha) in field condition. The same fungicide recorded lowest mean per cent stem rot incidence (3.33%) and (9.14%) which was 93.75% and 51.89% reduced over the control at 30 to 105 days after sowing in pot culture and sick soil, respectively. In the biological management Seed treatment with *Trichoderma viride* (@10 g/kg) and Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil) recorded lowest mean per cent mean stem rot incidence (5.96%) and (10.45%) which was 88.82% and 45.00% reduced over the control at 30 to 105 days after sowing in pot culture and sick soil, respectively. In field condition Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil) recorded lowest stem rot incidence (10.45%) and Seed treatment with *Trichoderma viride* (@10 g/kg) recorded highest pod yield (343.kg/ha) which was (89.85%) increase over the control.

Keywords: Bio agent, disease incidence, fungicide, germination, pod yield, stem rot

Introduction
Oilseed crop have been the backbone of agricultural economy of India from the immemorial. Groundnut (*Arachis hypogaea* L.) family leguminaceae is believed to be a native of Brazil (South America). It is known as king of oil seeds. It was introduced in the 18th century. India share 23 percent of the world's groundnut area and production. Groundnut is one of the important oil seed crops of the world and major source of edible oil. The kernel contains 40 to 50 per cent oil and 25 to 30 per cent protein. It also contains 18 per cent carbohydrates and minerals like Ca, Mg and Fe in higher levels in an available form, vitamins B1, B2 and niacin are present in a considerable level. It is used in hydrogenation and soap industries. After extraction of the residual oil, the cake contains 7 to 8 per cent nitrogen, which is used both in fertilizer and cattle feed. The groundnut haulms provide nutritive fodder during summer season in dry farming area. It helps in improving soil fertility. Groundnut is grown on 23.25 million hectares worldwide with a total production of 40.08 million metric tone and productivity of 1676 $kgha^{-1}$ (Anonymous, 2019) [1].

Though the area under groundnut cultivation has increased considerable over last few years on account of Government policies the yields have not been increased substantially. The major constrains in the yield are diseases, Pest and unreliable rainfall.

Collar rot (*Aspergillus niger* Van Teighem), early leaf spot (*Cercospora arachidicola* Hori), late leaf spot (*Cercospora personatum* Berk and Curt), root rot (*Rhizoctonia solani* Kuhn), rust (*Puccinia arachidis* Speg.) and stem rot (*Sclerotium rolfsii* Sacc.) are the major diseases of groundnut prevalent in India (Faujdar and Oswalt, 1992) [7]. Among the diseases the stem rot disease is quite wide spread across the states due to congenial weather conditions and causes considerable yield losses (Desai and Bagwan, 2005) [6]. Stem and pod rot of groundnut caused by *S. rolfsii*, *Corticum rolfsii* are major constrains to groundnut production in many groundnut growing regions of India and pose a serious threat to post rainy and summer season groundnut and is expanding irrigated production system. Stem rot an important disease causing significant yield losses in several groundnut growing countries (Mehan *et al.*, 1994) [15]. The pathogen attacks host plant during at all stages when conditions are favourable (Punja, 1985) [22] and yield losses over 25% have been reported (Mayee and Datar, 1988) [13].

Soil borne pathogen *S.rolfsii* causes considerable damage up to 50 per cent and result in losses of production (Ray, 1994). High temperature of 30°C, dense planting, frequent irrigation, moist conditions favours infection and fungal mycelial spread within and between plants (Aycock, 1966; Punja, 1985) [22].

Recently released bunch and semi spreading varieties through susceptible to *S. rolfsii* become popular due to short duration and high yielding capacity with good shelling percentage (Mayee and Datar,1988) [13]. The soil borne disease is very difficult and uneconomical to control with chemical treatments. The conventional method to control the diseases in groundnut crop is fungicide application (Gangopadhyay, *et al.,* 1996; Nutsugah *et al.,* 2007; Rakholiya *et al.,* 2012) [8, 17, 23]. The fungicides presently recommended to manage these diseases provide protection for limited period. The continuous use of traditional fungicides may cause bioaccumulation of the toxic residues besides giving rise to resistant strains. Increased public concern about pesticide utilization and the health hazards necessitates the exploitation of alternative methods of disease control like bioagents. Management of diseases caused by these soil borne plant pathogenic fungi by chemicals are not practicable owing to high cost besides causing environmental pollution and resistance development in target fungus (Biswas and Sen, 2000; Pant and Mukopadhyay, 2001; Patibanda *et al.,* 2002; Uma Maheshwari *et al.,* 2002; Rudresh *et al.,* 2005) [4, 19, 20, 28, 26]. Effort have been made to manage the disease with biotic agents. These bioagents are less detrimental, eco-friendly and safer than synthetic pesticides (Hashim *et al.,* 2003) [9]. *Trichoderma* spp, has been shown to attack long term survival structure like sclerotia of various pathogens (Henis *et al*., 1983) [10]. In view of this an experiment was conducted for management of the Stem rot caused by *Sclerotium rolfsii* through integrated disease management practices i.e. bioagents, plant products, chemicals and other methods.

Material and Methods

To find out the efficacy of bioagents, organic amendments and fungicides against *S.rolfsii* a pot culture experiments was planned and conducted in the glass house by applying randomized block design (RBD) with three replication, 12 treatments *viz.,* T_1- Seed treatment with *Trichoderma viride* (@10 g/kg), T_2- Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg), T_3-Seed treatment with *Trichoderma viride+Pseudomonas fluorescens* (5:5 g/kg), T_4- Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil), T_5- Seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + soil application of neem cake (50 g /Kg soil), T_6- Seed treatment with *Trichoderma viride* (@10 g/kg) + soil application of *Trichoderma viride* @ 50 g /kg soil), T_7- Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg) + Soil application of *Pseudomonas fluorescens* @ 50 g /kg soil), T_8- Soil application of *Trichoderma viride* (@ 50 g /Kg soil). T_9 – Soil application of *Pseudomonas fluorescens* (@50g/ kg soil), T_{10}- Soil application of neem cake (@50 g/kg + *Trichoderma viride* @ 50g/ kg soil), T_{11}- Seed treatment with Tebuconazole (250 EC) (@1.5ml/kg of seeds and T_{12} is untreated seeds as a control.The disease symptoms expressed on susceptible JL-24 were used as standard check for comparison of yellowing, partial and complete wilting of plant or branches.

The culture of test fungi (*S. rolfsii* Sacc.) were multiplied on sterilized sorghum grains and sand; maize medium, respectively earthen pots were disinfestations with 5% solution of copper sulphate and filled with autoclaved potting mixture of soil: sand: FYM (2:1:1) .these pots were inoculated with mass culture of *S. rolfsii* watered slightly and inoculated at room temperature for a 2-3 week.

The observations on seed germination were recorded at 7 days after sowing. The seeds which did not emerged were recorde d as pre emergence mortality and post emergence mortality w as calculated on the basis of geminate seedlings at 30, 45, 60 days after sowing and final plant stand was calculated on the basis of total number of seeds sown. Severely infected plants showed drying of whole plant with damaged pods with discoloration and whitish mycelial growth on pod (Lukose *et al*., 2008) [12] The data was analysed through analysis of variance (ANOVA) technique for factorial controlled randomized design and presented at 5% level of significance (P = 0.05) by the procedure prescribed by Panse and Sukhatme (1967) [18].

Result and discussion

The data on germination, stem rot incidence percentage and pod yield by the use of chemical fungicides, bio agents and organic amendments against *Sclerotium rolfsii* in pot and sick soil is presented in table 1- 4. From the data it is revealed that the germination, stem rot incidence percentage and pod yield of ground nut was significantly influenced due to use of fungicides, bio agents and organic amendments.

A. Germination of ground nut by the use of chemical fungicides, bio agents and organic amendments against *Sclerotium rolfsii* in pot and sick soil

Significant variation was observed in ground nut by the use of chemical fungicides, bio agents and organic amendments against *Sclerotium rolfsii* in pot and sick soil (table 1). The highest germination percentage (97.93%) was recorded by the Seed treatment with *Pseudomonas fluorescens* (@ 10g/kg) + soil application of neem cake (@ 50 g/kg soil) (T_5) followed by T_3 i.e. Seed treatment with *Trichoderma viride* + *Pseudomonas fluorescens* (5:5 g/kg) (95.60%) which was 10.25 and 9.35% higher than the control in pot culture. The highest germination (98.66%) was recorded in seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil, followed by the germination percentage (93.33%) recorded by the seed treatment with Soil application of *Trichoderma viride* (@ 50 g /Kg soil) (T_8) in sick soil. The lowest germination (86.00%) and (78.00%) was recorded in un treated seed i.e. control in pat and sick soil respectively. The bacterium *P. fleuorescens* significantly inhibited mycelial growth as well as sclerotial germination of *S. rolfsii* causing stem/collar rot. The bio-agent treatments positively influenced the germination of groundnut plants. The results indicated that the treatments of bio agents used as soil application combined with FYM were relatively more effective in increasing germination as compared to individual treatment and combination with seed treatment and soil application. The effectiveness of these isolate in enhancing the growth parameters *i.e*. shoot and root length in groundnut was also reported by Bhatiya *et al.,* (2005) [3], Ramesh and Korikanthimath (2006) [24], Kolte *et al.,* (2007) Singh *et al.,* (2012) [27], Narasimhan *et al.,* (2015) [16] and Meena *et al* (2018) [14] that were corroborated to our findings.

Table 1: Germination percentage in different treatment in pot culture and sick soil

Treatment details	Pot culture		Sick plot	
	Germination percentage (%)	Germination percentage over control	Germination percentage (%)	Germination percentage over control
T1 -Seed treatment with *Trichoderma viride* (@10 g/kg)	95.5(73.01)	11.04	85.30(65.56)	9.35
T2-Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg).	94.53(72.26)	9.91	81.00(60.43)	3.84
T3-Seed treatment with *Trichoderma viride* + *Pseudomonas fluorescens* (5:5 g/kg).	95.60(74.30)	11.16	82.00(55.87)	5.12
T4 - Seed treatment with *Trichoderma viride* (@ 10 g/kg)+ soil application of neem cake (50 g /Kg soil).	94.13(71.11)	9.45	89.33(68.77)	14.52
T5- -Seed treatment with *Pseudomonas fluorescens* (@10 /kg)+soil application of neem cake (50 g /Kg soil).	97.93(78.93)	13.87	86.00(61.58)	10.25
T6 -.Seed treatment with *Trichoderma viride* (@10 g/kg) + soil application of *Trichoderma viride* (@ 50 g /Kg soil).	95.00(73.53)	10.46	90.66(65.66)	16.23
T7- -Seed treatment with *Pseudomonas fluorescens* (@10 g/kg)+ Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil).	93.06(69.28)	8.20	98.66(84.56)	26.48
T8- -Soil application of *Trichoderma viride* (@ 50 g /Kg soil).	95.13(72.22)	10.61	93.33(69.18)	19.65
T9 -Soil application *Pseudomonas fluorescens* (@ 50 g/ Kg soil).	89.53(68.06)	4.10	82.66(61.83)	5.97
T10- -Soil application of neem cake (@50 g/kg + *Trichoderma viride* @ 50g/ kg soil).	90.53(64.92)	5.26	82.33(55.68)	5.55
T11 -Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds.	88.93(62.87)	3.40	86.66(63.41)	11.10
T12 - Control (untreated).	86.00(60.66)	0.00	78.00(51.27)	0.00
SE ±	3.1		8.3	
CD at 5%	9.3		2.4	

* Figures in parenthesis are Arc sin transformed values

B. Stem rot incidence percentage in different treatment in pot and sick plot

There was significant variation in stem rot incidence due to fungicide, bioagents and organic amendments in groundnut in pot culture and sick soil (table 2-3). In the biological management Seed treatment with *Trichoderma viride* (@10 g/kg) (T_1) and Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil) (T_4) recorded lowest mean per cent mean stem rot incidence (5.96%) and (10.45%) which was 88.82% and 45.00% reduced over the control at 30 to 105 days after sowing in pot culture and sick soil, respectively. (Table 2-3) The Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds (T_{11}) recorded lowest mean per cent stem rot incidence (3.33%) and (9.14%) which was 93.75% and 51.89% reduced over the control at 30 to 105 days after sowing in pot culture and sick soil, respectively.

Trichoderma viride attack directly and lyses the mycelium and sclerotia of *Sclerotium rolfsii* by hyphal coiling, entry through haustoria like structure and direct entry in hypha and scleroria gave efficient control over stem rot. Biswas and Sen (2000) [4] reported that stem rot of groundnut caused by *S. rolfsii* was significantly reduced by *T. harzianum* when delivered as seed dressing or soil application in the pot trials. Karthikeyan *et al.* (2006) [11] reported that one among the three isolates of *T. viride*, one isolate each of *T. harzianum* and *Pseudomonas fluorescens* were inhibitory to the growth of *S. rolfsii* the causal agent of stem rot of groundnut that are also supported to our study. Similar findings were reported by Singh and Dwivedi (1987), Thiribhuvanamala *et al.* (1999), Dandnaik *et al.,* (2000), Bahel (2002).

Table 2: Stem rot incidence percentage in different treatment in pot culture

Treatment details	Stem rot incidence after DAS (%)						
	30 DAS	45 DAS	60 DAS	75 DAS	105 DAS	Mean incidence (%)	Mean reduction (%) over control
T_1- Seed treatment with *Trichoderma viride* (@10 g/kg)	11.93(6.86)	0(0.00)	0(0.00)	5.79(33.37)	12.12(6.95)	5.96	88.82
T_2 -Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg).	23.77(13.99)	0(0.00)	5.03(2.89)	5.85(33.57)	13.54(7.78)	9.63	81.93
T_3 - Seed treatment with *Trichoderma viride* + *Pseudomonas fluorescens* (5:5 g/kg).	16.62(9.72)	1.44(0.82)	4.34(2.49)	6.03(34.52)	14.78(8.40)	8.64	83.79
T_4- Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil).	12.87(7.43)	3.75(1.00)	1.44(0.82)	5.33(30.68)	16.64(9.47)	8.00	84.99
T_5-Seed treatment with *Pseudomonas fluorescens* (@10 /kg) + soil application of neem cake (50 g /Kg soil).	15.13(8.72)	0(0.00)	2.22(1.27)	8.00(45.88)	14.68(8.44)	8.00	84.99
T_6-Seed treatment with *Trichoderma viride* (@10 g/kg) + soil application of *Trichoderma viride* (@ 50 g /Kg soil).	14.64(8.41)	6.03(3.45)	4.68(2.68)	7.10(4.07)	35.85(21.81)	13.66	74.38
T_7-Seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil).	9.55(5.48)	6.38(3.65)	3.66(2.09)	10.83(62.19)	24.16(14.25)	10.91	79.53
T_8-Soil application of *Trichoderma viride* (@ 50 g /Kg soil).	15.63(9.04)	7.37(4.22)	7.18(4.13)	12.91(74.97)	29.58(17.72)	14.53	72.74
T_9 -Soil application *Pseudomonas fluorescens* (@ 50 g/Kg soil).	10.46(6.03)	10.33(5.92)	0.(0.00)	13.77(80.18)	36.06(22.06)	14.12	73.51
T_{10} -Soil application of neem cake (@50 g/kg + *Trichoderma viride* @ 50g/ kg soil).	11.1(6.37)	16.50(9.67)	7.42(4.26)	10.02(57.02)	24.17(14.55)	13.84	74.04
T_{11}-Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds.	1.33(0.67)	0(0.00)	0(0.00)	4.33(24.84)	11.00(6.32)	3.33	93.75
T_{12}-Control (untreated).	30.36(17.95)	35.41(21.30)	18.41(10.66)	82.45(69.41)	100(89.98)	53.32	
SE ±	3.7	3.11	1.85	6.3	4.9		
CD at 5%	11.05	9.13	5.43	18.48	14.5		

* Figures in parenthesis are Arc sin transformed values

Table 3: Stem rot incidence percentage in different treatment in Sick soil

Treatment details	Stem rot incidence percentage (%)						
	30 DAS	45 DAS	60 DAS	75 DAS	105 DAS	Mean incidence (%)	Mean reduction (%) over control
T_1. Seed treatment with *Trichoderma viride* (@10 g/kg)	2.6(1.48)	3.99(2.28)	8.20(4.70)	14.96(8.60)	24.97(14.45)	10.94	42.42
T_2 -Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg).	2.66(1.52)	4.96(2.84)	6.99(4.00)	13.76(7.91)	26.07(15.11)	10.88	42.73
T_3 . Seed treatment with *Trichoderma viride* + *Pseudomonas fluorescens* (5:5 g/kg).	2.76(1.58)	5.20(2.98)	8.80(5.04)	15.57(8.95)	26.51(15.37)	11.76	38.10
T_4. Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil).	2.10(1.20)	3.12(1.78)	8.00(4.58)	14.00(8.04)	25.05(14.50)	10.45	45.00
T_5.Seed treatment with *Pseudomonas fluorescens* (@10 /kg)+soil application of neem cake (50 g /Kg soil).	2.26(1.29)	3.98(2.28)	7.02(4.02)	15.50(8.91)	24.12(13.95)	10.97	42.26
T_6-Seed treatment with *Trichoderma viride* (@10 g/kg) + soil application of *Trichoderma viride*(@ 50 g /Kg soil).	2.47(1.41)	4.43(2.54)	8.88(5.09)	16.20(9.32)	27.49(15.95)	11.83	37.79
T_7.Seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil).	2.88(1.65)	6.00(3.43)	9.08(5.20)	16.09(9.25)	28.91(16.87)	12.59	33.73
T_8.Soil application of *Trichoderma viride* (@ 50 g /Kg soil).	2.74(1.57)	6.10(3.49)	8.92(5.11)	15.90(9.14)	26.80(15.54)	12.09	36.36
T_9 .Soil application *Pseudomonas fluorescens* (@ 50 g/Kg soil).	3.01(1.72)	7.57(4.34)	9.00(5.16)	17.29(9.95)	32.00(18.66)	13.77	27.52
T_{10} -Soil application of neem cake (@50 g/kg + *Trichoderma viride* @ 50g/ kg soil).	3.01(1.72)	7.67(4.40)	9.15(5.24)	17.20(9.90)	30.21(17.68)	13.44	29.26
T_{11}.Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds.	0.38(0.21)	2.98(1.70)	6.08(3.48)	13.00(7.46)	23.27(13.55)	9.14	51.89
T_{12}.Control (untreated).	3.38(1.94)	9.55(5.48)	14.02(8.07)	23.00(13.29)	45.07(26.78)	19.00	0.00
SE ±	0.24	0.22	0.22	0.30	2.03		
CD at 5%	0.72	0.65	0.65	0.89	5.97		

* Figures in parenthesis are Arc sin transformed values

C. Stem rot incidence and pod yield in different treatment in field condition

There was significant variation in stem rot incidence and pod yield due to fungicide, bioagents and organic amendments in groundnut in field condition (table 4). The Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds recorded the lowest stem rot incidence (9.14%) and highest pod yield (466 kg/ha) in field condition. Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil) recorded lowest stem rot incidence (10.45%) and Seed treatment with *Trichoderma viride* (@10 g/kg) recorded highest pod yield (343.kg/ha) which was (89.85%) increase over the control. *Trichoderma* spp. produced a growth regulating factor that increased the rate of seed germination and dry weight which helped to overcome the seedling mortality ultimately resulted in higher population and yield in ground nut. Conclusively, the bio-agents used as soil application in combined with organic amendments reduced the disease incidence more effectively as compared to seed treatment and combination with seed treatment and soil application of bio-agents. All the bioagents treatments significantly enhanced the crop production, minimize seedling mortality percentage and increase per cent survival of groundnut plants. Singh and Singh (2012) [27] and Upadhyay and Mukopadhyay (1983) [29] also found significant effect of treatments with respect to reduce disease incidence, disease control and enhanced the plant yield production that were supported to our investigation. The reduction in soil borne plant diseases and subsequent enhancement in the yield of different crops after treatment with formulations of *Trichoderma* spp. has been reported by Subbaiah *et al.*, (2003), Darvin (2013) [5], Prasad *et al.*, (2017) [21] and Rashmi *et al.*, (2017) [25].

Table 4: Stem rot incidence and Pod yield in different treatment in field condition

Treatment details	Stem rot incidence (%)	Pod yield (kg/ha)	Increased pod yield over control
T_1 -Seed treatment with *Trichoderma viride* (@10 g/kg)	10.94	343.00	89.85
T_2.-Seed treatment with *Pseudomonas fluorescens* (@ 10 g/kg).	10.88	342.00	89.30
T_3-Seed treatment with *Trichoderma viride* + *Pseudomonas fluorescens* (5:5 g/kg).	11.76	264.66	46.49
T_4 - Seed treatment with *Trichoderma viride* (@ 10 g/kg)+ Soil application of neem cake (50 g /Kg soil).	10.45	290.00	60.52
T_5. -Seed treatment with *Pseudomonas fluorescens* (@10 /kg) + soil application of neem cake (50 g /Kg soil).	10.97	304.00	68.27
T_6 -.Seed treatment with *Trichoderma viride* (@10 g/kg) + soil application of *Trichoderma viride* (@ 50 g /Kg soil).	11.83	241.33	33.58
T_7. -Seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil).	12.59	295.33	63.47
T_8. -Soil application of *Trichoderma viride* (@ 50 g /Kg soil).	12.09	290.00	60.52
T_9 -Soil application *Pseudomonas fluorescens* (@ 50 g/ Kg soil).	13.77	296.00	63.84
T_{10}. -Soil application of neem cake (@50 g/kg + *Trichoderma viride* @ 50g/ kg soil).	13.44	280.00	54.98
T_{11} -Seed treatment with Tebuconazole (250 EC) (@ 1.5ml/kg) of seeds.	9.14	466.00	157.94
T_{12} - Control (untreated).	19.00	180.66	00.00
SE ±	0.59	30.14	
CD at 5%	1.17	890.56	

Conclusion

The fungicides, Tebuconazole seed treatment @ 1.5 ml/kg of seeds has shown lowest stem rot incidence and pod yield in the field condition. The same fungicide recorded the lowest mean per cent stem rot incidence in pot culture and sick soil. In the biological management the seed treatment with *Seed treatment with Pseudomonas fluorescens (@10 /kg)*+soil application of neem cake (50 g /Kg soil) and Seed treatment with *Pseudomonas fluorescens* (@10 g/kg) + Soil application *Pseudomonas fluorescens* (@ 50 g /Kg soil). Recorded highest seed germination in pot culture and sick soil, respectively. In field condition Seed treatment with *Trichoderma viride* (@ 10 g/kg) + soil application of neem cake (50 g /Kg soil) recorded lowest stem rot incidence and Seed treatment with *Trichoderma viride* (@10 g/kg) recorded highest pod yield which was (89.85%) increase over the control

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