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Studies on the efficacy of fungicides, organic amendments and biocontrol agent on Dry Root Rot (*Rhizoctonia bataticola*) of groundnut *in vivo*

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Pot culture studies with groundnut cv TCGS 888 under sterilized soil conditions indicated efficacy of mancozeb seed treatment @ 3g / Kg seed (66.7%) and neem cake soil application @ 0.5 t / ha (66.7%) applied either alone or in integration with *T. virens* in decreasing groundnut root rot incidence. Under unsterilized soil conditions, integration of mancozeb seed treatment, soil application of neem cake and biocontrol agent reduced groundnut root rot incidence by 90 per cent followed by mancozeb seed treatment alone by 70 per cent. Maximum vigour index (2940) was observed due to application of neem cake and *T. virens* under sterilized soil conditions. However, under unsterilized soil conditions only mancozeb and its combinations resulted in sustenance of vigour index (3040) in comparison with pathogen uninoculated check. Maximum dry weight of groundnut plants was observed due to application of mancozeb (2.9 g), neem cake (3.2 g) and *T. virens* either alone (2.7g) or its combinations under sterilized soil conditions. However, under unsterilized conditions, only mancozeb (30.0 g) and its combinations resulted in sustenance of biomass of the plant expressed as dry weight. Involving biocontrol agent or mancozeb gave significant increase in root nodulation under unsterilized soil conditions.

Key words: Mancozeb, *T.viride,* neem cake, groundnut, *R.bataticola*

INTRODUCTION

Groundnut *(Arachis hypogaea* Linn.) is one of the most important oil seed crop in the world and is believed to be native of South America. India has gradually become a major groundnut producing country in the world during last 5 to 6 decades. The crop assumes a great significance in the present day economy. India is the largest producer of groundnut in the world. More than 55 pathogens including viruses have been reported to cause diseases on groundnut. Besides foliar diseases like Tikka leaf spot and rust, root rot caused by *Macrophomina phaseolina* and wilt caused by *Sclerotium rolfsii* are attaining significance causing heavy losses to the groundnut yields in the recent years. Hence the present investigation has been undertaken to assess the performance of fungicides, organic amendments and bio control agent either alone or in integration in reducing dry root rot of groundnut *in vivo* under pot culture conditions.

MATERIALS AND METHODS

The following treatments, chosen based on the results obtained *in vitro*, were evaluated to assess their performance either alone or in integration in reducing dry root rot of groundnut *in vivo* under pot culture conditions. Each treatment was assessed for its performance in 'sterilized' and 'unsterilized' soil conditions separately.

Treatments

1. *T.virens* alone (0.01 g / kg soil)
2. Neem cake alone (0.5 tonnes/ ha soil)
3. Mancozeb alone as seed treatment (3 g/kg seed)
4. *T.virens* (0.01 g / kg soil) + Neem cake (0.5 tonnes/ ha soil)

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5. *T.virens* (0.01 g / kg soil) + Mancozeb (3 g/kg seed)

6. Neem cake (0.5 tonnes/ ha soil) + Mancozeb (3 g/kg seed)

7. *T.virens* (0.01g / kg soil) + Neem cake (0.5 tonnes/ ha soil) + mancozeb (3 g/kg seed)

Sorghum grain culture of *R. bataticola* was inoculated @100 g /6 kg soil pot. Twenty four hours after pathogen inoculation, *T.virens* mass multiplied on sorghum grains was added to top 12.5 cm soil and thoroughly mixed. Forty eight hours after pathogen inoculation (i.e., at the time of sowing), treatments such as seed treatment with fungicide and neem cake soil application were incorporated. Five groundnut seeds of cv TCGS-888 were sown in each pot and watered sufficiently. Observations were recorded on per cent germination (10 days after sowing), disease incidence / plant mortality, root length, shoot length, number of root nodules and dry weight of the plant.Untreated seeds were sown in pathogen uninoculated pots to compare the germination per cent and disease incidence :

Per cent plant mortality was estimated by using the formula. :

Per cent plant mortality = Total number of plants died / Total number of seeds sown

Vigour index was assessed using the formula given by Gopalakrishnan *et al* (2006).

Vigour index = per cent germination x mean total length of seedlings (cm).

RESULTS AND DISCUSSION

Effect of integration of fungicides, organic amendment and T.virens on dry root rot incidence of groundnut under pot culture conditions

Groundnut cv TCGS-888 germinated equally well (100%) in both sterilized and unsterilized soil conditions, in the presence (pathogen check) or absence of pathogen (pathogen uninoculated check). Under sterilized soil conditions 60 per cent mortality of groundnut plants was observed at 45 days after inoculation, whereas in unsterilized soil condition the same was 66.7 per cent (Tables 1 and 2).

Under sterilized soil conditions all the treatment viz., *T. virens* soil application 0.01 g/kg soil, mancozeb seed treatment @ 3 g/kg seed, soil application of neem cake @ 1.2 g/kg soil, *T.virens* + mancozeb, *T.virens* + neem cake, neem cake + mancozeb, and

Table 1: Effect of BCA, fungicide and organic amendment applied either alone or in combination on the incidence of dry root of groundnut in sterilized soil

Treatment	Germination (%)	Plant mortality (%)	Disease control (%)
T. virens (Tv)	100	26.6 (30.8)	55.7
Neem cake (Nc)	100	20(26.6)	66.7
Mancozeb (Mz)	100	20 (26.6)	66.7
Tv +Nc	100	20 (26.6)	66.7
Tv +Mz	100	26.6 (30.8)	55.7
Nc + Mz	100	40 (39.2)	33.3
Tv + Nc + Mz	100	40 (39.2)	33.3
Pathogen Check	100	60 (50.7)	-
Uninoculated Check	100	-	-
CD (p=0.05)		8.67	-
CV (%)		10.76	-

Tv –*T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Figures in parenthesis are arc sine value; Three replications were maintained for each treatment; BCA – Biocontrol agent, T- *Trichoderma*

Table 2: Effect of BCA, fungicide and organic amendment applied either alone or in combination on the incidence of dry root of groundnut in unsterilized soil.

Treatment	Germination (%)	Plant mortality (%)	Disease control (%)
T. virens (Tv)	100	60 (51.1)	10.1
Neem cake (Nc)	100	86.7 (69.2)	-30
Mancozeb (Mz)	100	20 (26.6)	70
Tv +Nc	100	66.6 (54.7)	0.5
Tv +Mz	100	80 (63.4)	-19.9
Nc + Mz	100	40 (39.2)	40
Tv + Nc + Mz	100	6.7 (14.9)	90
Pathogen check	100	66.7 (54.9)	-
Uninoculated Check	100	-	-
CD (p=0.05)		8.9	-
CV (%)		8.0	-

Tv –*T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Figures in parenthesis are arc sine values; Three replications were maintained for each treatment; BCA – Biocontrol agent, T- *Trichoderma*

T.virens + neem cake + mancozeb were found significantly better in decreasing the dry root rot incidence in groundnut. Least mortality (20%) of groundnut plants was recorded with neem cake, mancozeb and in *T.virens* + neem cake combination which was equivalent to 66.7 per cent disease control. *T.virens* applied either alone or in combination with mancozeb were found to be on par with 55.7 per cent disease control. Neem cake + mancozeb and neem cake + *T.virens* + mancozeb gave 33.3 per cent disease control, and were on par with *T.virens* and *T.virens* + mancozeb. The present study indicated that mancozeb and neem cake were found to be effective either alone or when integrated with *T. virens*.

Table 3: Effect of BCA, fungicide and organic amendment applied either alone or in combination on vigour index of groundnut in sterilized soil

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Vigour index
T. virens (Tv)	100	20.1	8.3	2840
Neem cake (Nc)	100	22.6	9.2	3177
Mancozeb (Mz)	100	19.2	8.5	2767
Tv +Nc	100	21.2	8.2	2940
Tv +Mz	100	18.1	7.8	2590
Nc + Mz	100	18.2	8.0	2613
Tv + Nc + Mz	100	18.2	8.9	2710
Pathogen Check	100	15.3	5.9	2127
Uninoculated Check	100	19.6	8.3	2790
CD (p=0.05)		4.86	1.69	592.1
CV (%)		10.9	8.9	9.23

Tv – *T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Vigour index = Per cent Germination x Mean total length of seedlings (cm); Three replications were maintained for each treatment; BCA – Biocontrol agent, T- *Trichoderma*

Table 4: Effect of BCA, fungicide and organic amendment applied either alone or in combination on vigour index of groundnut in unsterilized soil

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Vigour index
T. virens (Tv)	100	15.6	7.4	2310
Neem cake (Nc)	100	14.5	5.6	2003
Mancozeb (Mz)	100	19.9	9.1	2893
Tv +Nc	100	16.1	8.5	2470
Tv +Mz	100	17.8	9.3	2717
Nc + Mz	100	19.3	8.8	2817
Tv + Nc + Mz	100	20.1	10.3	3043
Pathogen Check	100	15	6.1	2110
Uninoculated Check	100	21.4	8.5	2997
CD (p=0.05)		4.63	2.13	570.2
CV (%)		11.16	11.07	9.4

Tv – *T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Vigour index = Percent Germination x Mean total length of seedlings (cm), Three replications were maintained for each treatment, BCA – Biocontrol agent, T- *Trichoderma*

Table. 5: Effect of BCA, fungicide and organic amendment applied either alone or in combination on the dry weight of groundnut plants in unsterilized and sterilized soil.

Treatment	Dry weight (grams)	
	Unsterilized soil	Sterilized soil
T. virens (Tv)	2.3	2.7
Neem cake (Nc)	1.4	3.2
Mancozeb (Mz)	3.0	2.9
Tv +Nc	2.2	2.9
Tv +Mz	2.7	2.7
Nc + Mz	2.4	2.3
Tv + Nc + Mz	2.7	2.8
Pathogen Check	1.6	1.3
Uninoculated Check	2.6	2.6
CD (p=0.05)	0.76	0.69
CV (%)	14.1	11.38

Tv – *T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Three replications were maintained for each treatment; BCA – Biocontrol agent, T- *Trichoderma*

Durai *et al.* (2006) observed that seed treatment with mancozeb 100 ppm gave only 36 per cent incidence of charcoal rots in sesame in comparison with 82 per cent incidence in pathogen check. Ramesh and Korikanthimath (2006) reported that *T. viride* applied as seed treatment and combination of seed treatment in soil application gave 50.4 per cent and 47.7 per cent seed germination of groundnut in comparison with 37.9 per cent in inoculated control. The same treatments recorded 9.7 per cent and 7.9 per cent root rot incidence compared to 19.9 per cent in control. Ushamalini *et al.* (1997) reported that application of neem cake @ 150 kg/ha resulted in

only 14.8 per cent root rot incidence in cowpea due to *M.phaseolina* compared to 38.3 per cent in control. Similar result of decreased disease incidence of sorghum charcol rot due to application of neem cake @ 500 kg/ha was reported by Jamadar and Desai (1996) and Ramesh and Korikanthimath (2006).

Under unsterilized soil conditions, among the individual treatments only mancozeb found to decrease the root rot incidence of groundnut (20% plant mortality equivalent 70% disease control). Least per cent plant mortality (14.9%) was observed when *T.virens* (soil application), neem cake (soil application) and mancozeb (seed treatment) were integrated which was equivalent to 90 per cent disease control followed by seed treatment with mancozeb alone (26.6% plant mortality which is equivalent to 70% disease control). Thus the present investigation revealed that in unsterilized soil seed

Table. 6: Effect of BCA, fungicide and organic amendment applied either alone or in combination on the root nodule formation in groundnut plants in unsterilized.

Treatment	No. of root nodul es per plant
	Un sterilized soil
T.virens (Tv)	7.3
Neem cake (Nc)	7.6
Mancozeb (Mz)	7.0
Tv +Nc	7.6
Tv +Mz	7.0
Nc + Mz	6.6
Tv+ Nc + Mz	8.3
Pathogen Check	4.0
Uninoculated Check	6.0
CD (p=0.05)	2.16
CV (%)	13.5

Tv –*T.virens* @0.01 g/kg soil; Nc-Neemcake @ 1.2 g/kg soil; Mz-Mancozeb @ 3 g/kg seed; Combination treatments received equal dose as that of individual treatment; Three replications were maintained for each treatment; BCA – Biocontrol agent, T- *Trichoderma*

treatment with mancozeb alone @ 3 g/kg seed, and integration of *T.virens* (soil application), mancozeb (seed treatment) and neem cake (soil application) appeared better in managing dry root rot of groundnut cv TCGS-888 among all the treatments evaluated. Pandey and Pandey (2005) reported that the germination per cent of tomato, chilli and brinjal seed substantially increased with the application of *Trichoderma* spp. in sterilized soil compared to unsterilized soil.

Effect of application of neem cake, T.virens and mancozeb on vigour index of groundnut under pot culture conditions

Vigour index depends on germination percentage and total length of the plant, and indicates growth promotion due to application of different management strategies applied either alone or in integration. In the present investigation neem cake (3177) and *T.virens* (2840) applied either alone or in combination (2940) with each other resulted in maximum vigour index, which were on par among themselves and with the pathogen uninoculated check (2790) in sterilized soil conditions (Tables 3 and 4).

In unsterilized soil, maximum vigour index was observed when mancozeb was integrated with neem cake and *T.virens* (3043) (Table 4). However, this was on par with pathogen uninoculated check (2997) and also with other combinations involving mancozeb but differed significantly when compared to pathogen inoculated check (2110). Application of neem cake (2003) or *T.virens* (2310) did not improve vigour index in comparison with pathogen inoculated check (2110) and were on par with each other. Bagri *et al.* (2004) reported higher vigour index in chick pea with seed treatment, (1406) compared to *M.phaseolina* inoculated check (811) under sterilized soil conditions.

Effect of application of T.virens, neem cake and mancozeb on dry weight of groundnut plants under pot culture condition

The result indicated that in uninoculated check the average dry weight of groundnut plants was 2.6 g in sterilized and also in unsterilized soil conditions (Table 5). However, the average dry wt in case pathogen inoculated pots was 1.6 g in unsterilized soil and 1.3 g in sterilized soil condition. This indicated significant reduction in dry weight in comparison with uninoculated check. All the treatments tested were on par with uninoculated check in sterilized soil condition but differed significantly with pathogen inoculated check.

In unsterilized soil conditions, all the treatments except neem cake applied and, neem cake and *T.virens* integrated treatments showed significant increase in dry weights compared to inoculated check, but were on par with uninoculated check. Maximum dry weight of groundnut plants was observed with integration of *T.virens*, neem cake and mancozeb (2.7 g) under unsterilized soil conditions. Under sterilized soil conditions neem cake alone applied gave maximum dry weight (3.2 g). Rajeswari *et al.* (1999) reported increased dry weight of mung bean plants with soil application of *T.virens* compared to pathogen inoculated control.

Effect of application of neem cake T.virens and mancozeb on root nodule formation of groundnut under pot culture condition

Groundnut, being a leguminous crop, has the ability to utilize atmosphere N through *Rhizobium* nodules. Hence, the no. of nodules indicated not only health of the plant but also impact of pathogen on the root system (Table 6). All the treatments gave significantly superior nodulation compared to pathogen check in unsterilized soil. Except neem cake applied either alone or in combination with *T.virens* or mancozeb, remaining all other treatments gave significant increase in root nodulation.

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