

RESEARCH ARTICLE

Integrated management of dry root rot [*Rhizoctonia bataticola* (Taub.) Butler] of chickpea

■ S. Raj Kumar, T. Srinivas, V. Prasanna Kumari and D. V. Sai Ram Kumar

SUMMARY

In vivo screening of natural farming product like bheejamrutha and cotton cake individually and in combination with mancozeb tolerant fungal antagonist *Trichoderma viride* isolate 3 (Tv-3) and fungicide mancozeb were tested against *Rhizoctonia bataticola* in pot culture under green house conditions and field conditions. The results revealed that seed treatment with bheejamrutham (200 ml kg⁻¹) + soil application of Tv-3 conidial suspension @ 1×10⁸ CFU ml⁻¹ fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha⁻¹ was found to be superior as it recorded the least disease incidence of 11.11 per cent and maximum shoot length, root length, highest vigour index, maximum fresh and dry weight. Integrated disease management of dry root rot of chickpea indicates that seed treatment with bheejamrutham (200 ml kg⁻¹) + soil application of Tv-3 conidial suspension @ 1×10⁸CFU ml⁻¹ fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha⁻¹ performed better in managing dry root rot of chickpea with a per cent disease reduction of 65.04 and recorded highest yield of 2263 kg ha⁻¹ followed by seed treatment with mancozeb @ 2.5 g kg⁻¹ + soil application of Tv-3 conidial suspension @ 1×10⁸ CFU ml⁻¹ fortified with 100 kg FYM @ 0.5%. + soil application of cotton cake @ 200 kg ha⁻¹

Key Words : Chickpea, *Rhizoctonia bataticola*, Trichoderma, Bheejamrutham, Cotton cake, Mancozeb

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Chickpea (*Cicer arietinum* L.) is one of the major grain legume pulse crops grown in India and other semi-arid regions of the world. In India, chickpea is cultivated in an area of about 10.22 M ha with a production of 9.8 M t and with the average productivity of 920 kg ha⁻¹ (Ministry of Agriculture and Farmers Welfare, 2017). In Andhra Pradesh, it is grown in an area of 6.30 lakh ha with an annual production of 9.12 lakh t and with a productivity of 1233 kg ha⁻¹ (Ministry of

Agriculture and Farmers Welfare, 2016).

The chickpea crop was reported to be attacked by nearly 172 pathogens (67 fungi, 22 viruses, 3 bacteria, 80 nematodes and mycoplasma) from all over the world (Nene *et al.*, 1996). However, only a few have the potential in devastating the crop. Some of the serious diseases in chickpea are Dry root rot (*Rhizoctonia bataticola*), wilt (*Fusarium oxysporum* f. sp. *ciceri*), wet root rot (*Rhizoctonia solani*), ascochyta blight (*Ascochyta rabiei*) and collar rot (*Sclerotium rolfsii*). Of them, dry root rot caused by *Rhizoctonia bataticola* (Taub.) Butler, is a major hindrance in our country for getting proper yields. The pathogen is soil borne and infects the crop from seedling to maturity stages leading to 10-25 per cent loss in yields. Hence, to find out the eco-friendly and economical management strategies for the disease, experiments was carried during *Rabi* 2017-18 in both the pot and the field conditions.

MATERIAL AND METHODS

Effect of selected bio agents, fungicides and natural products alone and in combination on dry root rot disease incidence and plant growth parameters in chickpea:

The experiment was conducted in greenhouse located in the Department of Plant Pathology, Agricultural College, Bapatla with the effective bioagent, *Trichoderma viride* isolate 3 (*Tv3*); fungicide mancozeb, natural farming product bheejamrutham and organic amendment cotton cake after thorough *in vitro* screening of ten bioagents, 10 fungicides, four natural farming

products and five organic amendments.

Fifteen chickpea seeds of cultivar JG-11 either treated or untreated were sown in each pot and watered sufficiently. Untreated seeds were sown in pathogen uninoculated pots to compare the disease incidence. The test pathogen *R. bataticola* was mass multiplied on sterilized sorghum seeds and added @ 30 g/ 5 kg soil. Forty eight hours after pathogen inoculation the following treatments were imposed.

Observations on the seed germination, plant population, disease incidence were recorded at 30 days and 45 days after sowing and based on the disease incidence per cent disease incidence (PDI) was calculated using the formula:

$$PDI = \frac{\text{Number of diseased plants}}{\text{Total number of seeds planted}} \times 100$$

Observations were also recorded on shoot length, root length, fresh weight, dry weight of plants and vigour index was calculated using the formula:

$$\text{Vigour index} = \text{Per cent germination} \times \text{Mean total length of seedlings (cm)}$$

Preparation of *Bheejamrutham*:

Cow urine : 5 lit
Cow dung : 5 kg
Calcium (Sunnam) : 50 g
Water : 20 lit

Container with 40-50 lit capacity has to be used for preparation. Take twenty lit water in the container and add urine / calcium in water. Tie the cow dung in a cloth and hang it half way into the container. Mix everything

Table A : Forty eight hours after pathogen inoculation

Treatments	Details
T ₁	: Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹
T ₂	: Seed treatment with conidial suspension of bio control agent (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ in the ratio of 1:1 for 30 min + Soil application of bio control agent conidial suspension @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%
T ₃	: T ₂ + Soil application of cotton cake @ 200kg ha ⁻¹
T ₄	: Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹
T ₅	: Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹
T ₆	: Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of bio control agent conidial suspension (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹
T ₇	: Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of bio control agent conidial suspension (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹
T ₈	: Soil application of cotton cake @ 200kg ha ⁻¹
T ₉	: Seed treatment with Beejamrutham @ 200ml kg ⁻¹
T ₁₀	: Pathogen inoculated
T ₁₁	: Control

very well and let it sit over night (24 hrs). Make sure to stir the mixture clockwise every 8 hours and squeeze the dung each time you stir. In 24 hours solution is ready to use.

Mass multiplication of *R. bataticola*:

For mass multiplication of the pathogen, 50g of sorghum seeds were washed thoroughly in tap water and soaked in water overnight in 250 ml conical flask with addition of a pinch of dextrose. After removing the water, the flasks were autoclaved for 20 min at 15 p.s.i and inoculated with 2-3 discs of 7 days old culture of test pathogen. After seven days the inoculum was used for studies.

Seed treatment:

A conidia suspension of the test isolates of *Tv -3* was prepared from a 7 day old culture of the isolate on PDA. The plate was flooded with 10 ml of sterile distilled water and shaken for a few minutes. The resulting suspension was filtered through muslin cloth and the conidial concentration was determined by using a haemocytometer. The spore concentration was adjusted to 10^8 conidia ml^{-1} using sterile distilled water.

Chickpea seeds were treated with *Tv -3* conidial suspension @ 1×10^8 CFU ml^{-1} in the ratio of 1:1 for 30 min prepared from one week old cultures and the seeds were used for sowing. For treatment with fungicide, the chickpea seeds were treated with compatible and effective fungicide mancozeb @ 2.5 g kg^{-1} of seeds and sown in the pathogen infested soil in the pots. Chickpea

seeds were treated with the bheejamrutham by sprinkling the bheejamrutham (200 ml kg^{-1}) on the seeds and shade dried for 10-15 minutes before sowing.

Soil application:

Soil application of *Tv -3* conidial suspension @ 1×10^8 CFU ml^{-1} fortified with 100 kg FYM @ 0.5% was kept in shade for 15 days and regularly watered for mass multiplication. Organic amendment *i.e.*, cotton cake was applied @ 200 kg ha^{-1} at 7 days before sowing in the pots. The pots were soil drenched with the mancozeb @ 2.5 g l^{-1} .

Integrated management of dry root rot of chickpea:

An experiment was laid out as per Randomized Block Design (RBD) during *Rabi-2017-18* at Agriculture College farm, Bapatla, Andhra Pradesh. The chickpea cultivar JG-11 was used for experimentation. Eight treatments replicated thrice with plot size of 5×4 m² with recommended agronomical practices were followed to conduct the experiment. The seeds were sown in each plot at 30×10 cm spacing. The sprinkler irrigations were given as and when required. Insecticidal measures were also taken out as and when required. The observations on root rot incidence was recorded at 30 and 45 days after sowing. The other observations like no. of pods $plants^{-1}$ and yield were recorded. Disease incidence (%) was calculated using the formula:

$$\text{Dry root rot incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \times 100$$

Treatments	Details
T ₁	: Seed treatment with mancozeb @ 2.5 g kg^{-1} + soil application of mancozeb @ 2.5 g l^{-1}
T ₂	: Seed treatment with <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} in the ratio of 1:1 for 30 min + soil application of <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} fortified with 100 kg FYM @ 0.5% .
T ₃	: Seed treatment with <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} in the ratio of 1:1 for 30 min + soil application of <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} fortified with 100 kg FYM @ 0.5% . + soil application of cotton cake @ 200 kg ha^{-1}
T ₄	: Seed treatment with bheejamrutham (200 ml kg^{-1}) + soil application of cotton cake @ 200 kg ha^{-1}
T ₅	: Seed treatment with mancozeb @ 2.5 g kg^{-1} + soil application of mancozeb @ 2.5 g l^{-1} + soil application of cotton cake @ 200 kg ha^{-1}
T ₆	: Seed treatment with mancozeb @ 2.5 g kg^{-1} + soil application of <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} fortified with 100 kg FYM @ 0.5% . + soil application of cotton cake @ 200 kg ha^{-1}
T ₇	: Seed treatment with bheejamrutham (200 ml kg^{-1}) + soil application of <i>Tv-3</i> conidial suspension @ 1×10^8 CFU ml^{-1} fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha^{-1}
T ₈	: Control

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of selected bio agents, fungicides and natural products alone and in combination on dry root rot disease incidence and plant growth parameters in chickpea:

Seed germination:

Seed germination was significantly superior in all the treatments when compared with T₁₀. Highest

chickpea seed germination (93.33%) was observed with T₂ followed by T₃ (91.11%) (Table 1). Significant differences were not observed between T₂ and T₃ and also at par with control (T₁₁) and significantly superior over pathogen inoculated (T₁₀). Lowest seed germination was recorded with T₄ (73.33%) and significantly reduced when compared with control (T₁₁).

Dry root rot incidence:

At 30 DAS, lowest mortality of chickpea (6.67%) was recorded in T₇ which is equivalent to 90.00 per cent disease control followed by T₆ (8.89) which is equivalent

Table 1: Effect of selected bio agents, fungicides and natural products alone and in combination on dry root rot disease incidence

Treatments	Details	Germination (%)	Per cent reduction in germination	Disease incidence (%)		Mean	Per cent disease reduction over control
				30 DAS	45 DAS		
T ₁	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹	86.67	13.33	17.78 (24.93)	26.67 (31.08)	73.33	64.71
T ₂	Seed treatment with conidial suspension of bio control agent (Tv3) @ 1x10 ⁸ CFU ml ⁻¹ in the ratio of 1:1 for 30 min + Soil application of bio control agent conidial suspension @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%	93.33	6.67	11.11 (19.46)	15.56 (23.22)	83.33	79.41
T ₃	T ₂ + Soil application of cotton cake @ 200kg ha ⁻¹	91.11	8.89	11.11 (19.46)	13.33 (21.41)	83.33	82.35
T ₄	Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹	73.33	26.67	24.44 (29.62)	31.11 (33.89)	63.33	58.82
T ₅	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹	84.44	15.56	17.78 (24.93)	24.44 (29.62)	73.33	67.65
T ₆	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of bio control agent conidial suspension (Tv3) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹	86.67	13.33	8.89 (17.34)	13.33 (21.41)	86.67	82.35
T ₇	Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of bio control agent conidial suspension (Tv3) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹	88.89	11.11	6.67 (14.96)	11.11 (19.46)	90.00	85.29
T ₈	Soil application of cotton cake @ 200kg ha ⁻¹	80.00	20.00	17.78 (24.93)	33.33 (35.25)	73.33	55.88
T ₉	Seed treatment with Beejamrutham @ 200ml kg ⁻¹	82.22	17.78	26.67 (31.08)	37.78 (37.91)	60.00	50.00
T ₁₀	Pathogen inoculated	62.22	37.78	66.67 (54.71)	75.56 (60.34)		
T ₁₁	Control	100.00	13.33	-	-	-	-
	S.E.±	3.96	-	0.40	0.49		
	C.D. (P≤0.05)	11.70	-	1.18	1.45		
	CV%	8.13	-	5.73	7.64		

*Figures in the parenthesis are arc sin values

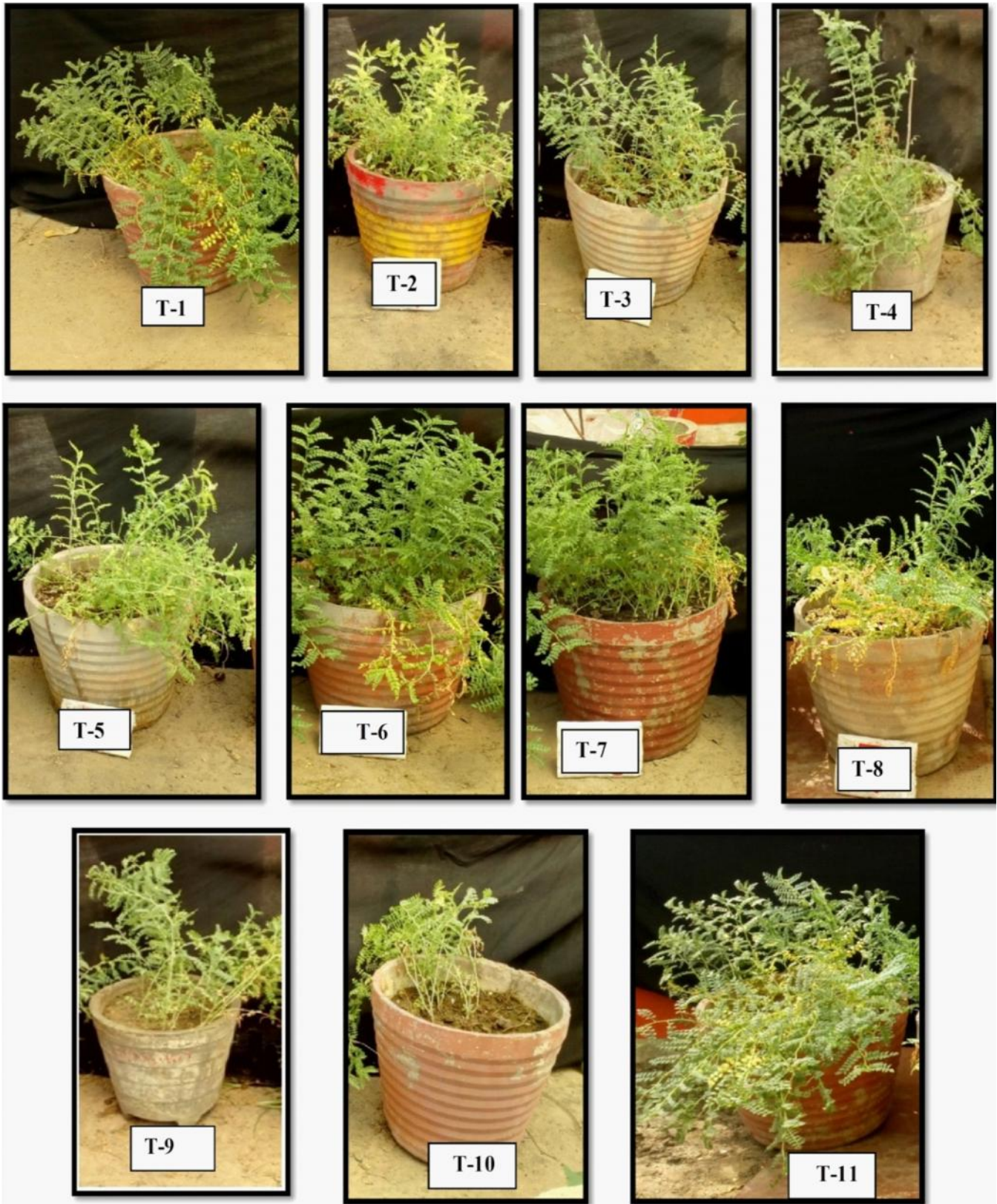


Plate 1: Effect of bioagents, fungicides and natural farming products and organic amendments alone or in combination on dry root disease incidence and plant growth parameters of chickpea

to 86.67 per cent disease control and significantly differed with all other treatments (Table 1). Highest disease incidence (66.67%) was observed with T₁₀ and all the treatments were significantly superior in controlling the disease over T₁₀.

At 45 DAS, lowest mortality was recorded in T₇ which is equivalent to 85.29 per cent disease control followed by T₆ which is equivalent to 82.35 per cent and were significantly superior over other treatments (Table 1 and Plate 1). All the treatments has significantly reduced the disease incidence compared with T₁₀, wherein highest disease incidence percentage was recorded (75.56%). Thus, the present investigation revealed that T₇ is better in managing dry root rot of chickpea in JG-11 cultivar among all the treatments evaluated.

Suriachandraselvan *et al.* (2004) reported that seed treatment with talc based formulation (4g kg⁻¹) of *T. viride* and *T. harzianum* significantly reduced the disease incidence compared to control and also found that seed treatment with these antagonists most effectively decreased the population of *M. phaseolina*

and increased the population of *Trichoderma* spp. Pawar *et al.* (2018) reported that *T. viride* as seed dressing exhibited good germination per cent, shoot length and root length and seedling vigour index as compared to *P. flourescens*. Shafique *et al.* (2015) reported that soil application of cotton cake alone also showed reduction of *M. phaseolina*.

Manjunatha *et al.* (2011) found that seed and soil application with bio agents was effective and gave maximum germination with less root rot disease incidence. Nagamani *et al.* (2012) reported that seed treatment with carbendazim @ 2g kg⁻¹ of seed + seed treatment with *T. viride* @ 4g kg⁻¹ of seed + soil application of FYM fortified with *T. viride* recorded as the best treatment to decrease the per cent mortality of dry root rot disease of chickpea caused by *R. bataticola*.

Vigour index:

Of all the treatments the highest vigour index (3824.17) was observed at T₇ followed by T₆ (3722.96) and were at par with each other (Table 1). The lowest

Table 2 : Effect of selected bio agents, fungicides and natural products alone and in combination on dry root rot disease incidence

Treatments	Deatils	Vigour index	Fresh weight (g)	Dry weight (g)
T ₁	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹	3357.04	52.00	9.33
T ₂	Seed treatment with conidial suspension of bio control agent (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ in the ratio of 1:1 for 30 min + Soil application of bio control agent conidial suspension @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%	3554.06	58.67	11.67
T ₃	T ₂ + Soil application of cotton cake @ 200kg ha ⁻¹	3668.55	60.00	12.00
T ₄	Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹	3673.55	66.00	12.33
T ₅	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of mancozeb @ 2.5g l ⁻¹ + Soil application of cotton cake @ 200kg ha ⁻¹	3380.22	54.00	10.33
T ₆	Seed treatment with mancozeb @ 2.5g kg ⁻¹ + Soil application of bio control agent conidial suspension (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹	3722.96	68.33	12.33
T ₇	Seed treatment with Beejamrutham @ 200ml kg ⁻¹ + Soil application of bio control agent conidial suspension (<i>Tv3</i>) @ 1x10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + Soil application of cotton cake @ 200kg ha ⁻¹	3824.17	70.67	14.00
T ₈	Soil application of cotton cake @ 200kg ha ⁻¹	3356.67	51.00	8.33
T ₉	Seed treatment with Beejamrutham @ 200ml kg ⁻¹	3529.62	54.00	11.33
T ₁₀	Pathogen inoculated	2180.56	20.00	3.67
T ₁₁	Control	4719.44	89.00	16.67
	S.E.±	184.40	1.12	0.79
	C.D.(P≤0.05)	544.31	3.33	2.35
	CV%	9.01	1.12	12.45

vigour index was recorded at T₈ (3356.67) and is significantly superior over pathogen inoculated control (2180.56) and inferior over healthy control (4719.44). T₂ recorded vigour index of 3554.06 and significant difference was not observed even if we apply cotton cake along with T₂ i.e., T₃ (3668.55) (Table 2).

The result revealed that the seed treatment with bheejamrutham @ 200 ml kg⁻¹ + soil application of Tv-3 conidial suspension @ 1×10⁸CFU ml⁻¹ fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha⁻¹ recorded maximum vigour index and significant difference was observed when compared with inoculated check and healthy check.

Fresh and dry weight of plants:

Highest fresh and dry weights were recorded in the T₇ (70.67g, 14.00g, respectively) followed by T₆ (12.33g) and were at par with each other and significantly superior over pathogen inoculated check. T₄ recorded

fresh weight of 66.00 g and significant difference was not observed with the above treatments. Lowest fresh weight was recorded at T₈ (51.00g) and significantly superior over pathogen inoculated check (20.00 g) (Table 2). The lowest dry weight was recorded at T₁₀ (pathogen inoculated) (3.67g) followed by T₈ which recorded 8.33g followed by T₁ (9.33g) and T₅ (10.33g) and were at par with each other (Table 2).

Integrated management of dry root rot of chickpea:

Lowest disease incidence was recorded with T₇ (7.65%) followed by T₆ (10.42%) and were at par with each other (Table 3). The disease control obtained with treatments T₃, T₄ and T₅ were 12.93 per cent, 13.29 per cent and 14.75 per cent, respectively and were at par with each other.

Maximum mean number of pods per plant was recorded by T₇ (49.33) which was at par with T₆ (46.00) and significantly superior over rest of the treatments.

Table 3 : Integrated disease management of dry root rot of chickpea during Rabi 2017-18

Treatments	Details	Disease incidence (%)	Per cent disease reduction over control	No. of pods plant ⁻¹	Yield (kg ha ⁻¹)
T ₁	Seed treatment with mancozeb @ 2.5 g kg ⁻¹ + soil application of mancozeb @ 2.5 g l ⁻¹	16.01 (23.58)	26.82	40.00	1464
T ₂	Seed treatment with Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ in the ratio of 1:1 for 30 min + soil application of Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%.	15.87 (23.47)	27.45	36.67	1567
T ₃	Seed treatment with Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ in the ratio of 1:1 for 30 min + soil application of Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%. + soil application of cotton cake @ 200 kg ha ⁻¹	12.93 (21.07)	40.89	42.33	1898
T ₄	Seed treatment with bheejamrutham (200 ml kg ⁻¹) + soil application of cotton cake @ 200 kg ha ⁻¹	13.29 (21.37)	39.24	39.00	1773
T ₅	Seed treatment with mancozeb @ 2.5 g kg ⁻¹ + soil application of mancozeb @ 2.5 g l ⁻¹ + soil application of cotton cake @ 200 kg ha ⁻¹	14.75 (22.58)	32.55	37.67	1665
T ₆	Seed treatment with mancozeb @ 2.5 g kg ⁻¹ + soil application of Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5%. + soil application of cotton cake @ 200 kg ha ⁻¹	10.42 (18.82)	52.38	46.00	2119
T ₇	Seed treatment with bheejamrutham (200 ml kg ⁻¹) + soil application of Tv-3 conidial suspension @ 1×10 ⁸ CFU ml ⁻¹ fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha ⁻¹	7.65 (16.05)	65.04	49.33	2263
T ₈	Control	21.88 (27.87)	-	32.00	1269
	S.E.±	1.04		2.11	132.51
	C.D.(P≤0.05)	3.19		6.46	405.82
	CV%	12.58		9.06	13.09

*Figures in the parenthesis are arc sine values

Lowest number of pods per plant (32.00) was observed in T₅ and was at par with untreated control (Table 3).

Maximum mean yield was observed in treatment T₇ (2263 kg ha⁻¹) which was significantly superior over all other treatments followed by T₆ (2119 kg ha⁻¹) and at par with each other. T₁ recorded the lowest yield among all the treatments (1464 kg ha⁻¹) and was at par with control (1269 kg ha⁻¹) (Table 3). Significant difference was not observed in yield between T₁, T₂ and T₄.

Results clearly indicated that the combined application of natural products, fungicides and bioagents as seed treatment and bioagents and cotton oil cake as soil treatment was found effective in controlling dry root rot disease of chickpea *i.e.*, seed treatment with bheejamrutham (200 ml kg⁻¹) + soil application of Tv-3 conidial suspension @ 1×10⁸CFU ml⁻¹ fortified with 100 kg FYM @ 0.5% + soil application of cotton cake @ 200 kg ha⁻¹ appeared better in managing dry root rot of chickpea among all the treatments evaluated.

Sreenivasa *et al.* (2009) reported that inoculation of the bacterial isolates from bheejamrutham resulted in improvement in seed germination, seedling length and seed vigour in soybean. Anis *et al.* (2010) reported that seed treatment with oil seed cakes like cotton cake, mustard cake (black and yellow) and taramera cake alone or in combination with *T. harzianum* and *T. resei* significantly reduced colonization of roots by charcoal rot fungus (*M. phaseolina*) and significantly increased growth of sunflower (*Helianthus annus* L.) plants. Highest reduction in charcoal rot of sunflower was observed when seeds of sunflower were coated with cotton cake and *T. resei* followed by taramera cake and *T. harzianum* and mustard cake in combination with *T. harzianum*.

Shafique *et al.* (2015) reported that soil application of cotton cake alone also showed reduction of *M. phaseolina*, *R. solani*, *F. solani* and *P. lilacinus* in cotton cake amended soil also showed suppressive effect on root rotting fungi and also reported that application of cotton cake 1 per cent alone or with PGPR and *P. lilacinus* showed positive impact on plant growth by improving plant height, fresh shoot weight and root length in okra. Karthikeyan *et al.* (2015) reported that maximum seed germination (75%), shoot length (43.2cm) and root length (16.0cm) was recorded in the seed treatment of *T. viride* followed by *T. harzianum*. Soil application of *Trichoderma* spp., *T. viride* recorded the minimum root rot incidence of black gram. Rafi *et al.* (2016) reported that combined effect of primed seeds with *A. nilotica*,

S. mukorossi leaves extract and *T.harzianum* spore suspension and amendment of soil with mustard cake and cotton oil cake @1% showed significant increase in growth parameters of okra like root length, shoot length and highest reduction in root rot fungi like *M. phaseolina*.

Arya *et al.* (2017) reported that *T. viride* and *T. harzianum* in combination as seed treatment and soil application were most effective in minimizing the root rot disease incidence of groundnut. Pawar *et al.* (2018) reported that *Trichoderma viride* as seed dressing exhibited good germination per cent (70.00), shoot length (9.33) and root length (7.55) and seedling vigour index (1181.60) as compared to *P. flourescens*. Suriachandraselvan *et al.* (2004) reported that combined seed treatment with talc based formulation (4g kg⁻¹) of *T. viride* and *T. harzianum* significantly reduced the disease incidence compared to control and also found that seed treatment with these antagonists most effectively decreased the population of *M. phaseolina* and increased the population of *Trichoderma* spp.

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