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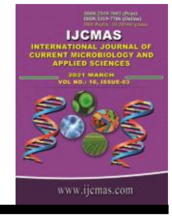

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Eco-friendly Management of *Rhizoctonia bataticola* Causing Dry Root Rot of Chickpea (*Cicer arietinum* L.)

G.M.J. Jennifer*, Shashi Tiwari, Jasmine Jyoti Murmu and Shubham Singh

Department of Plant Pathology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P.), India

**Corresponding author*

ABSTRACT

Keywords

Bio-agent, Castor oil, Chickpea, Clove oil, Disease incidence, Dry root rot, Neem oil, *Rhizoctonia bataticola*, Seed treatment, *Trichoderma viride*

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Chickpea (*Cicer arietinum* L.) is the third most important pulse crop of the world grown in semi- arid and tropical climate. It belongs to family Fabaceae. The major losses in chickpea yield are attributed mainly due to soil borne pathogens. Among them the dry root rot (DRR) caused by *Rhizoctonia bataticola* has become a major threat to chickpea production in recent years. An experiment was conducted in the Rabi season to check the efficacy of botanicals and *Trichoderma viride* against *Rhizoctonia bataticola* on field conditions. Three types of botanicals viz., Neem oil, Castor oil, Clove oil and one bio-agent viz., *Trichoderma viride* was selected @ 5% concentration as seed treatment. An untreated replication served as control. At desired number of days readings were taken for growth parameters and disease incidence. On the basis of single trail, it was observed that among all treatments seed treatment with Neem oil @2.5% + *Trichoderma viride* @ 2.5% showed the most significant results. Subsequently the highest incremental cost benefit ratio was obtained with treatment of Neem oil @2.5% + *Trichoderma* @2.5%.

Introduction

Among the gram legumes, chickpea/Bengal gram (*Cicer arietinum* L.) has occupied a prominent position. It is the third most important pulse crop of the world, next to beans (*Phaseolus vulgaris*) and peas (*Pisum satium*). It is a legume of the family-Fabaceae. Chickpea is comprised of Desi and Kabuli types. According to Food and Agriculture Organization (FAO) figures, India is the world's largest producer of chickpea. Chickpea ranks third among the pulse crops and accounting for 11.67 million tons annually. Land area devoted to chickpea has increased in recent years and now stands at an estimated 14.56 Mha. In India, chickpea was cultivated in an area about 106 Lha recording a production of greater than 111 Lt at the ever highest productivity level of 1056 kg/ha.

Major losses in chickpea yield are attributed mainly due to soil borne pathogens. The crop suffers from number of soil borne pathogens like dry root rot– *Rhizoctonia bataticola,* wet root rot- *Rhizoctonia solani*, collar rot- *Sclerotium rolfsii* and wilt- *Fusarium oxysporum*f. sp. *ciceris.* Recent reports indicated that dry root rot (DRR) is emerging as a potential threat to chickpea production (Pande *et al.,* 2010; Ghosh *et al.,* 2013). The DRR is caused by *Rhizoctonia bataticola* (Taub.) Butler. The dsease generally appears around flowering and podding stage. Most conspicuous symptom is sudden drying of the whole plant scattered in the field. Symptoms include yellowing, drooping of the petioles and leaflets only on the tips. The tap root turns black, shows signs of rotting and is devoid of lateral and finer roots. The dead roots are quite brittle and show shredding of bark and lateral root.

The Dry Root Rot in chickpea was first reported from India by Mitra, 1931.The DRR was not of much significance in chickpea earlier; however, it has become a major threat to chickpea production in recent years due to altered weather conditions, particularly on the account of longer drought spells. Besides chemical control, botanicals are environmentally non-polluted, largely cost effective. Hence, constitute as a suitable plant protection strategy of management.

Keeping in view the severity and losses caused by dry root rot disease, present research has been under taken to evaluate the effect of *Trichoderma* sp. And botanicals on growth parameters (height, branches) and disease incidence of chickpea *in-vivo* .The cost benefit ratio of treatments was also calculated.

Materials and Methods

Experimental site

The present investigation was carried out in the Central Research Farm, Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences; during the *Rabi* season of 2019-20, Prayagraj. Field experiment was laid-out in Randomized block design with three replication.

Mass multiplication of *Rhizoctonia bataticola*

Mass cultures of *Rhizoctonia bataticola* were prepared using sorghum grains in 1000 ml conical flasks. Sorghum grains were soaked overnight in two per cent sucrose solution and air dry the remaining excess moisture then autoclaved, to which five discs (5 mm diameter) from three days old culture of test pathogen was added and thoroughly shaken. These inoculated conical flasks were incubated for 2weeks at 28±2ºC. The inoculated flasks were shaken periodically to allow the uniform growth and maximum utilization of substrate by the pathogen.

Incubation of pathogen

The mass culture of *R. bataticola* multiplied on sorghum grains was directly incubated in the soil @ 100g/m2 of plot two weeks before transplanting. The inoculation was done in all the plots with 3 replications. The mass culture was well mixed with the soil. The pathogen *R. bataticola* inoculated in seed bed soil was allowed to multiply with proper soil moisture.

Soil treatment

The seven treatments (Botanicals) Neem oil @ 5% concentration per plot, Castor oil @ 5% concentration per plot, Clove oil @ 5% concentration per plot, (Bio control-agent) *Trichoderma viride*@ 2g per plot, *Trichoderma viride* + Neem oil @ 2.5+2.5 % concentration per plot, *Trichoderma viride* + Castor oil @ 2.5 + 2.5% concentration perplot, *Trichoderma viride* + Clove oil @

2.5+2.5 % concentration per plot were applied in the soil at 6-7cm depth after one to two week of pathogen inoculation. The untreated plots will be left as control plot.

Isolation of the pathogen

The pathogen was isolated from the disease infected plants and it was identified as the *Rhizoctonia bataticola*. Dry root rot infected roots will be collected. The infected roots were cut into small pieces ($0.5cm^2$), surface sterilized with mercuric chloride (0.1%) for 15-30 seconds, rinsed with three changes of sterile distilled water to remove the disinfectant and blotted dry. The sterilized pieces were plated (5pieces/dish) on potato dextroseagar (PDA) medium in Petridishes under aseptic conditions and incubated at 25^{o}C for 2 weeks.

For obtaining sufficient quantity of inoculums, pure cultures were obtained by subculturing. For this purpose, small bits of the fungus was taken at the tip of a sterilized needle and transferred aseptically to the center of fresh PDA medium in Petri dishes. The dishes were incubated for 2 weeks at 25°C in the dark.

Identification of the Pathogen

Morphologicalstudiesofthepathogenwerecond uctedfrompureculturebyplacingasmallbiton a slide and morphological characters were noted with the help of microscope. The young hyphaearethin, hyaline, aseptate and dichotomously branched and later produce typical black sclerotia.

The characteristic features of *R.bataticola* are right angled branching of the mycelium and constriction of the branch near the point of origin. The sclerotia formed are black, smooth, varying from spherical through oblong to irregular shapes (Sharma *et al.*, 2012).

Per cent disease incidence of dry root rot during survey

Per cent Disease Incidence was calculated by using the following formula: -

$$\textit{Percent DiseaseIncidence} = \frac{\text{Number of plants affected}}{\text{Total Number of plants observed}} \times 100$$

Observation of Cost: Benefit Ratio

The cost benefit ratio was calculated using the following formula

The value of c:b ratio of different treatments will be calculated by following formula

$$\text{C:B} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Where,

C: B – Cost Benefit Ratio

Results and Discussion

The disease appeared around flowering and podding stage. Symptoms included sudden drying of the whole plant, yellowing, drooping of the petioles and leaflets only on the tips. Leaves and stems of the affected plants ware straw colored and in some cases, lower leaves turned brown. The tap root turned black, showed signs of rotting, and was devoid of lateral and finer roots. The dead roots were quite brittle and showed shredding of bark and lateral root (Fig. 1).

The pathogen was isolated from the disease infected plants and it was identified as the *Rhizoctonia bataticola* based on morphological studies (Fig. 2).

Table.1 Effects of treatment on plant height and number of branches

Treatments		30 DAS		60 DAS		90 DAS	
		Plant height	Branches	Plant height	Branches	Plant height	Branches
T_0	Control	4.7	2.20	22.43	10.26	35.86	**15.40**
T_1	Neem oil	6.6	3.00	25.80	11.93	40.80	**17.53**
T_2	Castor oil	5.9	2.46	23.60	10.73	38.33	**16.60**
T_3	Clove oil	6.3	2.80	24.93	11.40	40.20	**16.86**
T_4	*T. viride*	6.8	3.40	26.20	12.20	42.06	**17.73**
T_5	**Neem oil + *T. viride***	8.6	4.20	31.10	14.00	47.73	**19.53**
T_6	Castor oil+ *T. viride*	7.0	3.60	27.73	12.66	44.40	**18.13**
T_7	**Clove oil + *T. viride***	7.2	3.86	28.46	13.33	44.86	**18.80**
F- test		**S**	**S**	**S**	**S**	**S**	**S**
C. D. (0.05)		**0.756**	**0.280**	**2.501**	**0.446**	**1.884**	**0.656**
S. Ed (±)		**0.349**	**0.129**	**1.155**	**0.206**	**0.870**	**0.303**

Table.2 Effect of treatments on dry root rot disease incidence

Treatments		Disease incidence		
		30 DAS (%)	60 DAS (%)	90 DAS (%)
T_0	Control	12.67	17.67	**48.16**
T_1	Neem oil	8.53	14.53	**24.53**
T_2	Castor oil	10.33	15.67	**25.93**
T_3	Clove oil	9.40	15.40	**25.40**
T_4	*T. viride*	8.20	14.20	**24.20**
T_5	**Neem oil + *T. viride***	6.27	12.27	**22.30**
T_6	Castor oil+ *T. viride*	7.93	13.93	**23.93**
T_7	**Clove oil + *T. viride***	6.73	13.40	**23.40**
F-test		**S**	**S**	**S**
C. D. (0.05)		**0.495**	**0.404**	**0.545**
S. Ed (±)		**3.195**	**1.561**	**1.246**

Table.3 Effects of treatment on yield

Treatments	Yield (kg/ha)	Total cost of yield	Total cost of cultivation	C:B ratio
Control	926.67	45191	25,425	**1:1.78**
Neem oil	1344.67	65569	28,025	**1:2.58**
Castor oil	1286.67	62741	27,845	**1:2.47**
Clove oil	1333.33	64984	28,925	**1:2.56**
T. viride	1366.67	66641	27,005	**1:2.62**
Neem oil + *T. viride*	1416.67	68884	27,515	**1:2.71**
Castor oil+ *T. viride*	1376.67	67129	27,425	**1:2.64**
Clove oil + *T. viride*	**1408.00**	**68640**	**27,965**	**1:2.70**

Fig.1 Symptoms of dry root rot

Fig.2 Isolation of pathogen from the disease infected plant root bits and growth of pathogen after incubation for 3 days in culture plate and slants

(a) (b) (c)

Fig.3 Effect of treatments in plant growth

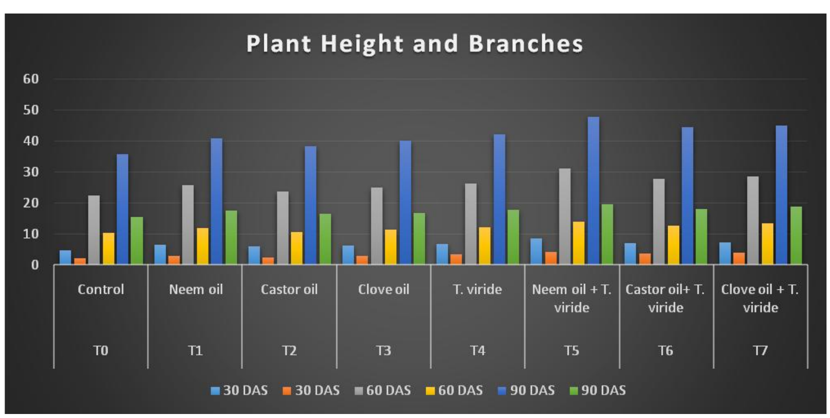


Fig.4 Effect of treatments on dry root rot disease incidence

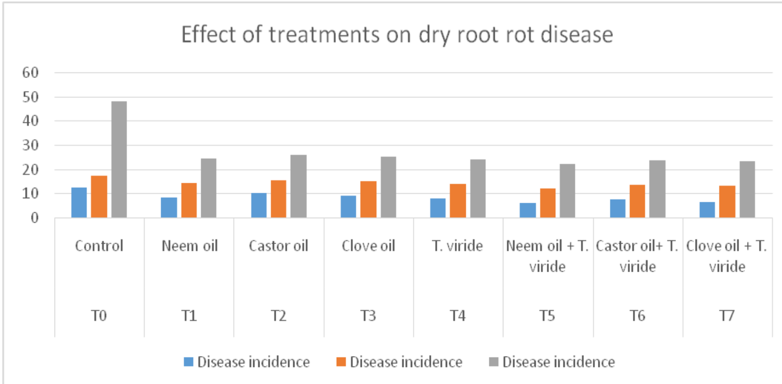
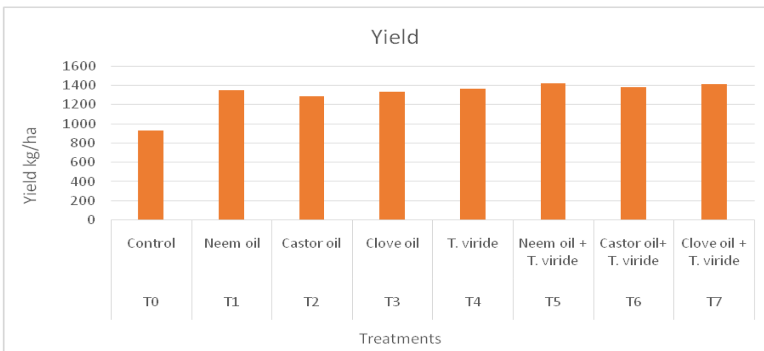


Fig.5 Effects of treatments on yield



Effect of treatments on plant growth parameters

As shown in Table 1 observations were recorded at 30, 60 and 90 DAS for disease incidence and also for growth parameters. Growth parameters included plant height and branches of all the treatments, treatment T_5 Neem oil + *T. viride@* (2.5%+2.5%) was found the best among all the treatments giving best height and more number of branches followed by T_7 Clove oil + *T. viride* (2.5%+2.5%) (Fig. 3).

At 90 DAS the maximum plant height was recorded in combined seed treatments T_5 (47.73), T_7 (44.86), T_6 (44.40) followed by low plant height in treatments T_4 (42.06), T_1 (40.80), T_3 (40.20), T_2 (38.33) and the least plant height recorded was in T_0 (35.86). Maximum plant branches were recorded in combined seed treatments T_5 (19.53), T_7(18.80), T_6 (18.13) followed by low number of plant branches in treatments T_4 (17.73), T_1 (17.53), T_3 (16.86),T_2 (16.60) and the least number of branches were recorded in T_0 control (15.40).Similar findings were reported by Mallaiah and Rao (2016) and they reported that combined seed treatment with *T. viride* and neem oil was more highly effective in increasing plant growth parameters.

Effect of treatments on disease incidence

Table 2 shows disease incidence in 30, 60 and 90 DAS. The maximum reduction percentage of disease incidence was recorded in combined seed treatments T_5 Neem oil + *T.*

viride (22.30) followed by the T_7 Clove oil + *T. viride* (23.40), T_6 Castor oil + *T. viride* (23.93) followed by minimum reduction percentage of disease incidence in treatments T_4 *T. viride* (24.20), T_1 Neem oil (24.53), T_3 Clove oil (25.40), T_2 Castor oil (25.93) and the lowest was recorded in treatment T_0 control (48.16) (Fig. 4).

Similar result was found by Choudhary and Ashraf (2019), Gnanaprakash *et al.*, (2015), Sangeetha and Jahagirdar (2013) where they showed that *Trichoderma viride* and neem can be recommended as an effective approach for the management of dry root rot.

Also results reported by Kaurav *et al*., (2019) showed that neem inhibited the growth of *Rhizoctonia bataticola.* Results were also in agreement with findings of Lakhran *et al.*, (2020), Brahmbhatt and Aravind (2018) who showed that *T. viride* was found the most effective against the fungus and neem was most effective in reducing the root rot. Manjunatha *et al.*, (2013) reported that seed treatment using *T.viride* can be used under field conditions to control dry root rot of chickpea.

C:B ratio

Cost benefit ratio is the ratio of gross return to cost of cultivation, which can also be expressed as return per rupee invested. This index provides an estimate of the benefit a farmer derives from the expenditure he incurs in adopting a particular cropping system. Any value above 2.0 is considered safe as the farmer gets Rs. 2 for every rupee invested. As shown in Table 3 the maximum yield was recorded in combined seed treatments T_5 (1416.67), T_7 (1408), (1376.67) followed by low yield in treatments T_4 (1366.67), T_1 (1344.67), T_3 (1333.33), T_2 (1286.67) and the lowest yield was recorded in treatment T_0 (926.67) (Fig. 5). Pandey *et al*. (2017) reported that the disease control and yield enhancement were highest with *T. viride* and also Manjunatha *et al.*. (2013) reported that the combination seed treatment with the bio-control agent showed least root rot incidence and highest yields as compared to the other biological or chemical seed treatments. The treatment wise economics of chickpea production were estimated and the results showed that treatment T_5 recorded the highest gross returns ₹ 68884/-, net returns ₹ 41369/-with C:B ratio 1:2.71 followed by T_7 with C:B ratio 1:2.70.

Investigations were made in the present study to devise an effective management strategy for dry root rot of chick pea. An attempt was made to observe whether the treatments imposed have any stimulatory (or) inhibitory effect on mean plant height, plant branches and disease incidence of chickpea plants.

From the above studies, it is concluded that control of disease resulting from infection by *Rhizoctonia* spp. is a major concern for farmer and plant pathologists. So adopting eco-friendly management measures using botanicals along with bio agent *Trichoderma* sp. is advisable to manage dry root rot of chickpea

On the basis of single trail, it is concluded that seed treatment with Neem oil + *Trichoderma viride* was most effective against dry root disease and has given the highest Plant height, No. of branches, minimum disease incidence and good yield when compared with other treatments. The highest incremental cost benefit ratio of 1:2.71 was obtained in the treatment of Neem oil + *Trichoderma viride*.

For soil borne pathogen, use of fungicide is not practical due to exorbitant cost and environmental hazards involved. Hence integrated management of the disease using bio-control agents and botanicals is the best alternative. Hence, Neem oil + *Trichoderma* is the best alternative to reduce the disease incidence of dry root rot disease and to get better yield.

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