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Effect of botanicals on collar rot of chickpea caused by *Sclerotium rolfsii* Sacc. in combination with *Trichoderma harzianum*

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Abstract

In this study, the effect of different botanicals in combination with *Trichoderma harzianum* were used to observe plants mortality and yield affected by collar rot of chickpea. The effect of different treatments on germination at 20 days after sowing and vigour index 1 (germination × plant height), vigour index 2 (germination × dry weight), 45, 60, 75 days after sowing (DAS) and also yield parameter like (yield per plot and yield in q/h) were evaluated at after harvesting of chickpea. Significant variant in germination of chickpea seeds were recorded under different treatments. The lowest germination was recorded in the control plot (T9) (85.89%) and maximum in (T8) with (97.33%) at 20 days after sowing. Highest vigour index 1 (2019.59) and vigour index 2 (147.94) were recorded in T8, maximum plant height in T8 (20.75, 25.25, 33.38 cm.), highest total number of branches per plant in T8 (5.47, 6.27, 7.67), maximum fresh weight in T8 (6.42, 17.50, 20.72 gm.), maximum dry weight in T8 (1.52, 4.26, 5.09), minimum plant mortality in T8 (3.55, 7.47, 14%) and maximum plant mortality in control (9.73, 15.07, 21%) were recorded at 45, 60, 75 DAS, and maximum yield per plot in T8 (1.68 kg) and also the yield parameter and plants mortality was best observed in T8 followed by in botanical T2 (Neem oil 2.5%) with combination of *Trichoderma harzianum*, respectively.

1. Introduction

Chickpea (*Cicer arietinum* L.) is, a self-pollinated, diploid (2n = 2x = 16) annual legume of family Fabaceae and known as various names, *viz*., Gram, Bengal gram, Garbanzo and Egyption pea. It was first cultivated in south eastern region of the world, but now it is also cultivated in semi-arid regions (Agarwal *et al*., 2012). Pulses contain higher proportions of protein (17%-30% by dry weight) in comparison to other plant foods. With the protein, chickpea is a good source of carbohydrates has comparison to other pulses, according to Wallace *et al.* (2016). There are various biotic and abiotic factors that affect the production of the chickpea in the world as well as in India too. The biotic factor includes insect pests and a number of devastating diseases caused by fungi, bacteria, viruses, and nematodes. The fungal diseases such as Fusarium wilt (*Fusarium oxysporium* f.sp. *ciceris*), Ascochyta blight (*Ascochyta rabiei*), collar rot (*Sclerotium rolfsii*), Verticillium wilt (*Verticillium dahliae*), black root rot (*Fusarium solani*), Phytophthora root rot (*Phytophthora megasparma*) and seed rot (*Aspergillus flavus*), *etc.* Among all of the diseases collar rot disease, caused by *Sclerotium rolfsii Sacc*., is a serious threat to chickpea that may cause 55-95% mortality of the crop at seedling stage under favourable environmental conditions (Gurha and Dubey, 1982).

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2. Materials and Methods

2.1 Preparation of botanicals

Fresh parts of the test plants (*Lantana camera*, *Eucalyptus* spp. *Ocimum sanctum* and *Azadirachta indica*) were collected and washed thoroughly in clean water. Hundred grams of each washed samples were grinded in mortar and pestle by adding equal amount (100 ml) of sterilized distilled water (1:1 W/V) and boiled at 80°C for 10 min in a hot water bath.The grinded material was filtered through muslin cloth followed by filtering through sterilized Whatman No. 1 filter paper and treated as standard 100 per cent plant extract (Nene and Thapliyal, 1982) and required concentrations of five per cent of each plant extract were prepared.

2.2 Treatments details

All the treatments were used as seed treatments. (T1) Seeds treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and *Pseudomonas* spp. (10 gm/kg seed). (T2) Seeds treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and Neem oil (2.5%). (T3) Seed treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and Jeevamrit (5%). (T4) Seed treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and *Lentana camera* extract (5%). (T5) Seed treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and *Eucalyptus* spp. extract (5%). (T6) Seed treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and *Ocimum sanctum* extract (5%). (T7) Seed treated with combination of *Trichoderma harzianum* (10 gm/kg seed) and Neem leaf extract (5%). (T8) Seed treated with combination of *Trichoderma harzianum*(10 gm/kg seed) and Carbendazim (3 gm/kg seed).

3. Results

Results presented in (Table 1), indicated that the treatment tested against *S. rolfsii* has a positive effect in germination percentage as T8 give maximum germination percentage *i.e.,* (97.33%), maximum vigour index 1 and vigour index 2 in T8, *i.e.* (2019.57) (147.94) respectively, Observations presented in (Table 2), the data was recorded at different days after sowing, *i.e.* 45, 60, 75 (DAS). Maximum plant height was observed in T8, *i.e.* (20.75 cm) (25.25 cm) (33.80 cm), respectively, Total No. of branches per plant highest in T8, *i.e.* (5.47) (6.27) (7.67), respectively; highest total no. of pod/plant and seed index were recorded in T8, *i.e.* (53) (21.67 gm), respectively (Table 3). In Table 4, the highest fresh weight was recorded in T8 (6.42 gm) (17.50 gm) (20.72 gm) and maximum dry weight in T8 (1.52 gm)(4.26 gm) (5.09 gm).

Table 1: Effect of different treatments on plant mortality and vigour index I and II of chickpe

Treatment	Per cent germination (%)	Vigour index 1 (germination × plant length)	Vigour index 2 (germination × dry weight)	Per cent mortality		
				45 DAS	60 DAS	75 DAS
T1	91.11	1589.86	104.77	7.03 ± 0.15	11.67 ± 0.83	17.67 ± 0.76
T2	95.11	1882.22	133.15	4.44 ± 0.39	8.17 ± 0.76	15.33 ± 2.08
T3	92.66	1652.12	109.33	5.90 ± 0.62	10.87 ± 0.81	17.27 ± 0.64
T4	89.77	1526.98	96.95	7.00 ± 0.50	12.50 ± 0.50	17.47 ± 1.31
T5	88.22	1458.27	76.75	7.80 ± 0.48	13.17 ± 1.26	17.50 ± 0.70
T6	93.88	1722.69	120.16	5.77 ± 0.32	10.20 ± 0.36	16.20 ± 1.06
T7	94.33	1780.95	123.57	5.30 ± 0.36	8.97 ± 0.45	15.50 ± 1.32
T8	97.33	2019.59	147.94	3.55 ± 0.30	7.47 ± 0.55	14.00 ± 1.00
T9	85.89	1313.25	67.85	9.73 ± 0.31	15.07 ± 1.01	21.00 ± 1.00
SE(m)	**0.55**	**33.36**	**0.11**	**0.23**	**0.43**	**0.59**
CD	**1.61**	**96.97**	**0.32**	**0.66**	**1.24**	**1.73**

(T1) *Trichoderma harzianum* (10 gm/kg seed) and *Pseudomonas* spp. (10 gm/kg seed). (T2) *Trichoderma harzianum* (10 gm/kg seed) and Neem oil (2.5%). (T3) *Trichoderma harzianum* (10gm/kg seed) and Jeevamrit (5%). (T4) *Trichoderma harzianum* (10 gm/kg seed) and *Lentana camera* extract (5%). (T5) *Trichoderma harzianum* (10 gm/kg seed) and *Eucalyptus* spp. Extract (5%). (T6) *Trichoderma harzianum* (10 gm/kg seed) and *Ocimum sanctum* extract (5%). (T7) *Trichoderma harzianum* (10 gm/kg seed) and Neem leaf extract (5%). (T8) *Trichoderma harzianum* (10 gm/kg seed) and Carbendazim (3 gm/kg seed), DAS-Days after showing, SE-Stander Error, CD-Critical Difference.

Table 2: Effect of different treatments on plant height and number of branches/plant

Treatment	Plant height (in cm.)			Total no of branches/plant		
	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS
T1	17.45 ± 1.36	22.62 ± 1.46	28.93 ± 1.29	4.27 ± 0.42	5.20 ± 0.35	5.33 ± 0.23
T2	19.79 ± 1.39	24.87 ± 0.98	32.07 ± 1.14	5.07 ± 0.90	5.93 ± 0.42	6.33 ± 0.23
T3	17.83 ± 1.67	23.60 ± 1.34	29.47 ± 1.29	4.33 ± 0.50	5.40 ± 0.00	5.47 ± 0.12
T4	17.01 ± 1.23	22.59 ± 0.95	28.47 ± 1.03	4.20 ± 0.53	5.00 ± 0.35	5.27 ± 0.12
T5	16.53 ± 1.29	22.05 ± 1.50	27.93 ± 1.01	4.13 ± 0.46	4.60 ± 0.40	4.87 ± 0.23
T6	18.35 ± 1.68	23.79 ± 1.51	30.47 ± 0.61	4.47 ± 0.42	5.60 ± 0.20	5.73 ± 0.31
T7	18.88 ± 1.52	24.17 ± 1.34	31.87 ± 1.10	4.73 ± 0.70	5.67 ± 0.31	6.00 ± 0.00
T8	20.75 ± 0.66	25.25 ± 1.10	33.80 ± 0.60	5.47 ± 0.64	6.27 ± 0.31	7.67 ± 0.58
T9	15.29 ± 0.71	20.94 ± 0.52	26.47 ± 1.47	3.40 ± 0.53	4.47 ± 0.50	4.60 ± 0.20
SE(m)	**0.29**	**0.33**	**0.30**	**0.15**	**0.13**	**0.16**
CD	**0.84**	**0.96**	**0.87**	**0.43**	**0.38**	**0.48**

(T1) *Trichoderma harzianum* (10 gm/kg seed) and *Pseudomonas* spp. (10 gm/kg seed). (T2) *Trichoderma harzianum* (10 gm/kg seed) and Neem oil (2.5%). (T3) *Trichoderma harzianum* (10 gm/kg seed) and Jeevamrit (5%). (T4) *Trichoderma harzianum* (10 gm/kg seed) and *Lentana camera* extract (5%). (T5) *Trichoderma harzianum* (10 gm/kg seed) and *Eucalyptus* spp. extract (5%). (T6) *Trichoderma harzianum* (10 gm/kg seed) and *Ocimum sanctum* extract (5%). (T7) *Trichoderma harzianum* (10 gm/kg seed) and Neem leaf extract (5%). (T8) *Trichoderma harzianum* (10 gm/kg seed) and Carbendazim (3 gm/kg seed), DAS-Days after showing, SE-Stander Error, CD-Critical Difference.

Table 3: Effect of different treatments on total number of pods/plant, seed index and yield

Treatment	Total number of pods/plant	Seed index (weight /100 Seeds) in gm.	Yield	
			per plot (in kg)	Q./ha
T1	36.67 ± 0.58	17.50 ± 1.50	1.51 ± 0.08	17.26 ± 0.73
T2	50.67 ± 5.86	20.67 ± 1.53	1.66 ± 0.15	18.70 ± 0.61
T3	41.33 ± 4.51	18.67 ± 1.53	1.56 ± 0.05	17.59 ± 0.73
T4	33.33 ± 0.58	17.43 ± 1.44	1.49 ± 0.02	16.85 ± 0.85
T5	31.67 ± 2.31	17.33 ± 2.08	1.48 ± 0.03	16.33 ± 0.40
T6	43.00 ± 3.00	19.17 ± 1.53	1.58 ± 0.12	17.88 ± 0.73
T7	46.33 ± 6.11	19.67 ± 1.53	1.65 ± 0.11	18.36 ± 0.50
T8	53.00 ± 7.00	21.67 ± 1.53	1.68 ± 0.08	19.29 ± 1.22
T9	28.33 ± 1.53	15.30 ± 0.61	1.25 ± 0.04	15.29 ± 0.84
SE(m)	**1.92**	**0.32**	**0.04**	**0.22**
CD	**5.58**	**0.94**	**0.12**	**0.63**

(T1) *Trichoderma harzianum* (10 gm/kg seed) and *Pseudomonas* spp. (10 gm/kg seed). (T2) *Trichoderma harzianum* (10 gm/kg seed) and Neem oil (2.5%). (T3) *Trichoderma harzianum* (10 gm/kg seed) and Jeevamrit (5%). (T4) *Trichoderma harzianum* (10 gm/kg seed) and *Lentana camera* extract (5%). (T5) *Trichoderma harzianum* (10 gm/kg seed) and *Eucalyptus* spp. extract (5%). (T6) *Trichoderma harzianum* (10 gm/kg seed) and *Ocimum sanctum* extract (5%). (T7) *Trichoderma harzianum* (10 gm/kg seed) and Neem leaf extract (5%). (T8) *Trichoderma harzianum* (10 gm/kg seed) and Carbendazim (3 gm/kg seed), DAS-Days after showing, SE-Stander Error, CD-Critical Difference.

Table 4: Effect of different treatments on Fresh and dry weight of plant

Treatment	Fresh weight (in gm.)			Dry weight (in gm.)		
	45 DAS	60 DAS	75 DAS	45 DAS	60 DAS	75 DAS
T1	4.80 ± 0.56	13.92 ± 0.48	14.30 ± 1.41	1.15 ± 0.17	3.49 ± 0.13	3.76 ± 0.35
T2	6.02 ± 0.93	15.65 ± 0.08	18.13 ± 1.14	1.40 ± 0.17	3.85 ± 0.13	4.59 ± 0.22
T3	5.12 ± 0.55	14.30 ± 0.72	15.69 ± 0.48	1.18 ± 0.19	3.51 ± 0.13	3.93 ± 0.18
T4	4.53 ± 0.55	13.44 ± 0.38	13.92 ± 1.69	1.08 ± 0.09	3.40 ± 0.12	3.61 ± 0.41
T5	3.76 ± 0.43	12.53 ± 0.76	13.30 ± 1.97	0.87 ± 0.05	3.27 ± 0.08	3.40 ± 0.41
T6	5.48 ± 0.56	14.83 ± 0.54	16.14 ± 0.50	1.28 ± 0.16	3.59 ± 0.07	4.17 ± 0.11
T7	5.69 ± 0.58	14.99 ± 0.52	16.78 ± 0.38	1.31 ± 0.17	3.76 ± 0.12	4.26 ± 0.03
T8	6.42 ± 0.89	17.50 ± 1.44	20.72 ± 2.61	1.52 ± 0.15	4.26 ± 0.32	5.09 ± 0.51
T9	3.29 ± 0.26	10.59 ± 0.32	10.53 ± 2.95	0.79 ± 0.05	2.79 ± 0.05	2.61 ± 0.63
SE(m)	**0.26**	**0.40**	**0.94**	**0.05**	**0.09**	**0.20**
CD	**0.77**	**1.16**	**2.73**	**0.14**	**0.26**	**0.58**

(T1) *Trichoderma harzianum* (10 gm/kg seed) and *Pseudomonas* spp. (10 gm/kg seed). (T2) *Trichoderma harzianum* (10 gm/kg seed) and Neem oil (2.5%). (T3) *Trichoderma harzianum* (10 gm/kg seed) and Jeevamrit (5%). (T4) *Trichoderma harzianum* (10 gm/kg seed) and *Lentana camera* extract (5%). (T5) *Trichoderma harzianum* (10 gm/kg seed) and *Eucalyptus* spp. extract (5%). (T6) *Trichoderma harzianum* (10 gm/kg seed) and *Ocimum sanctum* extract (5%). (T7) *Trichoderma harzianum* (10 gm/kg seed) and Neem leaf extract (5%). (T8) *Trichoderma harzianum* (10 gm/kg seed) and Carbendazim (3 gm/kg seed), DAS-Days after showing, (SE)-Stander Error, (CD) Critical Difference.

As shown in Table 2, chickpea yield was recorded in per plot (in kg), significantly varied from one treatment to another. The yield of chickpea per plot ranges from 1.32 kg to 1.68 kg. Table 4 and figure showed the highest grain yield (kg/plot) (1.68 kg) in (T8) and (1.65 kg/plot) in T2 were recorded best effective on grain yield over the control, *i.e.* T9 (1.32 kg), followed by (1.65 kg), T7 (1.61 kg), T6, (1.57 kg), T3 (1.51 kg) and (1.48 kg) in T5. Likewise yield q/h was recorded significantly varied from one treatment to another. Table 4 and Figure. showed the highest grain yield (q/h) (19.29 q), (T8) and (18.70 q) in T2 were recorded best effective on grain yield over the control, *i.e.*, T9 (15.29 q), followed by (18.36 q), T7 (17.88 q), T6 (17.59 q), T3 (17.26 q), T1 (16.85 q) and T4 (16.33 q) in T5, respectively.

The mortality presented in Table 2 showed that at 45, 60 and 75 days after sowing (DAS) (Table 6 and Figure). At 45 days after sowing, maximum mortality (9.73%) was observed in control plot (T9), which was statistically significant compared to other treatments. Minimum mortality (3.55%) was recorded in the plot where seeds were treated with T8, followed by T2 (4.44%), T7

(5.30%), T6 (7.80%). At 60 days after sowing, the Table 2 showed maximum mortality (15.07%) was recorded in control plot T9, where minimum mortality (7.47%) was found in the plot T8, followed by T2, T7, T6, T3 over the control as many worker like Pawar *et al.*, (2014) Das *et al.* (2014) and Khan and Javaid (2015) also revealed that the chemicals have the significant effect on mortality and disease inhibition of chickpea. As shown in Table 1 at 75 days after sowing maximum mortality (21%) was recorded in control plot T9. where minimum mortality (14%) was found in the plot T8, followed by T2, T7, T6, T3,T1, T4 and T5.

4. Discussion

Many researchers like Khan *et al.* (2020) and Tewari and Mukhopadhyay (2000) used botanicals and bioagents as seed treatments increased seedling emergence. More *et al.*, (2016) revealed that maximum seedling vigour index was recorded in Carbendazim followed by *Trichoderma viride* and *Azadirachta indica* in the requirement which support and shows the similarity observations are recorded in present investigation. Singh *et al.* (2018) revealed that the number of healthy pod per plant and seed index is similar as the present investigation. Tewari and Mukhopadhyay (2000) used botanicals as seed treatments and found affective in increases seedling emergence and grain yield. Many worker like Dutta *et al.* (1991) and the findings of Asgharian and Mayee (1991), Jhonson *et al.* (2008) was also similar as grain yield was increased while using of botanicals and bioagents. Kumar *et al.* (2008) also used bioagent and revealed that higher yield of chickpea.

Nagamma and Nagaraja (2015) revealed that the maximum inhibition of mycelial growth (71.67%) was noticed in *Trichoderma harzianum* which was followed by *Trichoderma viride* (63.33%) under *in vitro* condition. Bhuiyan *et al.* (2012) also revealed that the bioagents have the significant effect on *Sclerotium rolfsii* and maximum inhibition was recorded and many worker like More *et al.* (2016), Khan *et al.* (2020) also revealed that the botanicals have the significant effect on mortality of chickpea plant. Prabhu (2003) revealed that the different systemic and non-systemic fungicides against *Sclerotium rolfsii* and reported 100% inhibition by carboxin, which was followed by carbendazim (63%) + mancozeb (12%) and propiconazole.

5. Conclusion

In the current investigation, it is concluded that application of T8 [*Trichoderma herzianum* (10 g/kg seed) + Carbendazim (3 g/kg seed)] showed better performance in enhancing germination and reducing mortality percentage and appearance of the disease. This is also true that use of *Trichoderma herzianum* (10 g/kg seed) + Carbendazim (3 g/kg seed) promoted plant height, total number of branches/plant, total number of pod/plant reduced disease incidence and showed maximum grain yield of chickpea. In the botanicals, T2 [*Trichoderma harzianum* (10 g/kg seed) + Neem oil (2.5%)] was found to be the best in all prospects. In the remaining treatments, all were effectively controlling the disease and enhance the plant growth and production. For batter environment and to avoid hazardous effect of chemicals, the botanicals can be the alternative option to manage such kind of plant diseases.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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