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Field evaluation of seed treatment and soil application strategies for managing wilt–dry root rot complex in chickpea

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Abstract

The wilt/dry root rot complex in chickpea is an important disease that occurs in many parts of the country. Wilt/dry root rot pathogens affects the crop in all growth stages, resulting in yield losses in terms of both quality and quantity parameters of grain and this reinforces the need to exploit several management strategies including biological and chemical control. Therefore, an investigation was laid out to test the bio efficacy of *Trichoderma harzianum* and fungicides chemicals used alone and/or in combination against wilt/root rot disease of chickpea at RARS, Vijayapur, during *rabi* 2023-24. The field experiment comprised nine treatments arranged in three replications. The results revealed that seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml kg⁻¹ of seed, followed by soil drenching with *T. harzianum* @ 10 g L⁻¹ of water to infected and surrounding plants and application of Chickpea Magic spray at 40 days after sowing, significantly reduced disease incidence to 7.20% and recorded the highest grain yield (11.64 q ha⁻¹). This was followed by seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml kg⁻¹ of seed along with Chickpea Magic spray at 40 days after sowing, which resulted in 10.01% disease incidence and a grain yield of 10.48 q ha⁻¹. The findings indicate that integration of seed treatment, biological control, and foliar application effectively reduces wilt–dry root rot incidence and enhances chickpea productivity under field conditions.

Keywords: Integrated management, dry root rot, wilt, chickpea, *Rhizoctonia bataticola*

1. Introduction

Chickpea, *Cicer arietinum* L. is one of the most important pulse crops of India. In India, chickpea ranks second in area and third in production, perhaps is the largest producer of chickpea in the world covering 80% area and 85% of total production with a productivity of 844 kg per ha (www.iipr.res.in). In Karnataka, it is grown on an area of 1.09 m ha with a production of 0.57 m tonnes and the productivity is 622 kg per ha. Kalaburagi, Bidar, Dharwad, Vijayapur, Gadag, Ballari and Raichur are the major chickpea growing districts. The average production of chickpea is 15 to 20 quintal per hectare which is low in spite of high yielding varieties and new agronomic practices. Plant disease outbreaks are increasing and threaten food security of the world. Global yield losses due to crop pests and diseases on crops are large. Important diseases such as Turicum leaf blight in maize, downy mildew in sorghum, dry root rot in chickpea, phyllody in chickpea, leaf spots in groundnut, wilt in pigeon pea, necrosis disease in sunflower (Sundaresha *et al.*, 2012) ^[14] and bud blight caused by Groundnut bud necrosis virus (Balol and Patil, 2014) ^[2] *etc.* Bacterial blight in Pomegranate (Basamma *et al.*, 2014) ^[5] are contributing for the yield loss.

The chickpea crop is attacked by 172 pathogens (67 fungi, 22 viruses, 3 bacteria, 80 nematodes and mycoplasma) from all over the world (Nene *et al.*, 1996). Among all, only a few of them have the potential to devastate the crop. Some of the serious diseases in order of their importance are wilt (*Fusarium oxysporum* f. sp. *ciceri*) wet root rot (*Rhizoctonia solani*), dry root rot (*Rhizoctonia bataticola*) Ascochyta blight (*Ascochyta rabiei*), collar rot (*Sclerotium rolfsii*) and Chickpea rust (Basamma *et al.*, 2021) ^[14]. Among the several constraints affecting the productivity of chickpea, 10 to 35% loss in yields is due to dry root rot (Mahendra Pal) and 9 to 41% loss due to wilt (Khan *et al.*, 2004) ^[7].

For soil borne pathogens, 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 chemicals is the best alternative (Ramarethinum *et al.*, 2001)^[12]. Investigations were made in the present study to devise an effective management strategy for wilt/root rot complex of chickpea.

2. Materials and Methods

An experiment was laid out for the management of chickpea wilt/root rot complex as per randomized block design (RBD) during *rabi* 2023-24 at experimental block of Regional Agricultural Research Station, Vijayapur. The variety JG -11 was grown and treated with nine treatments which were replicated thrice with plot size of 3 × 4 m² and recommended agronomical practices were followed to conduct the experiment. The observations like per cent disease incidence, grain yield and benefit cost ratio were recorded.

Disease incidence (%): Based on observations the disease incidence was calculated by the following formula.

$$\text{Percent disease incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plants examined}} \times 100$$

Seed yield (q/ha): At the time of harvest, chickpea plants from all the treatments and replications were collected separately. After threshing and winnowing, the net plot yield was recorded and later converted to ha and expressed as q per ha.

Estimation of benefit cost (B:C) ratio: The economic analysis of the experiment was done by taking into consideration of market prices prevailing during 2023-24 for the produce and cost of treatment. B:C was calculated from gross returns and total cost of cultivation.

$$\text{Benefit: Cost} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

2.1. Treatment details

1. T₁: Seed Treatment (ST) with *T. harzianum* @ 10 gm per kg followed by soil drenching with *T. harzianum* @ 10 g per lt of water to infected and surrounding plants.

2. T₂: ST with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by soil drenching with *T. harzianum* @ 10 mg per lt of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing
3. T₃: ST with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg followed by soil drenching with *T. harzianum* @ 10 g per lt
4. T₄: ST with *T. harzianum* @ 10 gm per kg followed by soil drenching with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing
5. T₅: ST with *T. harzianum* @ 10 gm per kg followed by soil drenching with Carbendazim 25% + Mancozeb 50% @ 3.5 g per lm
6. T₆: ST with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg
7. T₇: ST with *T. harzianum* @ 10 gm per kg
8. T₈: ST with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by chickpea magic spray at 40 days after sowing
9. T₉: Control

3. Results and Discussion

3.1. Disease incidence (%) and yield (q/ha)

The results of the experiment conducted are presented in the Table 1 and 2.

Table 1: Integrated management of chickpea wilt/root rot complex

Treatments	Disease incidence (%)	Reduction over control (%)	Yield q/ha
T ₁	20.48 (26.90)*	21.53	7.17
T ₂	7.20 (15.46)	72.41	11.64
T ₃	14.32 (22.23)	45.13	9.00
T ₄	12.06 (20.30)	53.63	9.40
T ₅	16.37 (23.83)	37.28	8.39
T ₆	18.43 (25.38)	29.38	7.36
T ₇	22.67 (28.42)	13.15	6.27
T ₈	10.01 (18.44)	61.65	10.48
T ₉	26.10 (30.69)	--	5.00
S.Em ±	0.68	--	0.33
CD (5%)	2.04	--	1.00

* Figures in the parenthesis are arc sine transformed values

Table 2: Yield and benefit cost ratio of integrated disease management on chickpea as influenced by wilt/root rot complex

Sl. No.	Treatments	Yield (q/ha)	Cost of cultivation (Rs/ha)	Treatment cost (Rs/ha)	Total cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	B:C
1	T ₁	7.17	23335	982.8	24318	39435	1.62
2	T ₂	11.64	23335	2485	25820	64020	2.48
3	T ₃	9.00	23335	886.8	24222	49500	2.04
4	T ₄	9.40	23335	6012	29347	51700	1.76
5	T ₅	8.39	23335	3564	26899	46145	1.72
6	T ₆	7.36	23335	234	23569	40480	1.72
7	T ₇	6.27	23335	50	23385	34485	1.47
8	T ₈	10.48	23335	2159	25494	57640	2.26
9	T ₉	5.00	23335	0	23335	27500	1.18
	S.Em ±	0.33	--	--	--	--	--
	CD (5%)	1.00	--	--	--	--	--

Management of chickpea wilt/root rot complex revealed that all the treatments tested were significantly superior over untreated control. Among all the treatments, seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt of water to infected and surrounding plants followed by chickpea

magic spray at 40 days after sowing (T₂) recorded significantly lowest disease incidence of 7.20% with maximum yield of 11.64 q per ha yield from rest of the treatments. The next best treatment was seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by chickpea magic spray at 40 days after sowing (T₈) with 10.01% disease

incidence and 10.48 q per ha yield followed by seed treatment with *T. harzianum* @ 10 g per kg followed by soil drenching with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing (T_7) recorded 12.09 disease incidence and 9.40 q per ha yield, seed treatment with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt (T_3) had shown to record 14.32 disease incidence with yield 9.00 q per ha. Significantly highest disease incidence of 26.10% was recorded in control and lowest yield of 5.00 q per ha

3.2. Per cent reduction in disease incidence

The maximum reduction in disease incidence (72.41%) was recorded in the treatment combination of seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing (T_2). Seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by chickpea magic spray at 40 days after sowing (T_8) showed per cent reduction of 61.65%. It was comparatively less in other treatments viz., seed treatment with *T. harzianum* @ 10 gm per kg followed by soil drenching with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing (T_4) (53.63%), seed treatment with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt (T_3) (45.13%), seed treatment with *T. harzianum* @ 10 gm per kg followed by soil drenching with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per lt (T_5) (37.28%), seed treatment with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg (T_6) (29.38%), and seed treatment with *T. harzianum* @ 10 gm per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt of water to infected and surrounding plants (T_1) (21.53%). The lowest reduction in disease incidence (13.15%) was recorded in seed treatment with *T. harzianum* @ 10 gm per kg (T_7).

3.3. Benefit cost ratio (B:C)

The benefit cost ratio of integrated management of chickpea wilt/root rot complex was calculated by considering the total cost of cultivation, cost of treatments and gross returns. The highest benefit (2.48) was recorded in seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing (T_2). The next highest BC ratio (2.26) was recorded in seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg followed by chickpea magic spray at 40 days after sowing (T_8). Least BC ratio of 1.18 was recorded in untreated control.

These results are in conformity with Lokesh and Shashidara (2018) [9] who reported that the seed treatment with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg + chickpea magic spray 1 ml per lt of water twice at 50% flowering has recorded the least wilt/root rot incidence and highest yield in chickpea. Deepa *et al.* (2018) [6] also reported that the seed treatment with Carbendazim 25% + Mancozeb 50% @ 3.5 gm per kg followed by soil drenching with the same @ 3 gm per lt water to infected and surrounding plants was effective by recording least incidence and highest seed yield. Kulkarni and Ashtaputre (2020) [8] reported that significantly lower incidence of root rot and wilt in chickpea was recorded in seed treatment

with Thiophanate methyl 45% + Pyraclostrobin 5% FS @ 4 ml per kg of seed which was on par with the same @ 5 ml per kg of seed. Singh *et al.* (2003) [13] reported the efficacy of *T. harzianum* in controlling *R. bataticola* causing dry root rot in chickpea under *in vitro* and in field experiment.

4. Conclusion

In the integrated management trials of chickpea wilt/root rot complex, seed treatment with Thiophanate methyl 45% + pyraclostrobin 5% FS @ 4 ml per kg followed by soil drenching with *T. harzianum* @ 10 gm per lt of water to infected and surrounding plants followed by chickpea magic spray at 40 days after sowing was found highly effective by recording least disease incidence of 7.20% with maximum yield of 11.64 q per ha yield and highest benefit ratio (2.48).

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