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PC Chovatiya
M. Sc. Student, Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

SV Undhad
Associate Professor, Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

MH Dabhi
M. Sc. Student, Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

DM Ghatodiya
M. Sc. Student, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
PC Chovatiya
M. Sc. Student, Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Collar rot of chickpea: *In vivo* evaluation of fungicides, bioagents and soil amendments for disease management

PC Chovatiya, SV Undhad, MH Dabhi and DM Ghatodiya

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Abstract
One of the major pulse crops cultivated in temperate, sub-tropical and tropical climates worldwide is the chickpea (*Cicer arietinum* L.). Chickpea is known to affect by many fungal, bacterial and viral diseases. Among them, chickpea collar rot occurs in moderate to severe form in Gujarat state. Looking to the symptomatology, affected seedlings turn yellow, upon uprooting seedlings show rotting at the collar region which covered with whitish mycelial strands. A white mycelial coating can be seen on the tap root of completely dried seedlings and produced mustard grain sized light to dark brown structures known as sclerotia. Evaluation of different fungicides, bioagents and soil amendments against *Sclerotium rolfsii* under field condition and showed that all the treatments were effective as compare to control. Carboxin 37.5 + thiram 37.5 WS showed minimum disease incidence (6.22%) with maximum disease reduction over control (75.00%) whereas, neem cake treatment recorded maximum per cent disease incidence of (20.85%) with minimum disease reduction over control (16.67%). The corresponding maximum seed yield (1360 kg/ha) was observed in carboxin 37.5 + thiram 37.5 WS with per cent seed yield increase over control of 19.77 per cent whereas, control treatment exhibited minimum seed yield (1091 kg/ha).

Keywords: Chickpea, collar rot, *S. rolfsii*, fungicides, soil amendment, bioagents, management

Introduction
Chickpea (*Cicer arietinum* L.) is an essential annual pulse crop that belongs to the genus *Cicer*, family *Leguminosae* or *Fabaceae* and is also recognized as “Bengal gram”. In the world, it ranks third in importance among grain legumes, behind peas (*Pisum sativum*) and beans (*Phaseolus vulgaris*) (Aykoid and Doughty, 1964) [1]. Chickpea seeds are an excellent source of energy as; they contain protein (17.21%), carbohydrates (61.5%) and fat (4.5%). Green immature seeds of gram are used as vegetable while, husk and split beans are used as cattle feed (Jukanti *et al*., 2012) [2].

Chickpea production of India was 13.75 million tonnes from an acreage of 10.91 million ha. with a productivity of 12.6 q/ha. Chickpea solely contributes nearly (50%) of the Indian pulse production. States like Maharashtra (25.97%), Madhya Pradesh (18.59%), Rajasthan (20.65%), Gujarat (10.10%) and Uttar Pradesh (5.64%) are major chickpea producing states of India (Anon., 2023). Gujarat produce 1.44 million tonnes of output, which is higher than the national average. In terms of sowing area and production, Junagadh and Amreli districts lead with 819.30 and 753.95 hectares and 1489.98 and 1467.27 metric tonnes, respectively. However, in terms of productivity, Botad (2557 kg/ha) and Bhavnagar (2208 kg/ha) districts lead in 2023-24 (Anon., 2024).

Chickpea collar rot is a serious illness that spreads quickly. There is a decrease in plant population since the condition is limited to the seedling stage up to 45 days. The symptoms of collar rot seen at the seedling stage up to 6 weeks after sowing. Affected seedlings turn yellow, upon uprooting seedlings show rotting at the collar region which covered with whitish mycelial strands. A white mycelial coating can be seen on the tap root of completely dried seedlings. Mustard grain sized light to dark brown structures known as sclerotia, serve as over wintering bodies (Kotastthane *et al*., 1976) [5].

Collar rot of chickpea is an important soil borne and fast spreading fungal pathogen, which causes considerable damage to the plant stand. Generally, the disease is more in loamy soil regions and more prevalent in soybean-chickpea or paddy-chickpea based cropping system, when soil moisture is high and temperature is warm at the seedling stage. Seedling mortality in chickpea due to *S. rolfsii* has been reported to vary from 54.7 to 95.00 per cent (Shrivastava *et al*., 1984) [6].

Materials and Methods

The present study on efficacy of different fungicides, bioagents and soil amendments against *Sclerotium rolfsii* causing collar rot disease in chickpea were carried out at the Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India.

Field evaluation of fungicides, bioagents and soil amendments against collar rot of chickpea

A field trial was conducted at the Research Farm of the Department of Plant Pathology, Junagadh Agricultural University, Junagadh to study the efficacy of fungicides, soil amendments and bioagents for the management of collar rot of chickpea. A field trial was arranged in Randomized Block Design with three replications. Chickpea variety 'GG-3' was sown at the rate of 60 kg seeds per hectare at 30 × 10 cm distance in each of the gross plot size of 5.00 m x 3.00 m and net plot size of 4.00 m × 2.40 m and manually fertilized (20:40:00 NPK kg/ha) in soil. All agronomical practices were followed as and when required except fungicidal treatments.

Treatment details

Sr. No.	Treatments	Doses for seed treatment or soil application	Doses for drenching (g/10 L of water)
T_1	Seed treatment (ST) with mancozeb 75 WP and drenching at 25 DAS	2.5 g/kg	25 g
T_2	ST with carboxin 37.5 + thiram 37.5 WS and drenching at 25 DAS	3 g/kg	30 g
T_3	ST with fluxapyroxad 33.3 SC and drenching at 25 DAS	1 ml/kg	10 ml
T_4	ST with *Trichoderma viride* (2×10^6 cfu/g, min.) and soil application at 25 DAS	10 g/kg	100 g
T_5	ST with *Bacillus subtilis* (1×10^8 cfu/g, min.) and drenching at 25 DAS	10 ml/kg	100 ml
T_6	Soil application of neem cake at time of sowing	100 kg/acre	-
T_7	Control	-	-

*ST = Seed treatment

Methodology

Apparently healthy and diseased free seeds of chickpea variety GG-3 was collected from Pulse Research Station, JAU, Junagadh. Pathogen mass multiplied on 9:1 sand maize meal medium having strength of 2 x 10^6 cfu/ml, minimum was applied @ 10 g per meter row length (500 g/plot) in soil one week prior of sowing at 5 cm depth to increase the disease pressure (Padamini, 2014) [7]. Effect of non-systemic, systemic and ready-mix fungicides was tested by seed treatment. While bioagents and soil amendment were applied as a soil application. The fungicides, soil amendments and bioagents found effective from *in vitro* trial were used as a seed treatment and drenched 25 days after sowing of crop by dissolving at their effective concentration at the rate of 400 L solution per hectare. Required quantity of respective fungicides were added to measured quantity of water in order to set desired concentration. Whereas, the fungal bioagents having minimum 2×10^6 cfu/g and bacterial bioagents having minimum 1×10^8 cfu/ml were drenched by dissolving 1 kg or L of bioagents in 400 L of water per hectare. Control was also maintained without drenching with any fungicide, soil amendments and bioagents. Infected plants were recorded regularly by observing 5 plants in each row, totaling 25 plants per plot.

Observations Recorded

Per cent disease incidence calculated using following formula.

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

The per cent disease reduction over control was calculated with the help of following formula (Mathur *et al.*, 1971) [8].

$$\text{Disease control (\%)} = \frac{\text{PDI in control plot - PDI in treated plot}}{\text{PDI in control plot}} \times 100$$

$$\text{Yield increase over control (\%)} = \frac{\text{Yield in treated plot - Yield in control plot}}{\text{Yield in control plot}} \times 100$$

Result and Discussion

Field evaluation of fungicides, bioagents and soil amendments against collar rot of chickpea

Perusal of data presented in Table 1 and Plate 1 revealed that all the treatments were effective in reducing the disease incidence with corresponding increase in seed yield as compared to control under field condition.

Among the different treatments tried, seed treatment in chickpea plants at time of sowing and thereafter drenching at 25 days after sowing of crop with carboxin 37.5 + thiram 37.5 WS showed minimum disease incidence (6.22%) with maximum disease reduction over control (75.00%). The next effective treatment was fluxapyroxad 33.3 SC (9.17%) and mancozeb 75 WP (11.24%) with per cent disease reduction over control of 63.33 and 55.00, respectively. The treatment *Trichoderma viride* showed 15.00 per cent disease incidence with per cent disease reduction over control of 40.00. The treatment with moderately effective action was observed in *Bacillus subtilis* 1×10^8 cfu/g, min. (18.35%) with 26.67 per cent disease reduction over control and neem cake (20.85%) with per cent disease reduction over control of 16.67. Whereas, control treatment showed maximum per cent disease incidence of 25.02 per cent with high disease pressure.

Looking to the seed yield, seed treatment in chickpea plants at time of sowing and thereafter drenching at 25 days after sowing of crop with carboxin 37.5 + thiram 37.5 WS exhibited maximum seed yield (1360 kg/ha) with per cent seed yield increase over control of 19.17 per cent, but it was remained statistically at par with fluxapyroxad 33.3 SC (1320 kg/ha) and mancozeb 75 WP (1283 kg/ha) with seed yield increase over control of 17.32 and 14.96 per cent, respectively. The next effective treatment was *Trichoderma viride* 2×10^6 cfu/g, min. (1205 kg/ha) with per cent seed yield increase over control of 9.43 per cent, but it was remained statistically at par with and *Bacillus subtilis* 1×10^8 cfu/g, min. (1175 kg/ha) and neem cake (1155 kg/ha) with seed yield increase over control of 7.12 and 5.51 per cent, respectively. The control treatment exhibited minimum seed yield of 1091 kg/ha.

Table 1: Per cent disease incidence and seed yield of chickpea as influenced by different fungicides, bioagents and soil amendments

Treatments	Per cent disease incidence	Per cent disease reduction over control	Seed yield (kg/ha)	Seed yield increased over control (%)
Mancozeb 75 WP (2.5 g/L)	19.59 (11.24)*	55.00	1283	14.96
Carboxin 37.5 + Thiram 37.5 WS (3 g/L)	14.44 (6.22)	75.00	1360	19.77
Fluxapyroxad 33.3 SC (1 ml/L)	17.62 (9.17)	63.33	1320	17.32
Trichoderma viride (2×10^6 cfu/g, min.)	22.79 (15.00)	40.00	1205	9.43
Bacillus subtilis (1×10^8 cfu/g, min.)	25.36 (18.35)	26.67	1175	7.12
Neem cake (100 kg/acre)	27.17 (20.85)	16.67	1155	5.51
Control	30.01 (25.02)	0.00	1091	0.00
S. Em. ±	0.63		49.93	
C. D. at 5%	1.96		153.88	
C.V.%	7.29		7.05	

*****Data outside the parentheses are arcsine transformed, whereas inside are re-transformed values.

The present results corroborate the finding of Khalequzzaman (2016) [9]. They reported minimum disease incidence of 21.67 per cent in the treatment of carboxin 17.5 + thiram 17.5 FF against *S. rolfsii*. Shirsole *et al*. (2019) [10] showed mancozeb 75 WP inhibit the 79.71 per cent mycelial growth of *S. rolsii*. Whereas, More *et al*. (2016) [11] also reported the effectiveness of *Trichoderma viride* (92%) in germination of chickpea.

Conclusions

Based on present investigation, it concluded that chickpea (*Cicer arietinum* L.) is also a host of *Sclerotium rolfsii* Sacc. and it causes collar rot disease in chickpea. Under field evaluation of fungicides, soil amendments and bioagents, seed treatment at the time of sowing and thereafter drenching at 25 days after sowing of crop with carboxin 37.5 + thiram 37.5 WS, fluxapyroxad 33.3 SC and mancozeb 75 WP found highly effective in reducing disease incidence with corresponding increase in seed yield of chickpea as compared to other treatments.

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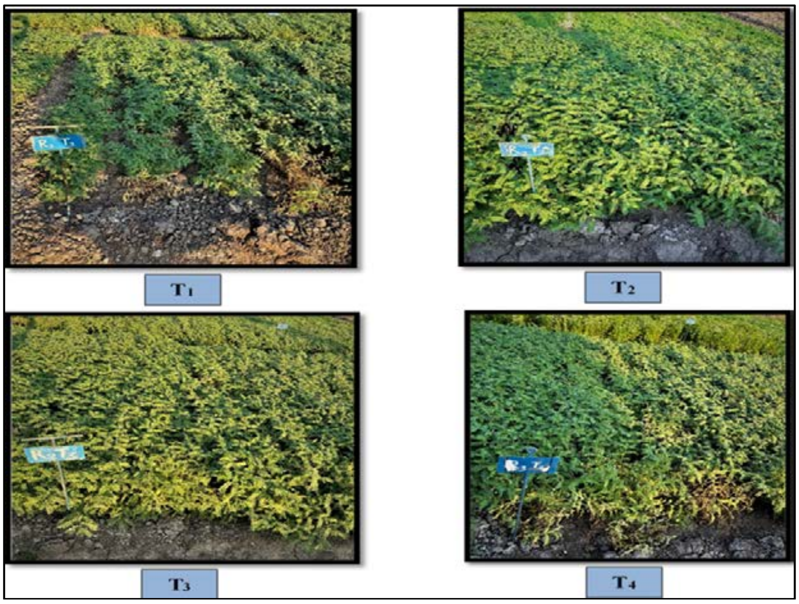
Conflict of interest

The authors declare that they have no conflict of interest.



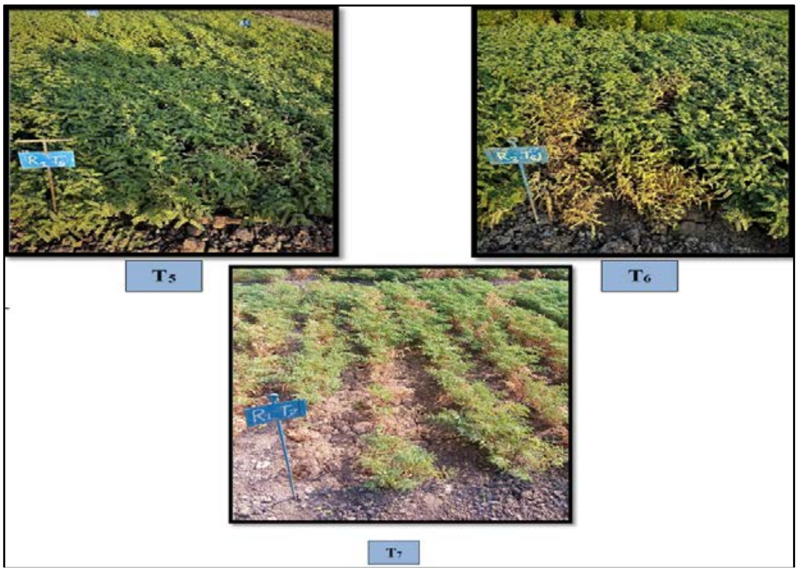


Plate 1: Field evaluation of fungicides, soil amendments and bioagents against collar rot of chickpea

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