



Efficacy of Biorational Approaches in Managing Collar rot Disease of Groundnut Caused by *Aspergillus niger*

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ABSTRACT

Background: Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops cultivated in India. However, its productivity is often reduced by several Seed and soil-borne pathogens that adversely affect germination, plant establishment and final yield. Collar rot caused by *Aspergillus niger* is a serious disease of groundnut, particularly during the early growth stages. To identify effective and eco-friendly management options, on-farm trials were conducted by Krishi Vigyan Kendra, Maulasar during *Kharif* seasons of 2021 and 2022 under farmers' field conditions. All treatments resulted in a significantly higher seedling emergence rate (80.80%-96.67%) compared to the control group (70.12%). The maximum seedling emergence (96.67%) was observed with the combination of *T. viride* soil application and propiconazole seed treatment. Furthermore, among all evaluated fungicides and bioagents, this specific combination recorded the lowest disease incidence (11.81%) and the highest pod yield (24.99 q/ha). This was followed by the standalone propiconazole seed treatment, which exhibited a disease incidence of 15.25% and a pod yield of 21.95 q/ha.

Methods: Different combinations of fungicides and biological control agents were evaluated. Treatments included soil application of *Trichoderma viride* 2.5 kg/ha, seed treatment with carbendazim 50 WP 2 g/kg seed, propiconazole 25 EC 2 ml/kg seed and *T. viride* 8 g/kg seed, as well as drenching with propiconazole 25 EC 500 ml/ha at 20 days after sowing. Observations were recorded on seedling emergence, disease incidence, pod yield, economic returns and benefit-cost ratio.

Result: All disease-management treatments performed better than the untreated control. The combination of soil application of *T. viride* (2.5 kg ha⁻¹) and seed treatment with propiconazole (2 ml kg⁻¹ seed) produced the best results, recording the highest seedling emergence (96.67%), lowest collar rot incidence (11.81%) and maximum pod yield (24.99 q ha⁻¹). Seed treatment with propiconazole alone was the next most effective treatment, resulting in lower disease incidence and improved yield compared with other treatments. The study demonstrated that integrating biological and chemical approaches can effectively suppress collar rot and enhance groundnut productivity.

Key words: *Aspergillus niger*, Collar rot, Disease management, Groundnut, Propiconazole, *Trichoderma viride*.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important member of Leguminosae family, widely grown food legume and oil seed crop of tropical and sub-tropical regions of the world. It is an important source of vegetable oil for majority of human population of the world and is a rich source of protein for human and animal consumption. Groundnut kernels contain 48-50 per cent edible oil and 26-28 per cent protein, along with rich dietary fibre, minerals and vitamins (Ntare *et al.*, 2008). The crop is believed to be native of Brazil (South America) and introduced to East Asia from South America (Weiss *et al.*, 2000). In India, though groundnut is cultivated in one or more seasons (*Kharif* and *Rabi* and summer) but nearly 80 per cent of the annual acreage and production comes from *Kharif* (June to October) season. The crop is primarily grown on a commercial scale in more than 82 countries in the world. In India, the total coverage area under groundnut cultivation is about 47.07 lakh hectares with annual production to the tune of 101.80 lakh tonnes and average productivity of 2163 kg/hectare (Anonymous, 2023-24). Major groundnut growing states of India are Gujarat, Andhra Pradesh, Rajasthan,

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Karnataka, Maharashtra and Tamil Nadu. Among these states, Gujarat stands first in the production while Andhra Pradesh in the area. Rajasthan stands seventh both in terms of the area and production. The crop is well

adapted to the conditions prevailing in Rajasthan and cultivated in about 8.91 lakh hectares with an annual production of 20.27 lakh tonnes and productivity of 2276 kg/hectare (Anonymous, 2023-24).

The primary groundnut-producing districts in Rajasthan include Bikaner, Jodhpur, Churu, Hanumangarh, Jaipur, Sikar, Nagaur and Dausa. In these regions, groundnut kernels serve as an affordable and vital source of dietary vegetable protein.

Groundnut cultivation is severely constrained by numerous fungal, bacterial and viral diseases. In Rajasthan, fungal pathogens represent the primary limiting factor for profitable production, causing substantial crop losses throughout all growth stages-from sowing and harvesting to storage. The most devastating diseases include early leaf spot (*Phaeoisariopsis arachidicola*), late leaf spot (*Phaeoisariopsis personata*), rust (*Puccinia arachidis*), collar rot (*Aspergillus niger*), stem rot (*Sclerotium rolfsii*), root rot (*Macrophomina phaseolina*) and afla root (*Aspergillus flavus*). Among these, collar rot, incited by *Aspergillus niger*, stands out as a destructive seed- and soil-borne disease that heavily impacts both the pre- and post-emergence phases of the crop. Infected seeds may rot within the soil or become covered with sooty black spore masses upon germination (Kumari and Singh, 2016). Consequently, collar rot causes severe reductions in both the pod and fodder yields of groundnut. The causal organism, *Aspergillus niger*, is a saprophytic, filamentous fungus characterized by smooth-walled, hyaline conidiophores. Its conidia are globose to sub-globose (1.38-4 µm in diameter), dark brown to black and rough-walled (Jochem, 1926). In Rajasthan, the warm climate renders groundnut kernels highly susceptible to *A. niger* infection. Globally, this disease accounts for annual yield losses exceeding 10%, with the fungus thriving in low-moisture soils at temperatures around 30°C (Karthikeyan, 1996; Kucuk and Kivank, 2003). The highest disease incidence, ranging from 25% to 50%, has been reported in Rajasthan (Kishore *et al.*, 2006). Although several seed-dressing fungicides are known to combat collar rot effectively (Gangopadhyay *et al.*, 1996), the extent of these losses necessitates field evaluations of combined fungicide molecules and bioagents to identify the most effective seed treatment strategy. According to (Bajya *et al.*, 2022) the disease was prevalent across all 200 fields surveyed in eight districts of Rajasthan. The overall disease incidence was 22.99%, ranging from 17.84% to 32.38% and resulted in significant monetary losses.

MATERIALS AND METHODS

The field trials were conducted at farmer's fields in Chhapari and Gugadwar villages during *Kharif* 2021 and 2022. The trial details are presented in Table 1. The improved technology that is, need based plant protection including carbendazim 50% WP, propiconazole 25 EC and *Trichoderma viride* was assessed in field conditions in

different combinations. Treatment (T₁- seed treatment with carbendazim 50% WP @ 2 g/kg seed); Treatment (T₂- seed treatment with propiconazole 25 EC @ 2 ml/kg seed); Treatment (T₃- seed treatment with *Trichoderma viride* @ 8 g/kg seed); Treatment (T₄- soil treatment with T₃ + seed treatment with T₂ @ 2.5 kg/ha + 2 ml/kg seed); Treatment (T₅- Seed treatment with T₃ + soil drenching with T₂ @ 8 g/kg seed + 500 ml/ha at 20 DAS) and Treatment (T₆) - untreated control were taken to know their efficacy against collar rot disease.

Ten replications, each with a plot size of 0.4 hectares, were used in the trials at ten farmers' fields. The percentage of germination, the percentage of disease incidence 45 days after sowing, the percentage of seed yield and the percentage of yield increase over control were all recorded. To understand the economics of treatments, statistics on the two-year experiment's net monetary return and cost-benefit ratio were also examined.

The disease incidence (%) was calculate using following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of rotted plants}}{\text{Total number of plants}} \times 100$$

The increase in grain yield (%) was calculate using following formula:

$$\text{Increase in grain yield (\%)} = \frac{\text{Grain yield from improved technology} - \text{Grain yield from farmer plot}}{\text{Grain yield from farmer plot}} \times 100$$

RESULTS AND DISCUSSION

All the treatments were found significantly superior in managing the collar rot over untreated control (35.73%), however, among all the treatments, minimum per cent disease incidence (11.81%) was recorded in T₄ (soil treatment with T₃ + seed treatment with T₂ @ 2.5 kg/ha + 2 ml/kg seed) (Table 2). Lower collar disease incidence (18.36 %) and (15.25%) was also observed when groundnut seeds were treated with carbendazim 50% WP and propiconazole 25EC (T₁ and T₂). Jedon *et al.* (2015) also observed that groundnut crops treated with propiconazole had a lower incidence of collar rot disease. According to the pooled year results, higher seed

Table 1: Details of experiment.

Parameter	Details
Crop	Groundnut
Season	<i>Kharif</i> 2021 and 2022
Variety	GG-20
Soil type	Sandy soil
Replications	10
Plot size	0.4 ha
Location	Chhapari and Gugadwar villages

germination (96.67%) was also observed in treatment T_4 -soil treatment with T_3 + seed treatment with T_2 @ 2.5 kg/ha + 2 ml/kg seed. Carbendazim 50% WP and propiconazole 25EC alone also proved their efficacy in seed germination with 91.41 and 93.35 per cent germination. In a similar trend, Sharma and Gour (2009) observed that treating groundnut seeds with carbendazim and propiconazole enhanced pea germination and seedling vigor. The highest seed yield of 24.99 q/ha was found when *T. viride* was applied to the soil and seeds treated with propiconazole with a yield increase of 61.09 per cent. This was followed by seeds treated with propiconazole (21.95 q/ha), with a yield increase of and 41.49 per cent. The study findings suggest that integrated disease management has a lot of potential for efficient and environmentally responsible disease control for the benefit of end users. These findings are consistent with those of Prajapati *et al.* (2016), who discovered that applying carbendazim, trifloxystrobin (25%) + tebuconazole (50%), Azoxystrobin (18.2%) + difenconazole (11.4%), hexaconazole and propiconazole could reduce black mold rot of onions (*Aspergillus niger*).

Additionally, Harsukh *et al.* (2011) found that under *A. niger* infection, seed treatment with *Trichoderma* decreased the disease incidence at 15 DAS. Groundnut collar rot and other soil-borne diseases have been somewhat controlled by seed treatment with biocontrol agents such as *T. viride* and *T. harzianum* (Gangwar *et al.*, 2014; Rawal *et al.*, 2013). In their study of fungicides, including vitavax, carboxin, propiconazole, thiram and mancozeb, Rakholia *et al.* (2012) found that the treatment of vitavax 200 WP 4.0 g kg⁻¹ seed had the lowest incidence of collar rot disease (5.16%) and the highest pod yield (1232 kg ha⁻¹), followed by propiconazole. According to Kapadiya and Moradiya (2017), two foliar tebuconazole sprays and seed treatment were very successful in preventing collar rot. Seed treatment with tebuconazole + trifloxystrobin (@ 0.2%) was found highly effective in reducing disease incidence (83.12%) and in increasing seed yield (84.71%) under field conditions. Thus, it can be concluded that the use of newer combined formulation as seed treatment before sowing provide us alternative source to manage root rot disease of fenugreek, according to Yadav *et al.* (2022).

The economics of all the treatments presented in Table 3 and showed that the maximum mean net return of

Table 2: Treatment details.

Treatments	Dose g/kg or ml/kg
T_1 - Carbendazim 50% WP	2 g/kg seed
T_2 - Propiconazole 25 EC	2 ml/kg seed
T_3 - <i>Trichoderma viride</i>	8 g/kg seed
T_4 - Soil treatment with	2.5 kg/ha + 2 ml/kg seed
T_3 +Seed treatment with T_2	
T_5 - Seed Treatment with	8 g/kg + 500 ml/ha
T_3 +Drenching with T_2	
Control (Untreated)	-

Table 3: Effect of different treatments on collar rot disease of groundnut under field condition during Kharif, 2021 and 2022.

Treatment	Germination %			Per cent disease incidence %			Yield q/ha %			Increase in yield over control		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
T_1 -Carbendazim 50% WP	90.91	91.91	91.41	18.81	17.91	18.36	20.35	20.46	20.40	33.53	29.65	31.59
T_2 -Propiconazol 25 EC	93.20	93.50	93.35	15.45	15.05	15.25	21.40	22.50	21.95	40.41	42.58	41.49
T_3 - <i>Trichoderma Viride</i>	80.10	81.5	80.80	27.27	25.10	26.18	17.15	17.80	17.47	12.53	12.80	12.66
T_4 -Soil treatment with T_2	96.15	97.20	96.67	12.72	10.90	11.81	24.31	25.67	24.99	59.51	62.67	61.09
T_3 +Seed treatment with												
T_5 -Seed treatment with	89.91	90.01	89.96	19.09	19.00	19.04	17.10	18.00	17.55	18.76	14.06	16.41
T_3 +Drenching with T_2												
Control (Untreated)	70.12	72.13	71.12	36.36	35.10	35.73	15.24	15.78	15.51	-	-	-

Table 4: Effect of treatment on economics in groundnut Kharif, 2021 and 2022.

Treatments	Gross cost (Rs/ha)			Gross return (Rs/ha)			Net return (Rs/ha)			B:C Ratio		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
T ₁	59300	59580	58990	113553	119047	116300	54253	59467	56860	1.91	2.00	1.95
T ₂	59560	61000	61020	124875	125190	125033	65315	64190	64752	2.10	2.05	2.07
T ₃	59000	59500	59250	98790	100327	99559	39790	40827	40309	1.67	1.69	1.68
T ₄	60200	60600	60400	142468	142213	142341	82268	81613	81941	2.37	2.35	2.36
T ₅	60800	61700	61250	99900	100035	99968	39100	38335	38718	1.64	1.62	1.63
T ₆	58400	58600	60400	87579	89154	88367	29179	30554	29867	1.50	1.52	1.51

₹81,941/ha was noted in treatment T₄ followed by treatment T₁ and T₂ with a mean net profit of ₹56,860/ha and 64,752/ha respectively. The benefit cost ratio of all the treatments is also present in Table 4 which reflects the income of ₹2.36 on spend of ₹1.0 when groundnut crop was treated with *Trichoderma viride* @ 2.5 kg/ha and propiconazole 25 EC @ 2 ml/kg seed (Mitra *et al.*, 2021). They have noted similar growth characters of *A. niger* isolates and assigned into various groups like slow, average and rapid growing isolates. Majority of studied isolates depicted average growth rate of colony, sporulation and conidial characters. all the isolates were showed cultural and morphological variability such as shape, colour and size of colony and size of conidia, conidiophores and columella. Showed maximum mycelial growth, conidia diameter, length and diameter of conidiophores and length and diameter of columella, early sporulation and found most virulent as it produced higher disease incidence (54.43%) (Bajya *et al.*, 2022).

CONCLUSION

The findings of the present study clearly indicate that integrated management strategies are effective in minimizing collar rot disease in groundnut. Among the treatments evaluated, soil application of *Trichoderma viride* combined with seed treatment using propiconazole proved superior by reducing disease incidence (11.81%) and enhancing crop establishment, pod yield (24.99 q/ha) and economic returns. The treatment recorded the lowest collar rot incidence and the highest productivity among all tested options. Therefore, integration of biological agents with suitable fungicidal seed treatment can be recommended as a practical and environmentally sound approach for sustainable management of collar rot in groundnut cultivation.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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