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On Farm Evaluation of Trichoderma against Root Rot (*Rhizoctonia solani*) in Clusterbean (*Cyamopsis tetragonoloba*)

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Abstract

Clusterbean, scientifically referred to as *Cyamopsis tetragonoloba* (L.) Taub., commonly encounters the challenge of root rot, also known as black root rot, instigated by *Rhizoctonia solani*, particularly in the *kharif* season. In fields where neither seed treatment nor soil application of *Trichoderma viride* were employed, the disease incidence ranged between 18.83 to 25.3%. In contrast, in demonstrated plots during the 2016 and 2017 seasons, where the seeds were treated @ 5 g kg^{-1} and the soil was treated @ 2.5 kg ha^{-1}, mixed with 250-300 kg FYM and thoroughly incorporated into the field before sowing, the root rot incidence decreased significantly to 9.91 to 10.5%. Comparatively, the disease control rate of the demonstrated approach over the farmers' standard practices was recorded at 53.85%, resulting in a maximum average yield of 13.9 q ha^{-1}. Additionally, the economic gross return and cost-benefit ratio were notably higher in the demonstrated approach (T_2) @ Rs. 56,295.00 ha^{-1} and 3.76, respectively; while in the case of the farmers' practice (T_2), it was Rs. 42,120.00 and 3.35.

Keywords: Cluster bean, *Cyamopsis tetragonoloba*, *Rhizoctonia solani*, Root rot, *Trichoderma viride*

Introduction

Cluster bean, scientifically identified as *Cyamopsis tetragonoloba* (L.) Taub., is a significant leguminous crop commonly referred to as Guar, belonging to the Fabaceae family (Shivran *et al.*, 2020), cultivated for both its grain and green vegetable produce. It finds prominence in the arid and semi-arid regions of tropical India, particularly in Rajasthan, where it is grown during the Kharif and Zaid seasons for seed and vegetable production. Notably, Rajasthan contributes significantly to the extensive cultivation of cluster bean, occupying 694 hectares and yielding an impressive 976 metric tons (Anonymous, 2016). Cluster bean is primarily cultivated for seed production in the arid and semi-arid regions, with a focus on the rainy season. However, it is also cultivated for vegetable purposes during both the Zaid and rainy seasons, ensuring a varied and consistent utilization of the crop throughout the year (Shivran *et al.*, 2020).

Root rot diseases (Figure 1), known to cause substantial

Figure 1: Root rot

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crop yield reductions ranging from 25% to 100% (Frisvad and Samson, 1991), pose a significant threat to cluster bean cultivation. Studies by Bajoria *et al.* (2008) estimated an annual yield loss of 10-15% globally, while Lodha *et al.* (1986) observed a 31.00% incidence of root rot, resulting in a 32.11% yield loss in the arid regions of Rajasthan. *Rhizoctonia solani* Kuhn, along with *Fusarium solani*, has been identified as a primary culprit causing root rot, leading to severe economic losses in the cultivation of clusterbean (Prasad, 1944; Dhingra and Sinclair, 1978; Lodha, 1993).

Rhizoctonia solani Kuhn [teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk 1956] is a soil-borne fungus with a diverse ecological presence, known for its ability to induce root rot disease in clusterbean plants. Apart from *Rhizoctonia solani*, Mathur and Shekhawat (1987) have reported that *Fusarium solani* also contributes to the occurrence of root rot in clusterbean. The infected host tissues often serve as sites for the production of the conidial or pycnidial stage. Primarily inhabiting the soil, this fungus spreads between plants through various means such as irrigation water, agricultural implements and cultural practices. Moreover, its sclerotia and pycniospores can become airborne, facilitating the pathogen's further dissemination within the field (Rangaswami and Mahadevan, 2008).

Considering the environmental risks associated with the uncontrolled and over use of chemical fungicides, a sustainable approach is imperative for effectively managing the root rot disease. Biological control methods employing *Trichoderma viride* have emerged as an environmental friendly and cost-effective strategy, effectively reducing the population and activity of root rot pathogens. This alternative approach not only ensures crop protection but also mitigates the adverse impacts on the environment caused by the indiscriminate use of chemical agents.

Materials and Methods

Trichoderma viride was evaluated for its efficacy in managing root rot in cluster bean during the *Kharif* seasons of 2016 and 2017. This evaluation took place through a Front Line Demonstration of Trichoderma at five different farmers' fields in various villages of Bansur tehsil. This initiative marked the first time such an evaluation was conducted by the Krishi Vigyan Kendra (ICAR-DRMR) Gunta Bansur, Alwar.

The prevalence of root rot posed a significant challenge throughout the crop season, prompting the use of *Trichoderma viride* (2×10^8 cfu) as a market product. The application involved seed treatment at a rate of 5 g kg^{-1} of seed and soil application @ 2.5 kg ha^{-1}, mixed with 250-300 kg of Farm Yard Manure (FYM) and thoroughly incorporated into the field before sowing. Initial observations of root rot incidence were recorded at 60-65 days after sowing, with five randomly selected spots (each covering an area of 2 m × 1 m) on each farmer's field being assessed.

The Percent Disease Incidence (PDI) and the disease control were calculated in the various experiments using the following methodology,

$$\text{Percent disease incidence (PDI)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants}} \times 100$$

Results and Discussion

Symptomatology of Root Rots at Farmers Fields

One of the primary signs of the disease is the drooping and eventual withering of leaves. Affected plants can wilt within a week of the initial symptom's appearance (Kumar *et al.*, 2020). Upon close examination of the stem, dark lesions become visible on the bark near the ground level. Furthermore, uprooted plants might display blackening and rotting symptoms in the basal stem and main root.

Study of Technology Gap

Prior to the implementation of the Trichoderma demonstration at the farmers' fields, the farmers' perspectives were documented through Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA), field visits and direct interactions (Figure 2). The findings indicated that the farmers had not adopted any preventive measures, such as seed treatment or soil application, for managing root rot disease, particularly utilizing bioagents like Trichoderma. The data presented in table 1 demonstrated a complete technology gap of 100% in seed treatment, either with fungicides or *Trichoderma viride* and a 90% technology gap in the soil application of Trichoderma for root rot management.

Figure 2: Field visit

Effects of Trichoderma viride Application on Root Rot Incidence

The technology demonstrated (T_2) revealed that seed treatment with *Trichoderma viride* @ 5 g kg^{-1} of seed and soil application @ 2.5 kg ha^{-1}, mixed with 250-300 kg of FYM before sowing, resulted in a minimal root rot incidence of 10.2%. In comparison, the farmers' practices exhibited a higher incidence at 22.1%, with a 53.85% disease control over the farmers' practices. These findings align with the studies of Dutta and Kalha (2011) and Nasser (2008). Additionally, Kumar and Upadhayay (2015) highlighted that the application of Trichoderma mixed in FYM within the soil reduced wilt incidence in pigeonpea. The decrease in root rot incidence may be attributed to *Trichoderma viride*'s capacity for mycoparasitism, characterized by the

Table 1: Technology adopted by the farmers before the demonstration of *Trichoderma viride* for Root rot management

Technology	Farmers' Practices	Technology Demonstrated	Gap Technology (%)
Seed treatment with any fungicides	No	Seed treatment with streptomycin for bacterial blight	100
Treatment of seeds with Trichoderma	No	Seed treatment @ 5 g kg^{-1} seed	100
Application of bioagents (Trichoderma) mixed in FYM to the soil	10% use insecticides as per the shopkeeper recommendation (Phorate)	Soil application @ 2.5 kg ha^{-1} mixed in 250-300 kg FYM	90

loops formation, coils and twists around the hyphae of the pathogen (Upadhyay and Mukhopadhyay, 1986), along with its biochemical/ antibiotic properties (Papavizas, 1985).

Effect of Trichoderma viride on Seed Yield and Cost Benefit Ratio

The average data over the course of two years, as depicted in table 3, revealed that the demonstration (T_2) resulted in the maximum seed yield of 13.9 q ha^{-1}, which was 33.65% higher than that achieved through the farmers' practices. Furthermore, the average economic gross return and cost-benefit ratio were also higher in the demonstrated approach (T_2) @ Rs. 56,295.00 ha^{-1} and 3.76, respectively, compared to Rs. 42,120.00 and 3.35, respectively, for the farmers' practice (T_2).

Utilizing antagonistic microorganisms for biological control offers a cost-effective, eco-friendly technology that effectively diminishes the number and activity of plant pathogens (Glick *et al.*, 1999; Sindhu *et al.*, 2009; Yang *et al.*, 2014). Similar outcomes were also reported by Kumar and Upadhyay (2015) in the pigeonpea wilt management.

Table 2: The impact of *Trichoderma viride* on root rot incidence in cluster bean at farmers' fields during *kharif* season 2016 and 2017

Treatments	Disease incidence (%)			Disease control over Farmer practices (%)
	2016	2017	Mean	
Farmers practices (T_1): No seed treatment with Trichoderma/ Fungicides for root rot	25.3	18.83	22.1	-
Demonstration (T_2): Seed treatment @ 5 g kg^{-1} seed and soil application @ 2.5 kg ha^{-1} mixed in 250-300 kg FYM	10.5	9.91	10.2	53.85

Table 3: The impact of *Trichoderma viride* on yield of seeds and cost-benefit ratio of Cluster bean at farmer field during the *kharif* season 2016 and 2017

Treatments	Yield (kg ha^{-1})			Mean yield increases over FP (%)	Avg. cost of cultivation (Rs. ha^{-1})	Avg. gross return (Rs. ha^{-1})	Avg. net return (Rs. ha^{-1})	B:C ratio
	2016	2017	Mean					
Farmers Practices	10.3	10.5	10.4	-	12,565.00	42,120.00	29,555.00	3.35
Demonstration	13.5	14.3	13.9	33.65	14,985.00	56,295.00	41,310.00	3.76

Conclusion

The recommended management technology for root rot disease entails a comprehensive approach. This involves seed treatment with 5 g kg^{-1} of seed and soil application @ 2.5 kg ha^{-1}, carefully mixed with 250-300 kg of FYM and thoroughly incorporated into the field before sowing. This method has proven to be highly effective, resulting in a notable decrease in the incidence of root rot, as well as an increase in overall crop yield when compared to the practices typically adopted by farmers.

This strategy not only offers an efficient means of mitigating the damaging effects of root rot disease but also presents a holistic approach that considers the long-term sustainability and productivity of the farming system. By emphasizing the importance of proactive measures, such as seed treatment and soil application, the recommended management technology serves as a pivotal step towards ensuring the stability and profitability of cluster bean cultivation. Furthermore, the use of organic inputs like FYM contributes to the enhancement of soil fertility and overall crop health, promoting a more environmentally friendly and sustainable agricultural practice.

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