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Appraisal to Efficacy of different Bioagents and Fungicides against Stem Rot of Cluster Bean incited by *Sclerotium rolfsii*

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ABSTRACT: Cluster bean (*Cyanosis tetragonoloba* L.) Taub is a major leguminous crop in India's dry and semi-arid regions during the Kharif season. Cluster bean stem rot, caused by *Sclerotium rolfsii* Sacc., has become a severe concern in recent years, resulting in yield losses of 50-70 percent, depending on the severity of the disease. For combating this disease, a variety of chemical fungicides are readily accessible, however many of them have developed resistance to the illness. This research intends to reduce the expense of agriculture caused by the use of ineffective chemicals and increase farmer revenue. The current study was conducted in the College of Agriculture, SKRAU, Bikaner, Rajasthan, at the Department of Plant Pathology and Experimental Farm. The experiment was set up in a randomised block design with twelve different treatments. During the experimentation, chemical fungicide, bioagents, and their combinations were investigated as seed as well as foliar spray treatments.

Treatment with carboxin 37.5 percent + thiram 37.5 percent + foliar spray with Tebuconazole 50 percent + Trifloxystrobin 25 percent among of all the fungicide combinations (7.30 per cent) and Seed treatment with *T. harzianum* @ 10 g kg^{-1} seed + soil application of *T. harzianum* @ 10 kg ha^{-1} (mixed with 100 kg FYM) among the bioagents were proved to be an effective therapy for preventing stem rot of cluster bean and minimising yield loss among the bioagents.

Keywords: *Sclerotium, Trichoderma, Bacillus,* Cluster bean, and bio-agents.

INTRODUCTION

Cluster bean (*Cyanosis tetragonoloba* L.) Taub is a major leguminous crop in India's dry and semi-arid regions during the Kharif season. Guar is another name for a cluster bean. It is a self-pollinated, short duration legume crop generally cultivated under resource constrained conditions on marginal and sub marginal lands (Kumar, 2005). Cluster bean belongs to the tribe *Indigoferae* of the Leguminosae (*Fabaceae*) family with diploid chromosome number 2n=14. The crop is known for drought tolerance having deep root system (Kumar and Rodge, 2012) It is a drought-resistant and resilient crop. Its deep penetrating root allows a plant to better utilise available moisture, increasing the potential for rainfed crops. Even at mild salinity and alkalinity, the crop thrives. Cluster bean pods are primarily consumed as vegetables and are green, long, slender pods. Minerals such as calcium, phosphorus, and iron, as well as vitamins A and C, are abundant. Cluster beans are grown for a variety of reasons, including as a vegetable, green fodder, green manure, and seed production. It is also utilised as an animal concentrate, and the extraction of gum, which is mostly found in the seed endosperm, provides a suitable raw material for a variety of industrial applications (Joshi and Arora, 1993). Cluster bean seeds have a gum content of 28 to 33 per cent. Cluster bean gum is utilised in many industries, including textiles, paper, petroleum, pharmaceuticals, food processing, cosmetics, mining, explosives, and oil drilling, among others. Furthermore, by fixing a significant amount of nitrogen from the atmosphere, it improves soil fertility. Guar gum and its derivatives are highly sought after around the globe.

India, Pakistan, Indonesia, America, Italy, Mexico, Brazil, and South Africa all grow cluster beans. Cluster bean cultivation covers 4.26 million hectares in India, with a yield of 2.42 million tonnes and a productivity of 567 kg/ha (Anonymous, 2020). Rajasthan is the country's largest cluster bean producer, accounting for over 80% of total cluster bean production. The cluster bean crop is grown on 35.30 lakh hectares in Rajasthan, with a production of 14.04 lakh tonnes and a productivity of 398 kg/ha (Anon, 2020).

The production and productivity of cluster bean in terms of grain and fodder is highly affected by several phytopathogenic fungal and bacterial diseases *viz.*, Bacterial blight (*Xanthomonas axonopodis* pv. *cyamopsidis*), Alternaria leaf spot (*Alternaria cyamopsidis*), Anthracnose (*Colletotrichum capsici* f.sp. *cyamopsicola*), *Curvularia* leaf spot (*Curvularia lunata*), Charcoal rot/Damping-off (*Macrophomina* *phaseolina*), Dry root rot/Leaf blight *(Fusarium solani* and *Rhizoctonia solani*), Myrothecium leaf spot (*Myrothecium roridum*), powdery mildew (*Oidiopsis taurica*), wilt (*Fusarium caeruleum*) (Rangaswami and Rao, 1957).

Cluster bean stem rot, caused by *Sclerotium rolfsii* Sacc., has become a severe concern in recent years, resulting in yield losses of 50-70 percent, depending on the severity of the disease. It has become a limiting factor for cluster bean crop cultivation due to its severity and destructive nature (Le *et al*., 2011). As a result, the current study focus on using various fungicide combinations and bio-agents to combat this damaging disease.

MATERIAL AND METHODS

The current study was conducted in the College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, at the Department of Plant Pathology and Experimental Farm. This study used a randomised block design with a total of twelve treatments. During the experimentation, chemical fungicide, bioagents, and culture therapy combinations were investigated as seed and foliar spray treatments. These treatments comprises of seed treatment Carbendazim 12% + Mencozeb 63% @ 2g kg^{-1} + foliar spray with Tebuconazole 50% + Trifloxystrobin 25% @ 1.5g L^{-1} (T_1), seed treatment with Carbendazim 12% + Mencozeb 63% @ 2g kg^{-1} + foliar spray with Thiophenate Methyl 15% + Copper Oxychloride 40% WP @2g L^{-1} (T_2), seed treatment with Carboxin 37.5% + Thiram 37.5% @ 2g kg^{-1} + foliar spray with Tebuconazole 50% + Trifloxystrobin 25% @ 1.5g L^{-1} (T_3), seed treatment with Carboxin 37.5% + Thiram 37.5% @ 2g kg^{-1} + foliar spray with Thiophenate Methyl 15% + Copper Oxychloride 40% WP @ 2g L^{-1} (T_4), seed treatment with Carbendazim 12% + Mencozeb 63% @ 2g kg^{-1} + foliar spray with Captan 70% + (Hexaconazole 5%) 75% WP @ 2 ml L^{-1} (T_5), seed treatment with *Trichoderma harzianum* @ 10 g kg^{-1} + soil application of *Trichoderma harzianum* 10 g kg ha^{-1} with 100 kg FYM (T_6), seed treatment with *Pseudomonas fluorescens* 10 g kg^{-1} + soil application of *Pseudomonas fluorescens* 10 kg ha^{-1} with 100 kg FYM (T_7), seed treatment with *Trichoderma harzianum* @ 10 g kg^{-1} + soil apllication of *Trichoderma harzianum* 10 kg ha^{-1} with 100 kg FYM + foliar spray with Tebuconazole 50% + Trifloxystrobin 25% @ 1.5g L^{-1} (T_8), seed treatment with *Pseudomonas fluorescens* 10 g kg^{-1} + soil application of *Pseudomonas fluorescens* 10 kg ha^{-1} with 100 kg FYM + foliar spray with Tebuconazole 50% + Trifloxystrobin 25% @ 1.5g L^{-1} (T_9), seed treatment with Carbendazim 12% + Mencozeb 63% @ 2g kg^{-1} + foliar spray with Mencozeb 64% + Thiophenete Methyl 12% @ 1.5g L^{-1} (T_{10}), seed treatment with Carbendazim 12% + Mencozeb 63% @ 2g kg^{-1} + foliar spray with Carbendazim 12% + Mencozeb 63% @ 2 g L^{-1} (T_{11}) and control (T_{12}). As a test crop, the cluster bean variety "RGC-936" was grown. Variety RGC-936 has an 85-90 day duration and a production potential of 8–10 q ha^{-1}. After the monsoon arrived, the crop was manually seeded with a 30 cm × 10 cm spacing. The seeds were treated with a combination of various fungicides and bioagents, as per the instructions, to protect the crop against soil and seed-borne illnesses. *Sclerotium rolfsii* incidence was recorded and disease incidence was worked out by the following formula (Rahman *et al*., 2013; Sundar *et al*., 1995).

$$\text{Disease incidence (\%)} = \frac{\text{No. of diseased plants}}{\text{Total no. of plants}} \text{x } 100$$

$$\text{Disease control (\%)} = \frac{\text{Disease incidence in control} - \text{Disease incidence in treatment}}{\text{Disease incidence in control}} \times 100$$

RESULT AND DISCUSSION

Different fungicides of control schedule for stem rot disease had a significant effect on disease incidence percentage and seed yield in the year of experimentation

A. Effect on Stem Rot Incidence

The results show that the fungicidal treatment with seed treatment with Carboxin 37.5 percent + Thiram 37.5 percent + foliar spray with Tebuconazole 50 percent + Trifloxystrobin 25 percent (7.30 percent) had the lowest incidence of stem rot of cluster bean, followed by seed treatment with Carbendazim 12 percent + Mencozeb 63 percent + foliar spray Captan 70 percent + (Hexaconazole 5 percent) 75 percent WP with (14.14 per cent). Seed treatment with Carboxin 37.5 percent + Thiram 37.5 percent @ 2 g kg^{-1} + foliar spray of Tebuconazole 50 per cent + Trifloxystrobin 25 percent @ 1.5 g $lit.^{-1}$ had the best disease control (82.04 per cent) Carbendazim 12 per cent + Mencozeb 63 percent @ 2 g kg^{-1} seed treatment + foliar spray of Captan 70 per cent + Hexaconazole 5 per cent (75 percent WP) @ 2 g $lit.^{-1}$ foliar spray resulted in 72.18 percent disease control.

Seed treatment with fungicide and soil application of bioagents, as well as a combination of seed treatment with fungicide and soil application with bioagent, were all assessed for disease management. Table 2 shows that seed treatment with *T. harzianum* @ 10 g kg^{-1} seed + soil application of *T. harzianum* @ 10 kg ha^{-1} (mixed with 100 kg FYM) resulted in a disease incidence of 22.59 percent, which was substantially higher than the control, which had a disease incidence of 40.66 percent.

Table 1: Treatment combinations of chemical fungicide, bioagents, and culture both as seed and foliar spray were tested during experiment.

Sr. No.	Treatments	Dose
T_1	ST [Carbendazim 12% + Mencozeb 63%] + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@ 2g\kg + FS@ 1.5g\L
T_2	ST [Carbendazim 12% + Mencozeb 63%] + FS [Thiophenate Methyl 15% + Copper Oxychloride 40% WP]	ST@2g\kg +FS@2g\L
T_3	ST [Carboxin37.5% + Thiram 37.5%] + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@ 2g\kg + FS@ 1.5g\L
T_4	ST [Carboxin 37.5% + Thiram 37.5%] + FS [Thiophenate Methyl 15% + Copper Oxychloride 40% WP]	ST@2g\kg +FS@2g\L
T_5	ST [Carbendazim 12% + Mencozeb 63%] + FS [Captan 70% + (Hexaconazole 5%)] 75% WP	ST@2g\kg +FS@2ml\Lt
T_6	ST [*Trichoderma harzianum*] + SA [*Trichoderma harzianum]*	ST@10g\kg + SA @10 kg\ha with 100 kg FYM
T_7	ST [*Pseudomonas fluorescens]* + SA [*Pseudomonas fluorescens*]	ST@10g\kg + SA@10 kg\ha with 100 kg FYM
T_8	T6+ FS [Tebuconazole 50%+ Trifolxystrobin 25%]	ST@10g\kg + SA @10 kg\ha with 100 kg FYM +FS@ 1.5g\L
T_9	T7 + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@10g\kg + SA @10 kg\ha with 100 kg FYM +FS@ 1.5gm\L
T_{10}	ST [Carbendazim 12% + Mencozeb 63%] + FS [Mencozeb 64% +Thiophenete Methyl 12%]	ST@2g\kg +FS@2g\L
T_{11}	ST [Carbendazim 12% + Mencozeb 63%] + FS [Carbendazim 12% + Mencozeb 63%]	ST@2g\kg +FS@2g\L
T_{12}	Control	

Table 2: Management of stem rot of cluster bean through different bio-agents and fungicides under field conditions.

Treatments	Dose	Percent disease incidence	Percent disease control	Yield (kg ha^{-1})
T_1 - ST [Carbendazim 12% + Mencozeb 63%] + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@ 2g\kg FS@ 1.5g\L	16.94 (24.25)	58.65	1004.56
T_2 - ST [Carbendazim 12% + Mencozeb 63%] + FS [Thiophenate Methyl 15% + Copper Oxychloride 40% WP]	ST@2g\kg +FS@2g\L	18.90 (25.71)	48.72	962.92
T_3 -ST [Carboxin37.5% + Thiram 37.5%] + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@ 2g\kg + FS@ 1.5g\L	7.30 (15.56)	82.04	1307.55
T_4 -ST [Carboxin 37.5% + Thiram 37.5%] + FS [Thiophenate Methyl 15% + Copper Oxychloride 40% WP]	ST@2g\kg +FS@2g\L	14.56 (22.35)	64.19	1052.43
T_5 -ST [Carbendazim 12% + Mencozeb 63%] + FS [Captan 70% + (Hexaconazole 5%)] 75% WP	ST@2g\kg +FS@2ml\Lt	11.31 (19.56)	72.18	1203.71
T_6 -ST [*Trichoderma harzianum*] + SA [*Trichoderma harzianum*]	ST@10g\kg + SA @10 kg\ha with 100 kg FYM	22.59 (28.35)	44.44	872.58
T_7-ST [*Pseudomonas fluorescens*] + SA [*Pseudomonas fluorescens*]	ST@10g\kg + SA@10 kg\ha with 100 kg FYM	30.31 (33.38)	25.45	834.36
T_8 - T_6+ FS [Tebuconazole 50%+ Trifolxystrobin 25%]	ST@10g\kg + SA @10 kg\ha with 100 kg FYM +FS@ 1.5g\L	19.02 (25.81)	52.68	1072.22
T_9 - T_7 + FS [Tebuconazole 50% + Trifolxystrobin 25%]	ST@10g\kg + SA @10 kg\ha with 100 kg FYM +FS@ 1.5gm\L	25.04 (30.00)	38.41	975.41
T_{10} -ST [Carbendazim 12% + Mencozeb 63%] + FS [Mencozeb 64% + Thiophenete Methyl 12%]	ST@2g\kg +FS@2g\L	14.14 (22.02)	64.68	1161.36
T_{11} -ST [Carbendazim 12% + Mencozeb 63%] + FS [Carbendazim 12% + Mencozeb 63%]	ST@2g\kg +FS@2g\L	15.26 (22.95)	62.46	1080.44
T_{12} –Control		40.66 (39.60)	-	735.90
S.Em±		1.50		68.86
CD (P=0.05)		4.43		97.38
CV (%)		13.22		11.65

ST- Seed Treatment, FS-Foliar Spray, SA- Soil Application

The disease incidence was reduced from 22.59 percent to 19.02 percent when the seed was treated with *T. harzianum* @ 10 g kg^{-1} seed + soil application of *T. harzianum* @ 10 kg ha^{-1} (mixed with 100 kg FYM) + foliar spray of Tebuconazole 50 percent + Trifloxystrobin 25 percent was administered. The statistics clearly show that fungicidal treatment and foliar spray were more successful than seed treatment and bioagent soil application. *T. harzianum* was more effective than *P. fluorescens* among the bioagents. When seed coating with Thiram (0.1 percent) was combined with soil application of *T. harzianum* @ 4 g kg^{-1} soil, Patibanda *et al.* (2002) reported effective control of *S. rolfsii* of groundnut. According to Adiver (2007), triazoles like as Tebuconazole, Cyperconazole, and Difenaconazole are effective against foliar fungal disease and soil born disease including stem rot.

Similar findings were corroborated by Jain *et al*. (2015); Shirsole *et al*. (2019) who studied the impact of several seed treatments on the vigour of various soil-borne fungus in tomato nurseries and discovered that seed dressing with Carboxin + Thiram was superior in reducing pre-emergence seed rot. AR, D.B. and Narayanaswamy (2018) found that utilising *Trichoderma viride* + press mud + Carbendazim (10.66) resulted in the lowest disease incidence of tuberose stem rot, and that using Hexconzole @ 0.1 percent resulted in the lowest disease incidence of 19.33 percent.

According to Charde *et al.* (2002), seed treatment with Propiconazole and Hexaconazole was superior in preventing *S. rolfsii*-caused groundnut stem rot and increasing shoot and root length. The collar rot of tomato induced by *S. rolfsii* was effectively decreased by seedling root dips in Mancozeb (0.1%) and Thiram (0.1%) (Dutta and Das, 2002). *S. rolfsii* was suppressed by seed treatment with hexaconazole and propiconazole. These fungicides were discovered to be absorbed by roots and then translocated to the length of the shoot and leaf (Tajane and colleagues 2002). *T. harzianum* was tested against *S. rolfsii* on tomato seedlings by Okereke *et al.* (2007), who discovered that *T. harzianum* inhibited *S. rolfsii* by 80.3 percent.

B. Effect on Grain Yield

Seed treatment with Carboxin 37.5 percent + Thiram 37.5 percent + foliar spray with Tebuconazole 50 percent + Trifloxystrobin 25 percent yielded the highest grain yield of cluster bean (1307.55 kg ha^{-1}), followed by seed treatment with Carbendazim 12 percent + Mencozeb 63 percent + foliar spray Captan 70 percent + (Hexaconazole 5 percent) 75 percent WP yielding 1203.71 kg ha^{-1} and seed treatment with (1161.36 kg ha^{-1}). In comparison to the control, where a yield of 735.90 kg ha^{-1} was recorded.

CONCLUSION

Fungicidal treatment with Carboxin 37.5 percent + Thiram 37.5 percent + foliar spray with Tebuconazole 50 percent + Trifloxystrobin 25 percent (7.30 percent) was shown to be successful in controlling stem rot and minimising yield loss in the current study. Seed treatment with *T. harzianum* @ 10 g kg-1 seed + soil application of *T. harzianum* @ 10 kg ha-1 (mixed with 100 kg FYM) resulted in a disease incidence of 22.59 percent, which was considerably better than the control. This finding of this experiment will help the farmers to adopt a safer method for management. To obtain precise information on the efficacy of an effective treatment, integrated disease management studies must be conducted in the same area for two to three years.

FUTURE SCOPE

Analyzing the efficacy of innovative compounds on the market and combining them with specialised bioagents can also help to minimise illness occurrence. The expense of cultivation can be reduced by using a certain concentration of a specific chemical. This research enables farmers to select an effective pesticide to combat stem rot of cluster bean. This However, such research boosts the availability of high-quality fungicides. Farmers are not exposed to phoney produce merchants as a result of this. This can also take into account the long-term impact on soil and human health. Growers of cluster bean can increase yields by minimising the infection of *Sclerotium rolfsii,* which causes collar rot disease.

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Conflict of interest. None.

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