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Eco-friendly management of gummy stem blight of bottle gourd

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Abstract

Gummy stem blight is an important disease affecting bottle gourd and can reduce plant vigour under favourable conditions. The present investigation was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri, to isolate and characterize the fungus associated with the disease and evaluate selected botanicals, chitosan and bioagents under *in vitro* and plant-culture assessment conditions. The fungus isolated from diseased tissues was identified morphologically as *Fusarium roseum,* and its pathogenic association was supported by symptom development in sick soil and reisolation. In poisoned-food assays, garlic (*Allium sativum)* extract at 10% produced the highest inhibition among the botanicals (41.37%), followed by ginger (*Zingiber officinale*) at 10% (38.05%). Chitosan showed increasing inhibition with concentration, with 0.6% giving the maximum inhibition (81.11%), followed by 0.5% (78.17%). In dual culture, *Trichoderma harzianum* recorded the greatest inhibition of mycelial growth (72.00%), followed by *T. viride* (69.99%). In the subsequent disease assessment, chitosan at 0.6% recorded the lowest severity after the third spray (33.34%) and the highest disease control (55.66%), followed by chitosan at 0.5% (51.92%) and Phule Super Biomix at 10 ml/litre (50.61%). The findings identify chitosan at 0.6% as the most promising treatment among those evaluated; further validation across locations and seasons is required.

Keywords: Bottle gourd, Gummy stem blight, *Fusarium roseum*, Chitosan, Botanicals, *Trichoderma*, Biological control

1. Introduction

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) is an important cucurbitaceous vegetable crop widely cultivated in tropical and subtropical regions. However, its production is affected by several diseases, among which gummy stem blight (GSB) is an important disease of cucurbit crops. The disease affects leaves, stems and fruits, causing leaf lesions, stem cankers, necrosis and gummy exudation, which may reduce plant vigour and productivity under favourable environmental conditions (Seblani *et al.*, 2023) [1].

Gummy stem blight is associated with species of *Stagonosporopsis*, and accurate pathogen identification is essential for effective disease management. Although resistant germplasm may provide a sustainable management option, variation in disease reactions among bottle gourd genotypes highlights the need for further research on disease resistance and alternative control strategies (Bhardwaj *et al.*, 2018; Dhananjaya *et al.*, 2023) [2, 3].

The increasing need for environmentally sustainable crop protection has encouraged the evaluation of plant extracts, chitosan and biological control agents against plant pathogens. Plant extracts possess potential antifungal properties, while chitosan can exhibit antimicrobial activity and stimulate plant defence responses. Similarly, *Trichoderma* species have shown promising antagonistic activity against gummy stem blight pathogens in cucurbit crops (Ruangwong *et al.* (2021) [4]; Nuangmek *et al.*, 2021) [5].

Considering the importance of gummy stem blight and the need for eco-friendly disease management, the present investigation was undertaken to isolate and characterize the associated pathogen, study disease symptomatology and evaluate the efficacy of plant extracts, chitosan and bioagents under in vitro and pot culture conditions.

2. Materials and methods

2.1 Experimental site and pathogen isolation

The investigation was conducted in the Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri. Naturally infected bottle gourd tissues were collected from the AICRP on Vegetable Crops, Department of Horticulture, MPKV, Rahuri.

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Infected tissue segments were surface sterilized and placed on potato dextrose agar (PDA). Emerging fungal growth was transferred to fresh PDA and purified by hyphal-tip isolation. The isolate was characterized on the basis of cultural and microscopic features. Pathogenicity was assessed using sick soil, and the fungus was reisolated from symptomatic plants.

2.2 In vitro evaluation of botanicals and chitosan

Botanical extracts of *Azadirachta indica, Allium sativum, Ocimum sanctum, Pongamia pinnata, Zingiber officinale* and *Allium cepa* were evaluated at 10% using the poisoned-food technique.

Chitosan was tested at 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6%, with an untreated control. Amended PDA was inoculated with a mycelial disc of the pathogen and incubated at 25 ± 1 °C. Colony diameter was measured and percentage inhibition was calculated using the following formula:

$$I = [\,(C - T)/C\,] \times 100$$

Where:

- **(I)** = Percentage inhibition of mycelial growth
- **(C) =** Colony diameter in the control
- **(T)** = Colony diameter in the treatment

2.3 Evaluation of bioagents

Trichoderma viride, T. harzianum, T. koningii, T. hamatum and Pseudomonas fluorescens were evaluated by dual culture on PDA. A pathogen disc and a bioagent disc were placed on opposite sides of the plate. Pathogen growth in the dual culture was compared with the untreated control. The experiment was conducted in a completely randomized design with four replications.

2.4 Disease assessment and statistical analysis

Promising treatments were assessed in a subsequent plant-culture experiment using seven treatments and three replications, as described in the source thesis. Disease severity was recorded before spraying and at seven days after the first, second and third sprays.

Percentage disease control was calculated relative to the untreated control. *In vitro* experiments were analysed using the statistical procedure described in the source thesis, with standard error and critical difference reported at the 1% level where available.

3. Results and discussion

3.1 Symptoms, isolation and morphological characteristics

Naturally infected plants showed water-soaked to brown lesions on leaves, petioles and stems. Lesions enlarged and became necrotic; elongated stem lesions, cracking and gummy exudation were also observed.

The fungus isolated on PDA produced initially white, cottony growth that developed pinkish to reddish or creamy-yellow pigmentation with age. Microscopy showed hyaline, septate and branched mycelium, hyaline conidiophores, cylindrical to oblong or slightly curved macroconidia with two or more septa, small single-celled microconidia, and brown, globose, double-walled chlamydospores occurring terminally and intercalarily.

Based on these morphological observations, the isolate was identified in the thesis as *Fusarium roseum*. Plants grown in sick soil developed symptoms while controls remained healthy, and a similar fungus was reisolated.

3.2 Efficacy of botanicals against Fusarium roseum

Botanicals differed in their inhibition of mycelial growth (Table 1). Garlic extract at 10% was the most effective, giving 41.37% inhibition and a colony diameter of 52.76 mm. Ginger extract at 10% ranked second, with 38.05% inhibition and 55.75 mm colony diameter. Neem extract was least effective, with 21.88% inhibition and 70.30 mm colony diameter.



Plate 1. Pure Culture and Spores of *Fusarium roseum*

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Plate 2. Efficacy of plant extracts against *Fusarium roseum* under *in vitro* conditions

3.3 Efficacy of chitosan against Fusarium roseum

Chitosan inhibited mycelial growth at all tested concentrations, with greater inhibition at higher concentrations overall. Chitosan at 0.6% recorded the maximum inhibition (81.11%) and the lowest colony diameter (16.86 mm), followed by 0.5% chitosan (78.17%; 19.50 mm). The lowest inhibition was recorded at 0.1% (65.85%; 30.50 mm).

Table 1. . *In vitro* efficacy of botanicals against *Fusarium roseum*

Plant Extract	Treatments	Concentration	Colony diameter (mm)	Inhibition (%)
Azadirachta indica	T_1	10%	70.30	21.88
Allium sativum	T_2	10%	52.76	41.37
Ocimum sanctum	T_3	10%	69.63	22.63
Pongamia pinnata	T_4	10%	64.23	28.63
Zingiber officinale	T_5	10%	55.75	38.05
Allium cepa	T_6	10%	64.74	28.06
Control	T_7	—	90.00	—
SEm ±			0.32	
CD at 1%			1.36	

3.4 Antagonistic activity of bioagents

The dual-culture assay showed variation among the bioagents (Table 3). *Trichoderma harzianum* recorded the highest inhibition (72.00%) with a colony diameter of 24.50 mm, followed by *T. viride* (69.99%; 27.02 mm). *Pseudomonas fluorescens* recorded the lowest inhibition (40.94%) among the tested bioagents.

Table 2. *In vitro* efficacy of chitosan against *Fusarium roseum*

Treatments	Chitosan concentration (%)	Colony diameter (mm)	Inhibition (%)
T_1	0.1	30.50	65.85
T_2	0.2	30.33	66.04
T_3	0.3	29.56	66.90
T_4	0.4	24.76	72.28

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Treatments	Chitosan concentration (%)	Colony diameter (mm)	Inhibition (%)
T_5	0.5	19.50	78.17
T_6	0.6	16.86	81.11
T_7	Control	89.33	—
	SEm ±	0.32	
	CD at 1%	1.36.	

Table 3. *In vitro* efficacy of bioagents against *Fusarium roseum*

Bioagent	Treatments	Colony diameter (mm)	Inhibition (%)
Trichoderma viride	T_1	27.02	69.99
Trichoderma harzianum	T_2	24.50	72.00
Trichoderma koningii	T_3	47.95	46.72
Trichoderma hamatum	T_4	39.07	56.58
Pseudomonas fluorescens	T_5	53.15	40.94
Control	T_6	90.00	—
SEm ±		0.35	
CD at 1%		1.40	

3.5 Performance of treatments in disease assessment

Disease severity increased from the first to the third post-spray observation across treatments, but the extent of disease development varied (Table 4). At seven days after the third spray, chitosan at 0.6% recorded the lowest disease severity (33.34%) and the highest disease control (55.66%).



Plate 3. Efficacy of chitosan against *Fusarium roseum* under *in vitro* conditions

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Plate 4. Efficacy of bioagent against *Fusarium roseum* under *in vitro* conditions

Chitosan at 0.5% recorded 36.15% severity and 51.92% disease control, while Phule Super Biomix at 10 ml/litre recorded 37.14% severity and 50.61% disease control. *Trichoderma harzianum* at 5 g/kg soil gave 43.20% severity and 42.55% disease control. Ginger extract at 10% was the least effective of the tested treatments, with 55.12% severity and 26.70% disease control. The untreated control reached 75.20% disease severity.

Table 4. Disease severity and disease control after the third spray

Treatment	Treatments	Concentration/rate	Disease severity (%)	Disease control (%)
Chitosan	T_1	0.6%	33.34	55.66
Chitosan	T_2	0.5%	36.15	51.92
Allium sativum extract	T_3	10%	50.90	32.31
Zingiber officinale extract	T_4	10%	55.12	26.70
Phule Super Biomix	T_5	10 ml/litre	37.14	50.61
Trichoderma harzianum	T_6	5 g/kg soil	43.20	42.55
Untreated control	T_7	—	75.20	—
SEm ±			0.47	
CD at 1%			1.99	

4. Conclusion

Under the conditions of the present investigation, chitosan at 0.6% was the most promising treatment, recording 81.11% inhibition of *Fusarium roseum* mycelial growth under in vitro conditions and 55.66% disease control in the subsequent disease assessment.

Garlic extract at 10% was the most effective botanical, recording 41.37% inhibition, while *Trichoderma harzianum* exhibited the highest antagonistic activity among the evaluated bioagents, with 72.00% inhibition.

These findings highlight the need for further evaluation of chitosan and other complementary eco-friendly treatments through replicated field trials across multiple seasons. In the present study, pathogen identification was based on morphological characteristics; therefore, molecular confirmation is recommended to strengthen taxonomic accuracy and reliability.

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