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Effect of Organic Amendments on Pigeonpea stem canker incited by *Macrophomina phaseolina* (Tassi) Goid under Pot Culture

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Abstract

Stem canker of pigeonpea, incited by *Macrophomina phaseolina* (Tassi) Goid, is recognized as one of the most widespread and damaging diseases, especially under rainfed farming conditions. Its soil-borne nature and complex disease cycle make effective management in the field quite challenging. In view of this, a study was carried out during 2023–24 to examine the potential of different organic amendments in managing this disease in pigeonpea (*Cajanus cajan*). Nine organic amendments were applied to the soil before sowing and evaluated using the sick soil technique. A susceptible pigeonpea variety, Khadka, was grown in earthen pots under controlled screen house conditions. The findings indicated that all the organic treatments were effective in lowering pre-emergence and post-emergence seedling mortality, as well as total plant mortality, when compared to the untreated control. The most effective organic amendment found was Neem seed cake, with significantly highest reduction in pre-emergence seed rot PRESR (80.52%) and post-emergence seedling mortality POESM (82.08%). This was followed by Castor seed cake (66.23% and 70.58%), Linseed seed cake (53.00% and 61.00%), Safflower seed cake (50.97% and 60.16%), Cotton seed cake (47.47% and 57.72%), Poultry manure (34.34% and 46.58%), Goat manure (30.40% and 43.91%), whereas, Sunflower seed cake (25.73% and 38.92%) and Vermicompost (24.38% and 38.28%) was found least effective with significantly least reduction.

Keywords: *Cajanus cajan*, *Macrophomina phaseolina*, organic amendments, sick soil method, pre-emergence seed rot, post-emergence seedling mortality, mortality

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is a major pulse crop grown in tropical and subtropical regions and contributes nearly 5 per cent to global legume production, with India as the leading producer. The crop is widely cultivated by small and marginal farmers under both rainfed and irrigated conditions because of its strong tolerance to drought and its ability to utilize residual soil moisture. It is a hardy and adaptable crop with a wide maturity duration ranging from 90 to 300 days. In addition to its economic importance, pigeonpea improves soil fertility through biological nitrogen fixation in the rhizosphere (Smitha *et al.*, 2015) [15].

Globally, pigeonpea accounts for about 5 per cent of total legume production (Hillocks *et al.*, 2000) [5], and more than 70 per cent of this production comes from India. It is the second most important pulse crop in the country after chickpea. According to Agricultural Statistics at a Glance (2021), pigeonpea is cultivated over 4.80 million hectares with a production of 4.28 million tonnes and an average productivity of 892 kg per hectare.

Among the diseases affecting pigeonpea, stem canker caused by *Macrophomina phaseolina* (Tassi) Goid has become increasingly serious in several pigeonpea-growing regions. The pathogen is primarily soil- and seed-borne and survives through structures such as microsclerotia and pycnidia (Farr *et al.*, 1995; Pun *et al.*, 1998) [3, 14]. It has a very wide host range, infecting over 500 plant species belonging to 75 families, including both monocots and dicots, and shows irregular distribution in soil (Mayek-Perez *et al.*, 2001; Su *et al.*, 2001) [11, 16].

In India, stem canker of pigeonpea was first reported by Kannaiyan *et al.* (1979) [9] from parts of Eastern Uttar Pradesh, particularly Varanasi and Mirzapur. The disease generally appears from flowering to physiological maturity stages. Infected plants develop necrotic lesions on the stem, which may girdle the basal portion, leading to flower drop, drying of branches, wilting, and eventually plant death. Yield losses due to this disease can range from 10 to 100 per cent (Smitha *et al.*, 2015) [15].

A decline in pigeonpea production has been observed in Maharashtra and Karnataka during 2023 and 2024 due to severe incidence of *Macrophomina* stem canker. Most of the cultivated varieties have been found susceptible to this disease. Changing climatic conditions, especially increased temperature and dry weather, have favored disease development in recent years, turning it into an emerging threat.

Considering the increasing severity of the disease and the significant economic losses reported in farmers' fields, particularly in the Marathwada region of Maharashtra over the past 5–6 years, there is a need to develop effective management strategies. Therefore, the present study was undertaken to evaluate the efficacy of different organic amendments against the pathogen under pot culture conditions in a screenhouse. The results of this study are expected to help in developing suitable management practices for controlling the disease under both laboratory and field conditions.

Material and Methods

An investigation on stem canker caused by *Macrophomina phaseolina* (Tassi) Goid in pigeonpea (*Cajanus cajan* L.) was carried out at the Department of Plant Pathology, College of Agriculture, Parbhani, during 2023–24. A number of experiments were undertaken to achieve the set objectives of the study. The materials utilized and the methodologies adopted for conducting these experiments are presented in the subsequent sections.

Evaluation of organic amendments

A total of nine organic amendments, namely vermicompost, poultry manure, goat manure, sunflower seed cake, safflower seed cake, linseed seed cake, neem seed cake, castor seed cake, and cotton seed cake, were assessed against *Macrophomina phaseolina* through soil application using the sick soil method under pot culture conditions in a screen house. All amendments, except vermicompost, were mechanically ground into a coarse powder before their application to the soil.

Earthen pots were filled with a potting mixture consisting of soil, sand, and farmyard manure (FYM). This mixture was inoculated with the test pathogen culture, previously multiplied on a sand: maize medium, at a rate of 50 g/kg of the mixture. The pots were adequately watered and incubated in the screen house for 10 days to allow proper establishment and multiplication of the pathogen, thereby creating sick soil conditions.

Subsequently, all the organic amendments were incorporated into the sick soil at the rate of 50 g/kg of the potting mixture. The contents were mixed thoroughly, watered regularly, and maintained under screen house conditions. After 72 hours of amendment application, healthy seeds of pigeonpea cv. Khadka, surface sterilized with 0.1% HgCl₂, were sown at the rate of 10 seeds per pot.

The pots were watered as needed and maintained in the screen house. Each treatment was replicated three times, with three pots per treatment per replication.

For comparison, control pots containing *M. phaseolina*-infested (sick) soil without any amendment and sown with surface-sterilized healthy seeds of the susceptible pigeonpea variety Khadka were maintained under similar conditions.

Experimental details

Design: Completely Randomised Design (CRD)

Replications: Three

Treatments: Ten

Treat.	Organic amendments	Treat.	Organic amendments
T ₁	Vermicompost	T ₆	Linseed seed cake
T ₂	Poultry manure	T ₇	Neem seed cake
T ₃	Goat manure	T ₈	Castor seed cake
T ₄	Sunflower seed cake	T ₉	Cotton seed cake
T ₅	Safflower seed cake	T ₁₀	Control (Untreated)

Observations were recorded on seed germination and pre-emergence seed rot (PESR) at 7 days after sowing, as well as post-emergence seedling mortality (PESM) at 30 days after sowing. The percentage of seed germination, pre-emergence seed rot (PESR), and post-emergence seedling mortality (PESM) were calculated using the following formulae.

$$\text{Germination (\%)} = \frac{\text{No. of seeds germinated}}{\text{Total no. of seeds sown}} \times 100$$

$$\text{PESR (\%)} = \frac{\text{Number of seeds ungerminated}}{\text{Total number of seeds sown}} \times 100$$

$$\text{PESM (\%)} = \frac{\text{Number of seedlings died}}{\text{Total number of seedlings}} \times 100$$

$$\text{Reduction (\%)} \text{ in PESR \& PESM} = \frac{C - T}{C} \times 100$$

Where,

C = Per cent rot / mortality in treatment pots

T = Per cent rot / mortality in untreated control pots

Results and Discussion

Effect of organic amendments

A total of nine organic amendments were evaluated as pre-sowing soil application to assess their efficacy against *M. phaseolina*, by sick soil method, in earthen pot sowing susceptible pigeonpea variety Khadka under screen house conditions. The results obtained on percentage seed germination, per cent mortality (Pre-, post-emergence) and reductions, over untreated control is presented in Table 1 and depicted in PLATE I and Fig. 1.

Seed germination

The results (Table 1) revealed that all the test organic amendments recorded significantly improved seed germination over untreated control (sick soil) and it was ranged from 47.38 to 88.54 per cent, as against 33.30 per cent in untreated control. However, significantly highest seed germination was recorded in Neem cake (88.54%). These were followed by the amendments viz., Castor seed

cake (78.19%), Linseed cake (69.45%), Safflower seed cake (68.26%), Cotton seed cake (65.46%), Poultry manure (56.44%), Goat manure (53.61%), Vermicompost (49.53%), whereas, Sunflower seed cake was found least effective with comparatively minimum seed germination of 47.38 per cent.

Pre-emergence seed rot (PRESR): The results (PLATE I, Table 1 & Fig. 1) revealed that the test organic amendments

significantly influenced pre-emergence seed rot (PRESR) which ranged from 13.46 to 52.27 per cent, as against 69.13 per cent in untreated control. However, it was significantly least with Neem seed cake (13.46%), followed by Castor seed cake (23.34%), Linseed cake (32.49%), Safflower seed cake (33.89%), Cotton seed cake (36.31%), Poultry manure (45.39%), Goat manure (48.11%) and Vermicompost (52.27%).

Table 1: Efficacy of organic amendments against *M. phaseolina*, causing Pigeonpea stem canker (Pot culture)

Tr. no.	Treatments	Germi-nation (%)	Incidence (%) *		Red. (%) over control	
			PRESR	POESM	PRESR	POESM
T ₁	Vermicompost	49.53 (44.73)	52.27 (46.30)	56.25 (48.59)	24.38 (29.59)	38.28 (38.22)
T ₂	Poultry manure	56.44 (48.89)	45.39 (42.35)	48.68 (44.25)	34.34 (35.87)	46.58 (43.04)
T ₃	Goat manure	53.61 (47.07)	48.11 (43.92)	51.12 (45.64)	30.40 (33.46)	43.91 (41.50)
T ₄	Sunflower seed cake	47.38 (43.50)	51.34 (45.77)	55.66 (48.25)	25.73 (30.49)	38.92 (38.60)
T ₅	Safflower seed cake	68.26 (55.71)	33.89 (35.60)	36.31 (37.05)	50.97 (45.56)	60.16 (50.86)
T ₆	Linseed seed cake	69.45 (56.45)	32.49 (34.75)	35.54 (36.59)	53.00 (46.72)	61.00 (51.36)
T ₇	Neem seed cake	88.54 (70.21)	13.46 (21.52)	16.33 (23.83)	80.52 (63.82)	82.08 (64.96)
T ₈	Castor seed cake	78.19 (62.16)	23.34 (28.89)	26.81 (31.18)	66.23 (54.48)	70.58 (57.15)
T ₉	Cotton seed cake	65.46 (54.01)	36.31 (37.05)	38.53 (38.37)	47.47 (43.55)	57.72 (49.44)
T ₁₀	Control (Untreated)	33.30 (35.24)	69.13 (56.25)	91.14 (72.68)	00.00 (00.00)	00.00 (00.00)
	S.E. ±(m)	0.94	1.17	0.66	0.63	0.73
	C.D. (P = 0.01)	2.79	3.47	1.96	1.87	2.17

*-Mean of three replications, Figures in parentheses are arcsine transformed values, Av.: Average, Mor.: Concentration, Red.: Reduction, PRESR: Pre emergence seed rot, POESM: Post Emergence Seedling Mortality.

Post-emergence seedling mortality (POESM)

Similar trend as that of pre-emergence mortality was observed in respect of post-emergence seedling mortality (POESM), which ranged from 16.33 to 56.25 per cent, as against 91.14 per cent in untreated control. However, it was significantly least with Neem seed cake (16.33%), followed by Castor seed cake (26.81%), Linseed seed cake (35.54%), Safflower seed cake (36.31%), Cotton seed cake (38.53%), and Poultry manure (48.68%) Goat manure (51.12%), Sunflower seed cake (55.66%) and Vermicompost (56.25%) but it was significantly highest in untreated control (91.14%).

Reduction in mortality

All of the organic amendments tested (Table 1 and Fig. 1) were found effective in reducing pre-emergence, post-emergence and total mortality, over untreated control.

The most effective organic amendment found was Neem seed cake, with significantly highest reduction in PRESR (80.52%) and POESM (82.08%). This was followed by Castor seed cake (66.23% and 70.58%), Linseed seed cake (53.00% and 61.00%), Safflower seed cake (50.97% and 60.16%), Cotton seed cake (47.47% and 57.72%), Poultry manure (34.34% and 46.58%), Goat manure (30.40% and 43.91%), Sunflower seed cake (25.73% and 38.92%), Vermicompost (24.38% and 38.28%).

The use of organic amendments is one of the indirect potential approaches of non-chemical means to control soil

borne plant pathogens / diseases, which not only reduces the disease incidence, but also increase soil fertility and microbial activity in general and particularly the antagonist's activity.

In the present study organic amendments viz., Neem seed cake, Castor cake, Safflower cake and Linseed cake resulted with significantly highest per cent reduction in pre-, post-emergence and total mortality induced by *M. phaseolina* in pigeonpea. Gawande *et al.* (2018) ^[4] recorded that significantly least average mortality with Neem seed cake (18.33%) ^[10], Cotton seed cake (24.34%), Groundnut cake (31.63%) and Sunflower cake (36.73%); Lakharan and Ahir (2018) studied Neem seed cake as most effective with minimum disease incidence (13.30 and 19.23%). Results obtained on the efficacy of different organic amendments against *M. phaseolina* pathogen are in conformity with those reported earlier by several coauthors viz., Javaid and Saddique (2011) ^[8] reported that plant mortality due to *M. phaseolina* inoculation was majorly reduced by 42 per cent and 80 per cent due to 1.0 and 1.5% dry leaves amendments, respectively, as compared to positive control. Dhingani *et al.* (2013) ^[2] confirmed that significantly lowest growth of mycelium and highest inhibition of *M. phaseolina* were observed in NSKE (59.40) followed by FYM (42.56%). Pawar *et al.* (2018) ^[13] confirmed that among organic amendments neem cake (35.22%) reported better reduction of disease as compare to castor cake (47.22%). These are similar to those reported earlier by several workers

(Muthuswami and Mariappan 1991; Hundekar *et al.*, 1998; Surichandraselvan 2005; Sudha and Prabhu 2008; Jaiman *et*

al., 2008; Pandhare *et al.*, 2015a; Suryawanshi *et al.*, 2015) [12, 6, 18, 17, 7, 19].

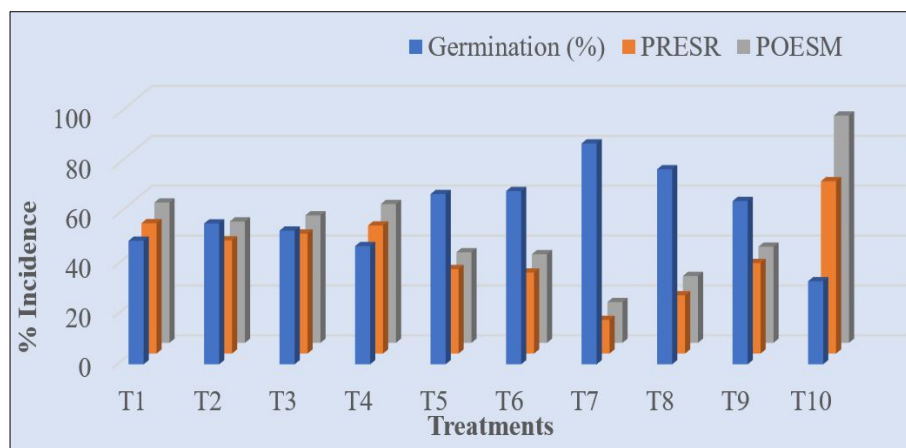


Fig 1: *In vitro* bioefficacy of the organic amendments against *M. phaseolina*, causing stem canker of pigeonpea (% incidence)

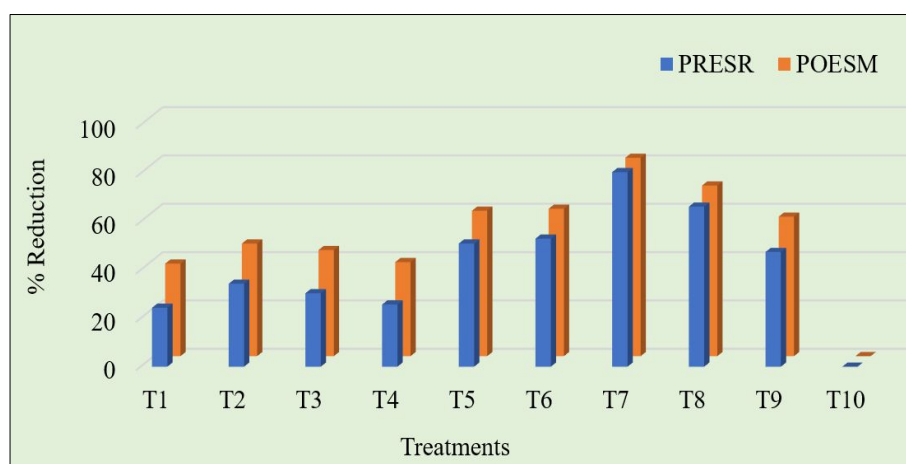


Fig 2: *In vitro* bioefficacy of the organic amendments against *M. phaseolina*, causing stem canker of pigeonpea (% reduction)

Treat.	Organic amendments	Treat.	Organic amendments
T ₁	Vermicompost	T ₆	Linseed seed cake
T ₂	Poultry manure	T ₇	Neem seed cake
T ₃	Goat manure	T ₈	Castor seed cake
T ₄	Sunflower seed cake	T ₉	Cotton seed cake
T ₅	Safflower seed cake	T ₁₀	Control (Untreated)





Plate 1: *In vitro* bioefficacy of the organic amendments against *M. phaseolina*, causing stem canker of pigeonpea

Conclusion

This study concludes that all nine soil organic amendments tested by sick soil method in pot culture were found significantly fungistatic to *M. phaseolina* and thereby resulted with significant increasing seed germination and reductions in pre-emergence seed rot (PRESR), post-emergence seedling mortality (POESM) and average mortality, caused by *M. phaseolina* in pigeonpea variety Khadka over untreated control. However, the most effective organic amendment found was Neem seed cake, with significantly highest reduction in PRESR (80.52%) and POESM (82.08%). This was followed by Castor seed cake (66.23% and 70.58%), Linseed seed cake (53.00% and 61.00%), Safflower seed cake (50.97% and 60.16%), Cotton seed cake (47.47% and 57.72%), Poultry manure (34.34% and 46.58%), Goat manure (30.40% and 43.91%), Sunflower seed cake (25.73% and 38.92%), Vermicompost (24.38% and 38.28%).

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