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Effect of organic amendments against soybean (*Glycine max* l.) charcoal rot caused by *Macrophomina phaseolina* (Tassi.) goid

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Abstract
The pot culture studies were undertaken to evaluate the efficacy of organic amendments for management of charcoal rot (*Macrophomina phaseolina*) of soybean (*Glycine max* L.). Among the 11 organic amendment tested, neem seed cake (@ 50 g/kg potting mixture) was found effective with significantly highest seed germination 79.99 %, reduction over pre-emergence seed rot 72.11 % and reduction over post-emergence seedling mortality 78.78 per cent. There was significantly least pre-emergence seed rot 20.00 % and post emergence seedling mortality 15.55 % recorded.

Keywords: organic amendments, charcoal rot, *Macrophomina phaseolina*

Introduction
Soybean [*Glycine max* (L.) Merrill] is a native of northern China and is the most important legume crop in the world. It contains 20 % oil of dry seed weight and it is an important source of protein, which reaches 40 % of dry seed weight along with calcium, iron, carotene, thiamine and ascorbic acid (El- Abady *et al.*, 2008). About 35 pathogens were reported to infect soybean in India (Gupta *et al.*, 2001). Fungi, nematodes, viruses, bacteria, and phytoplasmas are known to cause diseases of soybean. Charcoal rot of soybean caused by *Macrophomina phaseolina* (Tassi.) Goid. is known as major yield reducer and economically important disease of soybean. Disease severity increases as air and soil temperature increase from 28-35^0 C and when soil moisture is limited (Gary *et al.*, 1991). Charcoal root rot may be a difficult disease to control because of the nature of causal pathogen. Hence, a detailed and systemic study of organic amendments was required to manage charcoal rot disease.

Material and Methods
A pot culture experiment was conducted at department of Plant Pathology, College of Agriculture, Dapoli to evaluate the efficacy of the different organic amendments earlier reported effective against *M. phaseolina* by applying sick soil and soil application methods. An experiment was laid out in CRD with three replications and twelve treatments.
Earthen pots (30 cm dia.) filled with potting mixture (soil:sand:FYM) were inoculated (50gm/kg mixture) with the test pathogen multiplied on sand:maize medium, watered and kept in screen house for 15 days and allowed to proliferate the pathogen in pots (sick soil).
Then powdered test oil cakes were applied (50g/kg mixture) to the pots containing sick soils, mixed thoroughly, kept in screen house and pots containing sick soil without any organic amendments were maintained as untreated control.
After inoculation, each pot sown with five seeds (soybean Cv. JS-335) per pot, kept under screen house condition, watered regularly. All the treatments were replicated trice (3 pots/replication).
Observations on seed germination, pre-emergence seed rot and post emergence seedling mortality were recorded from 5th day onward.
The per cent seed germination, pre-emergence seed rot, post-emergence seedling mortality and reduction over control were calculated by using following formula:

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

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

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

$$\text{Control (\%) in PESR and PESM} = \frac{\text{\% Mortality in control - \% Mortality in treatment}}{\text{\% Mortality in control}} \times 100$$

Result and Descussion
The total of eleven organic amendments were evaluated as pre-sowing soil application against *M. phaseolina* (sick soil), by sowing susceptible soybean Cv. JS-335 in pot culture under screen house conditions. The result obtained on per cent seed germination, pre-emergence seed rot (PESR), post-emergence seedling mortality (PESM) and reduction over control.

Effect on seed germination
Results (Table 10) revealed that the soil application (preventive) with the organic amendments (@ 50 g/kg of soil) significantly improved the per cent seed germination over untreated control and it was ranged from 31.10 (Compost) to 79.99 per cent (Neem cake) as against 28.88 per cent in untreated control.

However, among amendments Neem cake was found most effective with significantly highest seed germination of 79.99 per cent against untreated control (28.88 %). The next better treatment was Cotton cake (75.55 %). This was followed by Groundnut cake (71.10 %), Safflower cake (66.66 %), Soybean cake (59.99 %), Poultry cake (51.10 %), Vermicompost (46.66 %), Goat manure (42.22 %) and Sheep manure (37.77 %). However, FYM and Compost were found least effective with comparatively minimum seed germination of 33.33 and 31.10 per cent, respectively.

Effect on pre and post-emergence mortality

Results revealed that all the tested amendments significantly influenced both pre-emergence seed rot (PESR) and post-emergence seedling mortality (PESM), caused by *M. phaseolina* in soybean Cv. JS-335. The pre-emergence seed rot (PESR) recorded in all the test amendments was ranged from 20.00 to 68.89 per cent, as against 71.11 per cent in untreated control (sick soil). However, significantly least seed rot was recorded in Neem cake (20.00 %). This was followed by Cotton cake (24.44 %), Groundnut cake (28.89 %), Safflower cake (33.33 %), Soybean cake (40.00 %), Poultry cake (48.89 %), Vermicompost (53.33 %), Goat manure (57.78 %) and Sheep manure (62.22 %). However, FYM and Compost were found least effective with comparatively maximum PESR of 66.67 and 68.89 per cent, respectively.

Similar trend in respect of the post emergence seedling mortality (PESM) was also observed and it was ranged from 15.55 to 71.10 per cent, as against 73.33 per cent in untreated control (sick soil). Among the amendments tested, Neem cake was found most effective with significantly least post-emergence seedling mortality15.55 per cent. This was followed by Cotton cake (19.99 %), Groundnut cake (22.21 %), Safflower cake (31.10 %), Soybean cake (35.55 %) Poultry cake (39.99 %), Vermicompost (44.44 %), Goat manure (51.10 %) and Sheep manure (53.33 %). However FYM and Compost were found least effective with comparatively maximum PESM of 64.44 and 71.10 percent, respectively.

The average mortality recorded in all the test amendments was ranged from 17.77 to 69.99 per cent, as against 73.22 per cent in untreated control (sick soil). However significantly least average mortality was recorded with Neem cake (17.77 %), followed by Cotton cake (22.21 %), Groundnut cake (25.55 %), Safflower cake (32.21 %), Soybean cake (37.77 %), Poultry cake (44.44 %), Vermicompost (48.88 %), Goat manure (54.44 %) and Sheep manure (57.77 %). Whereas, FYM and Compost were found least effective with comparatively higher average mortality of 65.55 and 69.99 per cent, respectively.

Per cent reduction over control

Result revealed that all organic amendments tested were found effective against test pathogen and significantly reduced both pre-emergence seed rot (PESR) as well as post-emergence seedling mortalities (PESM) in soybean Cv. JS-335.

The per cent reduction in PESR recorded in all the treatments was ranged from 03.12 (Compost) to 72.11 per cent (Neem cake) over untreated control (00.00 %). However, the Neem cake was found most effective and recorded significantly highest reduction (72.11 %) in PESR. This was followed by Cotton cake (65.44 %), Groundnut cake (59.38 %), Safflower cake (53.32 %), Soybean cake (43.63 %), Poultry cake (31.20 %), Vermicompost (24.54 %), Goat manure (18.48 %) and Sheep manure (12.42 %), FYM (06.06 %) and Compost (03.12 %).

The per cent reduction in PESM recorded in all the treatments was ranged from 03.04 to 78.78 per cent over untreated control (00.00 %). However, the organic amendment Neem cake was most effective and recorded significantly highest reduction (78.78 %) in PESM. The second and third best treatments of organic amendments found were Cotton cake (72.72 %) and Groundnut cake (69.70 %). This was followed by the organic amendments Safflower cake (57.57 %), Soybean cake (51.51 %), Poultry cake (45.46 %), Vermicompost (39.39 %), Goat manure (30.30 %) and Sheep manure (27.26 %), FYM (12.11 %) and Compost (03.04 %).

Average per cent mortality reduction (PESR and PESM) was recorded with all the test amendments was ranged from 03.08 per cent (Compost) to 75.44 per cent (Neem cake) over untreated control (00.00). However, significantly highest average mortality reduction (75.44 %) was recorded with Neem seed cake. This was followed by the organic amendments Cotton cake (69.08 %), Groundnut cake (64.54 %), Safflower cake (55.44 %), Soybean cake (47.57 %), Poultry cake (38.32 %), Vermicompost (31.96 %), Goat manure (24.39 %) and Sheep manure (19.84 %), FYM (09.08 %) and the least effective amendment was Compost (03.08 %).

Results obtained on the efficacy of soil amendments against *M. phaseolina* pathogen are in conformity with those reported earlier by several workers *viz.*, Javaid and Saddique (2011) reported that plant mortality due to *M. phaseolina* inoculation was significantly 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) reported that significantly least growth of mycelium and maximum inhibition of *M. phaseolina* was recorded in extracts of neem cake (59.40) followed by FYM (42.56 %). Pawar *et al.* (2018) reported that among organic amendments neem cake (35.22 %) recorded better reduction of disease as compare to castor cake (47.22 %).

Table 10: *In-vitro* efficacy of different organic amendments against *M. phaseolina* (Pot culture).

Tr. No.	Organic amendments	Germination * (%)	Mortality* (%)		Av. Mortality (%)	Reduction over control* (%)		Av. Reduction over control
			PESR	PESM		PESR	PESM	
T_1	FYM	33.33 (35.24)	66.67 (54.71)	64.44 (53.38)	65.55 (54.04)	06.06 (11.69)	12.11 (20.10)	09.08 (17.30)
T_2	Vermicompost	46.66 (43.05)	53.33 (46.90)	44.44 (41.78)	48.88 (44.34)	24.54 (28.98)	39.39 (38.83)	31.96 (34.27)
T_3	Neem cake	79.99 (63.61)	20.00 (26.35)	15.55 (23.12)	17.77 (24.88)	72.11 (58.26)	78.78 (62.65)	75.44 (60.32)
T_4	Compost	31.10 (33.85)	68.89 (56.10)	71.10 (57.49)	69.99 (56.76)	03.12 (10.62)	03.04 10.17)	03.08 (10.10)
T_5	Sheep manure	37.77 (37.89)	62.22 (52.07)	53.33 (46.90)	57.77 (49.47)	12.42 (20.39)	27.26 31.25)	19.84 (26.04)
T_6	Goat manure	42.22 (40.50)	57.78 (49.46)	51.10 (45.61)	54.44 (47.53)	18.48 (25.04)	30.30 33.33)	24.39 (29.41)
T_7	Safflower cake	66.66 (54.78)	33.33 (35.18)	31.10 (33.85)	32.21 (34.53)	53.32 (46.90)	57.57 (49.35)	55.44 (48.10)
T_8	Soybean cake	59.99 (50.78)	40.00 (39.18)	35.55 (36.57)	37.77 (37.90)	43.63 (41.29)	51.51 (45.84)	47.57 (43.58)

T_9	Cotton cake	75.55 (60.39)	24.44 (29.57)	19.99 (26.34)	22.21 (41.77)	65.44 (54.04)	72.72 (58.70)	69.08 (56.23)
T_{10}	Poultry cake	51.10 (45.61)	48.89 (44.34)	39.99 (39.17)	44.44 (41.77)	31.20 (33.91)	45.46 (42.34)	38.32 (38.15)
T_{11}	Groundnut cake	71.10 (57.49)	28.89 (32.47)	22.21 (27.85)	25.55 (30.30)	59.38 (50.40)	69.70 (56.84)	64.54 (53.48)
T_{12}	Control	28.88 (32.46)	71.11 (57.49)	73.33 (58.19)	72.22 (56.76)	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
	SE±	02.79	02.79	03.14	02.90	04.19	03.91	04.79
	CD (P=0.05)	08.21	08.21	09.22	9.06	12.31	11.48	14.94

*Mean of three replications, PESR- Pre-emergence seed rot, PESM- Post-emergence seedling mortality, Figures in parentheses are arc sine transformed values.

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