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RESEARCH PAPER

In vitro and *vivo* evaluation of some fungicides and organic amendments to control of *Fusarium solani* causing Indian Aloe (*Aloe barbadensis)* root

■ **MUKESH KUMAR JAT AND R.R. AHIR**

SUMMARY

Investigation on root rot (*Fusarium solani)* of Indian aloe (*Aloe barbadensis* Mill.*)* under jobner conditions was carried out in Department of Plant Pathology Lab., S.K.N. College of Agriculture Jobner to find out sutaible management strategies. Trials on the use of some fungicides and organic amendments to control the pathogen. Among five fungicides *viz.*, Benomyl, Thiophanate methyl, Captan, Carbendazim and Thiram and in case organic amendments neem cake, Vermicompost, Goat and Sheep manure, Mustard Cake and Wool Waste tested in different concentrations against *Fusarium solani* by following Poisoned Food Technique. Benomyl was found best with complete inhibition of the mycelial growth at 200 and 300 ppm concentrations, followed by Thiophanate methyl and *Neem* cake (79.0%) was found most effective in reducing mycelial growth of the fungus followed by Vermicompost (74.8%) effective against *Fusarium solani*. The effect of combinations of different fungicides and organic amendments against *Fusarium solani* were tested *in vivo* (pot house) condition Benomyl + *Neem* cake combination (0.3% + 1.25 g/kg soil) was found best with minimum per cent disease incidence (12.00%) followed by Thiophanate methyl + *Neem* cake (16.00%), Benomyl + Vermicompost (20.00%) which were observed to be less effective as compared to other fungicides and organic amendments.

Key Words : Indian Aloe, *Fusarium solani*, Fungicides, Organic amendment, Neem cake, Vermicompost

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Indian Aloe (*Aloe barbadensis* Mill. = *Aloe vera*) is the oldest medicinal plant , belongs to family Liliaceae. It is believed to have originated in Africa.Fresh juice of leaves is antipyretic, cathratic, cooling, refrigerant, useful in eye, liver and spleen troubles, skin diseases and x-ray burns, leaves juice is an important constituent of a large number of ayurvedic preparations. The mucilage of Indian Aloe is anti-inflammatory. Root is used in colic disorders (Chatterjee and Prakashi, 2001). Indian Aloe is attacked by several fungal diseases. During the survey Indian Aloe was found severely affected by root rot at Jobner and surrounding villages. It is difficult to control *F.solani* as it is having soil inhabiting nature (Majumdar *et al*., 2007). Looking to the seriousness of the disease

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present investigation was undertaken to manage the disease by use fungicides due to soil borne nature of the pathogen and also see the effect of some organic amendment.

MATERIAL AND METHODS

Efficacy of five systemic and non-systemic fungicides against mycelial growth of *Fusarium solani* was tested by Poisoned Food Technique (PFT) suggested by Nane and Thapliyal (1979). Four different concentrations *viz*., 50, 100, 200 and 300 ppm of each fungicide were tested. Required quantity of each fungicide was added separately to sterilized medium mixed thoroughly and poured in sterilized 10 cm diameter glass Petri plates and allowed to solidify for 12 hours. Each plate was inoculated with 2 mm disc of 7 days old culture of *Fusarium solani* with the help of sterilized cork borer and incubated at 25 $\pm$ 1^{0}C for 7 days. A control was also maintained where medium was not supplemented with any fungicides. The mycelial growth of the test fungus was recorded and per cent growth inhibition was calculated by Vincent (1947) formula given below. The experiment was conducted in Completely Randomized Design with five replications.

$$\text{Per cent} = \frac{C - T}{C} \times 100$$

where,

C = Diameter of colony in check (Average of both diagonals)

T =Diameter of colony in treatment (Average of both diagonals)

The effect of each organic amendments was tested at three different concentrations *i.e.* 10, 20 and 30 per cent. To get these, the required organic amendments quantity were sterilized in autoclave at 1.045 kg/cm^2 for 20 minutes and grinded separately in thoroughly washed with sterilized water electric grinder using equal amount of sterilized distilled water. The mixture was squeezed with double layered sterilized cheese cloth. The amendments thus obtained were considered as of 100 per cent concentration. Required amount of stock solution was added to PDA to get desired concentration.

The effect of organic amendments against mycelial growth of *Fusarium solani* were tested by PFT. Required quantity of each organic amendments were mixed thoroughly in melted Potato Dextrose Agar, to get desired concentration, just before pouring in sterilized 10 cm diameter glass Petri plates and was allowed to solidify for 12 hours. Each plate was inoculated with 2 mm disc of 7 days old culture of *Fusarium solani* with the help of sterilized cork borer. The inoculated Petri-plates were incubated at 25 $\pm$ 1^{0}C for 7 days. A control was also maintained where medium was not supplemented with any organic amendments. The experiment was conducted in Completely Randomized Design with four replications. Colony diameter (Two diagonals) was measured after 7 days of incubation. The per cent growth inhibition was calculated by Vincent (1947) formula as cited above.

The experiments were conducted in the year 2011-12 in Completely Randomized Design with four replications to see the effect of among fungicides, organic amendments tested under *in vitro* conditions, best two of each of them were also tested under *in vivo* conditions alone and in combinations by treating the seedlings and by applying in soil under pot condition *(in vivo)*. Following combination were used.

Sr. No.	Fungicides (dose) + organic amendments (dose)
1.	Benomyl (0.3%) + *Neem* cake (1.25 g/kg soil)
2.	Thiophanate methyl (0.3%) + Vermicompost (1.25g/kg soil)
3.	Benomyl (0.3%) + Vermicompost (1.25g/kg soil)
4.	Thiophanate methyl (0.3%) + *Neem* cake (1.25 g/kg soil)

Observations on number of seedlings showing symptoms and per cent disease incidence (PDI) were recorded 30 days after showing using formula described under following formula:

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

RESULTS AND DISCUSSION

The efficacy of different fungicides against *F. solani* at four concentrations *viz*., 50, 100, 200 and 300 ppm were assayed *in vitro*. Observations were recorded on mycelial growth of the test fungus. Under various treatments, the observations recorded on per cent inhibition of mycelial growth are presented in Table 1 and Plate 1. Results presented in Table 1 indicate that all the fungicidess at all the concentration inhibited the fungal growth and the data also revealed that the all the fungicides were significantly superior over check at all the concentrations. Benomyl gave complete growth

inhibition of *F. solani* at 200 and 300 ppm concentrations, except at 50 ppm (89.50) and 100 ppm (94.50%) and it was followed by Thiophanate methyl which gave complete mycelial growth inhibition of *F. solani* at 300 ppm concentration. Carbendazim and Thiram were observed as moderate inhibitors of the mycelial growth of *F. solani* at 50, 100, 200 and 300 ppm. Thiram was least effective against *F. solani*, root rot causing pathogen of Indian aloe at all the concentration under study. As the concentration was increased to 300 ppm, a drastic increase in the growth inhibition of the test fungus was observed.

Fungicide x concentration interactions was also found significant. Benomyl and Thiophanate methyl at 300 ppm gave complete growth inhibition (100.00%) followed by Carbendazim at 300 ppm (91.40%). However, Benomyl and Thiophanate methyl were at par in reducing the mycelial growth (P = 0.05) at all the concentration tested. Minimum inhibition was recorded in Captan at 50 ppm (52.00%) followed by Thiram (62.60%).

Efficacy of five organic amendments was tested *in vitro* at different concentration by Poisoned Food Technique against the mycelial growth of *Fusarium solani*. A perusal of data revealed that all organic amendments were significantly superior in inhibiting the mycelial growth of the fungus over control (Table 2 and Plate 2). Irrespective of the concentration, *Neem* Cake extract was found most effective in inhibiting mycelial growth (79.00%) closely followed by vermicompost (74.80) and goat and sheep manure (68.30) extracts. Mustard Cake and wool waste extracts were found least effective in inhibiting the mycelial growth of *Fusarium solani*. In general, higher concentration of organic

Table 1 : Efficacy of different fungicides against mycelial growth of *Fusarium solani* on 7th day of incubation at 25±1^{0}C *in vitro*

Sr. No.	Fungicides	Per cent inhibition of mycelial growth* Concentration (ppm)				Mean
		50	100	200	300	
1.	Benomyl	89.50 (71.09)	94.50 (76.44)	100.00 (90.00)	100.00 (90.00)	96.00 (78.46)
2.	Carbendazim	69.50 (56.48)	76.20 (60.80)	84.50 (66.82)	91.40 (72.95)	80.40 (63.72)
3.	Captan	52.00 (46.15)	64.70 (53.55)	71.50 (57.73)	75.80 (60.53)	66.00 (54.33)
4.	Thiophanate methyl	84.00 (66.42)	90.10 (71.66)	94.70 (76.69)	100.00 (90.00)	92.20 (73.78)
5.	Thiram	62.60 (52.98)	69.50 (56.48)	74.60 (59.74)	84.50 (66.82)	72.80 (58.56)
6.	Check Mean	0.00	0.00	0.00	0.00	0.00
			S.E.±	C.D. (P=0.05)		
	Fungicide (F)		1.75	4.94		
	Concentration (C)		1.01	2.85		
	F x C		3.03	8.56		

* Average of four replications
Figures given in parenthesis are angular transformed value

Table 2 : Efficacy of different organic amendments on mycelial growth of *Fusarium solani* on 7th days of incubation at 25 ± 1^{0}C *in vitro*

Sr. No.	Name of organic amendments	Per cent inhibition of mycelial growth* Concentration (%)			Mean
		10	20	30	
1.	*Neem* cake	71.50 (57.73)	80.40 (63.72)	85.10 (67.29)	79.00 (62.73)
2.	Mustard cake	53.00 (46.72)	59.50 (50.47)	65.70 (54.15)	59.40 (50.49)
3.	Wool waste	40.60 (39.58)	51.00 (45.57)	58.70 (50.01)	50.10 (45.05)
4.	Vermicompost	66.50 (54.63)	76.40 (60.94)	81.50 (64.52)	74.80 (59.87)
5.	Goat and sheep manure	61.50 (51.65)	67.00 (54.94)	76.40 (60.94)	68.20 (55.73)
6.	Check	0.00	0.00	0.00	0.00
	Mean				
			S.E.±	C.D. (P=0.05)	
Organic amendements extracts (OAE)			1.54	4.35	
Concentration (C)			0.89	2.51	
OAE X C			2.65	7.54	

* Average of four replications
Figures given in parenthesis are angular transformed value

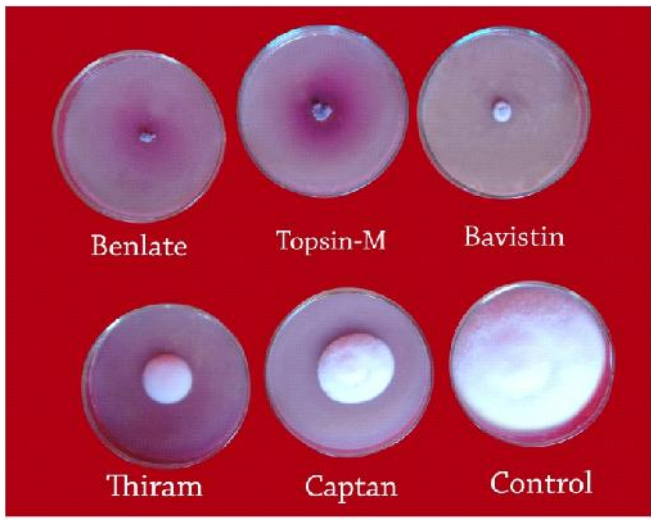

Plate 1 : Efficacy of different fungicides against mycelial growth of *Fusarium solani* at 300 ppm concentration (*In vitro*)

amendments was most effective in reducing mycelial growth as compared to low concentration. The maximum inhibition of mycelial growth (85.10%) was observed at 30 per cent concentration of *Neem* cake extract followed by vermicompost (81.50%) and goat and sheep manure (76.40). Organic amendments (OA) x concentration (C) interaction was also significant.

Efficacy of various systemic/non systemic fungicides against root rot pathogen of Indian aloe (*Fusarium solani*) by following Poisoned Food technique revealed that Benomyl found best fungicides with complete inhibition of mycelial growth of the fungus at 200 and 300 ppm concentrations. It was followed by Thiophanate methyl which gave complete inhibition of mycelial growth of *Fusarium solani* at 300 ppm concentration. Similar results were observed by Gupta *et al.* (1983). They tested efficacy of seven fungicides against *Fusarium solani* (Mart) Sacc. the incitent of root rot of Indian alone *in vitro* and found that Benomyl (Benlate) performed best (250 ppm), followed by Thiophanate methyl (Topsin-M), Carbendazim (Bavistin) and Thiram (200 ppm). Singh *et al.* (2000) also observed that Benomyl, Blitox-50, Captan, Carbendazim, Contaf and Indofil M-45 inhibit fungal growth.

In view of environmental pollution and associated health hazards as well as the development of fungicidal resistant strains of the pathogen, the application of organic amendments for management of plant disease increased in recent years and proved to be very effective against plant diseases. To find out possibilities of replacing fungicides with other eco-friendly products, organic amendments like *Neem* cake, mustard cake, wool waste, vermicompost and goat and sheep manure were tested *in vitro* against the mycelial growth of the fungus *Fusarium solani. Neem* cake was found most effective followed by vermicompost against mycelial growth of the pathogens. Haseeb and Kumar (2007) observed that Neem seed powder, *Neem* cake and Mint manure were moderately effective against *Fusarium oxysporum* causing wilt of brinjal under field conditions. Ekka and Prasad (2010), reported that under field conditions, Neem Cake effective aginst *Fusarium* spp. Efficacy of different fungicides and organic amendments alone and in combinations against root rots of Indian aloe at 30 days after transplanting by seedling deep method (in pot condition). Different systemic fungicides and organic

Table 3 : Efficacy of different fungicides and organic amendments alone and in combinations against root rot (*Fusarium solani)* of Indian aloe at 30 days after transplanting (Seedling dipping method*)

Sr. No.	Treatments	Dose (% + g/kg soil)	PDI	PDC
1.	Benomy + *Neem* cake	0.3 + 1.25	12 (20.27)	83.33 (65.90)
2.	Benomy + vermicompost	0.3 + 1.25	20 (26.57)	72.22 (58.18)
3.	Thiophanate methyl + *Neem* cake	0.3 + 1.25	16 (23.58)	77.78 (61.88)
4.	Thiophanate methyl + vermicompost	0.3 + 1.25	28 (31.95)	61.11 (51.42)
5.	Benomy	0.3	24 (29.33)	66.67 (54.74)
6.	Thiophanate methyl	0.3	32 (34.44)	55.56 (48.19)
7.	*Neem* cake	1.25 g	36 (36.87)	50.00 (45.00)
8.	Vermicompost	1.25 g	44 (41.55)	38.89 (38.58)
9.	Check (inoculated)	0.00	72 (58.05)	-
	S.E.±		0.60	
	C.D. (P=0.05)		1.72	

* Average of five replications ** Seedling inoculated by seedling dipping method Figures given in parenthesis are angular transformed values

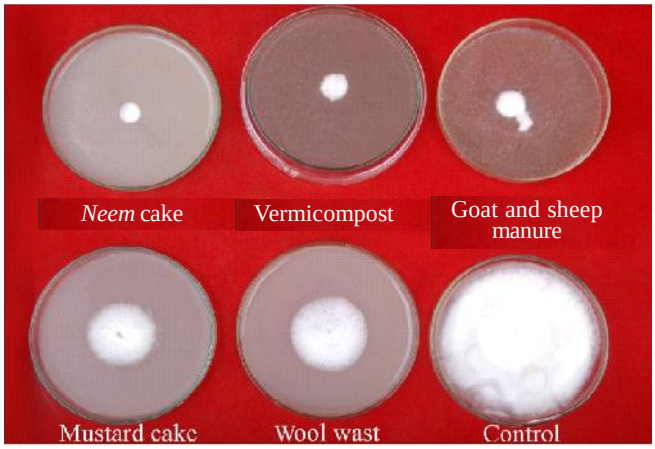

Plate 2 : Efficacy of different organic amendments against mycelial growth of *Fusarium solani* at 30 per cent concentration (*In vitro*)

amendments at their respective doses were further tested *in vivo* condition *against Fusarium solani* root rot causing pathogen, with respect of per cent disease incidence of Indian aloe. The data presented in Table 1. showed that combination *i.e.* Benomyl + *Neem* cake, Thiophanate methyl + *Neem* cake, Benomyl + vermicompost and Benomyl alone tested were found effective (Raychaudhuri, 2003). Among them Benomyl + neem cake combination (0.3% + 1.25 g/kg soil) was found best with minimum disease incidence (12.00%) followed by Thiophanate methyl + *Neem* cake (16.00%), Benomyl + Vermicompost (20.00%) and Benomyl alone (24.00%) at their respective dose/ concentration (Table 1.).

To find out synergistic interaction between fungicide and organic amendments a suitable combination of Benomyl + *Neem* cake, Thiophanate methyl + *Neem* Cake, Benomyl + vermicompost and Thiophanate methyl + vermicompost were used in present investigation Benomyl + *Neem* cake were found best (12.00% PDI) followed by Thiophanate methyl + *Neem* cake and Benomyl + vermicompost which showed 16.00 per cent and 20.00 per cent disease incidence, respectively. Similar results were also obtained by Ekka and Prasad (2010) under field conditions. They observed that oil Cake of *Azadirachta indica* (20 q/ha) recorded 54.40 per cent reduction in disease incidence and 20.44 per cent increase in yield over control whereas, organic amendments with oil Cake of Pongamiaglabra (20 q/ha) recorded 49.60 per cent reduction in disease incidence and 19.83 per cent increase in yield over control. Ashour *et al.* (1980) also observed that Benomyl (Benomy) completely inhibited the mycelial growth of pathogen.

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