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Efficacy of Soil Amendments and Elicitors Against Wilt Disease Of Pigeonpea Caused by *Fusarium oxysporum* f. sp. *udum*

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ABSTRACT
Fusarium oxysporum f. sp. udum is one of the most devastating soil-borne diseases causing wilt of pigeonpea. The aim of present investigation was to evaluate the antifungal activities of soil amendments and elicitors in pot culture which can be used to control wilt disease of pigeonpea. Results revealed that all the test amendments viz. Compost, Vermicompost, Poultry manure, Sheep manure, Groundnut cake, Cotton seed cake, Soybean seed cake, Castor cake, Neem seed cake, and Mustard cake significantly reduced mortality except gypsum and safflower seed cake. Per cent reduction of wilt incidence over untreated control ranged from 6.66 to 73.33 %. Maximum reduction of wilt incidence over control was recorded in neem seed cake (73.33 %) followed by castor seed cake (66.66 %). A total of four induced systemic resistance chemicals viz., salicylic acid, BABA, jasmonic acid and chitosan were used for seed treatment as well as for spraying and these were evaluated against F. udum, by sowing pigeonpea cv. ICP 2376 in pot culture. Total plant mortality was minimum (4 %) in jasmonic and chitosan used for seed treatment as well as for foliar spray, respectively. In case of untreated control cent per cent mortality was observed. Per cent reduction over control was ranged from 32 to 96 %. Maximum reduction over control was recorded in chitosan (96 %) and jasmonic acid (96 %). Minimum reduction over control was recorded in seed treatment of Carbendazim 1g / kg seed (32 %).
Keywords: Soil Amendments, Pigeonpea, *Fusarium oxysporum*

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INTRODUCTION

The pigeonpea crop ranks fourth in importance as edible legume in the world. Pigeon pea is extensively grown throughout the tropics, subtropics and warmer equatorial regions of Asia, East Africa and Central America in lower altitude areas between 30° N to 30° S, particularly in the semi arid and lower humid tropics. Globally, it is grown on approximately 5 million hectares in about 82 countries of the world. The major production area is located in India, Myanmar, Kenya, Malawi, Uganda and Tanzania [1].
It is mainly consumed as dry split dhal throughout the country besides several other uses of various parts of pigeonpea plant. Woody parts of the plant are used for fuel. It is an excellent source of protein (20-22%), supplementing energy rich cereal diets in a mainly vegetarian population (Saxena *et al*. 2010). It is mainly grown as intercrop with urdbean, moonbean, castor, sorghum, soybean, cotton, maize and groundnut in states, Maharashtra, Karnataka, Andhra Pradesh, Telangana, Madhya Pradesh, Uttar Pradesh, Gujarat, Jharkhand, Rajasthan, Odisha, Punjab and Haryana. It is widely used as a pulse, green vegetable, fodder and for a variety of other purposes [9].
Wilt caused by *Fusarium udum* is the most destructive disease of pigeonpea throughout India. The plant mortality upto 50 per cent has been observed with severe infection of wilt. The main symptoms are wilting of seedlings and adult plants. The wilting starts gradually showing yellowing and drying of leaves following by wilting of whole infected plant. The affected plants can easily be recognized in patches in the field.
Fusarium wilt is the most important disease of pigeonpea in India resulting in yield losses up to 67 per cent at maturity and 100 per cent in case of infection at pre-pod stage [6]. The *Fusarium* wilt in pigeonpea was first reported from Bihar by Butler [2]. Surveys conducted for the disease by Kannaiyan *et al*. [7] have indicated it to be a major problem in the states of Bihar and Maharashtra [10]. *Fusarium* wilt

characterized by wilting of the affected plants and characteristic internal browning or blackening of the xylem vessels extending from root system to stems. Partial wilting of the plants [13] and patches of dead plants [11] were reported to be common in the fields during advanced stages of plant growth. Considering economic importance of diseases present investigation was carried out to eco-friendly management (*in vitro*) of wilt diseases of Pigeonpea by incorporating green manure, farm yard manure, plant residues, oil cakes or animal residues in the soil which increases antagonistic microflora are being extensively employed against soil borne *F. udum* causing pigeonpea wilt diseases. Role of elicitors for development of diseases resistant mechanism in host can be derived by applying them in recent research.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Station, Badnapur VNMKV, Parbhani (M.S.), during *Kharif* 2016. A total of 12 organic amendments and were evaluated against *F. udum* (FOU 12) by soil application and sick soil method in pot culture. All of the test amendments were ground physically to rough powder and applied in the pots. Earthen pots (45 cm dia.) filled with sterilized potting mixture of soil: sand (3:1) and to the mass multiplied (sand: maize medium) culture of the isolate FOU 12 was added (@ 50 g / kg potting mixture), watered adequately and incubated for 10-12 days to proliferate the pathogen and make the potting mixture / soil sick with test pathogen.

The test amendments were applied (@ 50 g / kg mixture) to the earthen pots containing sick soil / potting mixture, mixed thoroughly, watered adequately and maintained in open space. Three earthen pots / treatment / replication were maintained. After a week of amendments application, surface sterilized (1 % NaOCl) healthy seeds of ICP 2376 were sown, (20 seeds / pot), watered as and when required to maintain 50 % water holding capacity. The earthen pots containing sick soil (without any amendment) and sown with healthy seeds of ICP 2376 were maintained as standard check.

Total four elicitors (chemicals inducing systemic resistance) were evaluated against *F. udum* (FOU 12) by seed treatments; drenching and Foliar spray in pot culture containing sick soil.

Observations on pre-emergence mortality (PREM) were recorded after a week of sowing and post-emergence mortality (POEM) / wilting at 90th days after sowing.

The per cent of pre-emergence mortality (PREM) and post-emergence mortality (POEM) / wilting were calculated by following formulae:

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

$$\text{POEM (\%)} = \frac{\text{No. of seedlings died}}{\text{Total no. of seedlings}} \times 100$$

RESULTS AND DISCUSSION

Pre, post-emergence and total mortalities

Results revealed that all the test amendments non-significantly influenced on pre-emergence mortality and significantly influenced on post-emergence mortality except gypsum and safflower seed cake. The pre-emergence mortality recorded with all the test amendments ranged from 0.00 to 6.67 per cent, as against 6.67 per cent in untreated control. The post-emergence mortality recorded in all the test amendments ranged from 26.67 to 86.67 per cent, as against 93.33 per cent in untreated control. Whereas, total mortality recorded in all the test amendments ranged from 26.67 to 93.34 per cent as against 100 % in untreated control (Table 1).

Per cent reduction over control

Results revealed that all the test amendments significantly reduced mortality except gypsum and safflower seed cake. Per cent reduction of wilt over untreated control ranged from 6.66 to 73.33 %. Maximum reduction of wilt incidence over control was recorded in neem seed cake (73.33 %) followed by castor seed cake (66.66 %).

Minimum reduction of wilt incidence over untreated control was recorded in gypsum and safflower seed cake (6.66 %). In case of untreated control cent percent mortality was observed. Except Safflower seed cake and gypsum, all rests of treatments were significantly superior over untreated control. These results are in conformity with the findings of those reported earlier by several workers against *F. udum* [14, 3, 5, 8, 12].

Table 1. Efficacy of soil amendments against *F. udum* (pot culture)

Tr. No.	Treatments	Wilt Incidence (%) *		Total Plant Mort. (%)	% Red. over control
		PREM	POEM		
T_1	Compost	0.00	73.33 (59.19)	73.33 (59.19)	26.67 (30.78)
T_2	Vermicompost	6.67	66.67 (54.97)	73.34 (59.19)	26.66 (30.78)
T_3	Poultry manure	0.00	80.00 (68.05)	80.00 (68.05)	20.00 (21.93)
T_4	Sheep manure	6.67	40.00 (38.84)	46.67 (42.68)	53.33 (47.28)
T_5	Groundnut cake	0.00	53.33 (46.90)	53.33 (46.90)	46.67 (43.06)
T_6	Cotton seed cake	0.00	46.67 (43.06)	46.67 (43.06)	53.33 (46.90)
T_7	Safflower seed cake	6.67	86.67 (72.27)	93.34 (81.14)	06.66 (08.85)
T_8	Soybean seed cake	0.00	66.67 (54.97)	66.67 (54.97)	33.33 (34.99)
T_9	Castor cake	6.67	26.67 (30.78)	33.34 (34.62)	66.66 (55.35)
T_{10}	Neem seed cake	0.00	26.67 (30.78)	26.67 (30.76)	73.33 (59.19)
T_{11}	Gypsum	6.67	86.67 (72.27)	93.34 (81.14)	06.66 (08.85)
T_{12}	Mustard seed cake	0.00	46.67 (43.06)	46.67 (43.06)	53.33 (46.90)
T_{13}	Control	6.67	93.33 (81.14)	100.00 (90.00)	00.00 (00.00)
SE ±		**6.01**	**6.51**	**6.424**	**6.420**
CD (P=0.01)		**NS**	**19.04**	**18.779**	**18.767**

*: Mean of three replications, Mort.: Mortality, Red.: Reduction, PREM: Pre emergence mortality, POEM: Post emergence mortality. Figures in parentheses are angular transformed values.

Table 2: Efficacy of ISR elicitors / chemicals against pigeonpea wilt (pot culture).

Tr. No.	Treatments	Wilt Incidence (%) *		Total plant mort. (%)	% Red. over control
		PREM	POEM		
T_1	Salicylic acid (ST @ 0.5 ml / kg of seed)	00.00 (00.00)	24.00 (26.30)	24.00 (26.30)	76
T_2	Salicylic acid (ST @ 0.5 ml / kg of seed) + Its FS @ 50 ppm)	00.00 (00.00)	16.00 (18.47)	16.00 (18.47)	84
T_3	β-amino butyric acid (ST @ 0.5 ml / kg of seed)	00.00 (00.00)	28.00 (31.62)	28.00 (31.62)	72
T_4	β-amino butyric acid (ST @ 0.5 ml / kg of seed) + Its FS @ 50 ppm	00.00 (00.00)	20.00 (23.78)	20.00 (23.78)	80
T_5	Jasmonic acid (ST @ 0.5 ml / kg of seed)	00.00 (00.00)	20.00 (20.98)	20.00 (20.98)	80
T_6	Jasmonic acid (ST @ 0.5 ml / kg of seed) + Its FS @ 50 ppm	00.00 (00.00)	04.00 (05.31)	04.00 (05.31)	96
T_7	Chitosan (ST @ 0.5 ml / kg of seed)	00.00 (00.00)	20.00 (23.78)	20.00 (23.78)	80
T_8	Chitosan (ST @ 0.5 ml / kg of seed) + FS @ 50 ppm	00.00 (00.00)	04.00 (5.31)	04.00 (5.31)	96
T_9	Salicylic acid (ST @ 0.5 ml / kg of seed) + Propiconazole (SD @ 0.1 %)	00.00 (00.00)	16.00 (21.24)	16.00 (21.24)	84
T_{10}	Jasmonic acid (ST @ 0.5 ml / kg of seed) + Propiconazole (SD @ 0.1 %)	00.00 (00.00)	08.00 (10.62)	08.00 (10.62)	92
T_{11}	Control (ST of Carbendazim 1 g / kg)	04.00 (05.31)	64 (53.28)	68.00 (55.81)	32
T_{12}	Control (ST of Carbendazim 1 g / kg) + Propiconazole (SD @ 0.1 %)	00.00 (00.00)	28.00 (28.84)	28.00 (28.84)	72
T_{13}	Control (Untreated)	04.00 (05.31)	96 (84.68)	100 (90.00)	00
S.E. ±		**NS**	**06.23**	**06.07**	**--**
C.D. (P = 0.01)		**2.08**	**17.72**	**17.28**	**--**

*: Mean of five replications, Mort.: Mortality, Red.: Reduction, PREM: Pre emergence mortality, POEM: Post emergence mortality. ST: Seed treatment, FS: Foliar spray and SD: Soil drenching. Figures in parentheses are angular transformed values.

In vitro evaluation of elicitors / ISR chemicals against *F. udum*

Pre, post-emergence and total mortalities

Results revealed that all the test elicitors / ISR and chemical fungicides non-significantly influenced on pre-emergence mortality and significantly influenced on post-emergence mortality. The pre-emergence mortality recorded in all the test ISR chemicals ranged from 0 to 4 to per cent, as against 4 per cent in untreated control. The post-emergence mortality recorded in all the test treatments ranged from 4 to 28 per cent, as against 96 per cent in untreated control.

Total plant mortality was minimum (4 %) in T_6 and T_8 where jasmonic acid and chitosan were used for seed treatment as well as for foliar spray respectively. In case of untreated control cent per cent mortality was observed. All the treatments were significantly superior in reducing mortality over untreated control.

Per cent reduction over control / effect on wilt

Results revealed that all the test elicitors played vital role to develop resistance in plant against wilt disease and significantly reduced mortality compared to untreated control. Per cent reduction of wilt over untreated control was ranged from 32 to 96 %. Maximum reduction of wilt incidence over untreated control was recorded in chitosan (96 %) and jasmonic acid (96 %). Minimum reduction of wilt incidence over control was recorded in T_{11}: seed treatment of carbendazim 1g / kg seed (32 %).

These results are in harmony with the findings of those reported earlier by few workers [4, 16, 15].

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