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In vitro evaluation of fungicides and bioagents against collar rot of elephant foot yam caused by *Sclerotium rolfsii* Sacc.

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Abstract
The pathogen was isolated from infected stem of Elephant foot yam on Potato Dextrose Agar in laboratory. The dark brownish lesions developed on stem and shriveling of the stem extended above collar for 2-5 centimeters. Thick mycelial mat and whitish pre mature sclerotia developed around collar region which later on converted into brown. Finally the seedling collapsed after 19th days of inoculation in field.

In an *in vitro* experiment, among the fungicides tested *in vitro,* propiconazole and metalxyl + mancozeb at 0.1 per cent, mancozeb 0.25 per cent totally inhibited mycelial growth and sclerotia formation of pathogen.

Among the bioagents tesed, *T. harzianum* resulted with significantly highest mycelial growth inhibition (68.88 %) and least number of sclerotia (6), followed by *T. viride* (56.66 % and 9.25) and *T. koningii* (43 % and 11.0).

Keywords: Evaluation, fungicides, bioagents and *T. harzianum*

Introduction
Tuber crops are the third most important food crop for man after cereals and grain legumes. Among them Elephant Foot Yam (*Amorphophallus paeoniifolius*) is important commercial tuberous root crop of tropical and subtropical region of the world mainly grown for its tubers. Elephant foot yam commonly known as Suran or Jimmikand and belongs to the family Araceae. Because of its higher yield potential, culinary properties, medicinal utility and therapeutic values, it is referred to as "King of tuber crops". It has long been used as a local staple food in many countries such as Philippines, Indonesia, Bangladesh, India, China and other South Eastern Asian countries. It is a cheap source of carbohydrate, rich in minerals and vitamin A and B. The corm is used as vegetable and also for preparing curries and pickles. The tubers are recommended to cure dysentery, tumor, asthma, swelling of lungs, vomiting, abdominal pain and also as blood purifier.

In India, it is popularly cultivated in the states of Andhra Pradesh, W.B, U.P, Gujarat and Jharkhand, and Jharkhand being leading state. It is substantially cultivated in Ranchi, Khunti, and Gumla districts of western plateau zone and Giridih district of central and North-Eastern plateau zone. Its cultivation as intercrop in new orchard of mango and litchi is also gaining tremendous popularity among orchard growers of Jharkhand (Kumar, 2012) [2].

The Elephant foot yam crop is affected by the diseases *viz*., foot rot (*Rhizoctonia solani*), Collar rot (*Sclerotium rolfsii*), Anthracnose (*Colletotrichum gloeosporides* Penz.), Leaf spot (*Cornyspora cassiicol* Berk and Curt), Bacterial leaf spot (*Xanthomonas campestris pv amorphophalli*), Mosaic (*Elephant foot yam mosaic virus*), etc. Among these diseases, the collar rot caused by *S. rolfsii* has been considered as one of constraints in successful cultivation of Elephant foot yam crop in India. (Sivapraksam *et al.,* 1982). The pathogen *S. rolfsii* is distributed in tropical and subtropical regions of the world where high temperature prevails (Sahoo *et al.,* 2016) [4]. This pathogen has a wide host range of 500 species in about 100 families including groundnut, pepper, potato, sweet potato, tomato and watermelon (Aycock, 1966) [1]. It is more destructive during rainy season, followed by warm dry weather. Soft and pseudo stem of plant are more vulnerable to this disease. Injury to collar region during intercultural operation, poor drainage, water logging, etc. acts as predisposing factors

for infection by *S. rolfsii*. The disease is more severe during rainy season, followed by warm dry

Materials and methods

The various aspects of present investigation on collar rot of Elephant foot yam were undertaken at the Department of Plant Pathology, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during 2017-18.

The materials used and methods adopted during of present investigation are being described under following sub heads.

Evaluation of fungicides

Six fungicides were tested against the test fungus by using poisoned food technique (Nene and Thapliyal, 1983). Potato Dextrose Agar medium was used as basal medium and distributed in 100 ml aliquots in each 250 ml Erlenmeyer conical flasks, which were sterilized at 1.0545 kg/cm^2 pressure for 20 minutes. The quantity of fungicides for each concentration was calculated for 100 ml medium separately. The weighed quantity of the fungicides added in melted PDA at 40^{0}C mixed thoroughly and poured into sterilized Petri plates and allowed to solidify. The mycelial discs of 5 mm diameter were cut from 7 day old culture with the help of sterile cork borer. Each disc was transferred aseptically to the centre of the already poured plates. The PDA plates without fungicide were also inoculated with fungal culture which served as control. The plates were incubated at 28 ± 1 ^{0}C in incubator. Three replications per treatment were maintained. The observations for colony diameter and sclerotia formation were recorded until whole of the plate in control treatment was fully covered with mycelial growth.

Per cent inhibition of growth was calculated by the following formula (Vincent, 1927) [7].

$$X = \frac{Y - Z}{Y} \times 100$$

Where,
X = Per cent inhibition
Y = Growth of fungus in control (mm)
Z = Growth of fungus in treatment (mm)

Evaluation of bioagents

The antagonistic activity of bio agents against *S. rolfsii* was determined by dual culture technique under *in vitro* condition (Stack *et al*., 1986) [6].

Mycelial discs measuring 8 mm diameter from one week old cultures of both fungal antagonist and the test pathogen were placed at equidistant on sterile Petri plates containing PDA medium. However for *Pseudomonas fluorescens*, one day old culture of bacteria was streaked on opposite side of the pathogen on NA medium. The Petri plates were incubated at 27 ±1 ºC. Four replications were maintained in each treatment. Suitable controls were kept without antagonist. Zone of inhibition were measured simultaneously day after inoculation of antagonist. Percentage inhibition of mycelial growth of test pathogen was calculated and the observations on sclerotial development affected due to bio-control agent were also recorded.

Per cent inhibition of growth was calculated by the following formula (Vincent, 1927) [7].

$$X = \frac{Y - Z}{Y} \times 100$$

Where,
X = Per cent inhibition
Y = Growth of fungus in control (mm)
Z = Growth of fungus in treatment (mm)

Results and discussion

Effect of fungicides on *Sclerotium rolfsii* Sacc

Six fungicides were screened against *Sclerotium rolfsii* Sacc. by Poisoned Food Technique (PFT). The data on the efficacy of different fungicides and their effect on mycelial growth and sclerotia formation of *Sclerotium rolfsii* were presented in Table 1. The data revealed that all the fungicides inhibited the mycelial growth and sclerotia formation. Metalxyl M + mancozeb (0.1 %), propiconazole (0.1 %), and mancozeb (0.25 %) completely inhibited (100 %) the growth and sclerotia formation of *S. rolfsii*. Copper Oxychloride (0.2 %) and carbendazim (0.1%) resulted in 13.7 and 8.5 per cent inhibition of test fungus with 46.33 and 37.33 sclerotia, respectively. Whereas least inhibition (0 %) and more sclerotia formation (56.33 nos.) was recorded in thiophenate methyl (0.1 %).

Table 1 Effect of different fungicides against *Sclerotium rolfsii* Sacc

Tr. No.	Treatments	Conc. %	Mean colony diameter (mm)*	Per cent inhibition over control	No. of sclerotia produced/plate
T_1	Thiophenate methyl	0.1	90.00	0	56.33
T_2	Mancozeb	0.25	0.00	100	0
T_3	Copper-oxy-chloride	0.25	82.33	8.5	46.33
T_4	Propiconazole	0.1	0.00	100	0
T_5	Carbendazim	0.1	77.66	13.7	37.00
T_6	Metalaxyl-M + Manocozeb	0.1	0.0	100	0
T_7	Control		90.00	0	82
S. Em		0.77			
C.D at 1%		3.26			

Effect of bioagents against *Sclerotium rolfsii* Sacc

The results revealed that the antagonists significantly reduced the growth of *S. rolfsii* either by overgrowing or by exhibiting inhibition zone. The data in Table 2 revealed that maximum per cent reduction (68.88 %) in colony diameter and less No. of sclerotia formation No of sclerotia by *S. rolfsii* over control was achieved due to *Trichoderma harzianum* when test fungus was placed. This was followed by *T. viride* (56.66% and 9.25 no. of sclerotia), *T. koningii* (43.00 % and 0 no. of sclerotia) and *P. fluorescens* (40.00 % and 11 no. of sclerotia) in the order mentioned.

Table 2: Effect of different bioagents against *Sclerotium rolfsii* Sacc.

Tr. No.	Treatments	Mean colony diameter (cm)*	Percent inhibition over control	No. of sclerotia produced/plate
T1	*T. koningii*	5.1	43.00	00.00
T2	*P. fluorescens*	5.4	40.00	11.00
T3	*T. harzianum*	2.8	68.88	6.00
T4	*T. viride*	3.9	56.66	9.25
T5	Control	9.00	0	68.25
S.Em ±		3.29		
C.D at 1%		13.71		

Discussion

Among the different fungicides tested under *in vitro* conditions, propiconazole (0.1%), mancozeb (0.25%), metalxyl M+mancozeb (0.1%) gave complete inhibition of mycelial growth as well as sclerotia formation. But, carbendazim (0.1%), copper oxychloride (0.25%) and thiophanate Methyl (0.1%) were ineffective against the pathogen. These findings are in concurrence with those reported by Prabhu and Hiremath (2003), Tiwari and Singh (2004), Mundhe (2005), Patil (2007), Haralpatil and Raut (2008), Patel *et al.* (2008), Sawant (2009) and Pandav (2012), Kumar (2012) [2], Salvi (2015). The results of present study revealed that the fungicides in trizole group are very effective against the soil borne pathogen. The fungicides included in the study found to be effective against the development of sclerotia in plate. The fungicides included in the study found to be effective against the development of sclerotium in plate.

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