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In vitro efficacy of Carbendazim against *Fusarium solani* causing rhizome rot of Ginger

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Abstract
The present study was undertaken to study the effect of Carbendazim on *Fusarium solani* causing rhizome rot of Ginger. Due to this disease development heavy economic loss occurs therefore, to control this disease different fungicides were tested against *Fusarium solani* and the fungicide Carbendazim was found effective against fungal growth causing rhizome rot of Ginger. The fungicide Carbendazim was tested at five concentrations i.e., 0.025, 0.05, 0.1, 0.15 and 0.2% *in vitro* against *Fusarium solani.* The result showed that 0.2% concentration of Carbendazim was most effective in controlling the growth of *Fusarium solani* causing rhizome rot of ginger.

Keywords: Rhizome rot, Carbendazim, *Fusarium solani* and Ginger

1. Introduction
Zingiber officinale Rosc. is one of the earliest known spices and is being cultivated as rhizome in India for vegetable and spice, since time immemorial. This plant belongs to family Zingiberaceae which is a tropical group, especially abundant in Indo- Malaysian region, consisting of more than 1200 plant species with 53 genera. The area under cultivation in India is 1.06 lakh ha and the total production is 3.70 lakh tones in 2009 (Spices Board, 2009). It is an important crop that earns a sizeable amount of foreign exchange for the country (Tarafdar and Saha, 2007) [13]. Among the major constraints for growing ginger is the rhizome rot. Even though important foliar diseases do exist, rhizome rot is very important in view of severe crop losses. It occurs in several parts of India wherever these crops are grown. The term rhizome rot is loosely used for all the diseases affecting the rhizome irrespective of pathogens involved, since the ultimate result is the partial or total loss of rhizome.
Rhizome rot of ginger can be controlled by the application of fungicides. Many researchers worked on the chemical control of the disease and they found very promising effect of different chemicals against the disease Stirling *et al*., 2006 [12] Usman, 2006 [15] Meena and Mathur, 2005 [6]; systemic and contact fungicides like Bavistin 50WP, Ridomil Gold MZ-72, Captan, Dithane M-¬45, Copper Oxychloride and Bordeaux mixture etc. were reported effective against the disease (Sagar, 2006) [10]. Thus, the present study was undertaken to find out the efficacy of Carbendazim fungicide to control rhizome rot of ginger.

2. Material and Method
Samples of infected and healthy rhizomes along with the soil were collected from different regions of Marathwada i.e., Parbhani, Hingoli, Nanded, Latur, Beed, Jalna and Aurangabad. The isolation of pathogen was made by taking 1 x 1 cm pieces of surface sterilized infected rhizome and inoculated aseptically on potato dextrose agar medium. The purification of pathogen was carried out by culturing on PDA medium by hyphal tip method for three times and maintained on PDA slants by using single spore and hyphal tip methods given by Tuite, (1969) [14] Wang and Wen (1997) [16], Kareppa et.al., (1998) [5] and Choi et.al., (1999) [4].
The isolated fungal pathogens were identified by preparing slides by mounting in cotton blue stain. The pathogen was identified on the basis of growth and characteristic features of the mycelium as well as reproductive structures and was further identified by sequencing. The identification of pathogen i.e., *Fusarium solani* (Mart.) Sacc. was confirmed by referring the standard literature of 'Illustrated genera of Imperfect fungi" (Barnett and Hunter, 1972) [2], Alexopoulos *et al*. (1996) [1].
The *in vitro* study was carried out by poisoned food technique as used by Nene and Thapliyal, (1993) [8] and Nasreen et. al., (2010) [7]. The required concentrations of fungicide was prepared and incorporated into sterilized, cooled potato dextrose agar. 20 ml of medium was poured into 90 mm sterilized petri plates and all plates were inoculated with actively growing 5 mm mycelial disc in the centre of media and incubated at room temperature for 7 days. Control was maintained without adding any fungicide to the medium. Three replications were maintained for each concentration and radial growth was measured in the form of millimeter (mm). The fungicide Carbendazim was tested at five concentrations i.e., 0.025, 0.05, 0.1, 0.15 and 0.2% *in vitro* against *Fusarium solani.* The observations were recorded until the control plate was full of growth of the pathogen and recorded the growth in millimeter (mm).
Statistical Analysis
Statistical analysis was carried out as per the procedure given by Panse and Sukhatme (1967) [9]. Data in percentage were transformed to arc sine and square route values and analysis was (CRD) and M-Stat C from Vasantrao Naik Marathwada University, Parbhani.

3. Results and Discussion
The fungicide Carbendazim was tested against *Fusarium solani* causing rhizome rot of ginger. The different concentrations of fungicide used for the treatment were from

0.025 to 0.2%, 0.0% was treated as control and incubated for seven days.

The control plate showed 5.00 mm growth on 1st day, 13.33 mm at 2nd day, 25.00 mm at 3rd day, 35.66 mm at 4th day, 52.33 mm at 5th day, 75.00 mm at 6th day and 90.00 mm at 7th day of incubation period. From this, it was revealed that, as incubation period increases, the growth of the *Fusarium solani* also increases and as the conc. of fungicide increases from 0.025, 0.05, 0.1, 0.15 and 0.2% the growth of the pathogen inhibited from 61.66, 43.33, 21.33, 5.00 and 5.00 mm respectively on 7th day of incubation period as given in Table 1, Fig. 1.. It was also noted that, as the conc. of Carbendazim increases, the growth level decreases at 0.2% conc. Therefore it can be concluded that 0.2% concentration of Carbendazim is most effective in controlling the growth of *Fusarium solani* causing rhizome rot of ginger. Similar results were observed by Nasreen and Ghaffar (2010) [7] who observed the effect of different fungicides for the control of *Fusarium solani* causing seedling, seed rot and root infection of bitter gourd, bottle gourd and cucumber. There observation showed that fungicides Carbendazim @ 100 ppm completely inhibit seed-borne infection of *F. solani.* Whereas Carbendazim and Carbendazim + Mancozeb gave 100 % inhibition of mycelial growth of *F. solani* at 0.2 and 0.3% concentrations (Chavan *et al*., 2009) [3]

Table 1: Effect of Carbendazim against growth of *Fusarium solani*

Incubation period (Days)	Growth (mm)					
	Conc. of Carbendazim (%)					
	0(Control)	0.025	0.05	0.1	0.15	0.2
1	5.00	5.00	5.00	5.00	5.00	5.00
2	13.33	11.33	8.66	5.33	5.00	5.00
3	25.00	21.66	14.33	7.00	5.00	5.00
4	35.66	32.33	21.66	11.33	5.00	5.00
5	52.33	43.33	28.33	14.33	5.00	5.00
6	75.00	55.66	32.66	17.33	5.00	5.00
7	90.00	61.66	43.33	21.33	5.00	5.00
SE ±	1.257	0.821	0.597	0.575	0	0
CD @ 5%	3.869	2.527	2.412	2.330	0	0

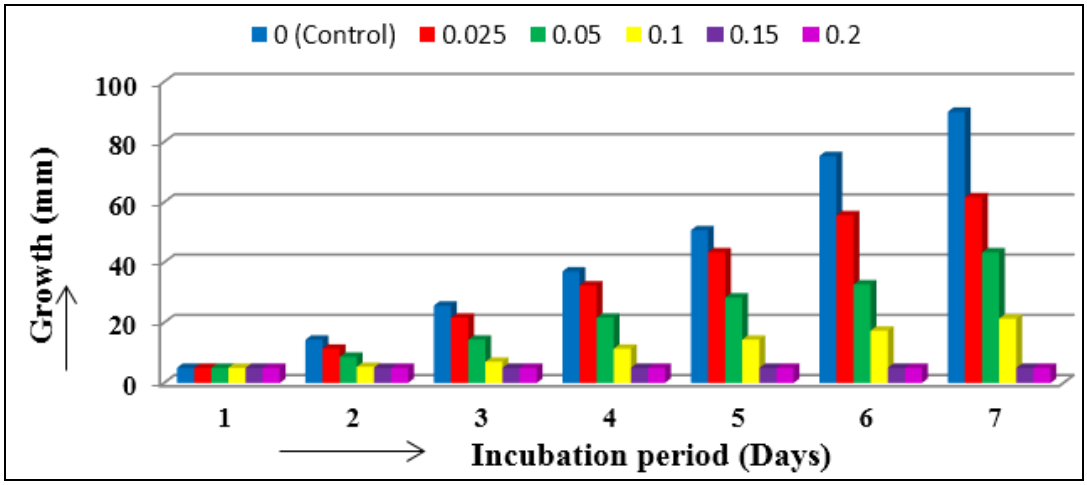

Fig 1: Effect of Carbendazim against growth of *Fusarium solani.*

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