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EFFICACY OF DIFFERENT FUNGICIDES AGAINST DRY ROT PATHOGEN OF POTATO CAUSED BY *FUSARIUM* SP. UNDER *IN VITRO* CONDITION

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ABSTRACT. Potato crop is affected by numerous diseases in field, as well as in storage conditions, particularly in cold storage. Dry rot of potato is caused by *Fusarium* sp. Dry rot of seed tubers can reduce crop establishment by killing developing potato sprouts, and crop losses can be up to 25%, while more than 60% of tubers can be infected in storage. It is a rich source of energy, which supplement food source of a country. In this experiment, four systemic and four non-systemic fungicides were tested at different concentrations *in vitro* for their comparative efficacy against inhibition of the growth of *Fusarium* sp. through poisoned food technique. To manage these diseases effectively, different concentrations of fungicides were tested. Results revealed against *Fusarium* sp. that carbendazim and benomyl significantly inhibited the fungal growth even at its lower concentration (100 ppm) and proved statistically superior over the rest of the fungicides tested at different concentrations and among non-systemic fungicides, MEMC significantly inhibited the fungal growth even at its lower concentration (1000 ppm).

Keywords: *Fusarium* sp.; dry rot; fungicides; inhibition.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most nutritious sources of food in the world. Besides cereals, potato is one of the crops, which can supplement food needs of a country. It has been recognized as a wholesome food and the richest source of energy in most of the countries of the world where, it forms an important part of the human diet. *Fusarium* dry rot is one of the most important diseases of potato, affecting tubers in storage and seed pieces after planting. *Fusarium* dry rot of seed tubers can reduce crop

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establishment by killing developing potato sprouts, and crop losses can be up to 25 %, while more than 60 % of tubers can be infected in storage. However, average annual crop losses attributed to dry rot have been estimated at 6 to 25 per cent (Chelkowski, 1989) and found that more than 60 per cent of tubers in storage can be affected (Carnegie *et al.*, 1990). *Fusarium* sp. that causes dry rot and spread readily among tubers during handling and planting, which results in seed tuber rots and poor plants stand (Hooker, 1981). The first symptoms of *Fusarium* dry rot are usually dark depressions on the surface of the tuber. In large lesions, the skin becomes wrinkled in concentric rings as the underlying dead tissue desiccates. Internal symptoms are characterized by necrotic areas shaded from light to dark brown or black in colour. This necrotic tissue is usually dry (hence the name given as dry rot) and may develop at an injury such as a cut or bruise. The pathogen enters the tuber, often rotting out in the center (Sandipan *et al.*, 2015). *Fusarium* dry rot is caused by several fungal species in the genus *Fusarium*. *Fusarium sambucinum* (teleomorph *Giberella pulicaris*) is the most common pathogen causing dry rot of stored tubers, but other *Fusarium* species are also known to cause dry rot, particularly *F. solani* var. *coeruleum* and *F. avenaceum*. However, *F. sambucinum* is may be the probably the main causal agent of dry rot, but *F. solani* var. *coeruleum* may also be present and affect the potato crop. *Fusarium* dry rot is both seed and soil-borne and is present in most potato growing areas. Spread is associated with damage through seed cutting, grading or harvesting. Wounds created during these processes allow the *Fusarium* fungi to enter the tuber and spread. Temperatures of 15 to 20°C and high relative humidity aid the growth of *Fusarium* dry rot.

Investigations conducted on the use of different fungicides for the control of dry rot of potato. Looking to the importance and need, different fungicides have been studied under *in vitro* condition for the effective management of dry rot disease of potato.

MATERIAL AND METHODS

To study the efficacy of different systemic and non-systemic fungicides against dry rot, pathogen of potato *in vitro*, the poisoned food technique was employed. The measured quantities of fungicides were incorporated in melted sterilized Potato Dextrose Agar (PDA) medium for pathogen aseptically to obtain desired concentration of the fungicides at the time of pouring the medium. The medium was shaken well to give uniform dispersal of the fungicides and poured into sterilized Petri plates under aseptic conditions.

The Petri plates were inoculated in the centre by placing seven days old mycelial colony discs of 5 mm diameter and then incubated at 28 ± 2^{o}C temperature for seven days. Simultaneously, a control was also maintained by growing the pathogen separately on fungicides free

PDA medium, respectively. Four replications were maintained in each treatment. Observations on radial growth of fungal pathogen was measured by averaging two diameters of colony at right angle to one another and the Percent growth inhibition (PGI) was calculated by the following equation (Asalmol *et al.*, 1990):

$$PGI = \frac{C - T}{C} \times 100,$$

where, PGI = Percent growth inhibition; C = Growth in control (mm); T = Growth in treatment (mm).

RESULTS AND DISCUSSION

Dry rot of potato (*Fusarium* sp.)

The results of bioassay of fungicides against *Fusarium* sp. are presented in *Table 1* and *Fig. 1* revealed that all the four systemic fungicides at different concentrations were found inhibitory to the fungal growth of dry rot pathogen under *in vitro* study. Carbendazim and benomyl significantly inhibited the fungal growth even at its lower concentration (100 ppm) and proved statistically superior over the rest of the fungicides tested at different concentration.

Table 1 - Percent growth inhibition of *Fusarium* sp. by systemic fungicides at different concentrations *in vitro*

Sr. No.	Fungicides		Concentration (ppm)	Per cent inhibition over control* (%)
	Trade name	Common name		*Fusarium* sp.
1	Bavistin	Carbendazim	100	86.72(99.17)**
			250	88.72(99.40)
			500	87.17(99.25)
			1000	88.41(99.40)
2	Benlate	Benomyl	100	87.03(99.22)
			250	86.61(99.15)
			500	86.91(99.20)
			1000	88.08(99.35)
3	Topsin-M	Thiophanate methyl	100	43.73(47.32)
			250	46.88(52.81)
			500	49.85(57.96)
			1000	51.52(60.82)
4	Bayleton	Triadimefon	100	46.87(52.81)
			250	51.90(61.46)
			500	57.75(71.07)
			1000	61.08(76.16)
5	Control	-	-	4.05(00.00)
S.Em. ±				0.388
C.D. at 5%				1.104
C.V. %				1.19

*Average of four replications; **Figures in the parenthesis are retransformed values.

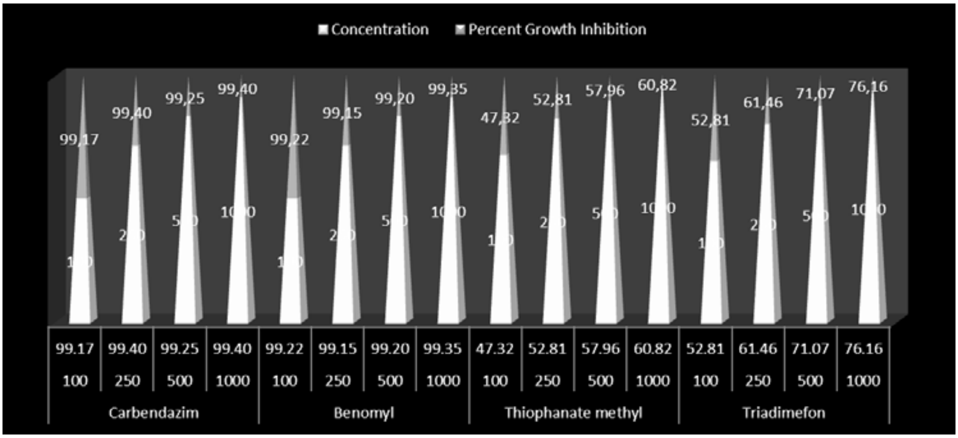

Figure 1 - Showing Percent growth inhibition of *Fusarium* sp. in different systemic fungicides

The next effective fungicide was triadimefon, which inhibited the fungal growth as 52.81, 61.46, 71.07 and 76.16 percent at 100, 250, 500 and 1000 ppm, respectively. Thiophanate methyl was least inhibitory to the fungal growth, which inhibited only 47.32, 52.81, 57.96 and 60.82 percent at 100, 250, 500 and 1000 ppm, respectively.

Among non-systemic fungicides, all the fungicides at different concentrations found inhibitory to the fungal growth of *Fusarium* sp. Methoxyethyl mercury chloride (MEMC) significantly inhibited the fungal growth, even at its lower concentration (1000 ppm), and proved to be the best and found statistically superior over rest of the fungicides tested. The next effective fungicides was tetramethyl thiuram disulphide (TMTD), which also inhibited the fungal growth, as 87.34, 91.17, 94.11 and 99.20 percent at 1000, 1500, 2000 and 3000 ppm, respectively, and found significantly superior over rest of the fungicides tested while, propineb stands next in respect of inhibition of fungal growth, as 27.34 and 52.64 percent at 1000 and 3000 ppm, respectively. Mancozeb was least inhibitory to the fungal growth, which inhibited only 14.11 and 42.34 percent fungal growth at 1000 and 3000 ppm, respectively (*Table 2* and *Fig. 2*). Similarly, Lashin and Henriksen (1977) reported that thiabendazole found very effective under *in vitro* against *Fusarium solani* var. *coeruleum*, causing dry rot of potato. Rafiq *et al.* (1995) reported that thiabendazole was most effective in checking the growth of *Fusarium oxysporum*, *F. solani*, *F. roseum* and *Rhizoctonia solani* at all concentrations used.

Table 2 - Percent growth inhibition of *Fusarium* sp., by non-systemic fungicide at different concentrations *in vitro*

Sr. No.	Fungicides		Concentration (ppm)	Per cent inhibition over control* (%)
	Trade name	Common name		*Fusarium* sp.
1	Emisan-6	MEMC	1000	86.84(99.20)*
			1500	86.99(99.22)
			2000	87.32(99.27)
			3000	88.87(99.42)
2	Dithane M-45	Mancozeb	1000	22.41(14.11)
			1500	32.83(28.95)
			2000	39.14(39.41)
			3000	40.86(42.34)
3	Antracol	Propineb	1000	31.83(27.34)
			1500	34.41(31.46)
			2000	37.60(36.76)
			3000	46.78(52.64)
4	Thiram	TMTD	1000	69.58(87.34)
			1500	73.24(91.17)
			2000	76.58(94.11)
			3000	86.84(99.20)
5	Control	-	-	4.05(00.00)
S.Em. ±				0.714
C.D. at 5%				2.031
C.V. %				2.57

*Average of four replications; ** Figures in the parenthesis are retransformed values.

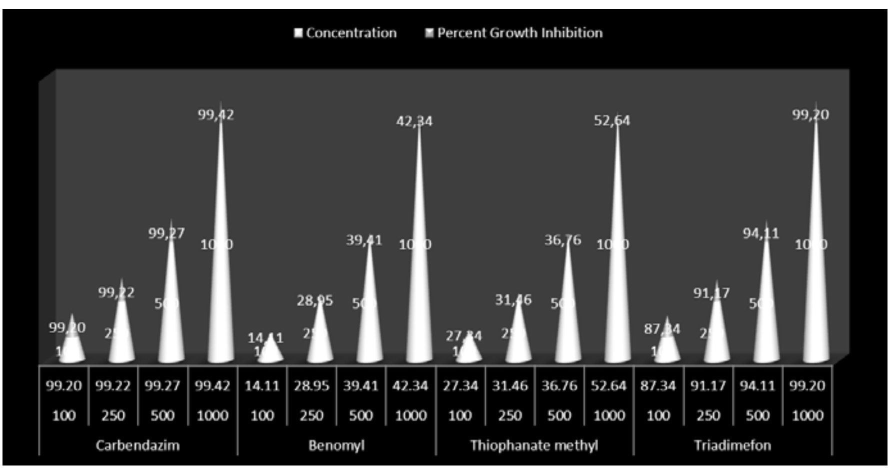

Figure 2 - Showing Percent growth inhibition of *Fusarium* sp. in different non-systemic fungicides

CONCLUSION

It can be concluded from the experiment, for the effective control of *Fusarium* sp., carbendazim and benomyl significantly inhibited the fungal growth even at its lower concentration (100 ppm) and proved statistically superior over the rest of the fungicides tested at different concentrations and among non-systemic fungicides, MEMC significantly inhibited the fungal growth even at its lower concentration (1000 ppm).

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