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## Survival of *Colletotrichum gloeosporioides* causing anthracnose of mango at different depths and durations in soil

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### Abstract

Survival of *Colletotrichum gloeosporioides* (Penz.) Penz., & Sacc. the causal organism of anthracnose disease of mango was studied at the CCS Haryana Agricultural University, Hisar. The naturally infected mango leaves collected from mango orchard were wrapped in synthetic nets and buried soil at different depths and durations under screen house conditions. The pathogen survived for seven months in soil as conidia or mycelium in infected debris under adverse conditions. As the depth and duration increased, there has been a decrease in viability of the fungus indicating its long survival on the soil surface only. The fungus could not survive at 5 cm depth after seven months of burial in comparison to 81.6 per cent survival at same depth after one month of burial. At 5 cm and 10 cm depth conidia or mycelium remained viable for five months at 2% urea concentration, however, fungus remained viable up to four months at 5% urea concentrations.

**Keywords:** Anthracnose, *Colletotrichum gloeosporioides*, Depth, viability

### 1. Introduction

Mango (*Mangifera indica* L.) is one of the world's most important fruit of the tropical and subtropical countries. It is cultivated extensively as a commercial fruit crop in India, China, Indonesia, Thailand and Mexico. Various biotic and abiotic stresses cause immense loss to mango crop throughout the world and destructive disease of mango are those caused by fungi, bacteria, viruses and phytoplasma. Among biotic stresses, mango anthracnose is the most serious fungal disease that causes maximum damage in mango (Kumari *et al.*, 2017) [6]. Crop losses caused by *C. gloeosporioides* generally occur as a direct reduction in quantity or quality of the harvested produce (Lakshmi *et al.*, 2011) [7]. This pathogen causes flower set reduction and yield losses in mango and can also damage foliage and under crowded and moist conditions cause serious problems in nurseries and young orchards (Kumar and Rani, 2010; Anisurrahman *et al.*, 2013) [5, 1]. This disease has become a serious threat due to their long survivability in soil and plant debris. Sankar and Kumari (2002) [8] reported that the *C. gloeosporioides* survived up to 90 days when infected plant parts buried in soil. At 120 days after burial no propagules could be recovered. Under laboratory conditions *C. gloeosporioides* survived up to 150 days. The survival of *C. gloeosporioides* generally reduced with increased soil depth and duration of burial of infected plant materials. The maximum reduction of fungal survival was observed below 20 per cent at 150 days of burial at 20 cm depth (Freeman *et al.*, 2002; Fokunang *et al.*, 2004) [4, 3]. Recently, Takushi, (2015) [9] observed that *C. gloeosporioides* was able to survive for long periods on diseased withered leaves, with survival period increasing with decreasing temperature. Since, no significant information is available on the survival of *Colletotrichum gloeosporioides* at different depths and durations of time under soil conditions in India; hence, the present studies were carried out on this aspect.

### Materials and Methods

#### Survival of *C. gloeosporioides*

#### To test viability of *C. gloeosporioides* at different depths and duration in soil

*C. gloeosporioides* infected leaves of mango were collected from experimental orchard of Department of Horticulture, in the month of March, 2016. In the last week of March, fifteen infected leaves were wrapped in synthetic net and each synthetic net was placed at different depths of 0 cm (on surface), 5 cm, 10 cm and 20 cm in surface sterilized earthen pots filled with field soil. Pots were arranged in a completely randomized design (CRD) with three replications.

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The synthetic bundles containing infected leaves of three pots were taken out at monthly interval starting from last week of April up to October, 2016. Infected leaves were washed in tap water, blot dried and cut into small pieces. These pieces were sterilized by dipping in 0.1 per cent mercuric chloride solution for 30 seconds followed by three washing in Petri plates containing sterilized water under aseptic conditions. After that, these cut pieces were transferred into the potato dextrose agar (PDA) medium of Petri plates. Then, Petri plates were incubated at  $25\pm 1^\circ\text{C}$  for 7 days. After 7 days, survival of pathogen was observed by the growth of viable fungal colonies on the medium. The per cent viability of *C. gloeosporioides* was calculated by using following formula given by (Freeman *et al.*, 2002) <sup>[4]</sup>.

$$\text{Per cent viability} = \frac{\text{Number of pieces showing fungal colonies}}{\text{Total number of pieces plated}} \times 100$$

#### Effect of urea on survival of *C. gloeosporioides* at different depths and duration in soil

*C. gloeosporioides* infected leaves of mango were collected from experimental orchard of Department of Horticulture, in the month of March, 2016. In the last week of March, fifteen infected leaves were wrapped in synthetic net and each synthetic net was placed at different depths of 0 cm (on surface), 5 cm, 10 cm and 20 cm in surface sterilized earthen pots filled with field soil (3kg soil/ pot). Urea (46%, N) solution @ 2% and 5% (w/v) were applied in each pot except control on the surface of soil. Pots were arranged in CRD with three replications. The per cent occurrence/viability of *C. gloeosporioides* was calculated by formula given by Freeman *et al.*, (2002) <sup>[4]</sup>.

#### Statistical Analysis

The factorial experiment in completely randomized design (CRD) had been conducted under screen house conditions. The data from the experiments were statistically analyzed by using relevant statistical OPSTAT computer software (OPSTAT <http://hau.ernet.in>).

#### Results

##### Viability of *C. gloeosporioides* at different depths and duration in soil under screen house conditions

Results in table 1 clearly revealed that viability of *C. gloeosporioides* as conidia or mycelium in infected leaves survived a maximum of 90.5 per cent, when infected leaves were placed at soil surface (0 cm) for one month in comparison to a minimum viability of 8.3 per cent after seven months. However, a maximum of 83.2 per cent fungal survival was recorded at soil surface in comparison to a minimum viability of 58.3 per cent at 20 cm depth after two months of burial. Viability of conidia or mycelium significantly declined from 66.1 per cent after three months to 6.6 per cent after six months at same depth. The fungus could not survive at 5 cm depth after seven months of burial in comparison to 81.6 per cent survival at same depth after one month of burial. As the depth and duration increased, there has been a decrease in viability of the fungus indicating its

long duration survival on the soil surface only. Hence, the viability of infected samples declined with increase in soil depths and duration of burial (Figure 1). At 10 cm soil depth, no fungal growth was observed after six months of burial, while at same soil depth fungal survival was recorded 74.4 per cent after one month of burial. The viable conidia were detected in infected leaves up to 13.3 per cent at 20 cm soil depth after five months of burial in comparison to 67.7 per cent at same depth after one month of burial.

##### Effect of Urea on survival of *C. gloeosporioides* at different depths and duration

Viability of *C. gloeosporioides* conidia or mycelium was sharply declined with the increase in soil depths, duration and urea concentrations under screen house conditions (Table 2). The viability of conidia was recorded a maximum of 74.4 per cent at 2 per cent urea concentration, while viability reduced from 74.4 to 66.6 per cent at 5 per cent urea concentration at soil surface after one month of burial. However, fungal survival was recorded 2.2 per cent at 2 per cent urea concentration, but in case of 5 per cent urea concentration the fungus could not survive at soil surface after seven months of burial. The viable conidia or mycelium was detected in infected leaves up to 24.4 and 21.1 per cent at 20 cm depth after one month of burial with 2 and 5 per cent urea concentration, respectively. The fungus could not survive at 5 cm depth after five and four months of burial with 2 per cent and 5 per cent urea concentration, respectively. At 5 cm and 10 cm depth conidia or mycelium remained viable for five months at 2 per cent urea concentration, however, fungus remained viable up to four months at 5 per cent urea concentrations (Figure 2 and 3). Hence, the viability of infected samples also declined with increase in soil depth, duration and urea concentrations.

#### Discussion

Studies on the survivability of *C. gloeosporioides* on mango infected leaves revealed that as the depth and duration increased, there has been a decrease in viability of the fungus. So, this indicating its long survival on the soil surface only. Thus, present investigation get positively supported by Freeman *et al.* (2002) <sup>[4]</sup> and Fokunang *et al.* (2004) <sup>[3]</sup>, where they reported that survival of *C. gloeosporioides* generally reduced with increased soil depth and duration of burial of infected plant materials. The maximum reduction of fungal survival was observed below 20 per cent at 150 days of burial at 20 cm depth. Sankar and Kumari (2002) <sup>[8]</sup> also support the results of present investigation; they reported that *C. gloeosporioides* could not survive after 120 days of burial in soil. The recovery of the viable propagules decreased with the increase in duration of burial. They also observed that under laboratory conditions *C. gloeosporioides* survived up to 150 days. Similar results were also observed by Takushi, 2015 <sup>[9]</sup> that *C. gloeosporioides* was able to survive for long periods on withered leaves. On the other hand, Boland *et al.* (1995) observed that *C. gloeosporioides* survived for two dry seasons as conidia on infected stem pieces of *S. scabra* placed on the soil surface. There is no information has been available in literature regarding the effect of urea on survival of *C. gloeosporioides* in mango.

**Table 1:** Effect of soil depth and duration of burial of *C. Gloeosporioides* in infected leaves on their viability under screen house conditions

Depth (cm)	Survival of <i>C. gloeosporioides</i> (%)*							Mean
	Last week of April	Last week of May	Last week of June	Last week of July	Last week of August	Last week of September	Last week of October	
0	90.5 (72.1)	83.2 (65.8)	70.0 (56.7)	61.1 (51.4)	46.1 (42.7)	19.4 (26.0)	8.3 (16.7)	54.1(47.3)
5	81.6 (64.6)	75.0 (59.9)	66.1 (54.3)	48.8 (44.3)	31.6 (34.2)	6.6 (14.8)	0.0 (2.9)	44.2 39.3)
10	74.4 (59.6)	64.4 (53.3)	58.3 (49.7)	33.3 (35.2)	22.2 (28.1)	0.0 (2.9)	0.0 (2.9)	36.1 33.1)
20	67.7 (55.4)	58.3 (49.7)	48.3 (44.0)	24.4 (29.5)	13.3 (21.3)	0.0 (2.9)	0.0 (2.9)	30.3 29.4)
Mean	78.6 (63.0)	70.2 (57.2)	60.6 (51.2)	42.0 (40.1)	28.3 (31.6)	6.5 (11.7)	2.0 (6.3)	-
	Duration		Depth		Duration× Depth		-	
SEm±	0.4		0.3		0.8		-	
C.D. (p=0.05)	(1.1)		(0.8)		(2.2)		-	

Note: *C. gloeosporioides* infected leaves were buried in pots in the last week of March, 2016

Figures in parentheses are angular transformed values

\*Per cent viability of fungus was tested in the last week of each month

+0.25 has been added in each observation for statistical analysis

**Table 2:** Effect of urea on survival of *C. gloeosporioides* at different depth and duration under screen house conditions

Duration (Time period)	Survival of <i>C. gloeosporioides</i> (%)* at 2% urea concentration					Survival of <i>C. gloeosporioides</i> (%)* at 5% urea concentration				
	Depth of burial (cm)				Mean (Duration)	Depth of burial (cm)				Mean (Duration)
	0 cm	5 cm	10 cm	20 cm		0 cm	5 cm	10 cm	20 cm	
April	74.4 (59.6)	66.1 (54.3)	48.8 (44.3)	24.4 (29.5)	53.4 (46.9)	66.6 (54.7)	53.3 (46.8)	39.4 (38.9)	21.1 (27.3)	45.1 (41.9)
May	58.3 (49.7)	46.1 (42.7)	31.6 (34.2)	19.1 (25.8)	38.8 (38.1)	50.5 (45.2)	41.1 (39.8)	26.6 (31.0)	17.2 (24.5)	33.8 (35.1)
June	41.6 (40.1)	28.3 (32.1)	18.3 (25.3)	11.6 (19.9)	25.0 (29.3)	34.4 (35.9)	22.2 (28.1)	17.8 (24.9)	8.3 (16.7)	20.6 (26.4)
July	24.4 (29.5)	16.6 (24.0)	5.0 (12.7)	1.1 (6.2)	11.8 (18.0)	19.1 (25.8)	11.6 (19.9)	2.2 (8.4)	0.0 (2.9)	8.2 (14.2)
August	11.1 (19.3)	7.7 (16.0)	0.5 (5.1)	0.0 (2.9)	4.8 (10.6)	5.0 (12.7)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	1.2 (5.3)
September	7.2 (15.5)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	1.8 (6.0)	1.6 (6.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.4 (3.9)
October	2.2 (8.4)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.5 (4.3)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)
Mean (Depth)	31.3 (31.8)	23.5 (25.0)	14.9 (18.1)	8.0 (12.80)	19.5 (21.9)	25.3 (21.6)	18.3 (20.4)	12.3 (16.0)	6.6 (11.4)	15.7 (18.6)
	Concentration		Duration	Concentration × Duration		Depth	Concentration × Depth		Duration × Depth	
SEm±	0.1		0.3	0.4		0.2	0.3		0.6	
C.D.(p=0.05)	(0.4)		(0.8)	(1.2)		(0.6)	(0.9)		(1.7)	

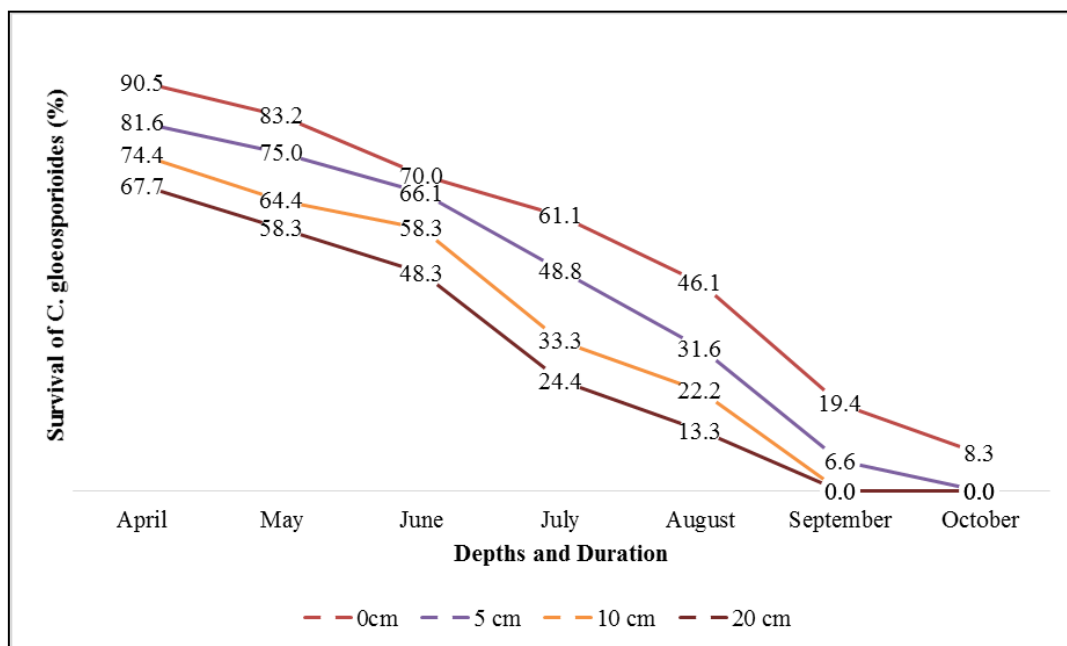
Note: *C. gloeosporioides* infected leaves were buried in pots in the last week of March, 2016

Figures in parentheses are angular transformed values

\*Per cent viability of fungus was tested in the last week of each month

+0.25 has been added in (2% urea) each observation of August, September and October for statistical analysis

+0.25 has been added in (5% urea) each observation of July, August, September and October for statistical analysis

**Fig 1:** Effect of soil depth and duration of burial on viability of *C. gloeosporioides*

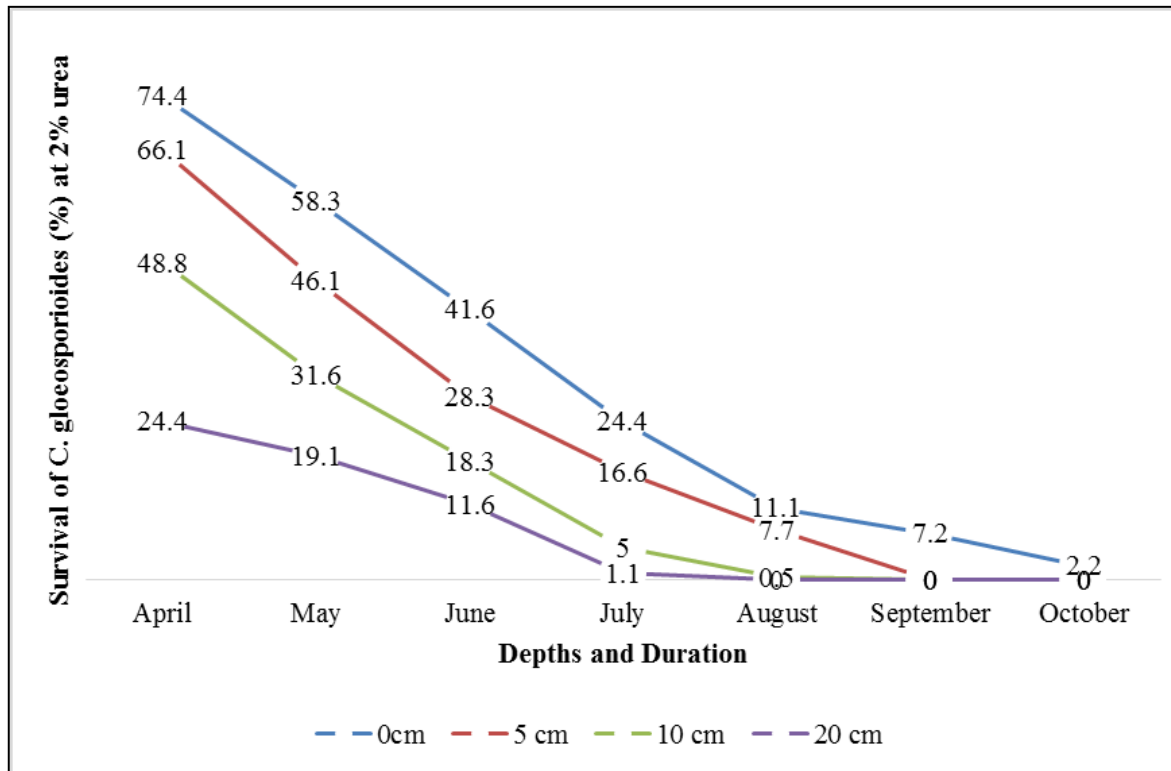


Fig 2: Effect of 2% urea on viability of *C. gloeosporioides* under screen house conditions

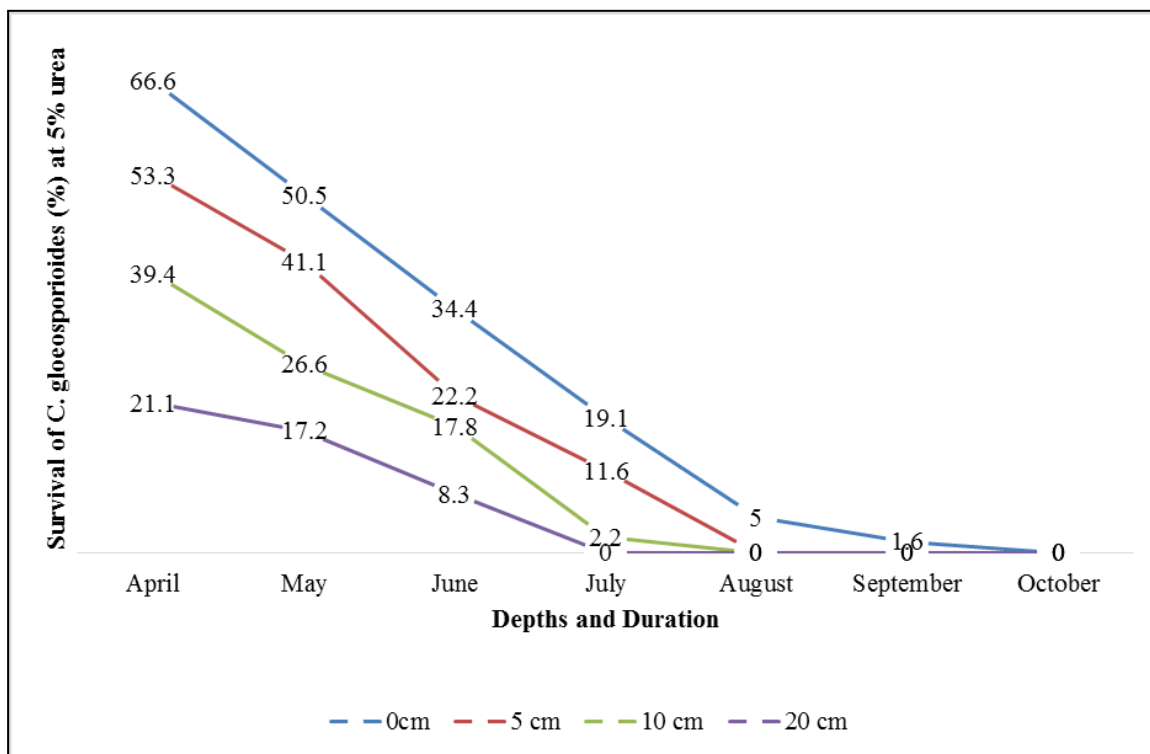


Fig 3: Effect of 5% urea on viability of *C. gloeosporioides* under screen house conditions

**Conclusion**

In conclusion, the fungus survived for long period of time in soil as conidia or mycelium in infected plant debris under adverse conditions. Viability of fungus was sharply declined with increase in soil depths, duration and urea concentrations under screen house conditions. Decline in viability of fungus at deeper depths may be due to the factors such as soil moisture, temperature and soil microorganisms.

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