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Response of biocontrol agent *Chaetomium* sp. towards different temperature and pH conditions under south Gujarat conditions

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Abstract
The genus *Chaetomium* features thermotolerant and thermophilic in nature and can grow at various temperatures and pH. This experiment was conducted in 2018-2019 at Navsari Agricultural College N.M. Department of Plant Pathology, Navsari (Gujarat). Total 10 isolates were isolated from various samples. Then from the best isolate (C2), The effect of temperature on isolate was studied and maximum growth was observed at 35 °C. *C. brasiliense* (C2) grew with a radial growth of 6.48 mm after 7 days of incubation. While no growth was observed at 45 °C. Also, the highest sporulation was recorded in C2 isolate at 35 °C temperature. Maximum growth was observed at pH 8 of *C. brasiliense* (C2: 6.85 mm) after 7 days of incubation. Sporulation was highest at pH 8 and maximum mycelium weight was found at pH 6.

Keywords: *Chaetomium*, growth behaviour, pH, temperature, sporulation, mycelium

Introduction
The most common species are *Chaetomium atrobrunneum* Ames, *C. funicola* Cooke, *C. brasiliense* Bat & Pontual, *C. fuscum* Basu, *C. globosum*, and *C. strumarium*.*C. globosum*. Several are very common in indoor environments (*C. elatum* Kunze, *C. globosum*, and *C. murorum* Corda). Most grow best between 25 to 35 °C and require a cellulose-rich medium for sporulation. The genus *Chaetomium* features thermotolerant and thermophilic species that can grow at temperatures up to 40 °C (Prokhorov and Linnik, 2011) [6]. Optimal growth of *Chaetomium* species was at 25 °C and 35 °C. While sporulation was observed at 30 °C-35 °C in PDA media. *Chaetomium globosum* was capable of growth on potato dextrose agar ranging in pH from 4.3 to 9.4. The optimal growth of this fungus, as well as chaetoglobosin C production, occurred at a neutral pH and sporulation was favored an acidic pH (Matthew *et al*., 2008) [5]. Neutral pH as well as alkaline pH was favourable for growth.

Materials & Methods
Effect of Temperature on Growth and Sporulation of *Chaetomium* sp.
The effect of temperature on the growth and sporulation of Chaetomium sp. were studied in laboratory conditions by using different temperatures *viz*., 25 °C, 30 °C, 35 °C, 40 °C and 45 °C for seven days. Four repetitions were taken for each temperature (Kiran, 2015) [4].
Sterilized PDA *i.e*., 20 ml was poured aseptically in sterilized Petri plates of 90 mm diameter. Plates were inoculated in the center with a 5 mm mycelial disc taken from Petri plates. The plates then were incubated at different temperatures in the BOD incubator. Each isolate was examined properly and regularly. The colony diameter was measured after 7 and 14 days of incubation. Observations recorded the colony diameters were recorded by measuring the linear growth of the colony in two directions for each plate and observations on sporulation were recorded on the basis of microscopic examinations.

Effect of pH on Growth and Sporulation of *Chaetomium* sp.
The effect of pH on the growth and sporulation of *Chaetomium* sp. was studied in laboratory conditions using different pH ranges from 4, 6, 8 and 10.
Methodology Media were prepared separately in a conical flask and the required pH was adjusted by adding 0.1% NaOH or 0.1% HCl and poured into the plate. Plates were inoculated with a Chaetomium disc of 5 mm diameter and were incubated at room temperature for 7 days.

Each pH treatment was repeated four times as Kiran (2015) [4] suggested. The colony diameter was measured after 7 and 14 days of incubation. Observation recorded Observations on growth and sporulation were recorded.

Result and Discussion

Effect of Temperature on Growth and Sporulation of *Chaetomium Brasiliense*

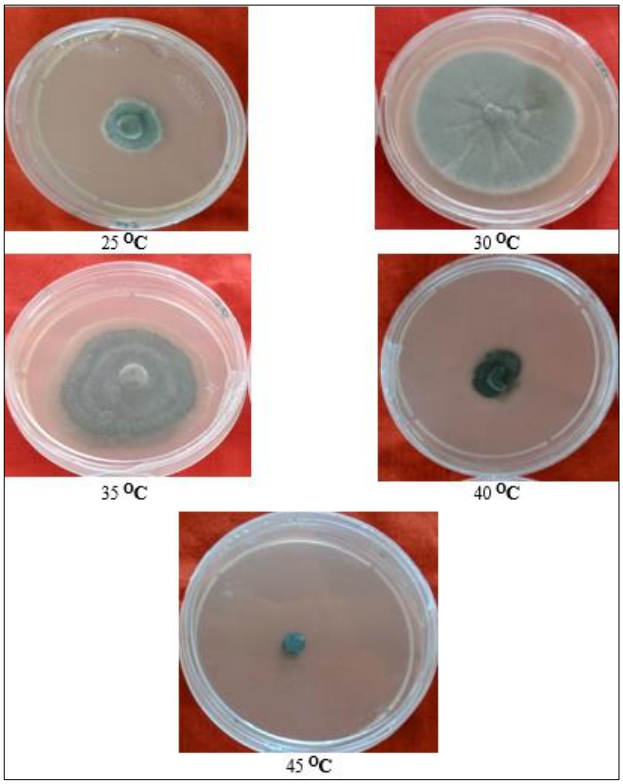
The effect of temperature on growth and sporulation of *Chaetomium Brasiliense* (C2) were studied by using different temperatures and the results are depicted in Table 1.

Results revealed that the growth of *Chaetomium Brasiliense* (C2) was significantly influenced by different temperature treatments. Maximum growth of *Chaetomium Brasiliense* was observed at 35 °C (6.48 mm) which was at par with 30 °C (6.30 mm). While minimum growth was observed at 25 °C (1.88 mm) and no growth was observed at 45 °C after 7 days of incubation. Similarly, after 14 days of inoculation maximum growth was observed at 30 °C (8.80 mm) which was at par with 35 °C (8.73 mm). While minimum growth was observed at 25 °C (3.15 mm) and 40 °C (3.05 mm). No growth was observed at 45 °C temperature.

Sporulation was highest at 35 °C (3.48×10^4) with next best at 30 °C (3.10×10^4). Minimum sporulation was observed at 25 °C (1.13×10^4) and 40 °C (1.10×10^4). While no sporulation was observed at 45 °C after 7 days of incubation. Similarly, after 14 days of inoculation, the highest sporulation was at 35 °C (4.75×10^4) with the next best at 30 °C (4.50×10^4). Minimum sporulation was observed at 25 °C (1.95×10^4) and 40 °C (1.18×10^4). While no sporulation was observed at 45 °C. Similar type of results was also recorded by Asgari and Zare (2011) [1], Yang *et al*. (2014) [7], Kiran *et al*. (2015) [4], and Khan *et al*. (2019) [3]. They recorded that most of *Chaetomium* spp. grew best at a temperature range between 25 °C to 35 °C.

Table 1: Performance of *Chaetomium brasiliense* (C2) under different temperature on PDA

Treatment	Temperature (°C)	Mean Growth (cm)		Mean Spore count (10^4)	
		7 days	14 days	7 days	14 days
T_1	25	1.88	3.15	1.13	1.95
T_2	30	6.30	8.80	3.10	4.50
T_3	35	6.48	8.73	3.48	4.75
T_4	40	2.03	3.05	1.10	1.18
T_5	45	0.00	0.00	0.00	0.00
S.Em±		0.07	0.09	0.04	0.06
C.D. at 5%		0.21	0.27	0.13	0.19
C.V. %		4.11	3.80	4.97	4.98



Effect of pH on growth, sporulation, and mycelium weight of *Chaetomium brasiliense* (C2)

The effect of pH on growth, sporulation and mycelium weight of *Chaetomium brasiliense* (C2) were studied under laboratory conditions by using different pH ranges and the results are presented in Table 2.

The results revealed that the effect of different pH ranges on the growth and sporulation of *Chaetomium brasiliense* showed maximum growth at pH 8 (6.85 mm) which was at par with pH 6 (6.68 mm). While minimum growth was observed at pH 10 (5.80 mm) and pH 4 (3.75 mm) after 7 days of incubation. Similarly, maximum growth was observed at pH 6 (8.35 mm), at par with pH 8 (8.15 mm). While minimum growth was observed at pH 4 (7.35 mm) and pH 10 (7.20 mm) after 14 days of inoculation.

Sporulation was highest at pH 8 (4.85×10^4) which was at par with pH 6 (4.35×10^4). While least sporulation were observed at pH 10 (2.15×10^4) and pH 4 (1.73×10^4) after 7 days of incubation. Similarly, after 14 days of incubation sporulation was highest at pH 8 (7.03×10^4) which was at par with pH 6 (6.33×10^4). While lower sporulation was observed at pH 10 (3.18×10^4) and pH 4 (3.00×10^4).

The mycelium weight of *Chaetomium Brasiliense* was found highest at pH 6 (0.47 mg) which was followed by pH 8 (0.46 mg) and pH 4 (0.26 mg). Also, the lowest mycelium weight was observed at pH 10 (0.14 mg) after 7 days of incubation. After 14 days, maximum mycelium weight was observed at pH 8 (0.65 mg), at par with pH 6 (0.62 mg). Also, the lowest mycelium weight was observed at pH 4 (0.28 mg) and pH 10 (0.31 mg). The present findings are in harmony with the similar studies carried out by Fogle *et al*. (2008) [2, 5], Prokhorov and Linnik (2011) [6], Zhou *et al*. (2017) [8] and Khan *et al*. (2019) [3] who recorded that most of *Chaetomium* spp. grew best at pH 4.5 to pH 9. Also, Khan *et al*. (2019) [3] reported that maximum mycelium growth was observed at pH 7.5 and sporulation was at pH 6.5.

Table 2: Performance of *Chaetomium Brasiliense* (C2) under different pH regimes on PDA

Treatment	PH	Mean Growth (mm)		Mean Spore count (10^4)		Mycelium weight (mg)	
		7 days	14 days	7 days	14 days	7 days	14 days
T_1	4	3.75	7.35	1.73	3.00	0.26	0.31
T_2	6	6.68	8.35	4.35	6.33	0.47	0.62
T_3	8	6.85	8.15	4.85	7.03	0.46	0.65
T_4	10	5.08	7.20	2.15	3.18	0.14	0.28
S.Em±		0.10	0.09	0.06	0.10	0.01	0.01
C.D. at 5%		0.29	0.26	0.19	0.32	0.02	0.03
C.V. %		3.41	2.2	3.72	4.27	4.39	4.83

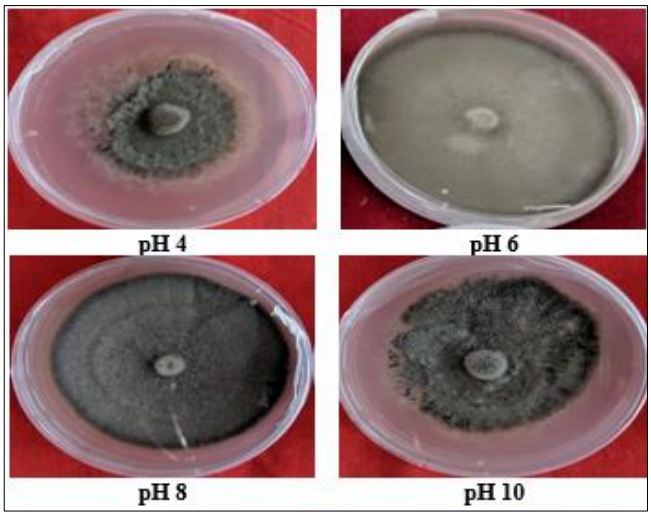


Photo: Performance of *Chaetomium Brasiliense* (C2) under different pH regimes on PDA

Summary and Conclusion

The effect of temperature on isolate C2 was studied and maximum growth was observed at 35 °C (*C. brasiliense*-C2:6.48 mm) after 7 days of incubation. After 14 days maximum growth of *C. brasiliense* (C2) was observed at 30 °C (8.80 mm). Highest sporulation was recorded in *C. brasiliense* (C2) which was observed at 35 °C ((3.48×10^4 and 4.75×10^4) at 35 °C (3.28×10^4 and 4.85×10^4) after 7-14 days of incubation. While no sporulation was observed at 45 °C after 7-14 days of incubation.

The effect of pH on growth, sporulation and mycelium weight on isolate C2 was studied and maximum growth of was observed at pH 8 (*C. brasiliense*-C2:6.85 mm after 7 days of incubation. After 14 days of incubation maximum growth of was observed at pH 6 (*C. brasiliense*-C2:8.35 mm). Sporulation was highest at pH 8 in (4.85×10^4 and 7.03×10^4) after 7-14 days of incubation. Maximum mycelium weight was found highest at pH 6 in *C. brasiliense* (C2:0.47 g) after 7 days of incubation. After 14 days of incubation, maximum mycelium weight was found at pH 8 in *C. brasiliense* (C2:0.65 g).

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