DOI: 10.54083/ResBio/4.2.2022/33-36 *Res. Bio.*, 2022, 4(2):33-36

Research Biotica

e-ISSN: 2582-6743

June, 2022

Article ID: RB108 Research Article

Adaptability of *Macrophomina phaseolina* and *Fusarium oxysporum* to Different Temperature and pH Causing Stem-Root Rot and Wilt Diseases of Jute

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Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Mahato, 2022. Adaptability of *Macrophomina phaseolina* and *Fusarium oxysporum* to Different Temperature and pH Causing Stem-Root Rot and Wilt Diseases of Jute. *Research Biotica* 4(2): 33-36.

Abstract

In order to ascertain the impact of physiological parameters like temperature and pH on growth and sporulation of *M. phaseolina* and *F. oxysporum*, causing stem-root rot and wilt diseases of jute, an experiment was conducted to examine. It was discovered that *Fusarium oxysporum* thrived at pH 5 (80.135 mg) while *Macrophomina phaseolina* grew best at neutral pH, or pH 7 (69.065 mg). *M. phaseolina* grows best at temperatures ranging from 35 °C to 30 °C, with no growth observed at lower temperatures. *Fusarium oxysporum*'s growth peaked at 25 °C (90.00 mm), and it significantly decreased below 15 °C and above 40 °C. In response to changes in temperature, fungal development slows.

Keywords: *Fusarium oxysporum,* Jute*, Macrophomina phaseolina,* pH, Temperature

Introduction

Due to its long, soft, glossy vegetable fibre and ability to be transformed into coarse, jute is a preferred fibre for reinforcing polymers. It is produced from members of the Corchorus genus of plant, which was formerly a member of the Tiliaceae family or, more recently, the Malvaceae family. Jute is a significant source of bast fibre (*C. olitorius* and *C. capsularis*). Its sticks are also used for fuel, car door panels, and fake ceiling boards, and its fibre is used to make bags, ornamental fabrics, and geotextiles.

India is the world's largest producer of jute and exports a sizable quantity of both raw jute and a variety of products. India produces more than 60% of all jute in the globe (Anonymous, 2013). West Bengal, Bihar, and Assam have the highest concentration of jute plantations.

More than 12 distinct diseases affect jute plants, 10 of which are known to be seed-borne, which reduces production and degrades fibre quality (Roy *et al.,* 2008). *M. phaseolina* is the most harmful of them all. From seed germination until harvest, it can infect any portion of the plant and can produce an infection rate of between 35 and 60 percent.

The incidence and development of diseases caused by *M. phaseolina* are encouraged under high temp and drought stressors circumstances because *M. phaseolina* is a polyphagous fungus with heterogeneous host specificity (Abawi and Corrales, 1990).

In addition to soils, plants, and air, *Fusarium* spp. are widely dispersed throughout all geographical regions. The distribution of Fusarium and the pattern of infection by different *Fusarium* species depend on geographical conditions, including climate. Climate variables including temperature, soil pH, and humidity affect *Fusarium* species' development, survival, and spread, which impacts crop damage.

The purpose of the current investigation is to assess how physiological variables like pH and temperature affect the growth of *F. oxysporum* & *M. phaseolina* and in vitro.

Article History

RECEIVED on 10th February 2022 RECEIVED in revised form 18th April 2022 ACCEPTED in final form 20th April 2022

Materials and Methods

Sample Collection

Samples for the isolation of phytopathogenic fungi were collected from the jute field of INS Farm SOA University. Suspected root and stems showing the symptoms of Charcoal Rot, Fusarium wilt were collected in sterile plastic bags.

Isolation and Identification

The collected plant samples of excised parts like twig, leaf, bark, stem, and roots *etc*. were washed with sterile water followed by the surface sterilization with 1% sodium hypochlorite. Then, root and stem samples were cut into the pieces of size 1 cm. The sterilized pieces were cultured on PDA with 50 mg litre^{-1} of streptomycin sulfate and incubated at 25 °C for 3-5 days and the researchers employed a 5-7-day-old fresh culture.

Identification of the fungal cultures was done according to standard microbiological procedure.

Impact of pH on Fungal Biomass of Associated Fungi in vitro

To investigate the optimal pH for mycelial development, the test fungus was examined in a pH range from 3 to 10. Conical flasks with a 100 ml capacity were filled with 50 ml of potato dextrose broth (PDB) for the experiment. By adding 1 N HCl or 1 N NaOH, the pH of PDB medium was changed from neutral to acidic and basic, respectively. The pH was then measured using digital pH meter and adjusted to various values between 3 and 10. At 28±1 °C, 5 mm agar discs were used to inoculate every flask. For each pH value, four replicas were retained. The filtering process used Whatman No. 1 filter paper, and then after five days of inoculation, mycelial mat was obtained. These mycelial mats spent 90 minutes being dried in a hot air oven at 60 °C. The mycelial mat's dry weight was recorded, and four replications of each pH were kept. The collected data were statistically examined.

Impact of Various Temperature Regimes of Associated Fungi on Mycelial Growth in vitro

The fungus *Macrophomina phaseolina*'s 5 mm mycelial disc was put on 90 mm petriplates with PDA media and incubated in triplicate at 15, 20, 25, 30, 35, 40, 45, and 50 °C and analysed using a completely randomised design. The fungal colonies' diameters were measured after 4 days of incubation, and the results of the statistical analysis were used to make decisions.

On the case of *Fusarium* species, 9 mm mycelial discs were transferred to PDA (potato dextrose agar) medium in Petri plates (90 mm) and incubated at temperatures of 15, 20, 25, 30, 35, 40, 45, and 50 °C in triplicate using a completely randomised design. The fungal colonies diameter was measured after 7 days of incubation, and the results were statistically analysed.

Results and Discussion

Impact of pH on Fungal Biomass of Associated Fungi in vitro

In response to changes in hydrogen ion concentration, variations in *M. phaseolina* and *Fusarium oxysporum* biomass accumulation were noted. It was discovered that the fungus could thrive in a wide pH range, from 3.0 to 10.0, and that the mycelium development could be affected by changes in pH. *M. phaseolina*'s biomass accumulated to its greatest extent at pH 7 (69.065 mg), then at pH 6 (68.195 mg). At pH 3.0, the least amount of mycelial development was seen (47.973 mg), and these findings are consistent with Khamari *et al.* (2018), further claimed that the pathogen could survive in a pH range of 6 to 8. *Macrophomina phaseolina* grows best in the neutral pH range (Table 1).

Table 1: Impact of pH on fungal biomass of *M. phaseolina* in vitro

SL. No.	pH	Dry mycelia weight (mg)
1	3.0	47.973
2	4.0	51.383
3	5.0	55.760
4	6.0	68.195
5	7.0	69.065
6	8.0	63.895
7	9.0	59.035
8	10.0	51.710
SE(m) ±		0.543
C.D. (0.05)		1.594

The maximum biomass accumulation for *Fusarium oxysporum* was seen at pH 5 (80.135 mg), accompanied by pH 6 (74.658 mg), pH 8 (30.928 mg), and pH 9 (14.195 mg). As indicated in Table 2, the results are identical to those from the Yadav *et al.* (2014) study in that the lowest most growth was observed at pH 10 (0.293 mg).

Table 2: Impact of pH on fungal biomass of *F. oxysporum* in vitro

SL. No.	pH	Dry mycelia weight (mg)
1	3.0	26.678
2	4.0	52.328
3	5.0	80.135
4	6.0	74.658
5	7.0	59.300
6	8.0	30.928
7	9.0	15.195
8	10.0	0.293
SE(m) ±		1.36
C.D. (0.05)		3.992

Impact of Various Temperature Regimes of Associated Fungi on Mycelial Growth in vitro

Macrophomina phaseolina's maximum radial growth was seen at 35 °C (0.951 cm), which is identical to the temperature regime of 30 °C (0.914 cm). The lowest mycelia growth was recorded at 15 °C, with 40 and 45 °C ranking second and third

in order of merit. These findings are consistent with those published by Khamari *et al.* (2018), who discovered that the pathogen was susceptible to temperatures between 30 and 40 °C. Table 3 makes it quite evident that pathogens prefer greater temperatures.

Table 3: Impact of various temperature regimes on mycelial growth of *M. phaseolina* in vitro

SL. No.	Temperature (°C)	Mean (cm)
1	15 °C	0.063
2	20 °C	0.400
3	25 °C	0.417
4	30 °C	0.914
5	35 °C	0.951
6	40 °C	0.749
7	45 °C	0.691
8	50 °C	0.460
SE(m) ±	0.035	
C.D. (0.05)	0.105	

F. oxysporum was found to grow to its maximum radial length at temperatures of 25 °C and 30 °C, respectively, measuring 8.8 cm and 8.6 cm. Reduced radial growth was seen at temperatures of 15, 35, and 40 °C, although moderate growth of the fungus was seen at 20 °C and the least amount of mycelial growth was seen at 45 °C. Table 4 presents the findings.

Table 4: Impact of various temperature regimes on mycelial growth of *F. oxysporum* in vitro

SL. No.	Temperature (°C)	Mean (cm)
1	15 °C	3.233
2	20 °C	7.267
3	25 °C	8.800
4	30 °C	8.633
5	35 °C	4.533
6	40 °C	3.733
7	45 °C	1.667
8	50 °C	0.000
SE(m) ±	0.141	
C.D. (0.05)	0.428	

There are published studies with similar results. According to Csöndes *et al.* (2012), the pathogen thrived in environments with pH levels between 4.0 and 6.0 and temperatures between 25 and 35 °C.

According to Sukanya *et al.* (2016), the *M. phaseolina* that causes the charcoal rot of sorghum was shown to grow most effectively at 35 °C and pH 6.0 after 72 hours of incubation.

The maximum growth of macrophomina, which affects maize and blackgram, was discovered at neutral pH of 7.0 by Chowdary and Govindaiah (2007), Bhupathi and Theradimani (2018).

According to Akhtar *et al.* (2011), the ideal temperature for fungi to develop and produce microsclerotia is 30-35 °C. According to Daami-Remadi and El Mahjoub (2006), *F. oxysporum* grows most well at temperatures between 25 and 30 °C. According to Ehsan *et al.* (1998), *F. oxysporum* grew best at a temperature of 25 °C for mycelial growth and 30 °C for sporulation. The ideal temperature for *F. oxysporum f. sp. vasinfectum'*s radial development was found to be 30 °C by Miao *et al.* (2000).

Conclusion

These *in vitro* research findings provided insight into the ideal environment for pathogen proliferation. It has been discovered that *F. oxysporum* and *M. phaseolina* can endure a broad range of pH and temperature. In addition, their ability to endure a wide pH range allows them to persist in the soil under various cropping methods. The already diminishing food supply would soon be in danger if soil-borne inocula increased. This issue highlights the requirement for better management techniques. Further field research should be conducted in natural weather conditions to learn more about the association between abiotic variables and the occurrence of disease.

Acknowledgment

Authors thankfully acknowledge the assistance and Lab facilities from Department of Plant Pathology, IAS, Siksha 'O' Anusandhan University, Bhubaneswar, India

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