Plant Archives Vol. 26, No. 1, 2026 pp. 1214-1220 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.1.165

IN VITRO PHYSIOLOGICAL AND CONIDIAL CHARACTERIZATION OF *ALTERNARIA TENUISSIMA* INDUCING LEAF BLIGHT IN KODO MILLET (*PASPALUM SCROBICULATUM* L.)

Alex Khalkho[1]*, A.K. Jain[1], Manisha Shyam[2] and S.K. Mishra[3]

[1]Department of Plant Pathology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, – 482 004, Madhya Pradesh, India.

[2]Department of Agronomy, AICRP on Small Millets, RARS, Dindori – 481 880, Madhya Pradesh, India.

[3]Department of Entomology, JNKVV – Dryland Horticulture Research and Training Centre, Garhakota, District – Sagar – 470 229, Madhya Pradesh, India.

*Address for Correspondence: Department of Plant Pathology, GB PUA&T, Pantnagar - 263 145, Uttarakhand, India.

*Corresponding author E-mail: alexkhalkho2306@gmail.com

(Date of Receiving-01-12-2025; Date of Revision-25-01-2026; Date of Acceptance-17-02-2026)

ABSTRACT

Kodo Millet (*Paspalum scrobiculatum* L.) is an ancient crop with diverse and numerous health benefits. Earlier, it was known to have countable number of diseases but now this crop is facing many health issues. One of the major diseases involved in limiting the production and causing substantial losses is leaf blight caused by *Alternaria tenuissima*. The present study was carried out in Department of Plant Pathology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. The experiment was set in Completely Randomized Design (CRD) and was replicated thrice *in vitro*. Investigations involved the study of physiological and conidial characterization studies. Five temperature range *viz.*, 15ºC, 20ºC, 25ºC, 30ºC and 35ºC were studied. On other hand, seven pH ranges *viz.*, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0 and 7.5 were evaluated. Results regarding these experiments were that the mycelial growth and sporulation of the pathogen was quite good in temperature of 25ºC and pH 5.5 respectively. As environment plays a very critical role in growth and sporulation of the pathogens, hence these *in vitro* studies could effectively be used under *in vivo* conditions to break the pathogen's life cycle in order to get more enhanced returns by the farmers. In addition, these studies could be used to give proper guidance to farmers for proper and effective management of the pathogen.

Key words : Kodo millet, Leaf blight, *Alternaria tenuissima*, Temperature, pH, Mycelial growth, Conidial characterization.

Introduction

Kodo millet (*Paspalum scrobiculatum* L.) is an ancient, small seeded and hardy crop which thrives very well in limited number of resources available (Jain and Sharma, 2010). The crop is believed to be originated in Africa but was later domesticated in India approximately 3000 years ago. The crop is a principal member of "Sri Anna" and is cultivated by the farmers of low-income group usually within the traditional systems followed by them (de Wet *et al*., 1983). Chromosome number of kodo millet is 2n=4x=40 and approximately 400 species come under the genus "*Paspalum*" and is often an annual crop. Kodo millet is monocot and its seeds are roughly 2.00 mm long and 1.5 mm wide which appears to be light brown to dark grey in its colour texture. Plant are slender grows up to 90 cm tall, leaf blades are linear, glabrous or pubescent, up to 40 cm long with the basal leaf sheath glabrous or pilose. Inflorescence is composed off more than five racemes that are alternatively arranged on a short to elongated primary axis (Clayton, 1975).

Different vernacular names used in different parts of the country are Kodon in Hindi, Harka in Kannada, Varagu in Tamil and Malayalam, Arika/Arikelu in Telugu, Kodra in Punjabi, Marathi and Gujarati and Kodua in

Oriya. Globally, the crop is cultivated in tropical and subtropical areas. Primarily the crop is grown in India. Besides India, kodo millet is also grown in Indonesia, Philippines, Thailand, Vietnam, Bangladesh, Myanmar and western part of Africa. In India, the crop is largely grown in the states of Madhya Pradesh, Chattisgarh, Tamil Nadu, Telangana, Maharashtra, Gujarat, Karnataka, Uttar Pradesh and Jharkhand (Hariprasanna, 2023).

In recent times, kodo has gained lot of importance due to high nutritive values, agronomic characters and number of health benefits. Kodo's nutritive values (per 100 gram) are as follows; 65.9g of CHO, 8.3g of protein, 1.4g of fat, 9.0g of fibre, 2.6g of minerals, 0.5mg of Fe, 188mg of P, 27mg of Ca, 0.09mg of riboflavin, 0.33mg of thiamine and 0.2mg of niacin (Deshpande *et al*., 2015). Lecithin is present in high amount in the grains, which is good for strengthening of nervous system. Gluten is absent in kodo millet and is good for people who are gluten intolerant. Kodo millet increases insulin sensitivity for people suffering from diabetes. Low glycaemic index, rich in antioxidants like polyphenols are unique properties of the grains. Consumption of kodo millet reduces the serious problems of bloating, stomach cramping, flatulence, constipation and lower the problems of cardio-vascular diseases (NAAS, 2013; Rajalakshmi *et al*., 2014).

Several plant pathogens which include fungi, viruses, bacteria, nematodes and phanerogamic partial root parasites are reported to cause diseases at various crop growth stages that limits the sustainable yields of kodo millet (Nagaraja *et al*., 2007). Among fungal pathogens, *Rhizoctonia solani* (Banded leaf blight), *Sporisorium paspali thunbergii* (Head smut), *Ephelis oryzae* (Udbatta), *Alternaria alternata* (leaf blight), *Puccinia substriata* (Rust) and several species of *Helminthosporum* were reported to infect the crop and can cause significant economic loss in grain yield under favourable climatic conditions (Jain and Sharma, 2010).

Leaf blight caused by *Alternaria* spp. and *Helminthosporium* spp. were reported long back in kodo millet as a minor disease but now leaf blight is becoming a major and an emerging problem in kodo millet (Nagaraja *et al.,* 2016). Few studies were done on characterization of pathogen, hence, needs more studies on different aspects of pathogen as well as disease.

Materials and Methods

Present investigation was carried out in the Department of Plant Pathology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India (latitude: 23.21ºN, longitude: 79.96ºE). Diseased samples of Kodo millet were collected from RARS, Dindori, Madhya Pradesh, India (latitude: 22.9418º North and longitude: 81.0768º East) (Images 1 and 2). Samples were then taken to the Department of Plant Pathology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India for further studies. Major symptom recognized during the collection of the diseased samples were the blightening/burning of the leaf's apical (tip) region which gradually progressed downwards towards the older part of the leaf (Gupta *et al.,* 1994).

Image 1 : Leaf blight of Kodo Millet (*Paspalum scrobiculatum* L.).

Image 2 : Burnt appearance in Kodo Millet.

After bringing the fresh infected samples from the field to the laboratory, small pieces of infected part of about 2-3 mm in size were cut with the help of sterilized scalpel, washed with sterile water 2-3 times and then in 0.1% of NaOCl (Sodium Hypochlorite Solution) in an alternative manner for 20 – 30 seconds each. This procedure is repeated three to four times.

Potato Dextrose Agar (PDA) medium was used to isolate the targeted pathogen. PDA powder was used to prepare PDA medium and then it was autoclaved at 121ºC at 15psi for 20 minutes. After autoclaving the PDA

medium was added with streptomycin sulphate powder (100 ppm) in order to avoid the bacterial contamination. 10 ml of PDA medium was poured into 90 mm of sterilized Petri plates and left for 10 -12 minutes to solidify under UV light in laminar air flow chamber. 4 pieces of small surface sterilized samples were kept into the plates in an evenly distributed manner. Above mentioned work was done in totally aseptic condition to avoid aseptic condition to avoid any type of contamination. For 5 – 6 days, at an appropriate temperature of 27 ± 2ºC Petri plates were incubated in biological oxygen demand (BOD) incubator and the growth and sporulation of the pathogen was also monitored. To locate the colonies and identification of the pathogen, microscope analysis was done. Pure culture of the pathogen was maintained in the slants and were stored for long term use at 4ºC.

Temporary mounts were prepared from the pure culture of the pathogen. Measurements of conidia were taken using binocular microscope (Leica company) and software (Leica Application Suite). Initially, light microscope was used for locating the presence of conidia. Morphological characters *viz.*, growth, septation of the conidia, size (length and width) and shape of the conidia were observed. The measurement of spores from 9 different spots on temporary mounts were observed under the 100X magnification microscope. The mean values of these measurements were calculated.

This particular experiment was set up to identify the best suitable temperature for the growth of mycelia and sporulation of the pathogen. Different temperatures were used for the experiment were; 15, 20, 25, 30 and 35 degrees, respectively. 100 ml medium of was poured in the conical flask of capacity 150 ml tightly packed with non-absorbent cotton plug and aluminium foil. These flasks were then sterilized in an autoclave for 20 minutes at 121ºC and 15 psi. The sterilized Petri plates of 90 mm were poured with the potato dextrose agar @ 10 ml per Petri plate. The test pathogen from 7-day old culture was taken and disc was cut of 5mm and transferred to these plates, sealed with parafilm and kept in an inverted position inside the BOD incubator at different temperatures mentioned above. The replication taken was four. The experiment ended on the 7th day and spore count by making temporary mount was done. Micrometry was done to ensure proper details regarding length and width of the pathogen in the treatments which showed spore count microscope (Leica company) and software (Leica Application Suite) at 100X.

Various pH range *viz.*, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0 and 7.5 were taken. The pH concentration of the media was maintained carefully by adding of 0.1N NaOH and 0.1N HCl in the PDA medium. Each trial was conducted in triplicates. 100 ml medium was poured in the conical flask of 150 ml capacity and pH was adjusted as mentioned above using pipette. The flasks containing PDA were then sterilized in an autoclave for 20 minutes at 121ºC and 15 psi. The medium was poured in sterilized Petri plates of 90 mm @ 10 ml. The 7 days old culture disc of 5mm was taken and then was inoculated into the Petri plates. Plates were kept in an inverted position in BOD incubator at 27 ± 2ºC. When plate got full, the spore count was done by making suspension of pathogen by cutting 5mm disc from each treatment with sterilized cork borer and suspending it in the test tube then shaking it properly. Temporary mount was prepared and spores were count from nine different microscopic fields. Micrometry was done to ensure proper details regarding length and width of the pathogen in the treatments which showed spore count microscope (Leica company) and software (Leica Application Suite) at 100X.

The data have been evaluated using OPSTAT online software in completely randomized design (CRD).

Results

Effect of temperature levels on growth and sporulation of *Alternaria tenuissima*

Effect on temperature levels on radial growth of mycelium, sporulation and conidial character of *A. tenuissima* were studied and results are presented in Table 1, Fig. 1 and Image 3. Significant variations in radial growth of fungus were observed at 48 hours to 192 hours after incubation. Radial growth recorded 48.3 mm to 74.4 mm in different temperature levels. Maximum mycelial growth was recorded at temperature of 25ºC (74.4 mm) followed by 67.7 mm at 20ºC, 58.6 mm at 30ºC and 55.4 mm at 35ºC. Minimum growth of the fungus was noted at 15ºC temperature (48.3 mm). Excellent sporulation of *A. teniuissima* was recorded at 25ºC, where it was fair at 20ºC. In rest of the temperature levels, sporulation was not observed.

Average conidial length of 27.10 μm and 30.87 μm

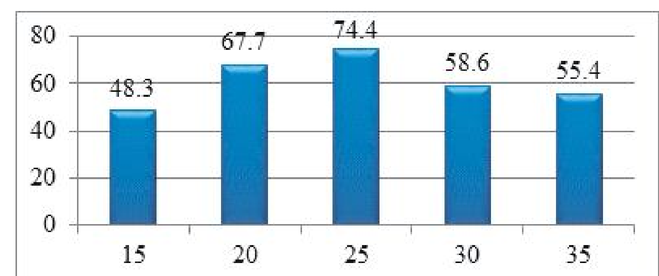

Fig. 1 : Effect of different temperature levels on mycelial growth of *Alternaria tenuissima.*

Table 1 : Effect of different temperature on mycelial growth of *Alternaria tenuissima.*

S. no.	Temperature	Radial growth (mm) after (hrs)							
		48	72	96	120	144	168	192	Sporulation Index
1	15	9.2	15.0	20.3	24.9	32.4	39.3	48.3	-
2	20	12.7	20.7	30.3	40.7	51.2	57.0	67.7	++
3	25	22.0	30.6	40.2	46.3	53.4	62.3	74.4	++++
4	30	10.4	16.3	24.6	38.5	45.6	52.7	58.6	-
5	35	10.1	17.0	24.6	30.5	37.7	46.9	55.4	-
	SEm±	0.42	0.79	0.94	0.84	0.90	0.93	0.86	
	CD (5%)	1.28	2.39	2.86	2.56	2.73	2.83	2.61	

[Scale of sporulation – (++++) = Excellent (>60 conidia per microscopic view); (+++) = Good (41-60 conidia per microscopic view); (++) = Fair (21-40 conidia per microscopic view); (+) = Poor (Less than 20 conidia per microscopic view); (-) = No sporulation.]

Table 2 : Conidial characteristics of *Alternaria tenuissima* as influenced by different temperatures.

S. no.	Temperature	Length of conidia		Width of conidia		Range of longitudinal septa	Range of transverse septa
		Range	Mean	Range	Mean		
1	15	-	-	-	-	-	-
2	20	24.38-31.87	27.10	9.88-12.38	11.33	1-3	-
3	25	20.51-43.16	30.87	8.65-15.52	12.53	2-4	0-2
4	30	-	-	-	-	-	-
5	35	-	-	-	-	-	-

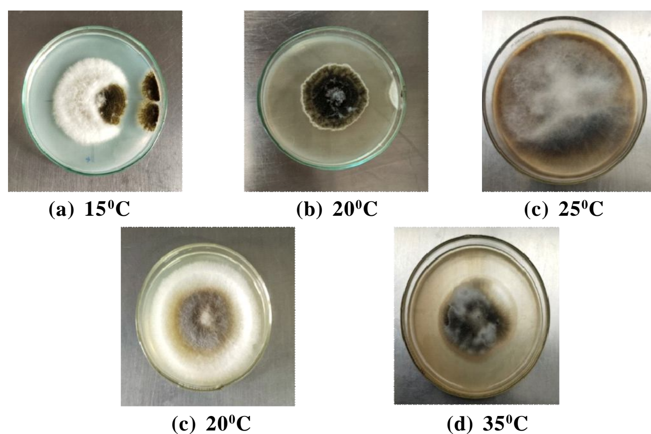

Image 3 : Effect of different temperatures on mycelial growth of *Alternaria tenuissima.*

was recorded at 20ºC and 25ºC temperature levels, respectively. Whereas average conidial width was 11.33 µm at 20ºC and 12.53 µm at 25ºC. Number of longitudinal septa was 2 to 4 and transverse septa were 0 to 2 at 25ºC temperature level. Only longitudinal septa (1 to 3) were observed at 20ºC (Table 2 and Image 4).

Effect of pH on growth, sporulation and conidial character of *A. tenuissima*

Effect of hydrogen ion concentration (pH) of the medium on fungal growth and sporulation of *A. tenuissima* was studied in seven pH, *i.e.*, 4.5, 5.0, 5.5,

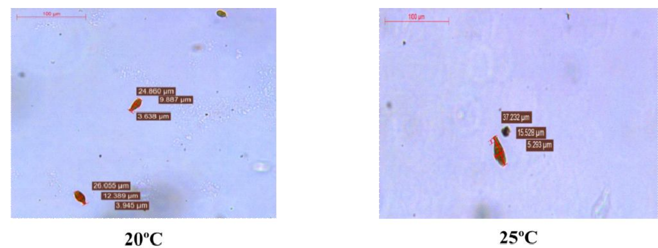

Image 4 : Conidial Characterization of *A. tenuissima* as influenced by different temperatures (10 x10 X).

6.0, 6.5, 7.0 and 7.5. Results are presented in table 3 and depicted in Fig. 2 and image 5. Radial mycelial growth varied from 73.3 mm to 89.6 mm was recorded at different pH after 264 hrs often incubation maximum mycelial growth was recorded at pH 5.5 (89.6 mm), which was closely followed by pH 6.0 (87.4 mm). Next best radial growth was noted at pH 6.5 (85.3 mm) followed by pH 7.0 (81.5 mm) which was significantly at par at pH 5.0 (80.5 mm) and 7.5 (80.2 mm). Least growth was recorded at pH 4.5 (73.3 mm). Poor to excellent sporulation was observed at different pH levels. Excellent sporulation was recorded at 5.5, whereas good sporulation was found at pH 6.5. Sporulation was fair at pH 5.0, 6.0, 7.0 and 7.5. Poor sporulation was observed at pH 4.5.

Conidial characteristics as influenced by pH levels are presented in Table 4 and Image 6, which reveals the variation in length, width and septation of conidia at

Table 3 : Effect of different pH on mycelial growth of *Alternaria tenuissima.*

S. no.	pH	Radial growth (mm) after (hrs)										
		48	72	96	120	144	168	192	216	240	264	Sporulation Index
1	4.5	15.1	20.7	26.4	32.3	38.9	43.4	53.3	57.7	65.3	73.3	+
2	5.0	11.4	21.2	30.3	38.3	46.3	54.5	62.4	68.7	74.3	80.5	++
3	5.5	16.1	28.9	38.0	46.0	54.2	62.8	71.8	81.0	87.5	89.6	++++
4	6.0	14.0	25.1	35.6	41.5	50.2	58.3	67.7	77.7	83.1	87.4	++
5	6.5	14.3	24.0	34.6	40.3	49.4	57.4	66.1	74.7	79.0	85.3	+++
6	7.0	14.8	23.1	33.3	39.2	46.6	53.6	60.8	69.3	75.5	81.5	++
7	7.5	13.6	22.8	29.9	37.1	45.1	52.9	59.5	68.6	74.9	80.2	++
	SEm±	0.65	1.02	0.70	0.81	0.88	0.86	0.91	0.98	1.11	0.68	
	CD (5%)	1.98	3.13	2.14	2.50	2.69	2.64	2.79	2.99	3.39	2.06	

[Scale of sporulation – (++++) = Excellent (>60 conidia per microscopic view); (+++) = Good (41-60 conidia per microscopic view); (++) = Fair (21-40 conidia per microscopic view); (+) = Poor (Less than 20 conidia per microscopic view); (-) = No sporulation.]

Table 4 : Conidial Characteristics of *Alternaria tenuissima* as influenced by different pH.

S. no.	pH	Length of conidia		Width of conidia		Range of longitudinal septa	Range of transverse septa
		Range	Mean	Range	Mean		
1	4.5	25.75-45.72	31.29	7.79-10.19	8.74	0-3	0-2
2	5.0	20.17-43.12	29.42	6.79-11.54	9.25	0-3	0-2
3	5.5	13.88-30.32	23.49	7.06-10.67	8.79	2-4	0-1
4	6.0	19.27-47.12	29.81	7.85-12.56	9.02	2-4	0-2
5	6.5	21.02-31.68	24.66	7.63-11.46	9.35	1-3	-
6	7.0	21.42-49.32	33.86	7.01-11.14	8.82	1-5	0-1
7	7.5	24.78-46.04	32.18	8.23-11.39	10.15	3-5	0-2

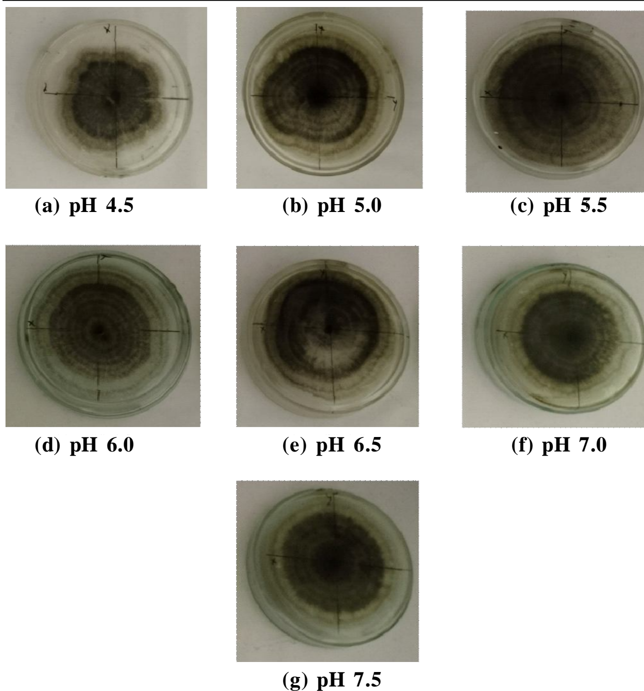

Image 5 : Effect of different pH on mycelial growth of *Alternaria tenuissima.*

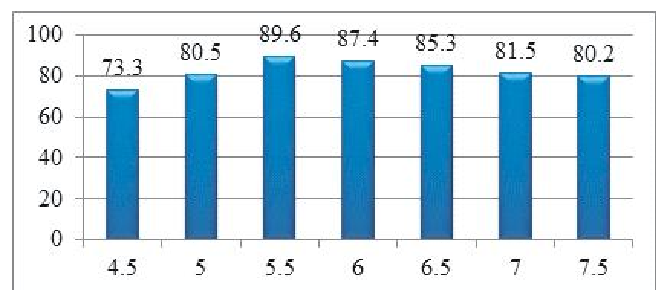

Fig. 2 : Effect of different pH ranges on mycelial growth of *Alternaria tenuissima.*

different pH. Average conidial length varied from 23.49 µm to 33.86 µm was maximum at pH 7.0, whereas minimum conidial length was noticed at pH 5.5. Conidial width varied from 8.74 µm to 10.15 µm was maximum at pH 7.5 and minimum at pH 4.5. Variation in number of longitudinal septa (3 to 5) were observed at pH 7.5, whereas minimum number of longitudinal septa were found at pH 4.5 and 5.0 (0 to 3). In rest of the pH levels, longitudinal septa vary from 0-3 to 2-4. Number of transverse septa was more or less similar 0 to 2 at different pH level concentrations examined.

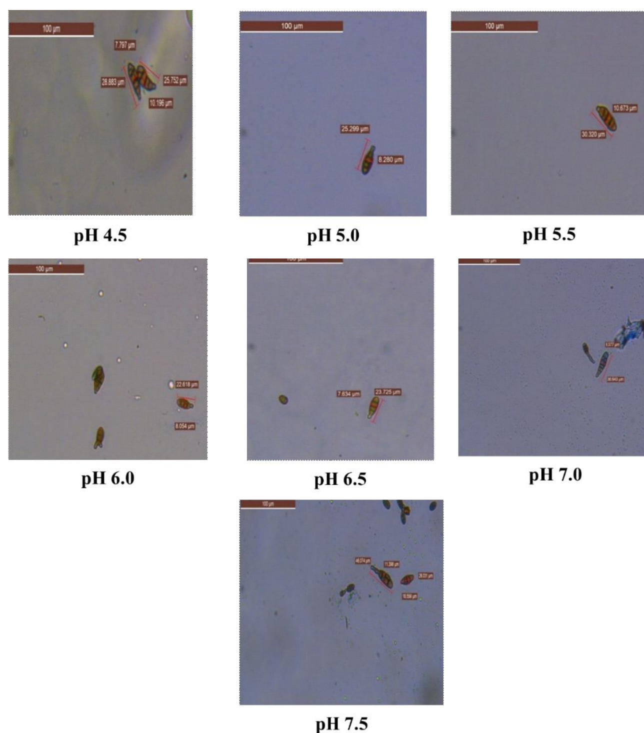

Image 6 : Conidial characterization of *A. tenuissima* as influenced by different pH ranges (10 x10 X).

Discussion

During the investigation, five ranges of temperature were used *viz.*, 15ºC, 20ºC, 25ºC, 30ºC and 35ºC. Among these five temperatures ranges 25ºC (74.4 mm) after 192 hours of incubation gained the maximum growth and sporulation. Hasija (1970) also suggested that 15-35ºC range was good for the growth of the pathogen. The findings coincided in line with that of Verma (1970), Kumar and Arya (1978), Singh *et al.* (2001a), Singh *et al.* (2001 b), Kantwa *et al.* (2015) and Hariprasad *et al.* (2018). Maheshwari *et al*. (2000) suggested that best growth of *A. alternata* was observed at 28ºC, which is close to 25ºC. Hubballi *et al.* (2010) reported the same findings where 25°C was proved to be the best optimum temperature after 30ºC. Sporulation was excellent in temperature of 25ºC, whereas it was fair in 20ºC. Verma (1970), Maheshwari *et al.* (2000), Singh *et al.* (2001 a), Singh *et al.* (2001 b), TianShu *et al.* (2009), Kantwa *et al.* (2015) and Hariprasad *et al.* (2018) found he same that 25ºC was the best and optimum temperature for the sporulation of different *Alternaria* spp.

Among 7 different pH range *viz.*, pH 4.5, pH 5.0, pH 5.5, pH 6.0, pH 6.5, pH 7.0 and pH 7.5. In our findings, best growth was seen in pH 5.5 (89.6 mm) and least was observed in pH 4.5 (73.3 mm). The findings of Singh *et al.* (2001 a) suggests that *A. alternata* grew best at pH 5.5. Hasija (1970) proved and showed that the best growth of *A. tenuis* (*A. alternata*) was between the pH range of 5.4 - 7.4. Regarding sporulation, the best and excellent sporulation was seen in pH 5.5 and it was good in pH 6.5. Findings of Verma (1970) explains that *A. alternata* sporulated best in pH 6.6 which was closely related to our finding for good sporulation in pH 6.5. Maheshwari *et al.* (2000) recorded highest sporulation at pH range of 5.5 – 6.5.

Conclusion

In conclusion, the optimum temperature recorded for the fast and high mycelial growth and excellent sporulation of *Alternaria tenuissima* was 25ºC temperature with pH 5.5 could be responsible for the devastating disease studied here in the experiments, *i.e.*, leaf blight caused by *Alternaria tenuissima*.

Acknowledgment

Authors would like to thank College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India for giving necessary support which includes equipment, apparatus, *etc.* and funding for putting up the experiments.

Conflict of interest

Authors have no conflict of interest to disclose.

References

Clayton, W.P. (1975). The *Paspalum scrobiculatum* complex in tropical Africa. *Kew Bulletin*, **30**, 101-105.

de Wet, J.M., Prasad Rao K.P., Mangesha M.H. and Brink D.E. (1983). Diversity in Kodo Millet, *Paspalum scrobiculatum*. *Economic Botany*, **37(2)**, 159-163.

Deshpande, S.S., Mohapatra D., Tripathi M.K. and Sadvatha R.H. (2015). Kodo millet-nutritional value and utilization in Indian foods. *J. Grain Processing and Storage,* **2(2)**, 16-23.

Gupta, S.P., Singh B.R., Tripathi D.P. and Yadav M.D. (1994). Prevalence of leaf blight disease on Kodo in UP. *Madras Agricult. J.,* **81(3)**, 166–167.

Hariprasad, K., Nagaraja A. and Patil S. (2018). Morpho-physiological characters of *Alternaria tenuissima* (Fr.) Keissl causing leaf blight of Kodo millet. *J. Mycopathological Res.,* **56 (1)**, 51-55.

Hariprasanna, K. (2023). Small millets in India: Current scenario and way forward. *Indian Farming*, **73(1)**, 38-41. https://epubs.icar.org.in/index.php/IndFarm/article/view/132568.

Hasija, S.K. (1970). Physiological studies of *Alternaria citri* and *Alternaria tenuis*. *Mycologica,* **62(2)**, 289-295. https://doi.org/10.1080/00275514.1970.12018967.

Hubballi, M., Nakkeeram S., Raguchander T., Anand T. and Samiyappan R. (2010). Effect of environmental conditions on growth of *Alternaria alternata* causing leaf blight of Noni. *World J. Agricult. Sci.,* **6(2)**, 171-177. http://

www.idosi.org/wjas/wjas6(2)/10.pdf.

Jain, A.K. and Sharma N.D. (2010). *Fungal disease problems of kodo millet: Diagnosis and Management. In Plant Disease and its management* (ed.) Trivedi, P.C. pp 15-28. Pointer Publisher, Jaipur 302003 (Raj.) India.

Kantwa, S.L., Shekhawat K.S. and Tetarwal J.P. (2015). Studies on physiological parameters of *Alternaria alternata* (Fr) Keissler - the incitant of leaf blight of groundnut. *Int. J. Plant Prot.,* **8(2)**, 359-363. https://doi.org/10.15740/HAS/IJPP/8.2/359-363.

Kumar, V.R. and Arya H.C. (1978). Nutritional requirements of *Alternaria triticina* causing leaf blight of wheat. *Geobios,* **5(1)**, 12-15.

Maheshwari, S.K., Singh D.V. and Singh S.B. (2000). Effect of temperature and pH on growth and sporulation of *Alternaria alternata* causing *Alternaria* leaf spot of dolichos bean. *Annals Plant Prot. Sci.,* **8(1)**, 33-35.

NAAS (2013). *Role of millets in nutritional security of India*. Policy paper No. 66. National Academy of Agricultural Sciences, New Delhi, 16p.

Nagaraja, A., Kumar B., Jain A.K. and Sabalpara A.N. (2016). Emerging Diseases: Need for Focussed Research in small millets. *J. Mycopathological Res.,* **54(1)**, 1-9.

Nagaraja, A., Kumar J., Jain A.K., Narasimhudu Y., Raghuchander T., Kumar B. and Hanumanthe Gowda B. (2007). *Compendium of small millets diseases*. Project coordinating cell, AICRP on small millets, UAS, Bengaluru, Pp 1-76.

Rajalakshmi, P., Devanathan R. and Savariraj Sahayam C. (2014). Special medicinal implications of Navadhanyam. *Int. J. Pharmaceut. Clin. Res.,* **6(1)**, 54-62.

Singh, S.K., Tuli L., Singh U.P. and Prithviraj B. (2001b). Effect of temperature, light/darkness and relative humidity on germination and sporulation of *Alternaria tenuissima*. *Indian Phytopathology,* **54(1)**, 128-130. https://epubs.icar.org.in/index.php/IPPJ/article/view/18874.

Singh, V., Kumar P. and Sinha A.P. (2001a). Influence of different media, pH and temperature on growth and sporulation of *Alternaria alternata* (fr.) Keissler, causing alternaria blight of chickpea. *Legume Res.,* **24(4)**, 238-242.

TianShu, G., MaoShan Z., BaiHong L. and ZiJun Z. (2009). Biological characteristics of the pathogen of *Schisandra chinensis* leaf blotch, *Alternaria tenuissima*. *J. Shenyang Agricult. Univ.,* **40(4)**, 435-438.

Verma, V. (1970). Effect of temperature, H^+ ion concentration on three pathogenic fungi. *Sydowia*, **23**, 164-168.