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Effect of Temperature on Growth and Development of *Rhizoctonia solani* (Kühn) f. sp. *saskii* Exner Incitant of Banded Leaf and Sheath Blight of Maize

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A B S T R A C T

Banded leaf and sheath blight of maize caused by *Rhizoctonia solani* (teleomorph: *Thanatephorus cucumeris*), is a complex pathogen and worldwide in distribution, a very destructive disease under favorable weather conditions causes substantial yield losses. Temperature is one of the factors playing an important role in fungi growth and spread. The objective of the research was to study the effect of temperature on growth of *R. solani* was studied on the isolate of maize collected from N.E. Borlaug Crop Research Centre, Pantnagar (29º N latitude, 79.3º E longitude), Uttarakhand, India. Among the mycelia and sclerotia inoculated plates, 30°C temperature was found significantly superior in mycelia radial growth after every 24 hours of incubation followed by 25°C, 35°C and 15°C. At 35°C production of sclerotia was found significantly superior followed by 30°C, 25°C and 15°C whereas at 0°C, 5°C and 40°C growth of mycelia and sclerotia formation restricted.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in the world. Maize grain has about 10% protein, 4% oil, 70% carbohydrates, 2.3% crude fiber, 10.4% albuminoides and 1.4% ash (Gopalan *et al.*, 2007). Maize crop attacked by number of fungal, bacterial and viral diseases. From different parts of the world, about 112 diseases of maize have been reported, of these, 65 are known to occur in India (Saxena, 2002). Banded leaf and sheath blight (BLSB) of maize is one of the most widespread and destructive disease of maize in Southeast Asian countries. The disease was first described and reported from Sri Lanka (Bertus, 1927) as sclerotial disease of maize caused by *Rhizoctonia solani* Kuhn. The *sasakii* group of *R. solani* Kuhn attacks

graminaceous hosts and causing distinct symptoms of bands on leaf and sheath and therefore, can be distinguished as a forma specialis *R. solani* f. sp. *Sasakii* (Ahuja, 1984). In India, this disease was first reported from Tarai region of Uttar Pradesh (Payak, 1996). It causes losses in grain yield ranging from 11.0 to 40.0 per cent (Singh, 1976).

The primary source of inoculum include sclerotia in soil or in infected host debris and the active mycelium on the other grass hosts that grow in the vicinity of maize plant in fields (Ahuja, 1985). Sclerotia which survive on plant debris often come up on the soil surface during field preparation and other operations. They come in contact with newly planted seedlings/plants and cause infection (Simon, 2014). Secondary spread is due to contact of healthy plants with infected leaves/sheaths and is responsible for the distribution of the pathogen during the main growing season of the crop (Gilligan, 2002). The young colonies produced by the fungus were fast growing and formed silky white colonies on Potato Dextrose Agar (PDA) medium; growth optimum at 25 and 30°C. Singh *et al.,* (1994) reported that the pathogen *R. solani* was unable to grow at 5, 7 and 45°C and sclerotial production was inhibited at 10°C. Ritchie *et al.,* (2009) found that optimum temperature for growth and sclerotial production was between 20-30ºC, whereas sclerotial germination restricts at 5ºC.

Despite the negative economic impact of sclerotia on maize as source of inoculum in soil for causing the bande leaf and sheath blight of maize and also as the data on influence of temperature on sclerotial formation and germination of *R. solani* is limited. We have attempted the experiment to learn more about the behavior of this pathogen under the different temperatures. Therefore, the objective of this study was to investigate the effect of temperature on mycelial growth, sclerotial production and germination of *R. solani* isolated from maize.

Materials and Methods

Infected leaves of maize exhibiting typical symptoms of banded leaf and sheath blight were collected in a paper bag from pathology block of N.E. Borlaug Crop Research Centre, GBPUA & T, Pantnagar, Uttarakhand, India. The leaves samples were brought to the laboratory for its microscopic examination and isolation. The pathogen was isolated on potato dextrose agar (PDA) and purified through hyphal tip or single sclerotia method (Rangaswami and Mahadevan, 2005). Pure culture maintained and stored in refrigerator at 5°C for futhur studies. The effect of temperature on the growth of fungus and germination of sclerotia was studied on PDA on different temperature values viz; 0°C, 5°C, 15°C, 25°C, 30°C, 35°C and 40°C.

The effect of temperature on growth and development of fungus on PDA medium under *in vitro*

Petri plates were poured with about 20 ml sterilized melted medium aseptically. After solidification of the medium, plates were centrally inoculated with 5 mm mycelial disc cut from the margin of 3 days old culture with the help of a sterilized cork borer and single sclerotia in each plate. Inoculated petriplates were incubated at 28±1ºC in BOD for mycelia growth measurement. Three replications of each treatment were maintained. The periodical observations of the mycelial growth characteristics such as colony diameter and growth pattern were recorded. Observations on sclerotia characteristics such as sclerotia number, days taken for sclerotia formation were also recorded. The mycelial growth was measured as mean of two perpendicular diameter of the colony. Four replicates were used for each treatment. Percent growth

inhibition was calculated by the following formula:

$$I = \frac{C-T}{C} \times 100$$

Where,
I= Inhibition percent of mycelial growth
C= Mycelial growth (mm) in control
T=Mycelial growth (mm) in treatments
After 15 days, sclerotial formation was recorded.

Results and Discussion

Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate under *in vitro*

After the incubation of single sclerotia and mycelia inoculated plates at various temperatures, The data presented that among all the temperatures tested 15°C, 25°C, 30°C and 35°C were suitable for the mycelia growth of *R.solani* at different period of incubation of single sclerotia and mycelia inoculated plates whereas 0°C, 5°C and 40°C temperatures were not suitable for the mycelia growth of *R.solani*. Among the various suitable temperatures maximum growth of mycelia observed at 30°C followed by 25°C, 35°C and 15°C.

After 48 hours of incubation single sclerotia inoculated plates (Table 1), the radial growth recoded at 30°C was maximum (35.00mm) which is followed by 25°C (24.333 mm) and 35°C (19.00mm). Minimum growth was observed at 15°C (17.00mm), whereas no growth was observed at 0°C, 5°C and 40°C. The same pattern of growth was observed in mycelia inoculated plates where growth at 30°C was maximum (39.00mm) which is followed by 25°C (31.667mm) and 35°C (24.333mm). Minimum growth was observed at 15°C (22.00mm), whereas no growth was observed at 0°C, 5°C and 40°C.

At 72 hours of incubation of single sclerotia inoculated plates (Table 2), maximum growth was observed 30°C (64.66mm) which is followed by at 25 °C (63.33mm) and 35°C (62.333mm) which are statistically at par. Minimum growth was observed at 15°C (44.00mm). The same pattern of growth was observed in mycelia inoculated plates where growth at 30°C being the superior (52.333) followed by 25°C (49.333 mm). At 15°C and 35°C the colony diameter of 39.00mm and 31.33mm was observed respectively. Whereas no growth was observed at 0°C, 5°C and 40°C.

After 96 hours of incubation of single sclerotia inoculated plates(Table 3), maximum mycelia growth observed at 25°C (90.00mm) and 30°C (90.00mm) which are statistically at par followed by 35°C (83.33mm) and 15°C (75.667.00mm). After incubation of mycelia inoculated the radial growth recoded at 30°C was maximum at 30°C (82.00mm) which is followed by 25°C (73.667mm), 35°C (69.333mm) and 15°C (63.667). There is no growth observed at 0°C, 5°C and 40°C.

Among the mycelia and single sclerotia inoculated plates which are kept in different temperatures in *in vitro*, at 30°C mycelia growth was found significantly superior after every 24 hours of incubation followed by 25°C, 35°C and 15°C. These results are in conformity with the finding of Singh *et al.*, (1994) who reported that the pathogen was unable to grow at 5, 7 and 45°C According to Tiwari and Khare, (2002) the hyphal stage of fungus can be successfully produced at 25°C in different medium, while sclerotia were observed at 30-35°C. The effects of temperature on the growth and sclerotia production among the isolates of *R. solani* reported that the optimum temperature for growth of *R. solani* was between 25°C and

30°C; whereas, for sclerotia production, it was 25°C. (Harikrishnan and Yang, 2004; Goswami, 2011; Lalan *et al.*, 2013 and Muhsin, 2013)

Table.1 Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate after 48 hours of incubation

Temperature	Radial growth*		
	Sclerotia inoculated plates	Mycelia inoculated plates	Mean A
0°C	0.000	0.000	0.000
5°C	0.000	0.000	0.000
15°C	17.000	22.000	19.500
25°C	24.333	31.667	28.000
30°C	35.000	39.000	37.000
35°C	19.000	24.333	21.667
40°C	0.000	0.000	0.000
Mean B	13.619	16.714	
Factors	C.D.	SE(d)	SE(m)
Temperatures (A)	1.146	0.556	0.393
Radial growth(B)	0.612	0.297	0.210
Factor(A X B)	1.620	0.787	0.556

*all values are mean of three replications. S.Em ± is standard error of mean.

Table.2 Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate after 72 hours of incubation

Temperature	Radial growth*		
	Sclerotia inoculated plates	Mycelia inoculated plates	Mean A
0°C	0.000	0.000	0.000
5°C	0.000	0.000	0.000
15°C	31.333	44.000	37.667
25°C	49.333	63.333	56.333
30°C	52.333	64.667	58.500
35°C	39.000	62.333	50.667
40°C	0.000	0.000	0.000
Mean B	24.571	33.476	
Factors	C.D.	SE(d)	SE(m)
Temperatures (A)	1.651	0.802	0.567
Radial growth(B)	0.882	0.429	0.303
Factor(A X B)	2.335	1.134	0.802

*all values are mean of three replications. S.Em ± is standard error of mean.

Table.3 Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate after 96 hours of incubation

Temperature	Radial growth*		
	Sclerotia inoculated plates	Mycelia inoculated plates	Mean A
0°C	0.000	0.000	0.000
5°C	0.000	0.000	0.000
15°C	63.667	75.667	69.667
25°C	73.667	90.000	81.833
30°C	82.000	90.000	86.000
35°C	69.333	83.333	76.333
40°C	0.000	0.000	0.000
Mean B	41.238	48.429	
Factors	**C.D.**	**SE(d)**	**SE(m)**
Temperatures (A)	1.175	0.570	0.403
Radial growth(B)	0.628	0.305	0.216
Factor(A X B)	1.661	0.807	0.570

*all values are mean of three replications. S.Em ± is standard error of mean.

Table.4 Effect of different temperatures on sclerotia characteristics of *Rhizoctonia solani* of maize isolate after incubation

Temperature	x(Days)		y(Number)	
	a*	b*	a*	b*
0°C	0.000	0.000	0.000	0.000
5°C	0.000	0.000	0.000	0.000
15°C	8.000	5.667	17.000	19.667
25°C	6.667	5.000	47.667	54.333
30°C	6.333	5.000	86.333	101.000
35°C	6.000	5.000	93.333	102.333
40°C	0.000	0.000	0.000	0.000
C.D.	1.091	0.772	2.989	3.473
SE(m)	0.356	0.252	0.976	1.134
SE(d)	0.504	0.356	1.380	1.604
C.V.	16.002	14.783	4.843	4.957

x: Days taken for sclerotia intiation; y: Number of sclerotia produced a*: Pertiplates inoculated with single sclerotia; b*: Pertiplates inoculated with mycelia. *all values are mean of three replications. S.Em ± is standard error of mean.

Fig.1 Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate after 96 hours of incubation of mycelia inoculated plates

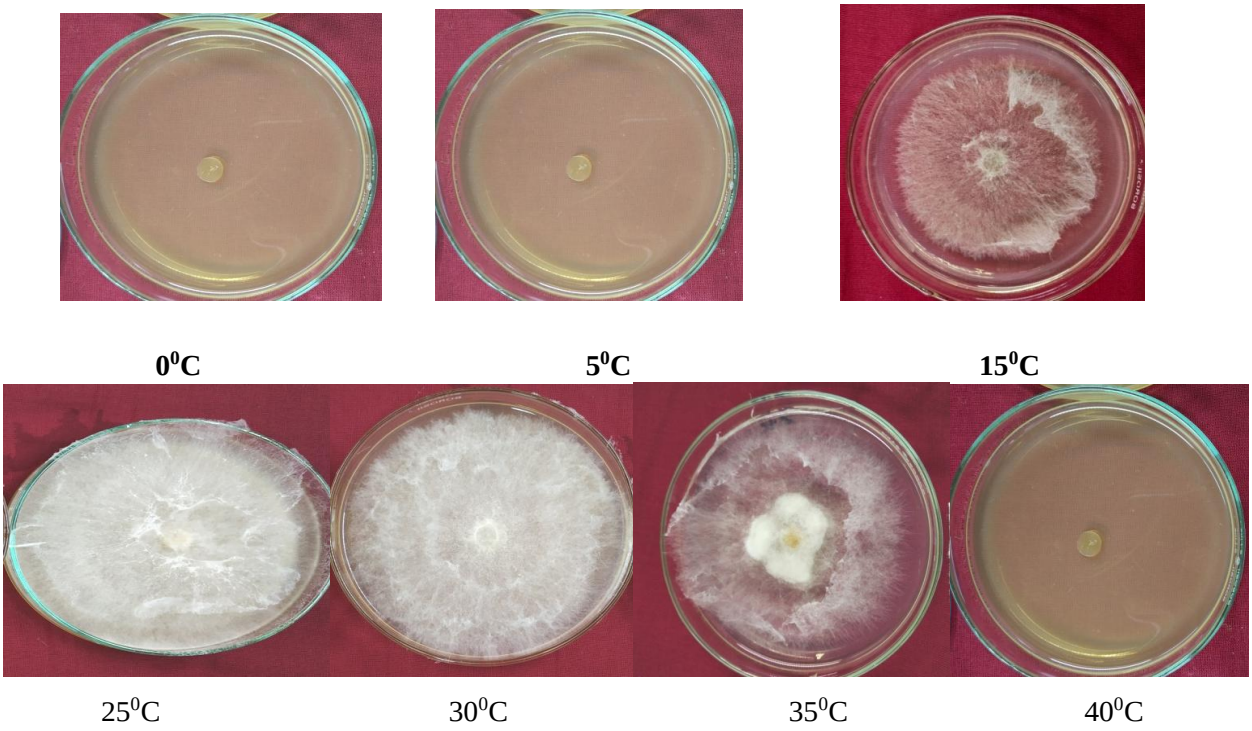
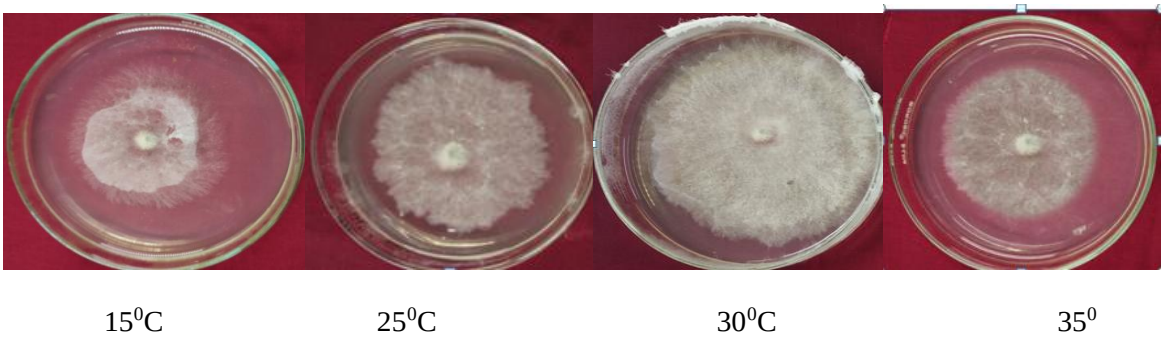


Fig.2 Effect of different temperatures on radial growth of *Rhizoctonia solani* of maize isolate after 96 hours of incubation of sclerotia inoculated plates



Effect of different temperatures on sclerotia l characteristics of *Rhizoctonia solani*

Petriplates were observed after 15days of inocubation for recording the number of sclerotia formed in both mycelia and sclerotia inoculated plates. Among these plates (Table 4), 35°C was found significantly superior in the formation of sclerotia followed by 30°C, 25°C and 15°C whereas, no sclerotia formation was observed at 0°C, 5°C and 40°C.

Maximum number of sclerotia 102.333 and 93.333 production observed at 35°C in the

mycelia and sclerotia inoculated plates respectively whereas in mycelia inoculated plates at 30°C number of sclerotia recorded was 101.00 which is followed by 25°C (54.333) and 15°C (19.667). Among the sclerotia inoculated plates medium sclerotia production was observed at 30°C (86.333) followed by 25°C (47.667). Minimum number of sclerotia (17.00) production observed at 15°C.

After inoculation with mycelia and sclerotia plates were observed for days taken for sclerotia initiation. In mycelia inoculated plates days taken for sclerotia initiation was recorded maximum at 15°C (5.66) followed by 25°C (5.00), 30°C (5.00) and 35°C (5.00) which are statistically at par. While in the sclerotia inoculated plates days taken for sclerotia initiation was recorded maximum at 15°C (8.00) which is followed by 25°C (6.667), 30°C (6.00) and 35°C (5.00). These results are in conformity with the finding of Ritchie *et al.,* (2009) found that optimum temperature for growth and sclerotial production was between 20-30ºC, whereas sclerotia germination restricts at 5ºC. Tiwari and Khare, (2002) also observed sclerotia at 30-35°C. Singh *et al.,* (1994) who reported that pathogen sclerotial production was inhibited at 10°C.

Laboratory studies revealed that among the mycelia and sclerotia inoculated plates, 30°C temperature was found significantly superior in mycelia radial growth after every 24 hours of incubation followed by 25°C, 35°C and 15°C. At 35°C production of sclerotia was found significantly superior followed by 30°C, 25°C and 15°C whereas at 0°C, 5°C and 40°C growth of mycelia and sclerotia formation restricted.

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