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Effect of temperature and relative humidity on conidial germination of *Leveillula taurica* (Lev.) Arn

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Abstract
Chilli (*Capsicum annuum* L.) is an important commercial crop in India, valued for its enticing colour, taste and pungency. Powdery mildew of chilli incited by *Leveillula taurica*, is one of the major devastating diseases causing both qualitative and quantitative yield loss. For initiation and progress of the disease temperature and relative humidity plays a key role. Different set of temperature and relative humidity were evaluated under laboratory condition. Results indicated that, the optimum temperature and relative humidity for conidial germination of *L. taurica* was found to be around 25 ℃ and 85%, respectively.

Keywords: Chilli, conidial germination, *Leveillula taurica*, relative humidity, temperature

1. Introduction
Chilli (*Capsicum annuum* L.) is an important vegetable cum spice crop in India. Indian chilli is considered to be world famous for two important commercial qualities *i.e*., colour and pungency levels. Indian chilli is mainly exported to Asian countries like China, Sri Lanka, Malaysia, Bangladesh, Singapore, Thailand and UAE *etc*. (Anon., 2019) [2]. In India, dried chilli was grown in an area of 701 thousand ha with the production of 1,751 thousand million tons (Anon., 2020). India has exported 44.90 thousand million tons of chilli during 2017-18 worth of 22,074.05 lakh rupees (Anon., 2018) [1]. Chilli contains high amount of vitamin C and other vitamins and minerals. Capsaicin is the main bioactive compound in chilli which is responsible for its pungent taste and various health benefits (Chakrabarthy *et al*., 2017) [5]. Chilli suffers from many foliar diseases like *Cercospora* leaf spot, powdery mildew, anthracnose, Murda complex and many other diseases among them powdery mildew caused by *Leveillula taurica* is a major constraint in chilli production causing yield loss of 42.82 per cent (Bademiyya and Ashtaputre, 2019) [4]. Generally, it coincides at the time of flowering and fruit formation during the month of September to January. The most common symptoms are affected leaves turn yellow on the upper surface and whitish powdery mass growth on the corresponding lower surface (Raghavendra, 2005) [10]. Environmental factors play a vital role in disease development and epidemic of chilli powdery mildew. Climate change may influence the interaction of plant-pathogen and their impact on production is largely debated and represents a challenge for the future disease management programmes under global changing conditions (Chakraborty *et al*., 2012) [6]. Initiation and progress of the disease is largely depending upon the prevailing temperature and relative humidity in the atmosphere, which influence the pathogen development and colonization. Hence, the present study was intended to know the effect of temperature, relative humidity, weather factors and elevated climatic conditions on development of chilli powdery mildew disease caused by *L. taurica*.

2. Materials and Methods
2.1 Effect of temperature on conidial germination of *L. taurica*: Powdery mildew infected chilli leaves were collected from the field, by shaking the infected leaves in the sterile distilled water spore suspension (4×10^3 conidia/ml) was prepared. Later, few drops of conidial suspension were placed on the cavity of glass slides and kept in the Petri dish lined with moist filter paper. The prepared Petri dishes were sealed with plaster and then incubated at different degrees of temperature, *i.e.*, 5, 10, 15, 20, 25, 30, 35 and 40 ºC. Observations were recorded at 24 h and 48 h after incubation.

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At each degree of temperature, three replications were maintained. The average percentage of germinated conidia was recorded and calculated by number of germinated conidia to the total number of conidia observed at 20 X magnification.

2.2 Effect of relative humidity on conidial germination of *L. taurica*

Six different levels of relative humidity (RH), *i.e.*, 50, 65, 75, 85, 95 and 100 per cent were set by using sulphuric acid and distilled water as explained by McLean and Cook (1951) [8]. Ten ml from the prepared solution was distributed in each desiccator to provide the desired RH level. Few drops of conidial suspension were placed on the cavity of glass slides. Each slide kept in the Petri dishes and then Petri dishes were placed in the desiccators containing desired RH level and incubated at 25 ± 1ºC. Observations were recorded at 24 and 48 h after incubation. At each degree of temperature, three replications were maintained. The average percentage of germinated conidia was recorded and calculated by number of germinated conidia to the total number of conidia observed at 20 X magnification.

3. Result and Discussion

3.1 Effect of temperature on conidial germination of *L. taurica*

The results obtained revealed that optimum temperature for conidial germination was found to be around 25 ± 1 ℃ (Fig. 3) with highest germination percentage of 33.91 and 47.26, followed by 25 ℃, 32.65 and 46.33 per cent after 24 and 48 h of incubation, respectively (Table 1, Fig. 1). Whereas least conidial germination (6.48 and 10.37%) was observed at 5 ℃ after 24 and 48 h incubation respectively. Maximum mean germination was recorded at 25 ± 1 ℃ (40.59%) and is on par with 25 ℃ (39.49%). Lowest mean germination was observed at 5 ℃ (8.42%).

3.2 Effect of relative humidity on conidial germination of *L. taurica*:

The result obtained from the study of influence of relative humidity on conidial germination revealed that, the highest per cent germination of 46.08 was recorded at 85 per cent RH (Fig. 4) after 48 h of incubation followed by 95 per cent RH (45.69%) and minimum per cent germination of 26.39 was observed at 50 per cent RH level after 48 h of incubation. There was no significant difference between 85 and 95 per cent RH, at both levels' maximum per cent conidial germination (37.88 and 36.29, respectively) was recorded (Table 2, Fig. 2). Relative humidity below 75 and above 95 per cent showed decreased germination percentage. The optimal RH levels for conidial germination was ranged from 75 to 95 per cent with 32.03 to 37.88 per cent conidial germination of *L. taurica*.

The results clearly indicated that temperature above 30 ℃ and relative humidity lower than 75 per cent and more than 95 per cent was not favourable for the conidial germination of *L. taurica*. The results are well supported by the findings of Plazola *et al*. (2003) [9], who reported that, the temperature of 30 °C and above were deleterious for conidial germination. Low RH levels (20-40%) reduced the spore germination, whereas high RH levels (80-90%) were favourable for conidial germination. Similar observations were made by Kim *et al*. (2009) [7] and Ramesh (2011) [11] who reported that, the optimum temperature and relative humidity for conidial germination was 25 ºC and 85 per cent respectively. Results obtained disagree with the findings of Zayan (2016) [12], who reported that the temperature of 30 ℃ and 100 per cent relative humidity was optimum for conidial germination of *L. taurica*. But, in our studies maximum conidial germination was observed at temperature of 25 ± 1 ℃ rather than 30 ℃ and relative humidity of 85 per cent. The conidial germination was decreased after 95 per cent RH and beyond 30 ℃ temperature.

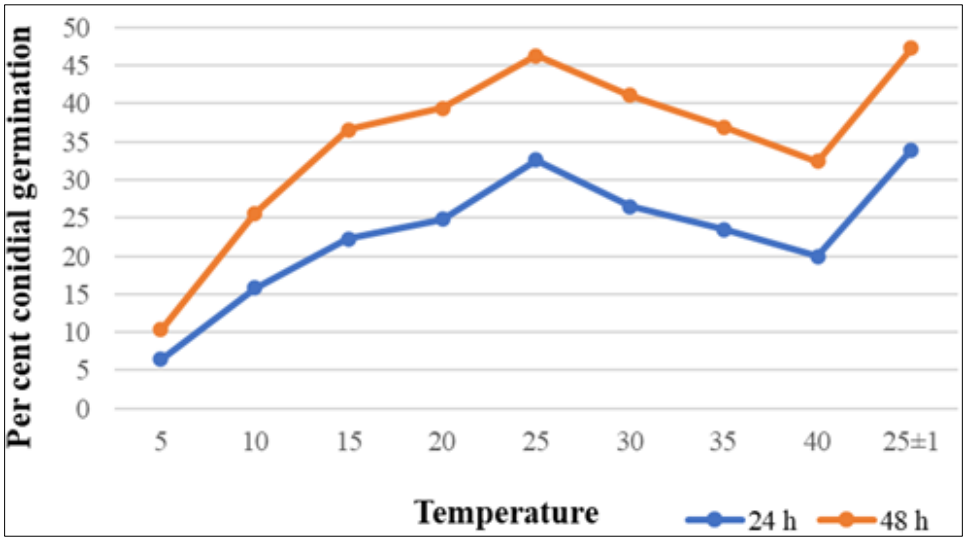

Fig 1: Effect of temperature on conidial germination of *L. taurica*

Table 1: Effect of temperature on conidial germination of *L. taurica*

Temperature (°C)	Germination (%) after		Mean conidial germination (%)
	24 h	48 h	
5	6.48*[j]	10.37[i]	8.42[f]
10	15.85[h]	25.63[e]	20.74[e]
15	22.24[fg]	36.57[c]	29.41[c]
20	24.81[e]	39.40[b]	32.11[b]

25	32.65 d	46.33 a	39.49 a
30	26.54 e	41.13 b	33.83 b
35	23.49 ef	36.92 ab	30.21 bc
40	19.94 g	32.40 cd	26.17 d
Laboratory condition (25±1℃)	33.91 cd	47.26 a	40.59 a
Mean	22.89 b	35.11 a	

*Mean of four replications, *P value* ≤ 0.05, a-j letters indicated DMRT values, similar letters indicates that, there is no significant difference between them.

Table 2: Effect of relative humidity on conidial germination of *L. taurica*

Relative humidity (%)	Germination (%) after		Mean conidial germination (%)
	24 h	48 h	
50	20.50*g	26.39 def	23.76 c
65	23.39 f	29.79 cd	25.64 c
75	27.37 cdef	35.24 b	32.03 b
85	29.81 c	46.08 a	37.88 a
95	28.39 cde	45.69 a	36.29 a
100	25.84 ef	30.29 c	28.11 c
Mean	25.88 b	35.58 a	

*Mean of four replications, *P value* ≤ 0.05, a-g letters indicated DMRT values, similar letters indicates that, there is no significant difference between them.

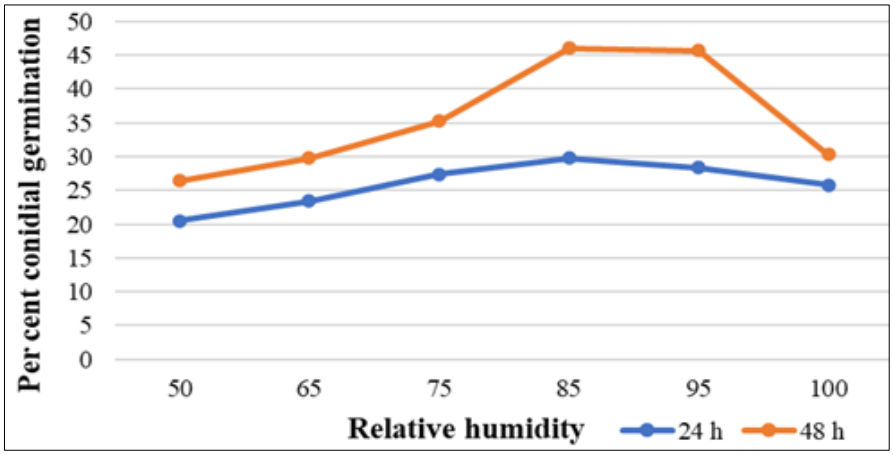

Fig 2: Effect of relative humidity on conidial germination of *L. taurica*

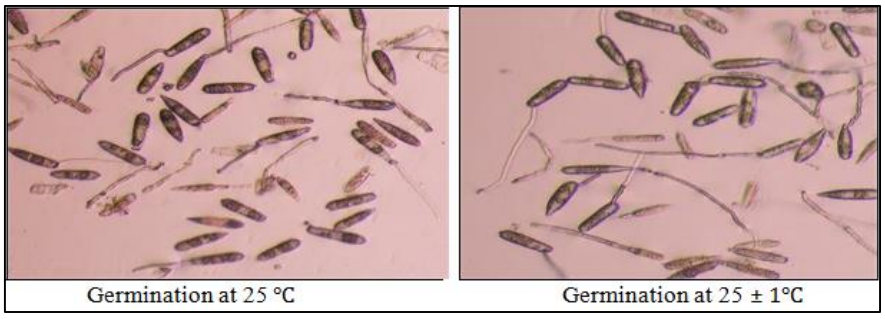

Fig 3: Effect of temperature and relative humidity on conidial germination of L. *taurica*

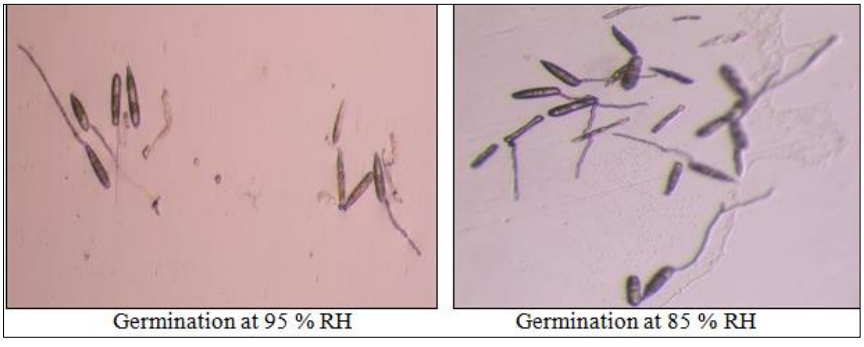

Fig 4: Effect of temperature and relative humidity on conidial germination of L. *taurica*

4. Conclusion

Powdery mildew of chilli is greatly influenced by the temperature and relative humidity in the atmosphere. Pathogen needs particular temperature and RH to show its full potential and beyond the optimal range, growth and development of the pathogen is abruptly disturbed. The optimum temperature and relative humidity for conidial germination of *L. taurica* was found 25 ℃ and 85%, respectively. Optimal range of temperature and relative humidity for the conidial germination was found between 20-30℃ and 75-95% RH. Knowledge on the influence of these key factors on disease development helps to develop precise forecasting model, which helps the farmers to take up timely protective measures for successful control of chilli powdery mildew.

5. Acknowledgement

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