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Research Note

The influence of temperature during the development of conidia on the germination of *Uncinula necator*

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Summary: Conidia of the obligate parasite *Uncinula necator* (conidial stage *Oidium tuckeri*) were cultured at various temperatures and subsequently observed during germination. Spores that produced at low temperatures had a higher germination rate at low temperatures compared to spores that developed at high temperatures. However, the latter still germinated at very high temperatures.

Key words: Oidium tuckeri, Uncinula necator, spores germination.

Introduction: In 1963, VANDERPLANK demonstrated that the epidemiology of fungal diseases in plants - and hence of *Uncinula necator* - is influenced by the length of the infectious period, the sporulation capacity and the effectiveness of infection. Since these parameters are influenced by meteorological parameters, the course and intensity of an epidemic largely depends on the actual weather conditions. During the growing period *U. necator* spreads by asexual conidia (*Oidium*) (GÄUMANN 1964). The germination rate of the condidia determines the actual infection and is hence an essential epidemiological parameter.

DELP (1954) and CHELLEMI and MAROIS (1991) found that the germination rate of *U. necator* conidia is correlated with temperature and relative humidity. However, it was observed in recent years that during the course of an epidemic, a linear relation between germination rates and weather conditions did not always exist. Recently FRIEDRICH and BOYLE (1993) demonstrated, that the germination of conidia of *Erysiphe graminis* depends on environmental factors influencing the development of the conidia. This study was designed to determine the influence of temperature on the rate of germination of conidia of *U. necator.*

Material and methods: Cuttings of *Vitis vinifera* cvs Blauer Spätburgunder (Pinot noir) and Müller-Thurgau, were propagated and grown under standard conditions in the greenhouse. To obtain conidia of *U. necator*, infected cuttings where grown in a plant growth chamber. After the onset of sporulation on some leaves (two fully developed conidia per conidiophore), conidia where brushed from the mycelium and placed on slides. The density of the inoculum was established by counting the conidia with differential-interference contrast microscopy at 200 fold magnification (Zeiss Axiophot). The conidia were then incubated in petri dishes at 90% relative humidity and constant temperature in permanent darkness for 24 h. The number of germinated conidia was established with microscopy. In accordance with DELP (1954) each test at a given temperature was repeated three times with approximately 800 spores. A similar rate of germination of *Oidium* conidia on slides and on leaves was found by STEIN *et al.* (1985).

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Results and discussion: To determine the influence of temperature on the rate of germination a standard method to produce reliable and reproducable results was necessary. It was important to use fresh conidia of an actively growing mycelium. Transfer and inoculation had to be dry, because wet conidia will rupture (STEIN *et al.* 1985). The influence of hyperparasites as described by HEINTZ and BLAICH (1990) was avoided by a careful culture of mycelium and by washing the leaves with distilled water before inoculation.

After separation from the mycelium 80 % of the conidia that developed under optimal temperatures of 24 °C (DELP 1954; CHELLEMI and MAROIS 1991) developed a germ tube after 24 h (Fig. 1), whereas the remaining 20 % were not longer turgid. The germination of a very low percentage of conidia started at 8 °C. The germination rate increased almost linearly between 10 °C and the optimal temperature 24 °C. Germination stopped at temperatures > 32 °C.

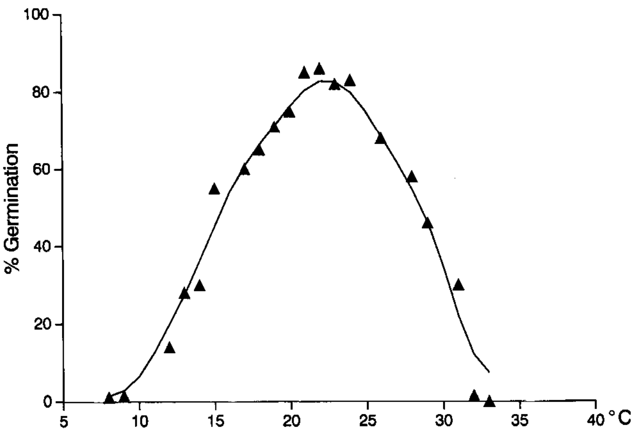
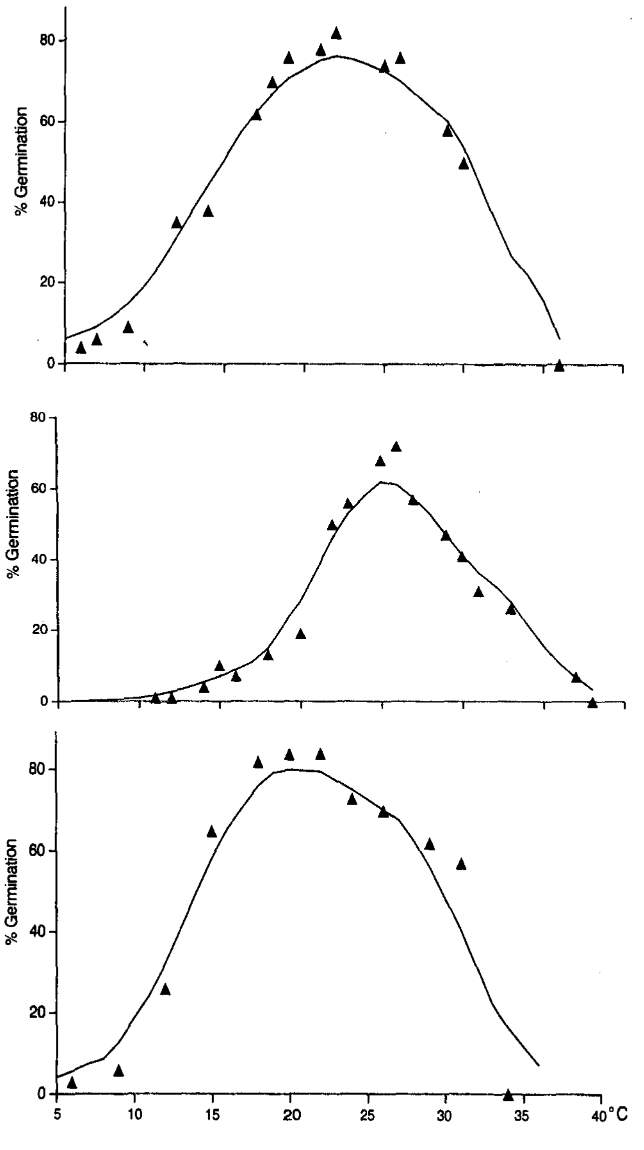


Fig. 1: The percentage of germination of grape powdery mildew conidia at different temperatures after culturing under 24 °C.

At a constant temperature of 31 °C, neither mycelium nor conidia were formed. If *U. necator* was cultured under a diurnal rhythm with 31 °C day and 21 °C night temperature the optimal germination temperature of the conidia shifted to 26 °C. These conidia reacted more sensitively to low temperatures and did not germinate at temperatures < 12°C. From 12 to 18 °C their germination rate increased slowly (Fig.2) and was > 0 up to 37 °C. High temperatures during the development of the conidia reduced the germination rate at low temperatures (8-18 °C), but at the same time the germination rate increased at high temperatures (29-37 °C). However, high temperature during development, influenced the conidia's ability to germinate. Under these conditions their highest germination rate was 72 %.

To exclude a change in the germination rate of conidia as a result of diurnal rhythm, inoculated plants were cultivated at a daily rhythm of 24/14 °C. Conidia that developed under these conditions already germinated at 6 °C and reached their highest rate of germination (80 %) at 22 °C (Fig. 3). This germination rate was equivalent to that of conidia developing at a constant temperature of 24 °C.



Figs. 2-4: The percentage of germination of grape powdery mildew conidia at different temperatures after culturing under a diurnal rhythm with **2**: 31/21 °C day/night; **3**: 24/14 °C day/night; **4**: 18/14 °C day/night.

To study the influence of low temperature on the growth of conidia, inoculated plants were cultivated at a daily rhythm of 18/24 °C. Under these conditions the resulting spores also germinated at 6 °C and the maximum germination was reached at 21 °C (Fig. 4). However, germination was clearly higher within the low temperature range (9-17 °C) compared to the spores produced at 24 or 24/14 °C. The germination at higher temperature (29-33 °C) was not reduced, however, at very high temperature (37 °C) germination ceased completely.

The shift in germination rate according to the temperature during spore development suggests that the fungus adjusts to the temperature, *i.e.*, if the spores develop at low temperature, their germination rate at low temperature is higher than that of spores which develop at high temperatures. If, on the other hand, spores develop at high temperature, their germination is reduced at low temperatures. At very high temperatures, germination occurs, but only at a rather low rate.

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