NOTAS CIENTÍFICAS

Influence of temperature and daily leaf wetness duration on the severity of bacterial leaf blight of garlic

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ABSTRACT

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In the present study, climate control chamber conditions were adopted to investigate the influence of temperature (10, 15, 20, 25 and 30°C) and leaf wetness duration (6, 12, 24 and 48 hours) on the severity of bacterial leaf blight of garlic, caused by *Pseudomonas marginalis* pv. *marginalis*. The relative density of lesions was influenced by temperature and leaf wetness duration (P<0.05). The disease was more severe at 20°C. The obtained data underwent non-linear regression analysis. Generalized beta function was used to fit the data on severity and temperature, while a logistic function was chosen to represent the effect of leaf wetness duration on the severity of bacterial blight. The response surface resulting of the product of those two functions was expressed as $ES = 0.019419 * (((x-5)^{0.5893}) * ((35-x)^{0.5474})) * (0.51754/(1+23.59597* \exp(-0.145695*y)))$, where: ES represents the estimated severity value (0.1); x, the temperature (ºC), and y, the daily leaf wetness duration (hours). This model shall be validated under field conditions to assess its use as a forecast system for bacterial leaf blight of garlic.

.**Keywords**: *Allium sativum, Pseudomonas marginalis* pv. *marginalis*, epidemiology, plant disease forecasting

RESUMO

Marcuzzo, L.L.; Füchter, D. Influência da temperatura e da duração diária do molhamento foliar na severidade da queima bacteriana do alho. ***Summa Phytopathologica,*** v.47, n.3, p.180-182, 2021.

No presente trabalho foram estudadas, em condições de câmara climatizada, a influência da temperatura (10, 15, 20, 25 e 30°C) e do molhamento foliar (6, 12, 24 e 48 horas) na severidade da queima bacteriana do alho incitada por *Pseudomonas marginalis* pv. *marginalis*. A densidade relativa de lesões foi influenciada pela temperatura e pela duração do molhamento foliar (P<0,05). A doença foi mais severa na temperatura de 20°C. Os dados foram submetidos à análise de regressão não linear. A função beta generalizada foi usada para ajuste dos dados de severidade e temperatura, enquanto uma função logística foi escolhida para representar o efeito do molhamento foliar na severidade da queima bacteriana. A superfície de resposta obtida pelo produto das duas funções foi expressa por $SE = 0{,}019419 * (((x-5)^{0{,}5893}) * ((35-x)^{0{,}5474})) * (0{,}51754/(1+23{,}59597 * \exp(-0{,}145695*y)))$, onde SE, representa o valor da severidade estimada (0,1); x, a temperatura (ºC) e y, o molhamento foliar (horas) diário. Este modelo deverá ser validado em condições de campo para aferir o seu emprego como um sistema de previsão da queima bacteriana do alho.

Palavras-chave: *Allium sativum, Pseudomonas marginalis* pv. *marginalis*, epidemiologia, previsão de doenças.

Bacterial leaf blight of garlic, caused by *Pseudomonas marginalis* pv. *marginalis* (= *P. fluorescens* biovar II), is an important disease in Brazil. Temperatures between 18 and 20ºC and prolonged leaf wetness duration have favored its development (6). Similarly to bacterial diseases in general, bacterial leaf blight of garlic is difficult to control and the use of copper-based products that act as protectants is common (3). On the other hand, antibiotics present little effectiveness due to low absorption and translocation; in addition, they are highly leachable and can generate harmful wastes to human health (9).

The establishment of a disease depends on the interaction among environment, host and pathogen. Environmental factors such as temperature and leaf wetness are critical to the epidemiological process. Nowadays, mathematical models are available to predict the best conditions for the occurrence of diseases (4). These models have been used for some plant disease systems such as soybean rust, downy mildew, *Glomerella* leaf spot in apple, and *Fusarium* head blight in wheat (8). Forecasting models for plant diseases are simplified representations of the reality and provide the most favorable conditions for the beginning, or the future development, of a disease, alerting to the ideal time for preventive control application (1).

The aim of this study was to establish the relationship between different temperature values and daily leaf wetness duration on the severity of bacterial leaf blight of garlic.

The study was conducted at Federal Institute "Catarinense" - IFC / Rio do Sul Campus, Santa Catarina State, Brazil. Micropropagated garlic bulbs, cv. 'Chonan', were transplanted into 500-ml polyethylene bags containing non-sterile soil and, after 45 days, when the plants had three expanded leaves, they were cleaned with a cotton pad for wax

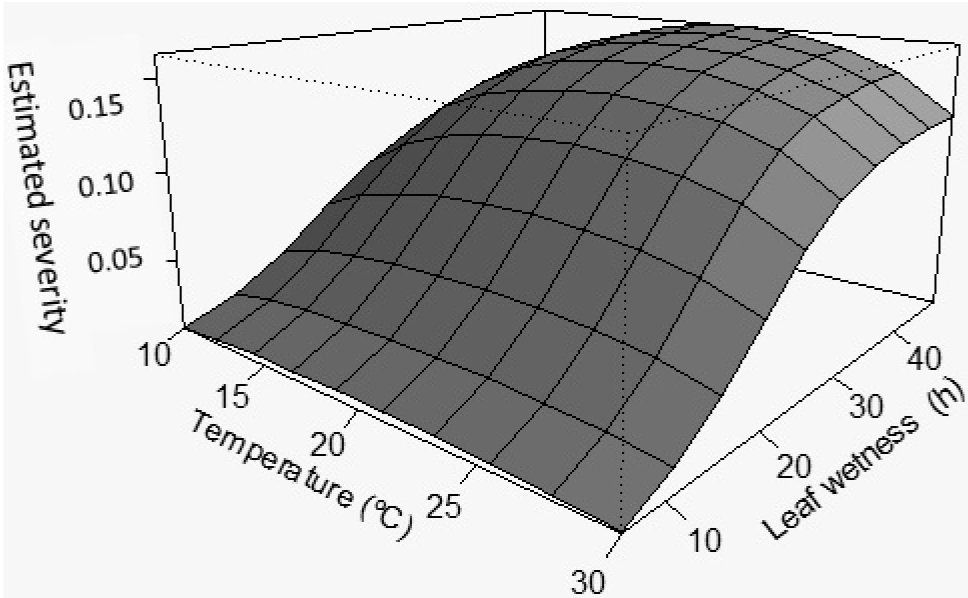

Figure 1. Estimated severity of bacterial leaf blight (*Pseudomonas marginalis* pv. *marginalis*) of garlic 'Chonan' based on the interaction between temperature and daily leaf wetness duration, represented by ES = 0.019419 * $(((x\text{-}5)^{0.5893})$ * $((35\text{-}x)^{0.5474}))$ * (0.51754/(1+23.59597* exp (-0.145695*y))), where: ES = estimated severity (0.1); x = temperature (ºC); y = leaf wetness duration (h). IFC/Rio do Sul Campus, 2018.

removal and inoculated with saline suspension adjusted to OD_{550} = 0.5 (5.6x10^9 CFU/mL) bacterial cells by the method of spraying until dripping, using a manual atomizer. Following inoculation, the plants were placed in a plastic tray containing one centimeter of non-sterile water to maintain the moisture and covered with a moistened clear plastic bag. To keep the relative humidity above 90%, a nebulizer was connected to the bag. The trays were transferred to biological oxygen demand incubators (BODs) adjusted to 10, 15, 20, 25 and 30°C, 12h light photoperiod, and kept for 6, 12, 24 and 48 hours under continuous moisture. At the end of each wetness period, the plants were dried in a heating forced air drier and transferred to 23°C (± 1°C). The disease severity was assessed based on the severity percentage on the three leaves at 14 days after inoculation, using the diagrammatic scale proposed by Paulakoski et al. (7).

A completely randomized design and three replicates were used for each combination of temperature and wetness duration. Each replicate consisted of one plant, and the average severity values of the three inoculated leaves were employed to determine the relationship between leaf wetness duration and temperature on the disease severity.

The response surface was a result of the product of two functions. Generalized beta function, expressed by the equation y = b1*$(T\text{-}b2)^{b4}$*$(b3\text{-}T)^{b5}$), was employed to determine the severity of the response to different temperatures, where b2 is the minimum temperature parameter estimator; b3 is the maximum temperature parameter estimator; b1, b4 and b5 are parameters of the equation; T is the independent variable, in this case, the temperature, and y is the estimated severity. The generalized beta function used to model the effect of temperature on the severity expresses the boundary between the maximum and the minimum temperature by introducing the proposed parameters in the model and demonstrates that an increase in temperature directly affects the disease development up to a specific limit, after which there is a sharp decrease (5).

The logistic function is used to correlate severity with leaf wetness duration and is expressed by the equation: y = ymax/(1+exp(-ln(yo/(ymax-yo)-r*x), where y is the predicted severity; ymax is the maximum disease severity; ln (yo/(ymax-yo) refers to the function of the proportion of disease in the first observation; r corresponds to the rate, and x is the wetness duration. This function represents leaf wetness and severity, demonstrating that longer leaf wetness duration leads to greater disease severity under favorable temperature conditions (10).

The following formula was established as an appropriate mathematical model to represent the response surface: ES = 0.019419 * $(((x\text{-}5)^{0.5893})$ * $((35\text{-}x)^{0.5474}))$ * (0.51754/(1+23.59597 * exp (-0.145695*y))), where ES = estimated severity value (0.1); x = temperature (°C), and y = wetness duration (Figure 1).

There was a gradual increase in the disease severity as the temperature increased from 10 to 20°C under continuous leaf wetness. The collected data are not corroborated by the literature, in which the ideal disease development is described to occur from 26 to 30°C (2), but the ideal temperature range of 18-20°C was described by Lopes & Quezado-Soares (6). However, they do not describe a mathematical model to explain the effect. For the interval between 10 and 15°C, there was a sharp increase in severity when leaf wetness duration exceeded 10 hours. However, at 30°C, symptoms were present, even after 40 hours of wetness.

The finding obtained for the interaction between temperature and leaf wetness allows greater understanding of the epidemiology of this disease and can be used to develop a climate model for computerized forecasting of bacterial leaf blight of garlic.

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