NOTAS CIENTÍFICAS

Development of a weather-based forecasting model for *Alternaria* leaf blight of carrot

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ABSTRACT

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In the present study, under controlled conditions, the influence of temperature (10, 15, 20, 25 and 30°C) and leaf wetness duration (6, 12, 24 and 48 hours) was studied on the severity of *Alternaria* leaf blight of carrot caused by *Alternaria dauci*. The relative density of lesions was influenced by temperature and leaf wetness duration ($P<0.05$). The disease was more severe at the temperature of 25°C. Data underwent non-linear regression analysis. The generalized beta function was used for fitting the data on disease severity and temperature, while a logistic function was chosen to represent the effect of leaf wetness duration on the severity of leaf blight. The response surface resulting of the product of the two functions was expressed as $ES = 0.004993 * (((x-8)^{1.13125}) * ((36-x)^{0.53212})) * (0.39219/(1+25.93072 * \exp(-0.16704*y)))$, where: ES represents the estimated severity value (0.1); x, temperature (ºC) and y, leaf wetness duration (hours). This model must be validated under field conditions to be used as a forecasting model for *Alternaria* leaf blight of carrot.

Keywords: *Daucus carota, Alternaria dauci*, epidemiologia, previsão de doenças.

RESUMO

Marcuzzo, L.L.; Tomasoni, C.M. Desenvolvimento de um modelo de previsão climático para a queima das pontas da cenoura. ***Summa Phytopathologica,*** v.45, n.4, p.413-414, 2019.

No presente trabalho foram estudadas, em condições de câmara climatizada, a influência da temperatura (10, 15, 20, 25 e 30°C) e da duração do molhamento foliar (6, 12, 24 e 48 horas) na severidade da queima das folhas da cenoura incitada por *Alternaria dauci*. 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 25°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 das folhas. A superfície de resposta obtida pelo produto das duas funções foi expressa por $SE = 0{,}004993 * (((x-8)^{1{,}13125}) * ((36-x)^{0{,}53212})) * (0{,}39219/(1+25{,}93072 * \exp(-0{,}16704*y)))$, onde SE, representa o valor da severidade estimada (0,1); x, a temperatura (ºC) e y, o molhamento foliar (horas). Este modelo deverá ser validado em condições de campo para ajustar o seu emprego como um sistema de previsão da queima das folhas da cenoura.

Palavras-chave: *Daucus carota, Alternaria dauci*, epidemiology, plant disease forecaster.

Alternaria leaf blight of carrot (*Daucus carota*), caused by *Alternaria dauci* (Kühn) Groves & Skolko, is an important disease in Brazil. Temperatures between 15 and 26ºC and prolonged leaf wetness periods usually favor its development (5). For the crop, it is the most relevant disease since it promotes total destruction of leaves and consequent yield reduction (4). Symptoms are small, dark-brown or black lesions surrounded by yellow areas, especially on the leaf margins. Under conditions favorable to the disease development, the spots may increase in number and size and may result in the death of most foliar tissues (8).

The establishment of a disease depends on the interaction among environment, host and pathogen. The environmental factors temperature and leaf wetness are critical to the epidemiological process. Mathematical models have been developed to predict the best conditions for the occurrence of diseases (2). These models have been used in some plant disease systems such as soybean rust, downy mildew, *Glomerella* leaf spot in apple, and leaf blight in wheat (6). Plant disease forecasting models are simplified representations of reality and indicate the most favorable conditions for the beginning or the future development of a disease, signalizing the time for preventive control (1).

The aim of this study was to establish the relationship between different temperature values and leaf wetness duration on the severity of *Alternaria* leaf blight of carrot.

The study was conducted at “Instituto Federal Catarinense – IFC” / Rio do Sul Campus, SC. Seeds of carrot beet cultivar Brasília were sown in 500-ml bags containing substrate mixture and non-sterile soil; after 75 days, showing three expanded leaves, the plants were inoculated with a suspension of *Alternaria dauci* spores grown for nine days in PDA to $1x10^4$ spores / mL, concentration determined in a Neubauer chamber by the spraying method until run-off with 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 shrouded in a clear and moistened plastic bag. A nebulizer was connected to the bag to keep relative humidity above 90%. The trays

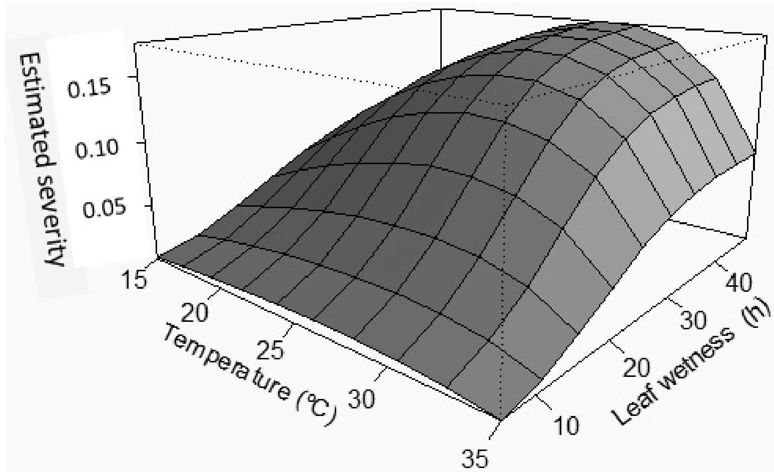

Figure 1. Estimated severity of *Alternaria* leaf blight (*Alternaria dauci*) of Brasília carrot based on the interaction between temperature and leaf wetness, represented by ES = 0.004993 * $(((x\text{-}8)^{1.13125})$ * $((36\text{-}x)^{0.53212}))$ * (0.39219/(1+25.93072 * exp (-0.16704*y))), where: ES = estimated severity (0.1); x = temperature (ºC); y = leaf wetness (h). IFC/Rio do Sul Campus, 2018.

were transferred to BODs adjusted to 15, 20, 25, 30 and 35°C and 12-hour photoperiod and were kept for 6, 12, 24 and 48 hours under continuous moisture. At the end of each wetness period, the plants were collected, dried with heated forced air and transferred to 25°C (± 1°C). The disease severity was assessed as severity percentage for the three leaves on the fifteenth day after inoculation based on the diagrammatic scale proposed by Strandberg (7).

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

The response surface is a result of the product of two functions. The generalized beta function expressed as the equation $y = b1*(T\text{-}b2)^{b4}*(b3\text{-}T)^{b5})$ was used 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, 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 maximum and minimum temperatures by introducing the proposed parameters in the model and demonstrating that the temperature increase directly affects the disease development until a specific limit is reached, after which a sharp decrease occurs (3).

The logistic function, expressed as the equation: y = ymax/(1+exp(-ln(yo/(ymax-yo)-r*x), is used to correlate severity with leaf wetness duration, where y is the predicted severity, ymax (maximum disease severity), ln (yo / (ymax-yo) is the function of the disease proportion in the first observation, r corresponds to a rate and x is the time of wetness. This function represents leaf wetness and severity because increasing the number of leaf wetness hours led to an increase in the disease severity under favorable temperature conditions (9).

The formula ES = ES = 0.004993 * $(((x\text{-}8)^{1.13125})$ * $((36\text{-}x)^{0.53212}))$ * (0.39219/(1+25.93072 * exp (-0.16704*y))), where ES represents the estimated severity value (0.1); x is the temperature (° C) and y is the wetness period, has been established as an appropriate mathematical model to represent the response surface (Figure 1).

There was a gradual increase in the disease as temperature increased from 20 to 25°C for a period of continuous leaf wetness. The collected data corroborate studies that describe ideal disease development from 15 to 26°C (4, 5, 8). Strandberg (7), evaluating the effect of temperature on the establishment of *A. dauci,* found that the disease severity was higher when temperature was 16-28°C but reduced when temperature was below 12°C. However, that author did not describe a mathematical model to explain this effect. In the present study, the interval between 15 and 20°C led to a sharp increase in severity when leaf wetness period exceeded 10 hours. However, at 35°C, there were symptoms even after 40 hours wetness.

The obtained information about the interaction between temperature and leaf wetness allows greater understanding of the disease epidemiology and can be used as a weather-based model for computerized forecasting of *Alternaria* leaf blight of carrot.

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