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RELATION BETWEEN DEGREE-DAY AND THE VEGETATIVE CYCLE

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1. INTRODUCTION

The theory of the degree-day has relevant importance for agrometeorological studies. This theory can be used to study several physicals parameters of such cultures as the duration of the vegetative cycle and the productivity.

Recently, Fernandes & Paiva (2003) idealized the degree-day of reference. This variable was created to indicate the thermal condition that the plant is and verify if it suffers thermal stress, or if it meets in an area which can provide an ideal condition of thermal energy.

Using this condition, the result is the degree-day of reference (GD_R). This parameter isn't weather depend. A GD_R only depend of the vegetable basal temperatures. Starting from the concept of degree-day of reference, the thermal index was elaborated (Fernandes & Paiva, 2003). This index express the relationship between the degree-day accumulation avaliable in the field and the degree-day of reference.

With these theories, the linear disturbance will be used to identify how an anomaly of accumulated degree-day in the field can interfere in the vegetative cycle.

This is the objective of this study: To evaluate how the thermal conditions of the area can make the vegetative cycle of the culture extended or shortened, having as reference a condition considered pattern. The pattern condition is the vegetative cycle of reference calculated with the hypothesis of the crop accumulate degree-day of reference all day vegetative cycle.

2. MATERIALS AND METHODS

The study of the anomalies in the degree-days generates the index of cycle anomaly (IAC), which indicates how the effect of the anomaly of degree-day affects the duration of the vegetative cycle. This index is the relationship between a standard value of vegetative cycle (vegetative cycle of reference) and the real vegetative cycle.

Firstly, the equations of the complete theory of degree-day will be shown mentioned in Ometto(1981). To compact the degree-day equations new variables were created :

$$A = T_x - T_m \qquad (1)$$

$$I = T_m - B_x \qquad (2)$$

$$S = T_x - B_x \qquad (3)$$

$$E - T_x - B_m \qquad (4)$$

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The variable T_x it is the maximum air temperature; T_m, minimum air temperature; B_x, maximum basal temperature and B_m, minimum basal temperature. With these four new variables, the equations are:

Case1:

$$B_x > T_x > T_m > B_m$$
$$GD = \frac{A}{2} + I \qquad (5)$$

Case 2:

$$B_x > T_x > B_m > T_m$$
$$GD = \frac{E^2}{2A} \qquad (6)$$

Case 3:

$$T_x > B_x > T_m > B_m$$
$$GD = \left(\frac{A}{2}\right) + I - \left(\frac{S^2}{2A}\right) \qquad (7)$$

Case 4:

$$T_x > B_x > B_m > T_m$$
$$GD = \frac{\left(E^2 - S^2\right)}{2A} \qquad (8)$$

Case 5:

$$B_x > B_m > T_x > T_m$$
$$GD = 0 \qquad (9)$$

Case 6:

$$T_x > T_m > B_x > B_m$$
$$GD = 0 \qquad (10)$$

The reference degree-day $\left(GD_R\right)$ is calculated below (Fernandes & Paiva, 2003):

$$GD_R = \frac{\left(B_x - B_m\right)}{2} \qquad (11)$$

The Thermal index $\left(IT\right)$ is defined as the reason among the degree-day observed and the reference degree-day:

$$IT = \frac{GD}{GD_R} \qquad (12)$$

The relationship among the deviation of the degree-day and the deviation of the vegetative cycle, that will be used to find the relationship between the cycle and the degree-days, will be found through the degree-day of reference, of the thermal index and of the theory of the lineal disturbance (Holton, 1972).

The theory of the lineal disturbance mentions that a variable can be divided in a basic part and a variable part:

$$A = \left|A\right| + A' \qquad (13)$$

Here, A is a variable, and this variable can be divides in a basic state $\left|A\right|$ and an anomaly A'. The anomaly part can be treated like very smaller than a basic state.

From these concepts, the impact of the degree-day accumulation will be evaluated in the duration of the vegetative cycle.

3. RESULTS

The degree-day anomaly is inversely proportional in relation of the anomaly of the vegetative cycle. This result is intuitive; more thermal energy received by the crop, less is the vegetative cycle and vice-versa. But, the effect of prolongating cycle is not intuitive, and the evaluation of this extend is useful. The result look more drastic in the effect of shortening. In the figure 1 it is shown an IAC behavior when IT change your value. Both indexes assume values greater than zero. The IAC assumes large values when the thermal index tends to zero. At IT value equal a zero, IAC tends to the infinite.

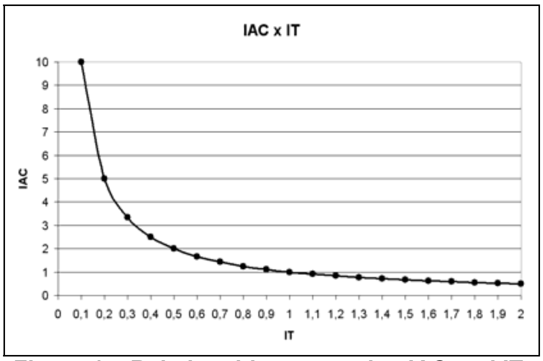

Figure 1 – Relationship among the IAC and IT.

In the figure 2, it displays how the anomaly of the vegetative cycle behaves with vegetative cycles of reference of 120, 180, 240 and 300 days.

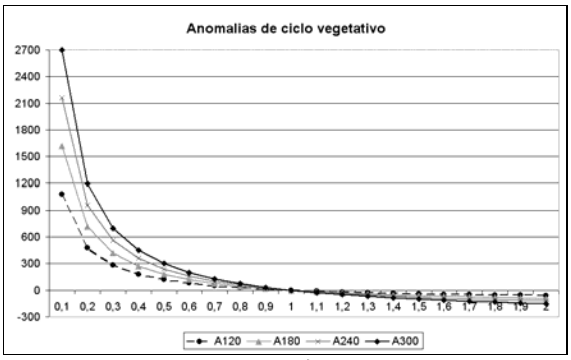

Figure 2 – Anomaly of vegetative cycle

The values of higher thermal index than 1 presents, take to negative anomalies of vegetative cycle (in relation of the reference vegetative cycle) , so the vegeative cycle becomes smaller than reference vegetative cycle. A thermal index equal to 2, reduces in 50% the vegetative cycle, while the $IT = 0,5$ increase the cycle in 100%, in this case, a real vegetative cycle is a double of reference vegetative cycle.

The anomaly of the cycle (n) in relation to the vegetative cycle of reference (M) is given by:

$$n = M\frac{(1 - IT)}{IT} \qquad (14)$$

In this equation, if the IT is less than 1, the vegetative cycle anomaly turns small . On the other hand, IT greater than 1 provoke positive anomaly, it means that a real vegetative cycle is larger than the reference vegetative cycle. The IT becomes small and the anomaly then becomes large.

The thermal index appears as a good tool for decision about to plant certain crop types in the same region, taking into account the impact of accumulation of thermal energy on the vegetative cycle.

4. CONCLUSIONS

The degree-day reference and the vegetative cycle of reference are razonable parameters to use in the study of deviation of the cycle, since it only depends on the culture and not the weather or the area studied.

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