PHYLLOCHRON BASED ON THERMAL TIME IN POTATO: ONE DEFINITION, SEVERAL VALUES.

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Introduction

The prediction of leaf number is an important part of many crop simulation models. The number of leaves on a stem is related to leaf area, to the timing of some developmental stages, and, in potato, to branching (VOS & BIEMOND, 1992). One way to predict the appearance of individual leaves is to use the phyllochron concept, defined as the time interval between the appearance of successive leaves (KLEPPER et al, 1982; KIRBY, 1995). The time needed for the appearance of one leaf can be expressed in thermal time (TT), measured in units of degree days (^oC d).

There are several ways to calculate TT (McMASTER & WILHELM, 1997). Consequently, the phyllochron may have different values, depending upon the approach used to calculate TT. The objective of this study was to estimate the phyllochron in potato in the field using different methods of calculating thermal time.

Material and methods

A field experiment was carried out at Santa Maria, RS, Brazil. Tubers of 'Dakota Rose' potato cultivar were planted on 25 September 2002 in seven meter rows. Spacing was 0.70m among rows and 0.33m among tubers. The number of leaves on one main stem/mother tuber was measured in 8 plants of 2 rows twice a week. It was assumed that a leaf had appeared when its apical leaflet was 1cm in length.

Daily TT was calculated by three different methods:

$TT=(Topt-Tb).(T-Tb)/(Topt-Tb)$, if $T<Tb$ then $T=Tb$ (Method 1)

$TT=(Topt-Tb).(T-Tb)/(Topt-Tb)$, if $T<Tb$ then $T=Tb$ and if $T>Topt$, then $T=Topt$ (Method 2)

$TT=(Topt-Tb).(T-Tb)/(Topt-Tb)$ when $Tb<T\leq Topt$ and $(Topt-Tb).(Tmax-Tb)/(Tmax-Topt)$ when $Topt<T\leq Tmax$ (Method 3)

where Tb is the base temperature (7^oC), Topt is the optimum temperature (21^oC), and Tmax is the maximum temperature (30^oC) for leaf appearance rate in potato (SANDS et al. 1979), and T is the mean daily temperature calculated from the average of minimum and maximum air temperatures. A graphical representation of the three methods is in Fig. 1.

The number of leaves was linearly regressed against accumulated GDD and the phyllochron was estimated by the inverse of the angular coefficient of the linear regression.

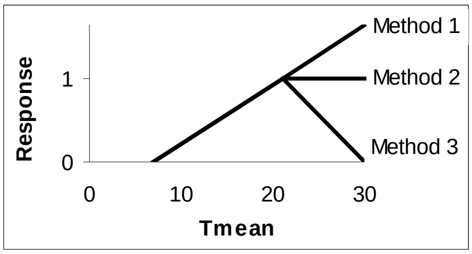

Figure 1. Schematic representation of the three methods for calculating daily thermal time in potato.

Results and discussion

Daily mean temperature, and precipitation during the experimental period is in Fig. 2. Mean temperature was often above Topt for leaf appearance in potato (21°C) and no water stress was observed in the plants.

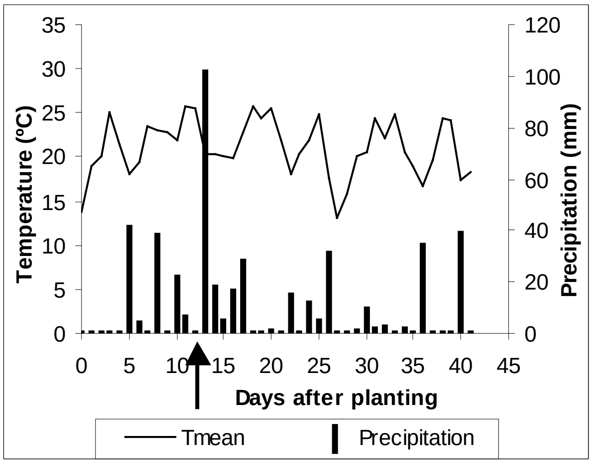

Figure 2. Daily values mean (Tmean) air temperature and precipitation throughout the experimental period. The date of 50% emergence (06/10/2002) is indicated by the arrow.

The relationship between number of leaves on the main stem and accumulated TT was linear, with an R^2=0.99 for all methods (Fig. 3).

The phyllochron was different and dependent upon the method of calculating thermal time. The phyllochron was estimated as 28.7, 26.7, and 23.4 ^oC d/leaf for method 1, method 2, and method 3, respectively.

In order to test the consequences of the different phyllochron values on the simulation of the number of main stem leaves, we predicted the appearance of leaves in a potato crop that had emerged on different dates throughout one year at Santa Maria, Fig. 4. We assumed that the final leaf number was 17 (VOS & BIEMOND,

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1992). In Southern Brazil, potato can be planted in Feb/Mar and Aug/Sept. When plants develop during winter and early Spring, there was no difference in the number of leaves simulated with the three methods. However, when plants develop in other months (Nov-Apr) the appearance of leaves was simulated faster with Methods 1 and 2. These results are preliminary because of only predicted data are presented. However, these results show that there are different ways to calculate TT and the predictions of leaf number with these different methods of calculating TT are different, depending on the time of the year. We are currently collecting leaf number data in a field experiment, to compare with the predicted data. The hypothesis is that method 3 should give better predictions because of the more realistic relationship between plant development and temperature, i.e., there is a minimum, an optimum, and a maximum temperature for leaf appearance in potato.

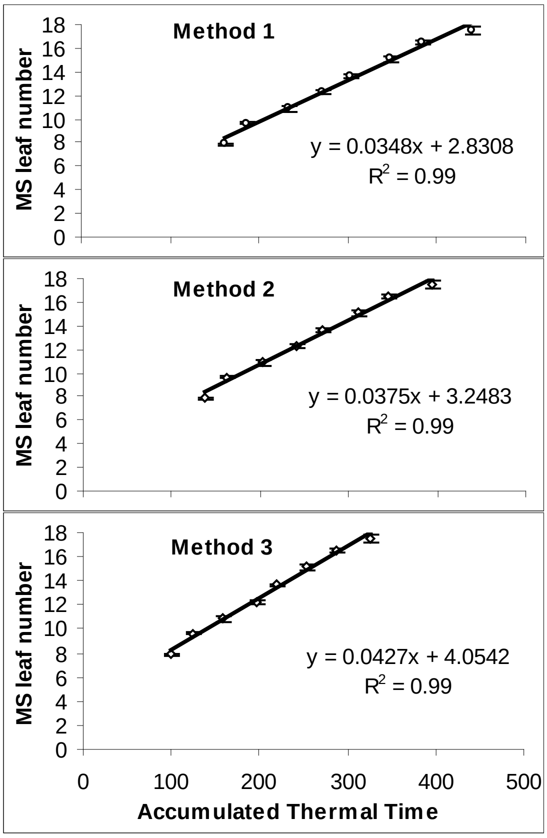

Figure 3. The relationship between number of leaves on the main stem of potato plants and accumulated thermal time.

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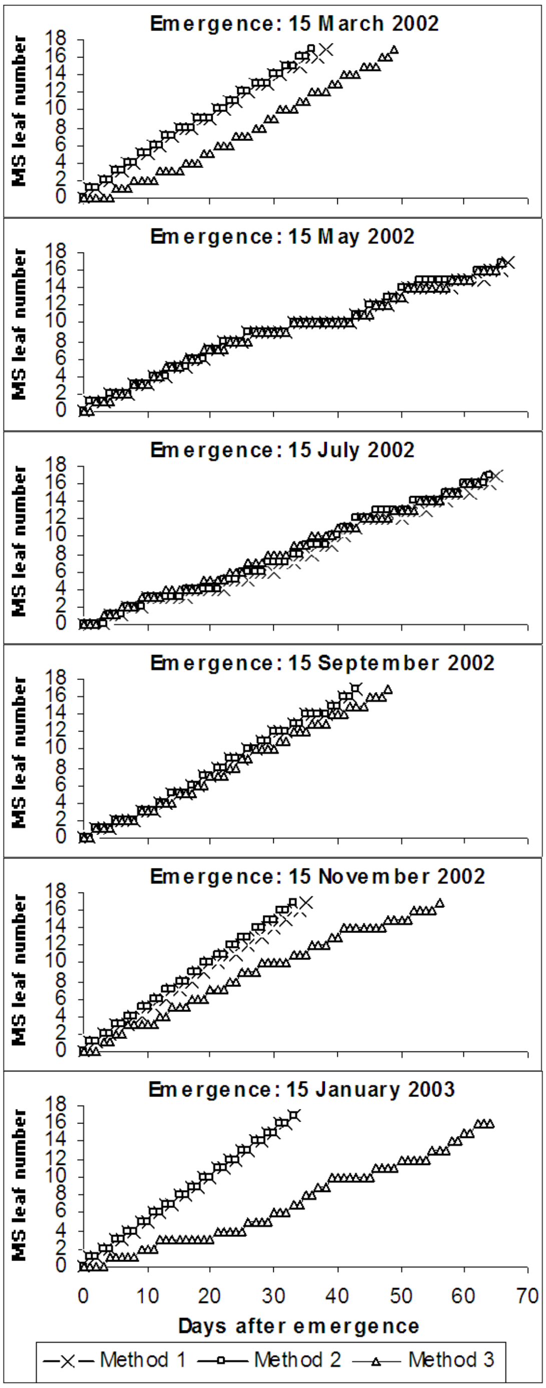

Figure 4. The prediction of leaf number on the main stem of potato plants based on the phyllochron with three different methods of calculating thermal time.