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Leaf appearance rate in Alexander grass (*Brachiaria plantaginea*) and morning glory (*Ipomoea triloba*) weeds.

Taxa de aparecimento de folhas nas plantas daninhas papuã (*Brachiaria plantaginea*) e corriola (*Ipomoea triloba*).

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TECHNICAL NOTE / NOTA TÉCNICA

Abstract: The objective of this study was to determine the leaf appearance rate (LAR) based on thermal time in Alexander grass (*Brachiaria plantaginea*) and morning glory (*Ipomoea triloba*) weeds. A field experiment was conducted at Santa Maria, RS, Brazil. Ten two-leaf seedlings of each species were transplanted on 27 October 2003 and grown without water stress. The main stem Haun Stage (HS) in Alexander grass and the main stem leaf number (MSL) in morning glory were measured twice a week. Daily degree days (STd_i, °C.d) were calculated using a base temperature of 10°C. Accumulated thermal time (TT) from transplanting to 22-28 MSL was calculated by accumulating STd_i. The number of leaves (HS and MSL) was linearly regressed against TT. The slope of the linear regression is the LAR (leaves/°C.d) and the phyllochron (°C d/leaf) was estimated by the inverse of the slope of the linear regression. The LAR was lower in Alexander grass (0.0262 leaves/°C.d) than in morning glory (0.0508 leaves/°C.d).

Key words: phyllochron, thermal index, degree days.

Resumo: O objetivo deste trabalho foi determinar a taxa de aparecimento de folhas (LAR) baseado na soma térmica nas plantas daninhas papuã (*Brachiaria plantaginea*) e corriola (*Ipomoea triloba*). Um experimento de campo foi conduzido em Santa Maria, RS. Dez plântulas com duas folhas completamente desenvolvidas de cada espécie foram transplantadas em 27 de outubro de 2003 e cultivadas sem deficiência hídrica. O estágio de Haun no colmo principal (HS) no papuã e o número de folhas na haste principal (MSL) na corriola foram medidos duas vezes por semana. A soma térmica diária (STd_i, °C.d) foi calculada usando uma temperatura base de 10°C. A soma térmica acumulada (TT) a partir do transplante até 22-28 MSL foi calculada somando-se STd_i. Foi realizada análise de regressão linear entre número de folhas (HS e MSL) e TT. O coeficiente angular da regressão linear é a LAR (folhas/°C.d) e o filocrono (°C.d/folha) foi estimado pelo inverso do coeficiente angular da regressão linear. A LAR foi menor no papuã (0,0262 folhas/°C.d) do que na corriola (0,0508 folhas/°C.d).

Palavras-chave: filocrono, soma térmica, graus-dia.

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Rev. Bras. Agrometeorologia, v. 14, n.2, p.248-251, 2006

Quantifying weed growth and developmental parameters is important and of interest in weed-crop competition studies and for weed management strategies. The ability of weeds to compete with crops for light is related to the rate that their leaves appear and expand (**CHAUVEL** et al., 2000). The calculation of the leaf appearance rate (LAR) is an important part of many crop simulation models (AMIR & SINCLAIR, 1991), including weed models (**CHAUVEL** et al., 2000). Integrating LAR over time gives the number of accumulated leaves on a stem (NL), which is an excellent measure of plant development (STRECK et al., 2003). The NL is also related to tiller appearance, to the timing of certain developmental stages, and to plant leaf area expansion (KLEPPER et al., 1982; McMASTER et al., 1991; STRECK et al., 2003).

The LAR has dimensions of [LEAF/TIME]. The time dimension in LAR can be expressed in thermal time (TT), with units of degree days (°C.d), which is a better time descriptor than calendar days (GILMORE & ROGERS, 1958; ARNOLD, 1960). Thus, a frequent unit of LAR is leaves/°C.d. Another way to express LAR is through the concept of the phyllochron, which is the time interval between the appearance of two successive leaves, with units of °C.d/leaf (KLEPPER et al., 1982; KIRBY, 1995).

Alexander grass (*Brachiaria plantaginea*) and morning glory (*Ipomoea triloba*) are important weeds that compete with summer crops in Brazil. While studies quantifying LAR in crops are often available (WARRINGTON & KANEMASU, 1983; SINCLAIR, 1986; MAJOR et al., 1990; STRECK et al., 2004), LAR values for weeds are rare (**CHAUVEL** et al., 2000). A literature search yielded no report of LAR in these two weed species, which constituted the rationale for this effort. The objective of this study was to determine the LAR based on thermal time in Alexander grass and morning glory weeds.

A field experiment was conducted at the experimental area, Plant Science Department, Federal University of Santa Maria (UFSM), Santa Maria, RS, Brazil (latitude: 29°43'S, longitude: 53°43'S and altitude: 95m) during the Summer 2003-2004. Ten seedlings of Alexander grass and morning glory were selected from a fallow field in the UFSM Campus immediately after emergence. On 27 October 2003, these ten seedlings had two fully developed leaves and were transplanted to a nearby plot in two rows (one row for each species). The rows were 1 m apart and plants were spaced 0.25m within the row. Each plant was a replication. Plants were irrigated as needed to avoid stress due to low soil water content. The amount of water used in the irrigation was empirically estimated based on Pan evaporation measured in a conventional weather station located about 200 m from the experimental area. On 03 November 2003, plants were fertilized with N-P-K at a rate of $40 g.m^{-2}$.

The main stem of each plant was tagged with a colored wire after transplanting. The main stem leaf number (MSL) was counted twice a week from 13 November 2003 to 06 January 2004 in all plants of both species. In Alexander grass, the blade length of the last and the penultimate main stem leaves was measured in order to calculate the main stem Haun Stage, HS (HAUN, 1973). In morning glory, a leaf was counted when its borders were unfolded. Daily degree days (STd_i) were calculated as (GILMORE & ROGERS, 1958; ARNOLD, 1960):

$$STd_i = (Tmean_i - Tb) \cdot 1\ day \quad \{°C.d\} \qquad (1)$$

where Tmean is the mean air temperature calculated as the average of the daily minimum and maximum air temperatures, and Tb is the base temperature. No reports have been found in the literature about Tb for LAR in these two weeds. Because in Subtropical climates as Rio Grande do Sul State these two weeds are naturally found infesting summer crops fields, a Tb=10°C was assumed in this study, i.e. the same Tb for LAR in summer crops such as maize (WARRINGTON & KANEMASU, 1983), sorghum (MAJOR et al., 1990), and soybean (SINCLAIR, 1986). Daily minimum and maximum air temperatures were measured in a conventional weather station located about 200 m from the experimental area. Accumulated thermal time (TT) from transplanting (i=1) to 22 MSL for Alexander grass and to 28 MSL for morning glory (i=n) was calculated by:

$$TT = \sum_{j=1}^{n} Std_i \quad \{°C.d\} \qquad (2)$$

The number of leaves (HS in Alexander grass and MSL in morning glory) was linearly regressed against TT. The slope of the linear regression is the LAR (leaves/°C.d). The phyllochron (°C.d/leaf) was estimated by the inverse of the slope of the linear regression (KLEPPER et al., 1982; KIRBY, 1995; STRECK et al., 2004).

There was a strong relationship (R^2=0.99) between main stem leaf number (HS and MSL) and TT for both weed species (Figure 1). This strong relationship indicates that temperature is a major environmental factor that affects leaf appearance in the two weed species. The slopes of the linear regressions presented in Figure 1 are the LAR values of the two species. The intercepts of the linear regressions were negative but this coefficient is not of interest in this study, as it is dependent upon the day that TT used in the abscissa starts to be accumulated (STRECK et al., 2004). LAR was lower in Alexander grass (0.0262 leaves/°C.d) than in morning glory (0.0508 leaves/°C.d). The inverse of LAR, the phyllochron, was 38.2 °C.d/leaf in Alexander grass and 19.7 °C.d/leaf in morning glory.

The phyllochron of both weed species estimated in this study is lower than the phyllochron of summer crops. Comparing summer C4 species, the phyllochron of Alexander grass was about 15% lower than in maize (45.2 °C.d/leaf, WARRINGTON & KANEMASU, 1983) and about 26% lower than in sorghum (51.7 °C.d/leaf, MAJOR et al., 1990). Comparing summer C3 species, the phyllochron of morning glory was about 65% lower than in soybean (55.5 °C.d/leaf, SINCLAIR, 1986). A lower phyllochron (a higher LAR) of the weed species compared to crops contributes for the high ability of weeds to compete for light with crops.

LAR and phyllochron values for the two weed species used in this study were not available and the results presented here are important contributions for the weed science area. However, the results reported here are from a one-year field experiment. Rate of leaf appearance and the phyllochron of other crop and weed species are reported to vary with sowing date McMASTER & WILHELM, 1995; KIRBY, 1995; **CHAUVEL** et al., 2000) and among years (FRANK & BAUER, 1995; **CHAUVEL** et al., 2000). Radiation and photoperiod are among the environmental factors that modify the LAR and the phyllochron of weed species in different sowing dates and growth conditions (**CHAUVEL** et al., 2000). Therefore, more experiments will have to be carried to quantify LAR and phyllochron of these two weed species in different sowing dates and years.

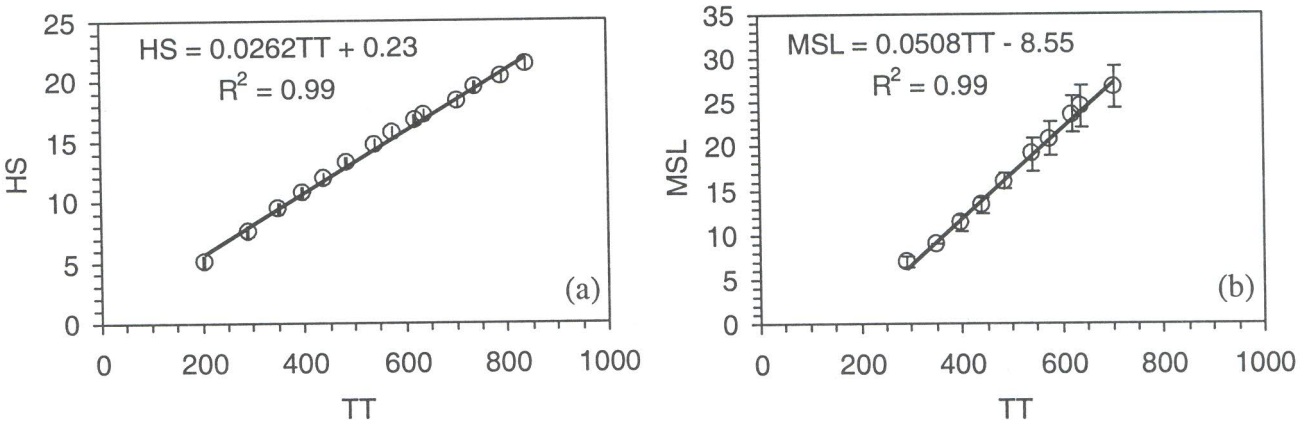

Figure 1. Number of leaves expressed as main stem Haun Stage (HS) and main stem leaf number (MSL) as a function of thermal time (TT, °C.d) in two weeds: (a) Alexander grass (*Brachiaria plantaginea*) and (b) morning glory (*Ipomoea triloba*). Santa Maria, RS, Brazil, 2003/2004. Error bars represent ± one standard deviation.

Rev. Bras. Agrometeorologia, v. 14, n.2, p.248-251, 2006

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