

# Base temperature for node emission and plastochron determination in tomato species and their hybrids

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**Abstract** – The objective of this work was to estimate the base temperature for node emission and plastochron determination in wild species of tomato, in the Redenção cultivar, and in their respective interspecific F<sub>1</sub> hybrids. The wild accessions *Solanum pimpinellifolium* AF 26970, *Solanum galapagense* LA-1401, *Solanum peruvianum* AF 19684, *Solanum habrochaites* var. *hirsutum* PI-127826, *Solanum habrochaites* var. *glabratum* PI-134417, and *Solanum pennellii* LA-716; the cultivar Redenção (*Solanum lycopersicum*); and their respective interspecific hybrids were evaluated, on the transplanting dates 12/22/2015, 2/12/2016, and 4/6/2016. The base temperature was estimated using the least mean squared error of the linear regression between the number of nodes and the accumulated thermal sum. The plastochron for the main stem and the first three lateral stems was estimated using the base temperature. The base temperature for node emission and plastochron determination varied from 4.5 to 14.8°C. The species *S. habrochaites* var. *hirsutum* accession PI-127826, *S. habrochaites* var. *glabratum* accession PI-134417, and their hybrids with the Redenção cultivar showed the lowest base temperatures and plastochron for the main stem, whereas the remaining wild species and interspecific hybrids had a base temperature near that of cultivated tomato. Wild species and interspecific hybrids of tomato show a great variation in base temperature for node emission and plastochron determination.

**Index terms:** *Solanum lycopersicum*, pre-breeding, thermal time, wild accessions.

## Temperatura-base para emissão de nós e determinação de plastocrono em espécies de tomateiro e seus híbridos

**Resumo** – O objetivo deste trabalho foi estimar a temperatura-base para emissão de nós e determinação de plastocrono em espécies silvestres de tomateiro, na cultivar Redenção e em seus respectivos híbridos interespecíficos F<sub>1</sub>. Avaliaram-se os acessos silvestres *Solanum pimpinellifolium* AF 26970, *Solanum galapagense* LA-1401, *Solanum peruvianum* AF 19684, *Solanum habrochaites* var. *hirsutum* PI-127826, *Solanum habrochaites* var. *glabratum* PI-134417 e *Solanum pennellii* LA-716; a cultivar Redenção (*Solanum lycopersicum*); e os seus respectivos híbridos interespecíficos, nas datas de transplante 22/12/2015, 12/2/2016 e 6/4/2016. A temperatura-base foi estimada com o método do menor quadrado médio do erro da regressão linear entre o número de nós e a soma térmica acumulada. O plastocrono para a haste principal e as três primeiras hastes laterais foi estimado com uso da temperatura-base. A temperatura base para emissão de nós e determinação do plastocrono variou entre 4,5 e 14,8°C. As espécies *S. habrochaites* var. *hirsutum* acesso PI-127826, *S. habrochaites* var. *glabratum* acesso PI-134417 e os respectivos híbridos com a cultivar Redenção apresentaram os menores valores de temperatura-base e plastocrono da haste principal, enquanto as demais espécies silvestres e os híbridos interespecíficos tiveram temperatura-base próxima à do tomateiro cultivado. As espécies silvestres e os híbridos interespecíficos de tomate mostram grande variação na temperatura-base para emissão de nós e determinação do plastocrono.

**Termos para indexação:** *Solanum lycopersicum*, pré-melhoramento genético, soma térmica, acessos silvestres.

## Introduction

The cultivated tomato (*Solanum lycopersicum* L.) has 16 species, besides the cerasiforme variety, which show higher or lower interspecific cross-compatibility

(Peralta et al., 2008). Each species has specific minimum, maximum, optimum development, and growth temperatures. For grown tomatoes, the lower, upper, and optimal base temperatures for the emission of vegetative structures are, respectively, 10, 34, and



22°C (Pivetta et al., 2007). However, since there are no records of the cardinal temperatures for the growth and development of wild tomato species, there is a lack of basic information about the development of these species as a function of air temperature, which could facilitate the transfer of desirable characteristics and the selection of materials in breeding programs.

Since commercial tomato cultivars are susceptible to injury at temperatures close to or below 5°C (Easlon et al., 2013) and show limited production in regions of low air temperature (Venema et al., 2000, 2008), the variability wild in species should be assessed for tolerance to this type of stress. Unlike the cultivated tomato, wild species, especially *Solanum habrochaites* S.Knapp & D.M.Spooner, are adapted to a wide range of latitudinal distribution and show favorable characteristics to plant development and growth even when thermal conditions are not so favorable during the day or along the cycle (Brüggemann & Linger, 1994).

In general, the response of plants to environmental conditions is evaluated by the qualitative and quantitative description of their physiological behavior (Venema et al., 2008; Otto et al., 2013). However, the base air temperature limiting leaf or node emissions is commonly estimated by mathematical models. These models simulate plant development as a function of the required thermal sum and have been adopted, for example, by Martins et al. (2007) for seedlings of two species of eucalyptus (*Eucalyptus saligna* Sm. and *Eucalyptus grandis* W.Hill), by Erpen et al. (2013) for sweet potato [*Ipomoea batatas* (L.) Lam.], by Lucas et al. (2012) for watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai], by Callejas et al. (2014) for Roxa mango (*Mangifera indica* L.) cultivar, and by Müller et al. (2009) for ryegrass (*Lolium multiflorum* Lam.).

In addition to base temperature, the thermal sum is a measure used to observe the effect of temperature on vegetative development and growth, in °C day (Heldwein et al., 2010; Lucas et al., 2012). The thermal sum has a strong relationship with the emission of vegetative structures in tomatoes; therefore, the concept of plastochron (°C day by node), which is the period of time between the emergence of two successive nodes on the stem, allows estimating the number of nodes as a function of air temperature (Pivetta et al., 2007). Studies using the plastochron concept have been carried out for several agricultural species such

as safflower (*Carthamus tinctorius* L.) by Streck et al. (2005), soybean [*Glycine max* (L.) Mer.] by Streck et al. (2008), cotton (*Gossypium hirsutum* L.) by Pereira et al. (2010), crambe (*Crambe abyssinica* Hochst.) by Toebe et al. (2010), snap beans (*Phaseolus vulgaris* L.) by Heldwein et al. (2010), watermelon by Lucas et al. (2010), sunflower (*Helianthus annuus* L.) by Souza et al. (2016), grapevine (*Vitis vinifera* L.) by Zeist et al. (2016, 2017), and even tomato by Pivetta et al. (2007). However, as is this case with base temperature, no studies using this concept are known for wild tomato species and interspecific hybrids.

Reliable base temperature and plastochron estimates allow identifying plant phenological behavior, defining management practices, assisting crop agricultural zoning, and identifying of genotypes best adapted to certain climatic conditions (Martins et al., 2007). Cultivars that require lower base temperatures for the emission of vegetative structures show lower susceptibility and greater efficiency, by increasing the production and adaptation of the tomato in sites where the temperatures are below 10°C.

The objective of this work was to estimate the base temperature for node emission and plastochron determination in wild species of tomato, in the Redenção cultivar, and in their respective interspecific F<sub>1</sub> hybrids.

## Materials and Methods

The experiments were carried out in 2015 and 2016, at the plant research center of the Agronomy Department of Universidade Estadual do Centro-Oeste, located in the municipality of Guarapuava, in the state of Paraná, Brazil (25°38'S, 51°48'W, at an altitude of 1,100 m). The climate is of the humid mesothermal subtropical type according to Köppen's classification, with an irregular dry season, warm summer, and moderate winter (Wrege et al., 2011).

The experimental design was a randomized complete block with three replicates, and the treatments were distributed in a 13x3 factorial arrangement (genotypes x transplanting dates). The replicates consisted of three plants, with a spacing of 0.40 between pots. The genotypes evaluated were six wild accessions of tomato (*Solanum pimpinellifolium* accession AF 26970, *S. galapagense* accession LA-1401, *S. peruvianum* accession AF 19684, *S. habrochaites* var. *hirsutum*

accession PI-127826, *S. habrochaites* var. *glabratum* accession PI-134417, and *S. pennellii* accession LA-716), the commercial cultivar Redenção (strain of *S. lycopersicum* with characteristics for processing), and their respective interspecific  $F_1$  hybrids, ('Redenção' x AF 26970, 'Redenção' x LA-1401, 'Redenção' x AF 19684, 'Redenção' x PI-127826, 'Redenção' x PI-134417, and 'Redenção' x LA-716), obtained from the cross between 'Redenção' (female parent) and the wild accessions (male parents), on three transplanting dates: 12/22/2015, 2/12/2016, and 4/6/2016.

Sowing was performed in 200-cell expanded polystyrene trays containing commercial substrates based on bio-stabilized pine bark, maintained in a floating hydroponic system in a greenhouse. The AF 26970 and AF 19684 accessions, as well as the interspecific hybrids, were sown together with the Redenção cultivar. The LA-1401, PI-127826, PI-134417, and LA-716 accessions were sown ten days earlier because the differences in their germination, emergence, and development. In order to guarantee a sufficient amount of seedlings, two seeds per cell were sown, with subsequent thinning of the seedlings between four and five days after emergence, leaving one seedling per cell.

Transplanting was performed when the seedlings had 4–5 leaves defined and expanded at 27, 25, and 26 days after emergence of the female parent on 12/22/2015, 2/12/2016, and 6/4/2016, respectively. The seedlings were transplanted into pots with a capacity of 8 dm<sup>3</sup>, which contained sieved soil and bovine manure in the proportion of 3:2. The soil was classified as an Oxisol of very clayey texture (Santos et al., 2013). The compound of sieved soil and bovine manure was previously corrected according to soil chemical analysis, by applying calcitic limestone, to raise base saturation 80% and to maintain the ratio of 4:1 between Ca and Mg. For basic planting fertilization, 15 g N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O (04-20-20) and 7.0 g simple superphosphate were applied per pot.

Micro-drip irrigation was performed according to plant needs. The phytosanitary control was carried out according to the technical recommendations for the culture, with preventive sprayings of the commercial products: thiamethoxam (Actara), thiamethoxam + lambda-cyhalothrin (Engeo Pleno), copper oxychloride + mancozeb (Cuprozeb), and azoxystrobin + difenoconazole (Amistar Top).

During the experimental period, the daily data of minimum and maximum air temperatures were collected using maximum-minimum temperature thermometers. After the seedlings were transplanted, the number of nodes visible on the main stem and on the first three first-order lateral stems of each plant was counted weekly during the development and growth cycle. A new node was identified when it presented a leaf of at least 1 cm in length (Pivetta et al., 2007).

The daily thermal sum (dT<sub>S</sub>, °C day) was calculated as proposed by Arnold (1960),  $dT_S = (T_{mean} - T_{base})$  for 1 day; in which  $T_{mean}$  is the mean air temperature, calculated by the arithmetic mean between minimum and maximum air temperatures, and  $T_{base}$  is the base temperature for node emission, below which there is no emission of new vegetative structures. The accumulated thermal sum (aT<sub>S</sub>, °C day) was defined by the sum of the daily values ( $aT_S = \sum dT_S$ ).

The number of nodes in the main stem was used to estimate  $T_{base}$ , through the method of the least mean squared error (LMSE) of the linear regression between the number of nodes and the aT<sub>S</sub> (Sinclair et al., 2004; Martins et al., 2007; Lucas et al., 2012). According to these authors,  $T_{base}$  values from 0 to 20°C, with intervals of 0.5°C, were tested in the mathematical model for the calculation of the dT<sub>S</sub>. The simple linear regression equations were estimated using the number of nodes in the main stem of each plot, and the aT<sub>S</sub> was calculated with the different  $T_{base}$ . From the arithmetic mean of the plots, the LMSE was plotted as a function of  $T_{base}$ . The  $T_{base}$  value was obtained when the LMSE was observed.

For  $T_{base}$  estimation, the number of nodes was counted from transplanting up to the beginning of fruit emergence on the stem, when at least 50% of the plants in the plot had at least one fruit at an early development stage. This period was chosen because, after the emergence of the first fruits, some tomato species and interspecific hybrids stopped the emission of nodes in the fruit stem.

The plastochron for the main stem and the first three lateral stems was estimated from  $T_{base}$ , considering the same period of development and growth used to calculate  $T_{base}$ . For this estimate, the inverse linear regression coefficient between the number of nodes visible on the stem and the aT<sub>S</sub> was used (Martins et al., 2007; Pivetta et al., 2007).

The plastochron data obtained from parents and interspecific hybrids were tested for normality and homogeneity of residual variances by the Lilliefors and Bartlett's tests, respectively. Subsequently, the data were subjected to the individual and joint analysis of variance by the F-test. When significant, means were subjected to the Scott-Knott grouping test, at 5% probability, and analyzed by the statistical software Assisat, version 7.7 (Silva & Azevedo, 2016).

## Results and Discussion

The average air temperature was 23.8, 23.0, and 18.3°C, and the absolute minimum and maximum temperatures were 14.1 and 33.9°C, 9.0 and 32.6°C, and 0.3 and 33.4°C, respectively, for the transplanting dates 12/22/2015, 2/12/2016, and 4/6/2016 (Figure 1).

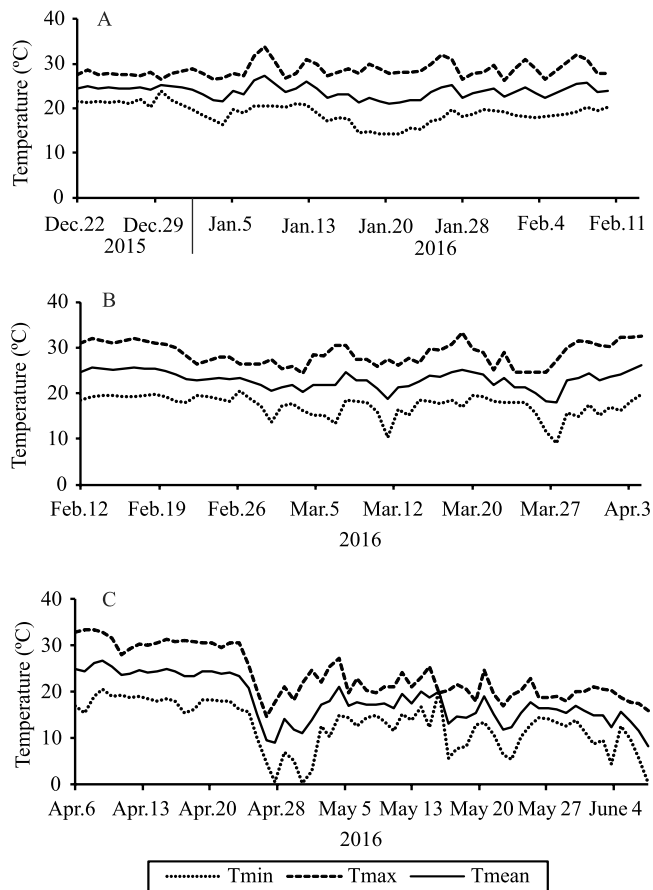
The regression equations between the number of nodes visible on the main stem and the aTS for the genotypes showed a close relationship ( $R^2 \geq 0.91$ ), pointing to linearity. In addition, air temperature was considered the main meteorological element to control the emergence of vegetative structures, as also verified by Pivetta et al. (2007) in cultivated tomato, Martins et al. (2007) in eucalyptus, and Streck et al. (2005) in safflower. Likewise, Liu & Heins (2002) stated the importance of thermal energy to plant growth and development due to the high linearity between the numbers of nodes and accumulated thermal sum of tomato species and interspecific hybrids.

A variation was observed for the LMSE of the regression equations for the Tbase values used to calculate the aTS of the genotypes on the three transplanting dates (Figure 2). The LMSE method was efficient in estimating the Tbase for all genotypes on all dates, except 12/22/2015 when the AF 26970 and LA-716 accessions and the 'Redenção' x AF 19684 hybrid presented decreasing LMSE with increasing Tbase.

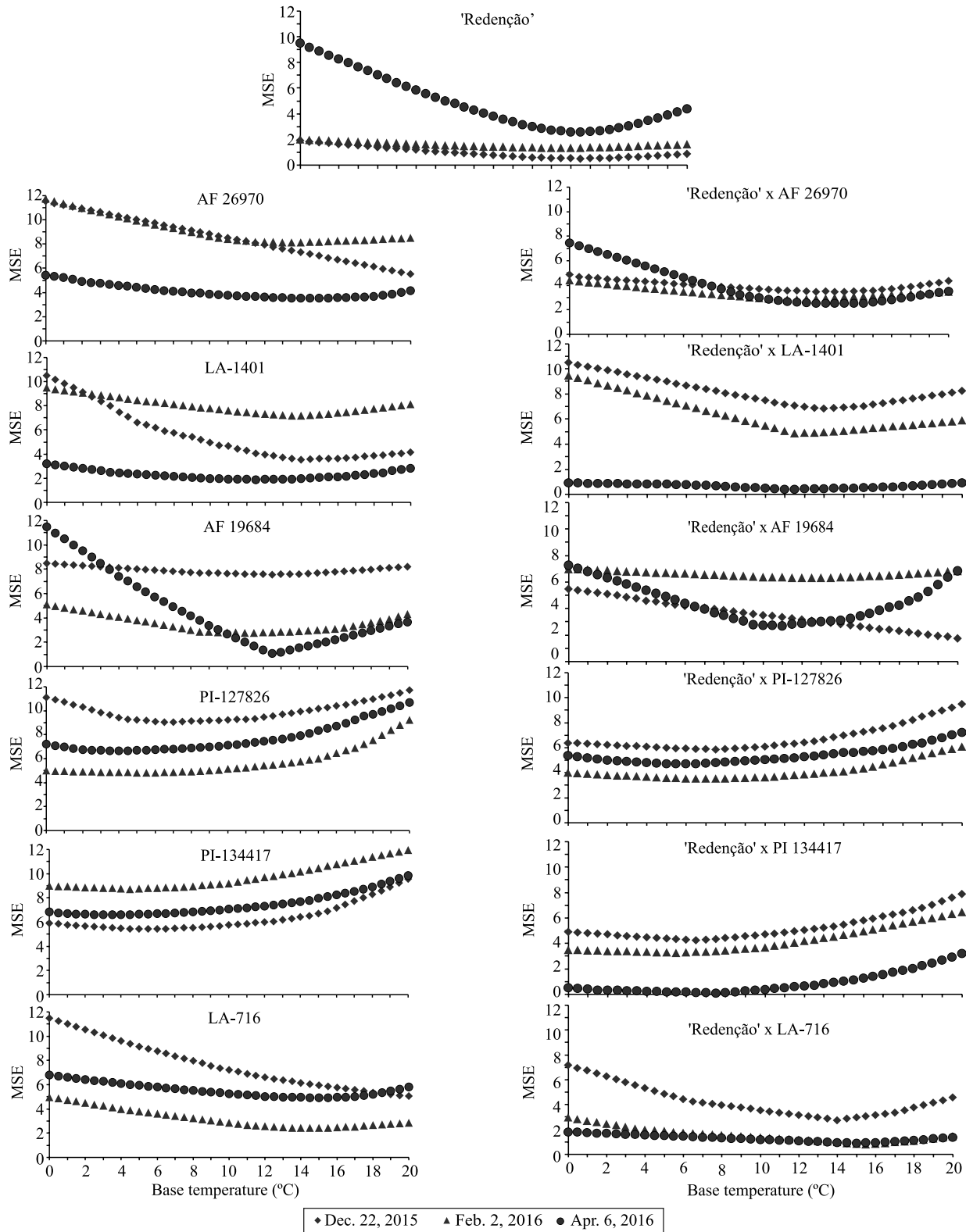
In general, the estimated Tbase varied little among the three dates. The lowest Tbase values were verified for the wild species *S. habrochaites* var. *hirsutum* accession PI-127826 and *S. habrochaites* var. *glabratum* accession PI-134417, with values for the three dates ranging from 3.5°C (4/6/2016) to 6.5°C (12/22/2015) and from 3.5°C (4/6/2016) to 5.5°C (12/22/2015), respectively (Figure 2).

The lower Tbase for node emission observed for *S. habrochaites* var. *hirsutum* is in alignment with Patterson et al. (1978) and Venema et al. (2008), who found this variety is adaptable to a wide range of latitudinal distribution, with favorable physiological characteristics for plant growth and development, even at lower temperatures. However, there are no known reports on the vegetative development of *S. habrochaites* var. *glabratum* with lower thermal availability.

Low Tbase values were also verified for the 'Redenção' x PI-127826 and 'Redenção' x PI-134417 hybrids at the transplanting dates, ranging from 5.5°C (4/6/2016) to 7.0°C (2/12/2016) and from 5.5°C



**Figure 1.** Minimum (Tmin), maximum (Tmax), and average (Tmean) air temperatures recorded during the monitoring of the Redenção cultivar (female parent), wild accessions (male parents), and respective interspecific hybrids of tomato (*Solanum lycopersicum*) on the transplanting dates 12/22/2015 (A), 2/12/2016 (B), and 4/6/2016 (C).



**Figure 2.** Mean squared error (MSE) of the linear regression between the number of nodes in the main stem and the accumulated thermal sum, using base temperatures to obtain the daily thermal sum, for the Redenção cultivar (female parent), wild accessions (male parents), and respective interspecific hybrids of tomato (*Solanum lycopersicum*) on the transplanting dates 12/22/2015, 2/12/2016, and 4/6/2016.

(2/12/2016) to 7.5°C (4/6/2016), respectively (Figure 2). These values showed that the F<sub>1</sub> hybrids inherited characteristics related to Tbase for nodal emission from their respective male parents, PI-134417 and PI-127826. In contrast, higher Tbase values were observed for the other genotypes, ranging from 11 to 15°C (Figure 2).

Since Tbase for node emission varied little between transplanting dates, Tbase values for thermal sum and plastochron estimates were defined as the arithmetic mean of the three transplanting dates. These values were the following: 14.2°C for 'Redenção', 13.8°C for AF 26970, 13.5°C for LA-1401, 12.2°C for AF 19684, 5.2°C for PI-127826, 4.5°C for PI-134417, 14.8°C for LA-716, 13.0°C for 'Redenção' x AF 26970, 11.8°C for 'Redenção' x LA-1401, 11.8°C for 'Redenção' x AF 19684, 6.3°C for 'Redenção' x PI-127826, 6.4°C for 'Redenção' x PI-134417, and 14.8°C for 'Redenção' x LA-716.

The average Tbase of the Redenção cultivar, i.e., 14.2°C (Figure 2), was 4.2°C higher than that of *S. lycopersicum* tomatoes. It should be noted that 'Redenção' is a cultivar with a specific growth habit, with characteristics for industrial processing, recommended for cultivation in the lower-middle region of the São Francisco basin (Ferraz et al., 2003). The climatic conditions of the area where the

breeding selection cycles were carried out to obtain the Redenção cultivar may have contributed to Tbase above 10°C, which was the value used to calculate the thermal sum, as in Pivetta et al. (2007).

The estimated Tbase for node emission is indicative of the thermal energy required for plant development to begin (Sinclair et al., 2004; Martins et al., 2007). The obtained results show that the PI-127826 and PI-134417 accessions and their interspecific F<sub>1</sub> hybrids required lower Tbase for node emission. The descendants of the varieties of *S. habrochaites*, *S. hirsutum*, and *S. glabratum* are an alternative for breeding programs to obtain strains able to develop vegetatively with less thermal energy availability.

The plastochron estimated for the main stem only differed between transplanting dates for the genitor *S. pennellii* accession LA-716, showing 24.4, 31.5, and 30.0°C day per node, respectively, for 12/22/2015, 2/12/2016, and 4/6/2016 (Table 1). The fact that the other genotypes showed similar plastochron values for the main stem is considered an advantage, since it makes the model more stable, broadly applicable, and easy to use, as also verified by Lucas et al. (2012) in 'Crimson Sweet' watermelon, at distinct cultivation dates and in three crop years.

The highest plastochron values for the main stem were observed in the LA-1401, AF 19684, and LA-

**Table 1.** Plastochron of the main stem for the Redenção cultivar (female parent), wild accessions (male parents), and respective interspecific hybrids of tomato (*Solanum lycopersicum*) on the transplanting dates 12/22/2015, 2/12/2016, and 4/6/2016<sup>(1)</sup>.

Genotype	Plastochron (°C day per node)			Average
	12/22/2015	2/12/2016	4/6/2016	
'Redenção'	17.8Ab	18.2Ac	18.1Ad	18.0c
AF 26970	18.1Ab	18.7Ac	19.3Ac	18.7c
LA-1401	23.8Aa	24.2Ab	25.7Ab	24.6b
AF 19684	25.5Aa	25.5Ab	26.2Ab	25.7b
PI-127826	16.0Ac	17.5Ad	18.2Ad	17.2d
PI-134417	16.5Ac	18.5Ac	18.7Ad	17.9d
LA-716	24.4Ba	31.5Aa	30.0Aa	28.6a
'Redenção' x AF 26970	18.5Ab	19.5Ac	20.3Ac	19.4c
'Redenção' x LA-1401	17.8Ab	19.1Ac	20.1Ac	19.0c
'Redenção' x AF 19684	18.1Ab	19.1Ac	20.3Ac	19.2c
'Redenção' x PI-127826	15.7Ac	16.3Ad	17.9Ad	16.6e
'Redenção' x PI-134417	15.1Ac	16.2Ad	16.9Ad	16.1e
'Redenção' x LA-716	18.4Ab	19.5Ac	20.0Ac	19.3c
Average	18.81C	20.30B	20.91A	-

<sup>(1)</sup>Means followed by equal letters, uppercase in lines and lowercase in columns, do not differ by Scott-Knott's test, at 5% probability.

716 wild accessions on 12/22/2015; and in LA-716 on 2/12/2016 and 4/6/2016 (Table 1). These results show that the accessions required a greater accumulation of thermal energy to emit a node for the same air temperature on the different transplanting dates.

In relation to the first three lateral stems, the lowest plastochron values for the first two lateral stems were observed for the Redenção cultivar and the LA-1401 and PI-134417 accessions, as well as for the 'Redenção' x AF 26970 and 'Redenção' x LA-716 hybrids. The lowest values for the third lateral stem were observed for 'Redenção' x LA-716 (Table 2). In the third lateral stem, there was a greater interaction between genotypes and transplanting dates than in the main stem and the other lateral stems (Tables 1 and 2).

In the three transplanting dates, both on the main stem and on the lateral stems, lower plastochron values were found for the 'Redenção' x LA-716 interspecific hybrid, when compared with the LA-716 male parent (Tables 1 and 2). This result makes it possible to infer that the 'Redenção' x LA-716 hybrid required a lower aTS for the appearance of nodes in the main and lateral stems than its wild parent. A similar behavior was also verified for the 'Redenção' x LA-1401 and 'Redenção' x AF 19684 hybrids on the main stem, 'Redenção' x AF 26970 on the first lateral stem, and 'Redenção' x PI-127826 on the third lateral stem, which presented lower plastochron values than

the male parents. These results are possibly related to the heterotic effect due to the crosses of contrasting tomato genotypes (Figueiredo et al., 2017). In the present study, the interspecific crosses reduced the plastochron values obtained for the hybrid, compared with the average of the parents, showing a value close to that of the Redenção cultivar.

The accession *S. galapagense* LA-1401 was the only genotype with a lower plastochron value in the lateral stems than in the main stem in the three transplanting dates; the other genotypes showed a lower plastochron value on the main stem than on the lateral ones (Tables 1 and 2). For the Redenção cultivar, the AF 19684 and LA-716 accessions, and the 'Redenção' x AF 26970, 'Redenção' x LA-1401, 'Redenção' x AF 19684, 'Redenção' x PI-127826, and 'Redenção' x PI-134417 hybrids, lower plastochron values were observed in the first two lateral stems (Table 2).

For *S. habrochaites* var. *glabratum* accession PI-134417 (Figure 2), besides the lower average Tbase (4.5°C), low plastochron values were found for the main and lateral stems (Tables 1 and 2). Therefore, it can be inferred that this accession, as well as *S. habrochaites* var. *hirsutum* accession PI-127826, if developed with lower thermal availability, shows a greater efficiency in node emission as a function of air temperature.

**Table 2.** Plastochron (°C day per node) of the three first-order lateral stems for the Redenção cultivar (female parent), of wild accessions (male parents), and respective interspecific hybrids of tomato (*Solanum lycopersicum*) on the transplanting dates 12/2/2015, 2/12/2016, and 4/6/2016<sup>(1)</sup>.

Genotype	LS1			Average	LS2			Average	LS3			Average
	12/22/2015	2/12/2016	4/6/2016		12/22/2015	2/12/2016	4/6/2016		12/22/2015	2/12/2016	4/6/2016	
'Redenção'	18.1Ac	19.0Ac	20.0Ac	19.0d	20.4Ad	19.5Ac	21.7Ac	20.5c	32.0Ac	31.5Ad	33.2Ad	32.0e
AF 26970	28.2Ab	26.9Ab	29.3Ab	28.1b	27.5Ac	29.3Ab	31.1Ab	29.3b	29.7Ac	30.3Ad	32.1Ad	30.7e
LA-1401	19.9Ac	20.1Ac	21.4Ac	20.5d	20.0Ad	21.1Ac	22.4Ac	21.2c	20.0Ad	19.1Ae	22.4Ae	20.5f
AF 19684	27.1Ab	28.0Ab	29.2Ab	28.1b	25.3Ac	28.0Ab	25.7Ac	26.3b	31.3Ac	30.6Ad	33.0Ad	31.6e
PI-127826	25.0Cb	33.5Ba	41.2Aa	33.2a	40.0Ab	40.9Aa	43.0Aa	41.3a	59.8Ba	57.2Bb	68.0Aa	61.7b
PI-134417	18.4Ac	18.9Ac	19.5Ac	18.9d	20.2Ad	20.0Ac	21.9Ac	20.7c	20.9Ad	19.8Ae	21.1Ae	20.6f
LA-716	32.0Aa	33.5Aa	30.9Ab	32.1a	49.0Aa	29.3Bb	48.2Aa	42.2a	61.0Ba	85.2Aa	58.7Bb	68.3a
'Redenção' x AF26970	21.5Ac	22.5Ac	23.3Ac	22.4c	21.7Ad	20.9Ac	21.0Ac	21.2c	30.7Bc	30.0Bd	44.6Ac	35.1d
'Redenção' x LA-1401	27.8Ab	28.1Ab	29.5Ab	28.5b	28.2Ac	29.0Ab	27.3Ac	28.2b	39.8Bb	41.1Bc	55.0Ab	45.3c
'Redenção' x AF 19684	27.7Ab	27.1Ab	28.9Ab	27.9b	25.7Ac	27.1Ab	26.3Ac	26.4b	40.1Ab	40.5Ac	43.9Ac	41.5c
'Redenção' x PI-127826	31.9Aa	33.9Aa	30.6Ab	32.1a	37.0Bb	33.2Bb	46.8Aa	39.0a	44.0Ab	43.2Ac	42.0Ac	43.1c
'Redenção' x PI-134417	32.7Aa	33.4Aa	33.1Ab	33.1a	22.3Bd	32.0Ab	34.6Ab	29.6b	39.5Ab	43.0Ac	42.7Ac	41.7c
'Redenção' x LA-716	19.9Ac	21.9Ac	22.1Ac	21.3c	21.9Ad	22.5Ac	25.2Ac	23.2c	30.4Ac	21.7Ae	22.9Ae	25.0f
Average	25.4C	26.7B	27.6A	-	27.6B	27.1B	30.4A	-	36.7B	37.9B	39.9A	-

<sup>(1)</sup>Means followed by equal letters, uppercase in lines and lowercase in columns, do not differ by Scott-Knott's test, at 5% probability. LS1, first lateral stem; LS2, second lateral stem; and LS3, third lateral stem.

## Conclusions

1. Wild species and interspecific hybrids of tomato (*Solanum lycopersicum*) show a great variation in base temperature for node emission and plastochron determination.

2. The wild species of tomato *S. habrochaites* var. *hirsutum* accession PI-127826 and *S. habrochaites* var. *glabratum* accession PI-134417, as well as their hybrids with *S. lycopersicum*, present the lowest values of base temperature and plastochron for the main stem, while the other wild species and interspecific hybrids have a base temperature close to that of the cultivated tomato.

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