Blooming Time Differences Among Seedling Peach Clones

Jorge A. Zegbe-Domínguez and Agustín F. Rumayor-Rodríguez, *Instituto Nacional de Investigaciones Forestales y Agropecuarias-Campo Experimental Calera, Apartado Postal No. 18, Calera, Zac., 98500, México.*

ABSTRACT. Fourteen outstanding clones of local seedling peaches were studied in relation to their blooming time. The cultivar 'Sam Houston' served as the control. Bloom length in julian days of six phenological stages (from bud swell to the end of blooming), and estimated heat requirements (growing degree hours) to reach each stage were used. Based on three years of field observations, differences in blooming were detected among genotypes, where S66 and 'Sam Houston' had the earliest date of full bloom (March 6th and 12th, respectively); while S134 was the latest blooming clone (April 4th). Important differences in heat requirements to reach full bloom between genotypes and years were also observed, suggesting that late blooming in our local seedling peaches may be due to different heat requirements during ecodormancy.

RESUMEN. Catorce genotipos sobresalientes de duraznero criollo y 'Sam Houston' como testigo, fueron estudiados en relación a su período de floración, usando la longitud de floración en días julianos en seis estadíos fenológicos (desde yema hinchada hasta el fin de la floración), y estimando los requerimientos térmicos (unidades calor) para cada estadío fenológico. Con Base en tres años de observación de campo, diferencias estadísticas significativas (P = 0.05) fueron detectadas entre genotipos, donde la selección S66 y 'Sam Houston' presentaron la floración más temprana (6 y 12 de marzo, respectivamente) y la selección S134 la más tardía (4 de abril). También, se observaron diferencias importantes en los requerimientos de calor entre genotipos y años, sugiriendo que la floración tardía en nuestro durazno criollo es debida a las diferencias en la cantidad de calor durante ecoletargo.

Peach growing in Zacatecas, México is an important activity, where approximately 25,000 ha are grown. These orchards have been almost exclusively established by seed for the last 50 years. Fruit type resembles a clingstone peach with a sweet, firm and yellow flesh that makes fruit suitable for the regional fresh market and industry. Due to the propagation method used, differences up to 40 days in blooming dates among individual trees within an orchard may be noted. In addition, a wide variation of fruit production in this region from season to season is common, particularly due to spring frosts which can cause blossom damage to early blooming genotypes. Frequent reductions in production does not allow growers to provide a consistent quantity of product to the industry and fresh market. Therefore, the selection of local seedling clones, along with the introduction and development of new genotypes, may be an approach to minimize spring frost injury by switching to late-blooming cultivars.

Late blooming of deciduous fruit trees has been associated with the length of winter chilling requirements to overcome the endodormant period, and the heat requirements in the ecodormant phase needed to initiate bud break in spring (Gianfagna and Mehlenbacher, 1985). Genotypes with high chilling requirements can not be grown in mild winter climates without observing several symptoms, such as delayed foliation and poor fruit set, associated with the lack of chilling (Erez, 1987); however, cultivars with bloom delayed due to a high heat requirements in the ecodormant phase would be useful in diverse environments (Gianfagna and Mehlenbacher, 1985).

The objective of this study was to evaluate local seedling peach clones according to their bloom dates, blooming time and heat requirements for blooming.

Materials and Methods

The experimental orchard was established in 1987 at "Campo Experimental Calera", 22°54'34" north latitude and 102°39'33" west longitude. The site is at

2,197 m above sea level, and has a mean annual temperature of 16.9C, while its mean chilling accumulation, from November to February, is 634 chill units (Richardson et al., 1974). However fluctuations from 250 to 1000 chill units may occur in "warm" and "cold" winters, respectively.

Fourteen late blooming clones of local seedling peaches with 'Sam Houston' as a control, were planted in 4 replicates of 3 trees, giving a total of twelve trees per genotype.

The length (BL) and dates (BT) for the blooming period of each genotype were studied by visual estimation of phenological stages in the spring of 1992, 1993 and 1994. Phenological stages were coded according to the following scale: 1 = bud swell, 2 = silver tip, 3 = green tip, 4 = beginning of blooming, 5 = full bloom (90 % of floral buds open) and 6 = end of blooming; although for this study, emphasis was made in the last three stages. Phenological stages were taken twice a week throughout the blooming period. Length of the blooming period (BL) of each genotype was calculated by subtracting julian dates for the beginning of blooming from those for the bloom end. Floral bud density (FBD) was estimated by taking five shoots, measuring their length, and making counts of the floral buds. Bud densities were only evaluated in seven selected clones with differences in bloom characteristics and yields, and it was expressed as number of buds per 20 cm of shoot length (NB/20 cm).

Winters were characterized by the estimation of total chill units (CU) from November to February each season by taking average temperatures (Richardson et al., 1974). The amount of growing degree hours (GDH) required to reach each of the above mentioned phenological stages was calculated by the residual method, with a base temperature of 4.5C (Lombard and Richardson, 1979). Calculations of heat accumulation was initiated when temperatures were high enough to negate chilling; this occurred in deferent dates each year. These dates were February 28th in 1992, January 21st in 1993, and, January 26th in 1994.

Blooming and GDH data were analyzed by a multiple linear autoregression model of first order, including dummy variables to detect significant statistical differences between genotypes. In addition, cluster analysis was used for grouping plant material according to the average distance of their heat requirements (GDH) for full bloom. Statistical analysis were carried out by PROC AUTOREG and PROC CLUSTER in SAS (SAS, 1985).

Results and Discussion

In the three experimental years, the tendencies for BT and BL of the included genotypes was conserved. The stepwise analysis of blooming characteristics, in a combined analysis for the three years, indicated that significant differences among clones were present. 'S66' and 'Sam Houston' were the earliest blooming clones, and S134 was the latest clone; while the remaining clones, were found to be intermediate (Fig. 1; Table 1). The differences in blooming among clones may

Table 1. Flower bud density and blooming time for seven selected peach clones at Campo Experimental Calera, Zacatecas, México. 1992-1994.

Clones	Blooming time[z] (days)	Mean flower bud density
Sam Houston	26 **[y]	13.0 b
S31	37 NS	20.8 a
S66	37 **	17.0 ab
S111	29 NS	21.0 a
S128	29 NS	17.6 ab
S134	35 *	13.8 b
S135	33 NS	20.2 a
Mean	32	17.6

[z]Mean of three years.
[y]Means separated by stepwise analysis. NS,*,** Nonsignificant or significant, Tukey's (P = 0.05 or 0.01), respectively.

be due to the time when an impulse to reinitiate growth is received and not only the response to a prolonged blooming period, as mentioned by Byrne (1986). This finding is based on data for 'Sam Houston' under our conditions, taking into consideration its origin and chilling requirements (550 CH) compared with the seedling genotypes included in the study.

The Mexican seedling clones had a larger number of flower buds per 20 cm of shoot length than 'Sam Houston' (Table 1). This result confirms previous studies reported by Pérez et al. (1993). Byrne (1986) reported bud densities for 'Texstar' of 13.1 NB/20 cm, which agree with the number of flower buds found in 'Sam Houston' in our work; therefore, it is suggested that the lower bud densities, (compared to our seedlings) is characteristic of cultivars originating in the United States. However, a diverse response was observed in clone S134, which is a local seedling and had similar FBD to 'Sam Houston'. This seedling clone has the highest chilling requirement in our collection, and this behavior could be related to poor adaptation to local conditions. A similar observation was found with 'Springcrest' cultivated under the climatic conditions of Rome Italy, compared to those under Mexican tropics (Pérez et al., 1993; Pérez-Gonzáles, 1993). FBD may be influenced by climate.
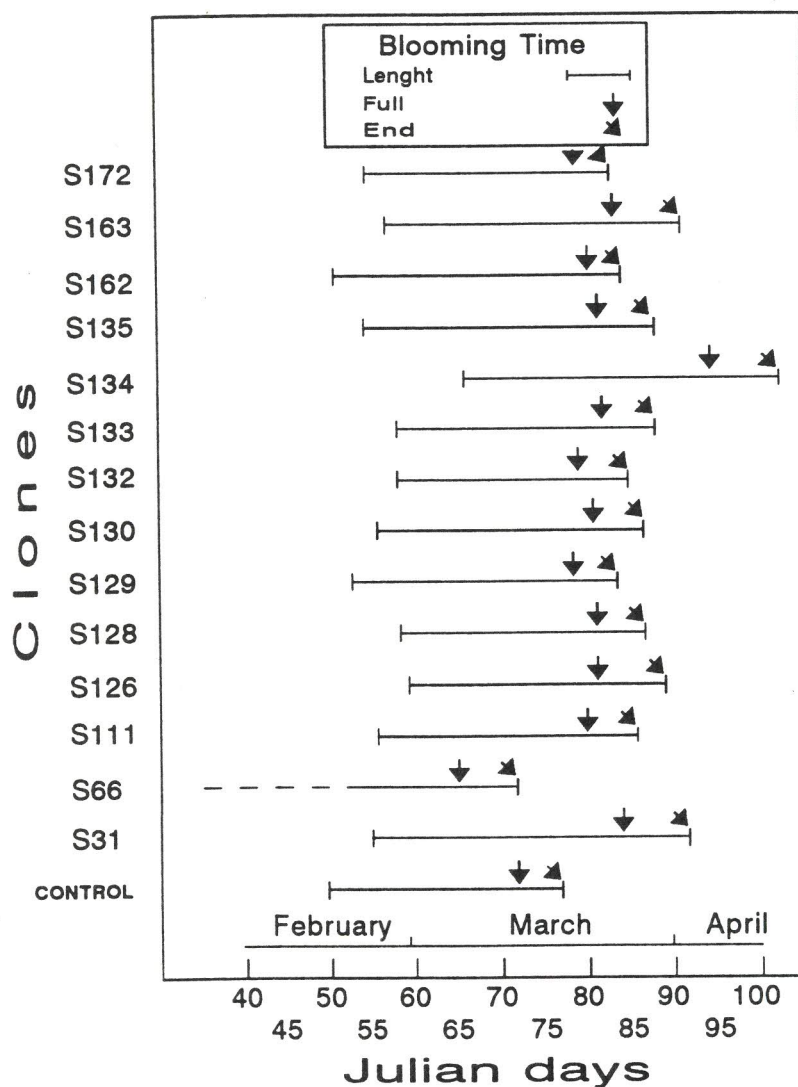

Figure 1. Length of blooming of 15 seedling peach clones at Campo Experimental Calera, Zacatecas, México.

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Late blooming and high FBD are desirable traits to reduce spring frost damage in this peach growing area. Additionally, it is advisable to have late harvest dates for economical reasons. These characteristics are opposite to other regions (Byrne, 1986).

The climatic information obtained for the 3 years of study indicated an inconsistency in winter chilling accumulation, which is considered normal in tropical and subtropical regions (del Real, 1987). Thus, in the 1991-92, 1992-93 and 1993-94 winters, 807, 310 and 127 CU were registered, respectively. The authors believe that the amount of accumulated chilling in the last two winters was not enough for the resumption of normal growth of all clones, since their average low temperature requirements are around 550 CH, (Bowen, 1971).

As a result of different chilling accumulation, GDH to full bloom among clones and years were modified. The GDH of all clones during the spring of 1992, when enough chilling to break dormancy was registered, were smaller than those of the next two springs, after winters with lack of chilling (Table 2) When the winter chilling was uniform and satisfied, the differences in GDH to reach full bloom among clones were more evident, which is explained by the coefficient of variation. On the other hand, the GDH to full bloom in all clones was larger when the winters had insufficient chilling than those in a cold winter (Fig. 2). This relation confirms previous research conducted under controlled environments in peach trees and others fruit trees species (Couvillon and Erez, 1985). However, it is clear that clones which had successfully completed their requirements during endodormancy or had been overexposed to chilling during ecodormancy, required a specific amount of high temperatures (GDH) to reinitiate growth. Other reports confirm this in peach (Werner et al., 1988) and other fruit tree species such as apple (Gianfagna and Mehlenbacher, 1985; Hauagge and Cummins, 1991), and sour cherry (Werner et al., 1988; Iezzoni and Mulinix, 1992).

Table 2. Growing degree hours (base temp. of 4.5C) accumulated to full bloom for 15 seedling peach clones at Campo Experimental Calera, Zacatecas, México.

| Clones | Growing Degree Hours | | | Pooled[z] | Day/Month[y] |
	1992	1993	1994		
Sam Houston	87	470	507	377 ± 185	12/03
S31	111	638	586	455 ± 274	25/03
S66	75	385	442	301 ± 161	06/03
S111	171	597	556	441 ± 218	21/03
S126	156	587	539	454 ± 198	23/03
S128	192	618	543	445 ± 196	22/03
S129	123	562	540	411 ± 221	19/03
S130	138	617	572	440 ± 227	22/03
S132	108	640	541	429 ± 259	20/03
S133	138	568	694	457 ± 248	23/03
S134	227	765	622	565 ± 212	04/04
S135	120	623	558	443 ± 233	22/03
S162	127	621	561	436 ± 231	21/03
S163	133	650	594	463 ± 250	24/03
S172	136	560	542	388 ± 213	19/03
Coeff. Var	29	10	7	48	

[z]Mean of three years ± SE.
[y]Mean date of full bloom in three years.

The variation detected among clones allowed for the formation of three groups according with their heat requirements to full bloom (392, 439 and 457 GDH). The lowest requirement group included 'Sam Houston' and clones S172 and S129; while clones S31, S126, S133 and S162 were grouped into the second group. The third group included clones S111, S128 S130, S132, S135 and S163.

On the other hand, cluster analysis detected two clones (S66 and S134) considered atypical within the collection (Fig. 3). Over three years, S66 bloomed on March 5th and required 301 GDH, while S134 achieved full bloom on April 4th and required 565 GDH. In this germplasm collection, both clones

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represented the extremes in relation to heat requirements. This suggests that some genotypes S129; while clones S31, S126, S133 and S162 were grouped into the second group. , such as clone S66, were selected for a high affinity to heat requirements instead of that of winter chilling; while other clones, such as S134, behaved inversely and had larger chilling requirements than 550 CU.

Data of several studies (Spiegel-Roy and Alston, 1979; Gianfagna and Mehlenbacher, 1985) suggest the possibility that the differences observed in spring bud break among genotypes is regulated more by high heat requirements in ecodormancy than chilling during endodormancy. This conclusion agrees to previous observations in apple (Gianfagna and Mehlenbacher, 1985), and peach and cherry (Werner et al., 1988). Therefore, it was possible to distinguish those clones (e.g. S66) with a "minimum" winter chilling requirement and a "minimum" amount of post-rest energy, which were able to bloom and set a good commercial crop, from those (e.g. S134) with high chilling and heat requirements which reduces its adaptation or introduction to diverse environments. These findings suggest the need to consider the computation of specific base temperatures for each included genotype (Gianfagna and Mehlenbacher, 1985; Werner et al., 1988). The obtained information will be important to improve germoplasm classification and their potential adaptation to different environments.
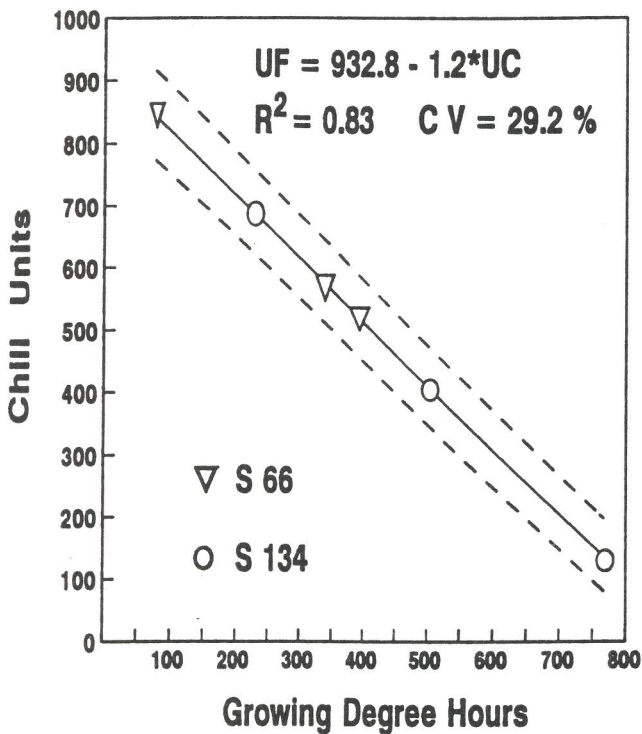

Figure 2. Predicted chill units based on growing degree hours required for 15 seedling peach clones. Area bound by dashed lines indicates a 95% confidence interval. Campo Experimental Calera, Zacatecas, México.
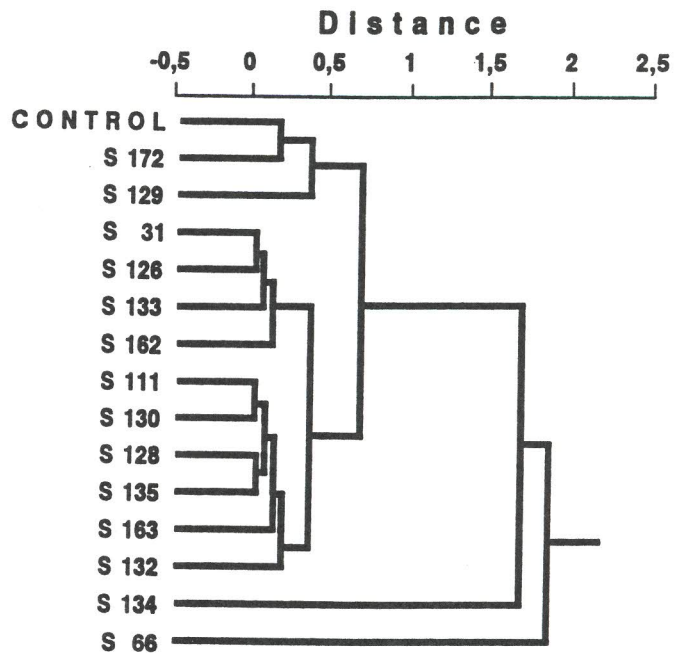

Figure 3. Dendogram of heat requirements for 15 seedling peach clones using the average distance method. Campo Experimental Calera, Zacatecas, México.

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