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Modifying Bloom and Harvest Date of Peach with Interstems and Rootstocks

T.G BECKMAN[1]

Abstract

Avoidance of spring freeze injury through bloom delay can provide more consistent cropping in areas prone to late spring frosts. In this study, a Ta Tao #6 interstem significantly retarded bloom of 'Springcrest' and 'Harvester' peach, averaging nearly 8 days delay. Significant freeze events occurred in two of the four cropping years observed. However, the bloom delay provided by a Ta Tao #6 interstem was sufficient in only one of these events to significantly improve fruit yield. Attempts to close a harvest gap between 'Harvester' and 'Redglobe' peach cultivars by altering fruit maturation were only partially successful. Fruit maturation of 'Harvester' and 'Springcrest' on Ta Tao #6 interstem trees was delayed on average 3.6 days over the 3 cropping seasons observed when compared to that of their 2-piece counterparts on Lovell seedling rootstock without the interstem. However, 2-piece trees of 'Redglobe' on Halford seedling rootstock failed to advance maturation compared to their counterparts on Lovell rootstock and the net shift in the harvest window of 'Harvester' peach was insufficient to close the 11-12 day gap observed between the two cultivars. Nevertheless, the use of Ta Tao interstems to delay bloom and fruit maturation may offer growers a useful tool to manage their spring frost risk and harvest management.

Introduction

Spring freeze injury is a major factor limiting peach production in the southeastern United States. Although complete crop losses are rare, significant reductions in crop load are a frequent occurrence. A variety of chemicals, oils and management practices have been shown to modify bloom date (1). Recent work has identified several interstems and rootstocks which are capable of modifying bloom date significantly (3,7,10,11,15,16).

A typical peach cultivar will provide marketable fruit over a 7-10 day harvest period. Hence, growers must carefully select a series of cultivars to provide an uninterrupted flow of product throughout the summer harvest season. In the absence of a continuous succession of high quality, productive, marketable cultivars for the Southeast, growers have expressed interest in manipulating currently preferred cultivars to fill perceived gaps in the production schedule. The use of interstems or rootstocks that could delay fruit maturation in combination with those that advance fruit maturation might allow the use of preferred cultivars over a significantly longer market period and, thus, close some of the current gaps between the harvest windows of popular cultivars.

[1] Research Horticulturist, United States Department of Agriculture, Agricultural Research Service, Southeastern Fruit and Tree Nut Research Laboratory, 21 Dunbar Road, Byron, GA 31008

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The purpose of this trial was to determine the efficacy of a Ta Tao #6 interstem to delay both bloom and fruit maturity and Halford rootstock to advance fruit maturation such that (1) spring freeze injury is minimized, and (2) a production gap between the 'Harvester' and 'Redglobe' cultivars could be narrowed or closed.

Materials and Methods

Two separate trials were prepared (Table 1). Trees of 'Redglobe' budded on Halford rootstock were purchased from a commercial nursery while all other treatments were prepared by the author. Ta Tao #6 (P.I. 101668) interstem treatments were constructed over 2 seasons with interstems ca. 22 cm in length. With the exception of the Ta Tao #6 interstem treatments all trees were 1-year old at planting. Trees were planted in March 1994 at a spacing of 6.1 m (between rows) x 4.6 m (in-row) at the Southeastern Fruit and Tree Nut Research Laboratory near Byron, Georgia. Soil type was a Faceville fine sandy loam, a clayey, kaolinitic, thermic, Typic Paleudult. Trees were trained to a standard open-center system and maintained according to standard commercial recommendations (6). No supplemental irrigation was supplied. Each spring trees were judged to be at full bloom when ca. 70% of flowers had opened (based on visual inspection). Fruit were harvested in the years from 1997 to 1999 at 3- to 4-day intervals at a commercially mature stage, i.e. as ground color changed from green to yellow. No attempt was made to sort cullage; hence, weights reported are gross yields. Trunk diameter was measured 30 cm from the soil surface at planting and each fall thereafter following defoliation (typically late November). Diameters were converted to trunk cross-sectional area for analysis.

Plot design of the 'Springcrest'-budded trial was a randomized complete block with 10 single-tree replicates of each of the 2 interstem/rootstock treatments (Table 1). Plot design of the 'Harvester'-'Redglobe'-budded trial was a randomized complete block with 8 single-tree replicates of each of the 4 cultivar/interstem/rootstock treatments (Table 1). Data were analyzed by the General Linear Models (GLM) program of the Statistical Analysis System for personal computers (14). Mean separation was performed by Waller-Duncan *k*-ratio *t* tests.

Results and Discussion

Bloom delay for avoidance of spring freezes. In all four cropping years, 3-piece trees with Ta Tao #6 interstems provided a significant delay in full bloom of both 'Springcrest' and 'Harvester' compared to 2-piece trees budded on Lovell or Halford (Table 1). Bloom delay ranged from 3-15 days and averaged nearly 8 days over four years of observation. For the purpose of avoiding spring frost this delay was pertinent only in 1996 and 1998 when frosts occurred during or after full bloom. Fruit yield was unusually low in 1999 even though there was no threat of damage from a spring freeze. This may have been caused by the below average chill accumulation that winter which delayed bloom. As a result trees bloomed during unusually warm weather which has been shown to cause reduced fruit set (4).

Table 1. Annual chill accumulation, date of last freeze[z] and effect of interstem and rootstock on full bloom date[z] of peach cultivars (Byron, Ga, 1996-1999).

	Year			
	1996	1997	1998	1999
Chill accumulation[y]	1261	1052	1100	708
Last freeze (<-2°C)	68-70	47	69-72	64
Last freeze (<0° and >-2°C)	82-83	37	73	75
Cultivar/interstem/rootstock	Full bloom date			
Trial 1				
Springcrest/TT#6/Lovell	76 a[x]	65 a	70 a	83 a
Springcrest/Lovell	61 b	62 b	63 b	76 b
Trial 2				
Harvester/TT#6/Lovell	75 a	71 a	77 a	86 a
Harvester/Lovell	67 b	65 c	67 c	80 c
Redglobe/Lovell	66 bc	68 b	71 b	82 b
Redglobe/Halford	68 b	68 b	70 b	83 b
MSD[w]	2.3	1.7	2.0	2.0

[z] Julian date.
[y] Hours at or below 7°C from 1 October through 15 February.
[x] Means within column of each trial followed by same letter not significantly different.
[w] MSD=Minimum Significant Difference , Waller Duncan *k*-ratio *t* Test (k-ratio=100).

The spring freeze of 1996 was particularly devastating for the southeastern peach industry. This event consisted of seven days of freezing temperatures and included three nights below –4°C which has been reported to kill 90% of flowers at full bloom and 1 night below –9°C which has been reported to kill 90% of flowers at first pink (2). All 2-piece treatments in this study were at or beyond full bloom during this event (Table 1). A later, less severe event occurred after full bloom of the 3-piece, Ta Tao #6 interstem treatments. Despite the significant bloom delay provided by the Ta Tao #6 interstems even this treatment failed to produce a crop (Table 2). Growers in the nearby middle Georgia area subsequently reported no crop on 'Springcrest' and less than 5% on 'Harvester' and 'Redglobe' in their orchards (9).

In 1998 a five-day freezing event occurred during bloom with three nights below –4°C but none below –6°C. All 2-piece treatments in this study were at or

beyond full bloom and all 3-piece treatments with Ta Tao #6 interstems were at or beyond first pink when this event occurred (Fig. 1). This time, avoidance of spring frost by the bloom delay afforded by the Ta Tao #6 interstem provided a significantly higher yield on both 'Springcrest' and 'Harvester' as shown in Table 2. Even though yields were lower than in 1997, the per unit value of this crop in a low cropping year industry-wide would typically be expected to be much higher than average.

Results indicate that Ta Tao #6 interstems will reliably delay spring bloom of peach cultivars. However, the utility of this effect will depend upon the timing of late freeze events. Exceptional events, such as occurred in 1996 still defeated this approach. However, 1998 clearly demonstrated the utility of this strategy. The salvation of one crop in the lifetime of an orchard might well justify the additional cost of a 3-piece tree.

Table 2. Effect of interstem and rootstock on annual and cumulative yield (kg/tree) of peach cultivars (Byron, Ga., 1996-1999).

	Year				
Cultivar/interstem/rootstock	1996	1997	1998	1999	Cumulative
Trial 1					
Springcrest/TT#6/Lovell	0	25 a[z]	11 a	14	51 a
Springcrest/Lovell	0	14 b	3 b	13	31 b
Trial 2					
Harvester/TT#6/Lovell	0	32	21 ab	22	75
Harvester/Lovell	0	32	7 c	28	64
Redglobe/Lovell	0	39	22 a	25	87
Redglobe/Halford	0	37	16 b	22	75
MSD[y]	-	**ns**	**6**	**ns**	**ns**

[z] Means within column of each trial followed by same letter not significantly different.
[y] MSD=Minimum Significant Difference , Waller Duncan *k*-ratio *t* Test (k-ratio=100)

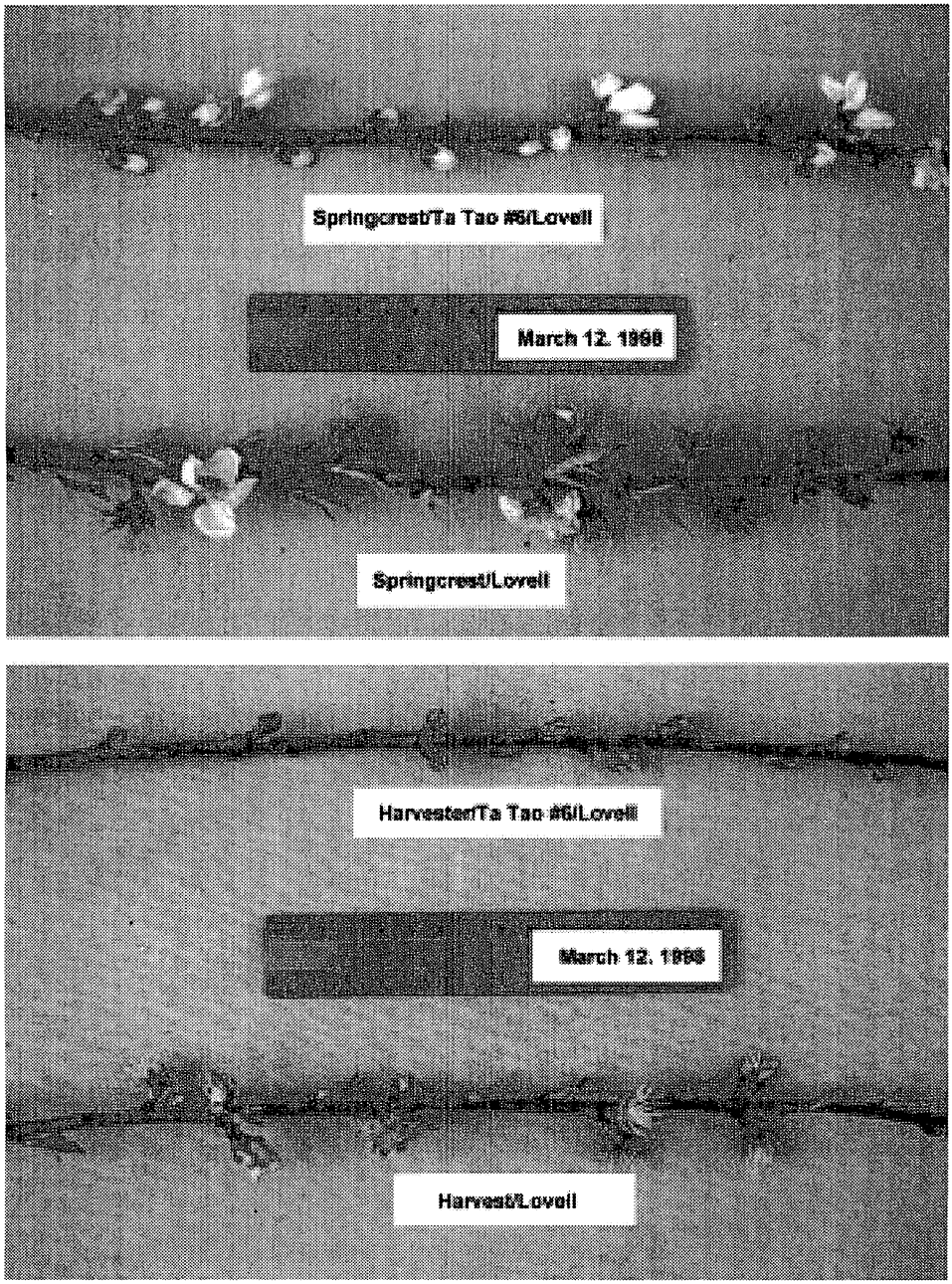

Figure 1. Bloom development of Springcrest (top) and Harvester (bottom) showing the delaying effect of a Ta Tao #6 interstem during the Spring 1998 freeze at Byron, GA (Julian day 71).

Manipulation of fruit maturity. With the exception of 'Harvester' in 1998, all trees of 'Springcrest' and 'Harvester' on 3-piece Ta Tao #6 interstem trees displayed a significant delay in fruit maturity compared to their 2-piece counterparts on Lovell during this study (Table 3). This delay ranged from 1 to 6 days and averaged 3.6 days over 3 years of observation. 'Harvester'/Lovell and 'Redglobe'/Lovell displayed an 11-13 day gap in their harvest dates which is larger than the 8-day difference reported by Okie (8). Contrary to a report (3) that Halford will advance the maturity of 'Redhaven' trees compared to those budded on Lovell, we saw no difference in fruit maturity of trees of 'Redglobe' budded on these two rootstocks in this study. As a result, we were unable to completely close this production gap between 'Harvester' and 'Redglobe' with the treatments utilized. Nevertheless, the use of Ta Tao #6 interstems to delay fruit maturation and, in turn, extend the useful season of preferred cultivars appears feasible.

Tree vigor. Several studies have noted that trees with Ta Tao interstems or rootstocks are typically less vigorous than their 2-piece counterparts (7, 10, 11). This proved true in this study (Table 4). At the end of six growing seasons 3-piece trees of 'Springcrest' on Ta Tao #6 interstems were only 81% the size of their 2-piece counterparts on Lovell. Trees of 'Harvester' on Ta Tao #6 interstems were only 73% the size of their 2-piece counterparts on Lovell, in spite of the fact that the 2-piece trees of 'Harvester'/Lovell were significantly smaller than their 3-

Table 3. Effect of interstem and rootstock on weighted average harvest date[z] of peach cultivars (Byron, Ga., 1996-1999).

	Year			
Cultivar/interstem/rootstock	1996	1997	1998	1999
Trial 1				
Springcrest/TT#6/Lovell	-	147 a[y]	146 a	150 a
Springcrest/Lovell	-	142 b	143 b	144 b
Trial 2				
Harvester/TT#6/Lovell	-	167 a	171 b	177 b
Harvester/Lovell	-	162 b	170 b	175 c
Redglobe/Lovell	-	174 a	181 a	187 a
Redglobe/Halford	-	174 a	181 a	188 a
MSD[x]	-	2	2	2

[z] Julian date calculated per Stembridge and Gambrell (13).
[y] Means within column of each trial followed by same letter not significantly different.
[x] MSD=Minimum Significant Difference, Waller Duncan *k*-ratio *t* Test (k-ratio=100).

piece counterparts at planting. In these trials, we observed no problem training any treatment to fill its allotted space. However, the in-row spacing of 4.6 m utilized in these short-term trials is considerably closer than the 5.5 to 6.1 m typically utilized for open-centered trained trees in this industry. Nevertheless, 3-piece trees of both 'Springcrest' and 'Harvester' on Ta Tao #6 interstems displayed equal, if not greater, yield efficiency in all years of this study compared to their 2-piece counterparts on Lovell (Table 5). As a result, cumulative yield efficiency was greater for both 'Springcrest' and 'Harvester' on Ta Tao #6 interstems than their 2-piece counterparts on Lovell. This suggests that per hectare yields should be at least comparable if tree density is adjusted upward to compensate for the lower vigor of 3-piece trees with Ta Tao #6 interstems.

Table 4. Effect of interstem and rootstock on trunk cross sectional area (cm^2) of peach cultivars (Byron, Ga., 1994-1999).

	Year						
Cultivar/interstem/rootstock	Planting	1994	1995	1996	1997	1998	1999
Trial 1							
Springcrest/TT#6/Lovell	0.5[z]	13.6 b	31 b	53 b	87 b	114 b	150 b
Springcrest/Lovell	0.5	16.2 a	38 a	64 a	117 a	143 a	185 a
Trial 2							
Harvester/TT#6/Lovell	0.3 b	12.3 ab	27	50	71 b	114 b	133 b
Harvester/Lovell	0.1 c	8.8 b	30	54	88 ab	144 a	181 a
Redglobe/Lovell	0.6 a	13.5 ab	31	53	91 a	119 ab	146 b
Redglobe/Halford	0.7 a	14.6 a	33	51	87 ab	117 ab	154 b
MSD[y]	0.1	4.9	ns	ns	16	30	25

[z] Means within column of each trial followed by same letter not significantly different.
[y] MSD=Minimum Significant Difference , Waller Duncan *k*-ratio *t* Test (k-ratio=100)

Conclusions.

This study supports the efficacy of Ta Tao interstems to delay bloom and thereby avoid spring frost events in at least some years. An associated delay in fruit maturation may also be useful to extend the harvest season of preferred cultivars thereby narrowing if not closing production gaps. Recent work indicates that it may not be necessary to undergo the expense of producing 3-piece trees with Ta Tao interstems. The effect appears to be produced by a transmissible agent (5) present in many of the Ta Tao selections and can be introduced into a conventional 2-piece tree by budding with

Table 5. Effect of interstem and rootstock on annual and cumulative yield efficiency (kg/cm^2) of peach cultivars (Byron, Ga., 1996-1999).

		Year			
Cultivar/interstem/rootstock	1996	1997	1998	1999	Cumulative
Trial 1					
Springcrest/TT#6/Lovell	-	0.29 a[z]	0.10 a	0.09 a	0.34 a
Springcrest/Lovell	-	0.12 b	0.02 b	0.07 b	0.17 b
Trial 2					
Harvester/TT#6/Lovell	-	0.45	0.19 a	0.16	0.57 ab
Harvester/Lovell	-	0.37	0.05 c	0.15	0.36 c
Redglobe/Lovell	-	0.43	0.19 a	0.19	0.64 a
Redglobe/Halford	-	0.43	0.14 b	0.17	0.52 b
MSD[y]	-	ns	0.04	ns	0.11

[z] Means within column of each trial followed by same letter not significantly different.
[y] MSD=Minimum Significant Difference , Waller Duncan *k*-ratio *t* Test (k-ratio=100)

a piece of infected vegetative wood (12). This could afford growers considerable flexibility in establishing blocks of preferred cultivars with slightly varying bloom and fruit maturity windows, depending on whether or not portions have been infected with this agent after planting.

Literature Cited

1. Anderson, J.L. and S.D. Seeley. 1993. Bloom delay in deciduous fruits. Hort. Rev. 15:97-144.
2. Ballard, J.K., E.L. Proebsting, and R.B. Tukey. 1984. Critical temperatures for blossom buds – Peaches. Wash. State Univ. Ext. Bul 914.
3. Beckman, T.G., W.R. Okie and S.C. Myers. 1992. Rootstocks affect bloom date and fruit maturation of 'Redhaven' peach. J. Amer. Soc. Hort. Sci. 117:377-379.
4. Edwards, G.R. 1987. Temperature in relation to peach culture in the tropics. Acta Hort. 199:61-62.
5. Gibson, P.G, G.L. Reighard, S.W. Scott and M.T. Zimmerman. 2001. Identification of graft-transmissible agents from 'Ta Tao 5' peach and their effects on 'Coronet' peach. Acta Hort. 550:309-314.
6. Myers, S.C. (ed.) 1989. Peach Production Handbook. Georgia Extension Handbook No. 1. 221 pp. Coop. Ext. Serv., Univ. of Georgia, Athens, Ga.
7. Okie, W.R. 1990. Ta Tao P.I. 101686, affects bloom date and tree size of 'Sunprince' peach. Fruit Var. J. 44:87-89.
8. Okie, W.R. 1998. Handbook of peach and nectarine varieties: performance in the southeastern United States and index of names. U.S. Dept. of Agr., Agr. Hdbk. No. 714.
9. Okie, W.R., G.L. Reighard, W.C. Newall, Jr., C.J. Graham, D.J. Werner, A.A. Powell, G. Krewer and T.G. Beckman. 1998. Spring freeze damage to the 1996 peach and nectarine crop in the southeastern United States. HortTechnology 8:381-386.
10. Reighard, G.L. 1995. Use of peach interstems to delay peach phenology. Acta Hort. 395:201-207.
11. Reighard, G.L. 1998. Manipulation of peach phenology, growth, and fruit maturity using interstems. Acta Hort. 465:567-572.

12. Reighard, G.L., D.R. Ouellette, and K.H. Brock. 2001. Modifying phenotypic characters of peach with graft transmissible agents. Acta Hort. 557:163-167.
13. Stembridge, G.E. and C.E. Gambrell, Jr. 1974. Measuring peach thinning and maturation responses. HortScience 9:29-30.
14. SAS Institute, Inc. 1996. SAS for Windows, Version 6.12, SAS Institute, Inc., Cary NC.
15. Young, E. and J. Houser. 1980. Influence of Siberian C rootstock on peach bloom delay, water potential and pollen meiosis. J. Amer. Soc. Hort. Sci. 105:242-245.
16. Young, E., and B. Olcott-Reid. 1979. Siberian C rootstock delays bloom of peach. J. Amer. Soc. Hort. Sci. 104:178-181.

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The Wilder Medal Committee of the American Pomological Society (APS) invites nominations for the 2004 Wilder Silver Medal Award. The Wilder Medal was established in 1873 in honor of Marshall P. Wilder, the founder and first President of the Society.

The Wilder Medal is conferred on individuals or organizations which have rendered outstanding service to horticulture in the area of pomology. Special consideration is given to work relating to the origination and introduction of meritorious fruit cultivars. Individuals associated with either commercial concerns or professional organizations will be considered if their introductions are truly superior and have been widely planted.

Significant contributions to the science and practice of pomology other than through fruit breeding will also be considered. Such contributions may relate to any important area of fruit production such as rootstock development and evaluation, anatomical and morphological studies, or noteworthy publications in any of the above subjects.

To obtain nomination guidelines, contact committee chairperson, Desmond R. Layne, Dept. of Horticulture, Box 340375, Clemson University, Clemson, SC 29634 0375; phone: 864-656-4961; fax: 864-656-4960; e-mail: dlayne@clemson.edu. Nominations must be submitted **by 1 May 2004.**