Technische
Informationsbibliothek (TIB)
German National Library of
Science and Technology
Welfengarten 1 B
30167 Hannover, Germany
T +49 511 762-8989
F +49 511 762-8998
customerservice@tib.eu
www.tib.eu

Hannover,24.05.2019

WorldShareILL - Bitte an Beku2 weiterleiten

TIB - document delivery - delivery note

delivery notifications

customer number:	HLS
order number:	195921668
order date:	23.05.2019
delivery service	POST
delivery type:	copy
delivery priority:	normal

customer data:

name:	
E-Mail:	
reference number:	
your delivery note:	

bibliographic reference:

shelf mark:	ZG 462 / Haus2
title:	Proceedings of the American Society for Horticultural Science.
volume/issue:	56
date of publication:	1950
pages:	122-128
author:	
article:	CHILLING REQUIREMENTS OF PEACH VARIETIES

Chilling Requirements of Peach Varieties

By J. H. Weinberger, *U. S. Department of Agriculture, Fort Valley, Georgia*

The winter of 1948–49 was the warmest in 17 years at Fort Valley, Ga., and many peach trees in the area suffered seriously from lack of chilling weather to break the rest period of their buds. The season offered an unusual opportunity to observe the behavior of a number of peach varieties affected by prolonged dormancy and to study their chilling requirements.

Review of Literature

It is difficult to establish an accurate measure of the chilling requirements of peach varieties. Lammerts (4) classified them in California on the basis of the spread between bud development of each variety and that of Lukens Honey as a base, after correcting for the normal difference between their times of development following a relatively cold winter. This provided an index number seemingly more reliable than the arbitrary grade numbers otherwise assigned. Under eastern conditions, the influence of varying temperatures on rate of development during the blossoming period would introduce a large error with this method. Lesley (5) assigned grades to varieties in years when prolonged dormancy was severe, according to their leaf development. This method offered a rapid and, for the purpose intended, adequate measure of chilling requirements. Brooks and Philp (1) classified peach varieties in California on the basis of bud drop following the warm winter of 1940–41. Yarnell (6) compared bud response to chilling by localities in Texas, but did not recognize the effect of the time interval in breaking the rest period.

Methods

Hutchins has stated (3) that a thousand hours of temperatures of 45 degrees F or lower was sufficient to break the rest period of most peach varieties at Fort Valley. These "hours of chilling" have been used in the present study, and the accumulation of hours for the last 12 winters at Fort Valley are shown in Table I. Only 880 hours oc-

Table I. Accumulation of hours of temperature 45 degrees F or lower, 1937 to 1949, U. S. Horticultural Field Laboratory, Fort Valley, Ga.

	October		November		December		January		February		March	
	15	31	15	30	15	31	15	31	15	28	15	31
1937–38	11	70	126	309	562	669	862	1011	1070	1164	1226	1234
1938–39	11	41	58	211	358	584	671	866	937	1035	1079	1130
1939–40	3	85	153	260	385	596	869	1212	1389	1586	1708	1776
1940–41	2	5	81	194	324	436	630	768	975	1180	1342	1429
1941–42	5	13	125	193	341	486	744	897	1122	1321	1468	1529
1942–43	1	24	102	190	402	574	820	969	1120	1252	1375	1431
1943–44	0	52	161	269	396	658	935	1055	1229	1255	1333	1377
1944–45	0	26	77	209	472	609	797	937	1103	1169	1209	1221
1945–46	8	37	85	213	460	757	868	1104	1252	1351	1420	1441
1946–47	15	15	48	72	207	378	520	609	815	990	1169	1299
1947–48	0	0	29	159	269	469	667	982	155	1237	1321	1365
1948–49	0	71	115	187	254	422	512	585	669	694	825	880

curred during the winter of 1948–49, and serious prolonged dormancy trouble ensued. In the other 11 winters, chilling was adequate for normal peach bud development, except in 1947, for varieties with high chilling needs.

An effort was made in this study to evaluate actual chilling requirements by determining when the rest period was broken following measured exposure to chilling weather. Ten twigs of the previous season's growth, each 14 to 16 inches long, were brought indoors from the orchard, into either a greenhouse or laboratory, at three intervals: when 700 hours, 900 hours, and 1100 hours of temperature of 45 degrees F or lower had accumulated. Basal ends of the twigs were placed in water and subsequent bud development was observed. This test was repeated each winter for a period of 11 years, covering a wide range of weather conditions. Not all varieties, however, were tested each year. Three weeks after the twigs were brought into warmth, records were made of flower bud development and leaf bud growth. If half the flower buds had advanced to the green stage of development, or beyond, in three weeks, their rest was considered broken. For leaf buds, 40 to 50 per cent of the buds must have initiated growth by the end of three weeks. These measures were arbitrary, but seemed to agree most closely with normal development in the orchard. Actually, the shock of cutting the twig stimulated bud development and could not be ignored.

Results

In Table II are shown the hours of chilling each variety required by February 15 to break the rest period of its buds, together with the number of years each variety was observed. The orchard behavior of varieties following the warm winter of 1948–49 is furnished for comparison (Tables II and III). The date of full bloom of a variety indicates roughly the chilling requirement of the variety, and to a lesser extent the heat requirement to develop blossoms. The leaf development of varieties on trees of bearing age was noted on three dates, April 6, April 13, and May 2, 1949, and grades 1 to 8 were assigned. Grade 1 indicated the most advanced foliation, typical of Australian Saucer, and grade 8 the most delayed foliation. The April readings provided the best check on varieties with low chilling requirements, while the May 2 reading brought out the greatest difference in the late-foliating varieties. Flower bud survival and condition of crop also are included.

Discussion

Recognition of a time interval necessary for buds to complete their processes before the rest period is broken was essential in determining chilling requirements. Late winter chilling after growth started was of no assistance to many varieties. Also, intensive early-winter chilling hastened the rest-breaking processes and shortened the rest period, but a greater number of chilling hours was necessary to accomplish

Table II. The Feb. 15 chilling requirement of peach varieties; and their orchard response following the warm winter of 1948–49. (Leaf development rating: 1 = most advanced, 8 = most delayed.)

	Chilling requirement			Orchard response in 1949			
	Years observed	Hours 45 degrees F or lower		Full bloom (date)	Leaf development (rating)	Flower bud survival (grade)	Fruit crop (grade)
		Flower buds	Leaf buds				
Afterglow	5	750	750	Mar 23	4	Good	Fair
Australian Saucer	–	——	——	Jan 21	1	——	None
Belle	8	850	950	Mar 25	5	Good	Heavy
Best May	2	850	750	Mar 23	4	Good	Fair
Candoka	3	850	950	——	–	——	——
Colora	3	1,050	950	——	–	——	——
Cumberland	2	850	850	——	–	——	——
Dixigem	5	850	950	Mar 26	6	Fair	Light
Dixigold	7	850	950	——	–	——	——
Dixired	3	950	1,050	Apr 1	6	Fair	Light
Duke of York	4	1,150	1,250	Apr 4	8	Very poor	None
Early Elberta (Stark)	6	850	850	Apr 1	7	Poor	——
Early Halegaven	7	850	1,050	——	6	Fair	Light
Early Hiley	4	750	750	Mar 23	4	Good	Good
Early Jubilee	2	850	850	Mar 26	5	Fair	Light
Early Rose	12	1,150	1,150	Apr 7	6	Food	Fair
Early Vedette	2	950	1,050	Apr 4	6	Poor	Light
Early Wheeler	8	950	1,050	Mar 31	8	Poor	None
Eclipse	2	950	950	——	6	——	——
Elberta	9	850	950	Mar 27	6	Fair	Light
Erly-Red-Fre	9	850	1,150	Mar 31	7	Fair	Light
Fairs Beauty	11	1,050	1,050	Mar 31	7	Poor	——
Fay Elberta	5	750	750	Mar 23	5	Good	Fair
Fireglow	9	750	850	Mar 25	5	Good	Light
Fisher	8	950	1,050	Mar 31	7	Fair	Light
Flaming Gold	2	750	750	Mar 20	4	Good	Good
Fuzzless Berta	2	1,150	1,050	None	7	Very poor	None
Gage	3	750	850	——	–	——	——
Gemmers Elberta	5	750	950	——	6	——	——
Goldeneast	8	1,050	1,050	Apr 4	7	Fair	Light
Golden Jubilee	11	850	850	Mar 25	5	Good	Good
Halberta Giant	4	850	850	——	–	——	——
Halegold	2	850	950	Mar 27	6	Fair	Light
Halehaven	10	850	950	Mar 25	6	Fair	Fair
Herbhale	5	850	950	Mar 29	–	Fair	Light
Hiley	11	750	750	Mar 23	4	Good	Good
Ideal	4	850	1,050	Mar 29	6	Fair	Light
Jewel	–	——	——	Jan 27	2	Good	None
J. H. Hale	5	850	950	Mar 29	6	Fair	Light
July Elberta	4	750	750	——	–	——	——
Kalhaven	4	950	950	——	–	——	——
Lizzie	3	950	1,050	Mar 30	6	Good	Light
Maxine	6	1,050	1,150	Apr 7	8	Very poor	Light
Mayflower	6	1,150	1,250	None	8	Very poor	None
Midway	6	850	1,050	Mar 23	5	Good	None
Newday	9	750	750	Mar 22	4	Good	Good
Pacemaker	4	750	750	Mar 23	4	Poor	Light
Raritan Rose	4	950	1,150	——	–	——	——
Redelberta	6	750	950	——	–	——	——
Redhaven	7	850	950	Mar 30	6	Fair	Fair
Redrose	7	850	850	Mar 23	4	Good	Good
Rio Oso Gem	5	850	950	Mar 31	6	Fair	Light
Salberta	2	850	950	Mar 29	6	Fair	——
Salwy	3	1,050	1,050	——	–	——	——
Shippers Late Red	10	850	850	Mar 31	7	Fair	Light
Southland	5	750	750	Mar 22	4	Good	Good
Sullivan	8	850	950	Mar 27	6	Fair	Light
Summercrest	4	950	1,050	——	–	——	——
Sunhigh	7	750	750	Mar 21	4	Good	Light
Triogem	7	850	950	Mar 28	–	——	——
Up-to-date	2	850	1,150	——	–	——	——
Valiant	6	850	950	——	–	——	——
Vedette	9	1,050	1,050	Mar 30	6	Fair	Light
Veteran	4	1,050	1,150	——	–	——	——
Worlds Earliest	5	750	850	Mar 28	7	Good	Light

Table III. Flowering and foliation of young bearing beach trees of newer varieties. Fort Valley, 1949. (Leaf development rating: 1 = most advanced, 8 = most delayed.)

Variety	Full bloom (date)	Leaf development (rating)	Flower bud survival (grade)	Fruit crop (grade)
Autumn	Mar 30	6	Fair	None
Cherryred	Mar 21	7	Fair	Light
Earlyeast	Mar 25	5	Good	Light
Early Triogem	Mar 22	5	Good	Good
Fairhaven	Mar 21	7	Fair	Light
Flamingo	Mar 17	4	Good	Good
Goodcheer	Mar 5	4	Good	None
Jerseyland	Mar 29	6	Fair	Fair
Laterose	Mar 17	6	Good	Light
Loring	Mar 16	7	Fair	Light
Meadowlark	Mar 9	3	Good	Light
Missouri	Mar 23	6	Poor	None
Ozark	Mar 28	7	Fair	None
Prairie Rose	Mar 27	6	Poor	None
Redcrest	Mar 5	3	Good	None
Summer Rose	Mar 15	4	Good	Light
Vanguard	Mar 29	8	Fair	None
Wild Rose	Mar 14	4	Good	Fair

this. For example, Hiley buds were ready to grow normally in early February 1941, after 750 hours of chilling; but in 1944, a 900-hour accumulation by January 15 was insufficient. In 1940, 1,000 hours served to break their rest by January 22. Likewise, 1200 hours accumulated by January 31 was not sufficient to break the rest of Goldeneast and Fairs Beauty buds in 1940, but 1050 hours by February 15 was adequate in 1948. In the orchard, uniform swelling of flower buds occurred by February 15 in all except the extremely cold winters, when bud development was retarded by low temperatures, or the extremely warm winters when lack of chilling prevented bud growth. This swelling of flower buds indicated that the rest period had been broken naturally by that date. Thus in Table II, February 15 is considered the critical date for the breaking of the rest period and for the accumulation of chilling hours. If a variety had not had its chilling requirements satisfied by February 15, it tended to suffer from prolonged dormancy even though additional chilling occurred later. For instance, Erly-Red-Fre leaf buds, having a chilling requirement of 1150 hours, suffered slightly from prolonged dormancy following the winter of 1946–47, although the total accumulation to March 31 was 1299 hours. The February 15 accumulation of 815 hours was insufficient and the later chilling was not fully effective.

Chilling Requirements:—At Fort Valley, the average accumulation of 1063 hours of chilling by February 15 was sufficient to satisfy the chilling requirements of all but a few varieties of peaches (Table II). Of the common varieties, Hiley and Early Hiley represented the group having the lowest chilling requirement, 750 hours for flower and leaf buds. Southland, Sunhigh, and Newday are in the same group. Elberta flower buds require only a little more chilling than Hiley flower buds, but Elberta leaf buds require considerably more chilling. This difference in chilling requirements between flower and leaf buds is important. Following the warm winter of 1948–49, Elberta trees at Fort Valley set fair crops of fruit but due to lack of foliage develop-

ment the peaches fell off before pit-hardening stage (Fig. 1). Hiley trees, under the same conditions, set a fairly good crop that matured, for the chilling requirements of their flower and leaf buds are nearly identical. Erly-Red-Fre also is a striking example of a variety with a moderate chilling requirement for flower buds, 850 hours, and a high requirement for leaf buds, 1150 hours. Mayflower and Duke of York require the most chilling of any variety studied, 1150 hours for flower buds and 1250 for leaf buds.

FIG. 1. Elberta tree, Fort Valley, Georgia, suffering from prolonged dormancy. May 4, 1949.

Orchard behavior:—The orchard behavior of varieties in the 1949 season is given in Table II. The behavior of young bearing trees of new varieties, whose chilling requirements have not yet been determined, is presented in Table III. In 1949, only varieties requiring not more than 750 hours of chilling developed to a degree approaching normality. The blossoming of these varieties was delayed, for the same varieties grown 75 miles to the north blossomed two weeks earlier. The opening of flower buds was irregular, extending over a 7 weeks' period. Foliage development was nearly normal, but delayed. Since only 669 hours of chilling accumulated by February 15, 1949, the slightly abnormal behavior of these varieties was anticipated. Opening of flower and leaf buds on other varieties was more delayed and irregular in accordance with their higher chilling requirements. On May 2, 1949, those varieties in class 5 for leaf development, Table II, characterized by Golden Jubilee, were foliating in the center of the

trees from older buds, which need less chilling than one-year-old buds, had uniform terminal growths up to one inch long, and had only a few twigs without lateral buds breaking. On the same date, Elberta trees, representative of class 6, had clusters of foliage in the centers of trees, terminal growths just starting, and many twigs without leaf development. Class 7 varieties had few leaves in centers of trees, few tip buds started, and few lateral buds growing. Erly-Red-Fre is in this group. Mayflower trees, in class 8, had practically no foliage development on May 2 in the centers of the trees, or elsewhere.

Flowering on varieties with high chilling requirements was very irregular and was delayed in some cases to April 7. Varieties not in full bloom by April 7 had too low a survival of flower buds to determine a date of full bloom. In general, pollen production was poor though tests showed that a small percentage of the pollen would germinate. Many anthers failed to dehisce. All varieties had some flower buds with atrophied styles and stigmas, either alive or dead, in which the ovary grew and developed, but the style and stigma remained of bud-stage size. Tests showed that none of these abnormal flowers set fruit. Many flower buds died during the winter, the loss being greatest on those varieties having a high chilling requirement (Table II). Approximately one-third of the Elberta flower buds died, while 95 per cent of the buds on high-chilling varieties, such as Mayflower, Maxine, and Fuzzless Berta, failed to survive. This loss of buds was apparently not due to low temperatures, and seemed to occur mostly in late January and February.

The amount of fruit each variety matured in 1949 (Tables II and III) was associated with its chilling requirement. Such varieties as Hiley and Southland, whose development was more nearly normal, had the heaviest fruit production. Mayflower and Duke of York had no fruit, while other varieties were intermediate. A few varieties that naturally tend to set heavy crops, such as Early Rose and Belle of Georgia, produced well in spite of prolonged dormancy trouble.

From these data it appears that in the extreme southern peach-growing regions of the Southeast the most dependable production may be anticipated from those varieties that have a chilling requirement slightly higher than the minimum February 15 chilling accumulation of the locality involved. A rest period of this intensity is sufficient to delay blossoming following normal or colder than normal winters until the frost hazard is reduced, but will not cause serious prolonged dormancy trouble following milder winters. Varieties with slightly higher chilling requirements would succeed if they have strong fruit-setting habits.

Literature Cited

1. Brooks, R. M., and Philp, G. L. Climate in relation to deciduous fruit production in California. I. Effect of the warm winter of 1940–41 on peach and nectarine varieties in northern California. *Proc. Amer. Soc. Hort. Sci.* 39: 190–194. 1941.
2. Higdon, R. J. Effects of insufficient chilling on peach varieties in South Carolina in the winter of 1948–49. *Proc. Amer. Soc. Hort. Sci.* 55: 236–238. 1950.

3. HUTCHINS, L. M. Unpublished paper presented at the 1932 meeting of Amer. Soc. Hort. Sci.
4. LAMMERTS, W. E. An evaluation of peach and nectarine varieties in terms of winter chilling requirements and breeding possibilities. *Proc. Amer. Soc. Hort. Sci.* 39: 205–211. 1941.
5. LESLEY, J. W. Peach breeding in relation to winter chilling requirement. *Proc. Amer. Soc. Hort. Sci.* 45: 243–250. 1944.
6. YARNELL, S. H. Texas studies on the cold requirement of peaches. *Proc. Amer. Soc. Hort. Sci.* 37: 349–352. 1940.