

Peach Varieties Vary In Resistance To Frost At Blossoming

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Peach growers in the eastern United States have suffered serious crop losses during recent seasons because of frosts and freezes during the blossoming period. In 1949 and 1950 damage ranging from moderate to severe occurred in many orchards located in the area between Georgia and northern Virginia. The Virginia peach crop in 1950 was reduced to less than 50 per cent of the previous year and states lying south of Virginia reported almost a complete loss of crop.

Growers have long been aware that resistance of peach blossoms to frosts and freezes is affected by many factors. They have observed also that there is marked varietal variation in the response to low temperatures at blossoming. Elberta has been observed many times to be one of the most susceptible varieties to frost injury. (1) (2) (6).

Peach Breeding and Variety Orchard at Blacksburg

The peach breeding program of the Virginia Agricultural Experiment Station has as one of its objectives the development of new varieties especially adapted to Virginia conditions. Resistance to spring frosts is one of the characters desired in view of the frost

hazards encountered in this state and the absence of large bodies of water in the peach growing areas which might have an ameliorating influence on prevailing temperatures in adjacent areas.

A variety collection for use in the breeding program is being maintained by the Experiment Station orchard about five miles south of Blacksburg. The Blacksburg area is not considered a desirable location for commercial fruit growing because of the prevalence of spring frosts. The altitude of nearly 2200 feet and the proximity of nearby mountain ranges having altitudes of up to 4400 feet present spring frost threats in many years. The site of the Experiment Station orchard has been considered, however, to be more favorable for fruit growing than most of the nearby area because of the good air drainage prevailing there.

The first plantings were made in this orchard in 1945. Additional trees have been set out each year since that time in the way of replacements and extension of the original collection. Two or four trees of each variety or selection under test were included in this orchard. The earlier plantings were random-

ized but this system was later abandoned and two or more trees of a given kind are now planted together wherever space permits.

The orchard has grown well and bore good crops of fruit in 1947 and 1948. In 1949, however, the crop was completely destroyed by freezes on April 17 and 21 at which times minimum temperatures of 27° and 24° were recorded in the orchard. These freezes occurred nearly three weeks after the full bloom period on March 28-31 which had been favorable for a heavy set of fruit.

In 1950 a series of heavy frosts and sharp freezes occurring during the blossoming season destroyed most of the flowers, buds, and young fruits in the orchard. The many varieties showed such variation in the proportion of the crop that survived that it appeared worthwhile to record the proportion of crop yielded by them. The planting consists of many new varieties and seedling selections from different peach breeding programs. Their response to the unfavorable blossoming conditions in the orchard at Blacksburg may be of interest to fruit breeders and variety testers in general.

Details of 1950 Climatic Conditions and Injury

The fruit season of 1950 got off to an unfavorable start because of the unseasonably warm conditions that prevailed in late December and January. Temperatures were so mild in early January that the buds of some varieties of peaches showed

pink by January 17. By February 1 pink tips could be found on trees of most varieties. The warm weather was followed by a gradual cooling off after February 10 and more nearly normal temperatures occurred during late February and most of March. The lowest temperature of the winter occurred on March 4 when 4 and 9° F was recorded. Temperatures moderated during the last ten days of the month, however, and it became evident that full bloom in the peach orchard would occur April 1-5.

Emasculation of peach blossoms for breeding purposes was started March 30 and the first pollinations were made April 1 on trees protected by cellophane covered houses. By April 3 and 4 the orchard was considered to have reached the peak of its bloom period. Some of the early blossoming varieties were beginning to shed a few petals. Later blossoming varieties such as Veteran, Shippers Late Red, and Redhaven had many open flowers but also had about as many buds that were still tightly closed or showing only a small area of pink at the tips. The general appearance of the orchard was a mass of pink with heavy bloom on all varieties. The total lack of crop in 1949 no doubt contributed to a heavier than normal bud set for 1950.

The blossom condition had been checked on most varieties several to many times after February 1. Some injured buds or blossoms were found on many of the varieties after hard

freezes that occurred on February 21, March 2, March 4, March 9, and March 15. As the full bloom period approached, however, it appeared that all varieties showed at least 65 per cent survival of the buds. Most varieties showed only 10 to 20 per cent of injured buds or pistils. It seemed that the chances for a full crop of peaches had in no way been reduced by the numerous freezes that had occurred after obvious bud development became evident by mid-January.

The following minimum temperatures occurred as shown by a minimum recording thermometer located in the orchard after the full bloom period had been reached:

April 1—27° F	April 12—37° F
April 2—34° F	April 13—28° F
April 3—44° F	April 14—24° F
April 4—52° F	April 15—18° F
April 5—40° F	April 16—28° F
April 6—30° F	April 17—23° F
April 7—24° F	April 18—48° F
April 8—31° F	April 19—37° F
April 9—37° F	April 20—39° F
April 10—36° F	April 21—36° F
April 11—38° F	April 22—26° F

(last frost)

The period from April 6 to 22 was one of very disagreeable weather conditions. Cloudy, windy weather prevailed with several light showers, freezing mists and snow squalls. The range of temperatures during that period was very narrow with only a few hours of temperatures in excess of 50° F. Winds of almost gale proportions occurred April 13, 14, and 15. These winds were especially

noticeable during the nights of April 13 and 14.

The condition of the blossoms was noted almost daily after April 7. Many injured pistils were found on trees of most varieties and even the entire flowers were killed in some cases. Nearly all varieties had enough apparently uninjured pistils to give promise of a fair crop up to April 13. The freezes on April 14 and 15, however, resulted in heavy damage to the buds and blossoms of nearly all varieties. The overall aspect of pink bloom in the orchard was changed to one of brown, dead petals on all but a few varieties. Closer inspection of individual trees and blossoms did indicate that some varieties showed an appreciable number of normal appearing flowers or buds. Since most of the earlier efforts at emasculation and pollination of blossoms for breeding purposes had been destroyed, trees of Veteran, Afterglow and Shippers Late Red which showed good to excellent blossom and bud survival were emasculated and pollinated for the breeding program. Fair sets resulted from these efforts.

Development of the flowers and young fruits occurred normally after April 22, the date of the last frost. Most trees shed all of their blossoms or buds very quickly. In a few instances there was considerable dropping of partially developed fruits about four to six weeks after full bloom but in most cases the pistils never showed any sign of development. The quantity of fruit re-

maining on some trees in late June thinned to commercial standards indicated that thinning of the crop where necessary. When the fruit would be desirable. Accordingly, started to ripen every tree was the orchard was systematically checked for crop condition and other

TABLE I—Fruit Set in the Virginia Agricultural Experiment Station Peach Orchard at Blacksburg in 1950

Variety	Days Ripe Before or After Elberta	Fruit Set	Variety	Days Ripe Before or After Elberta	Fruit Set
World's Earliest	— 63	2	Early Flame		
Cherry Red	— 50	N.S.	Nectarine	— 24	4
Ft. Valley 117	— 48	N.S.	South Haven No. 20	— 24	3-
N. J. 113	— 43	1(L.T)	July Elberta	— 23	3
Erly-Red-Fre	— 41	1(L.T)	V.P.I. 10	— 23	3
Early East	— 41	2-	V.P.I. 1	— 23	4
Dixired	— 39	2	U.S.D.A. 3705	— 22	2-
N. J. 137	— 39	1(T)	V.P.I. 7	— 22	2-
U.S.D.A. 7230	— 39	4	Redrose	— 22	3
Gaheb	— 39	4	V.P.I. 9	— 22	3
V.P.I. 3	— 36	N.S.	V.P.I. 8	— 21	1(H.T.)
Prairie Daybreak	— 36	3-	Improved Pallas	— 21	4
U.S.D.A. 3714	— 35	2	Fireglow	— 21	3+
U.S.D.A. 385	— 34	2-	Newday	— 21	4
Rosebud	— 34	2	V.P.I. 16	— 20	3
Fisher	— 32	1(L.T.)	Vedette	— 20	1(H.T.)
Best May	— 32	3	U.S.D.A. 8695	— 20	4
Marigold	— 32	4	U.S.D.A. 3724	— 20	3+
Prairie Sunrise	— 32	4+	Goldeneast	— 18	2-
Starking Delicious	— 32	N.S.	Prairie Rose	— 18	2-
U.S.D.A. 7417	— 32	4	Illinois K-62	— 18	4
U.S.D.A. 7601	— 32	4	Herbhale	— 18	4
Oriole	— 29	N.S.	V.P.I. 12	— 18	4
Raritan Rose	— 29	3+	Pacemaker	— 18	4
Jerseyland	— 29	1-	V.P.I. 13	— 18	4
Missouri 948	— 29	4	Sunhigh	— 17	N.S.
Redhaven	— 29	1(T)	Halehaven	— 17	3
Dixigem	— 28	4	U.S.D.A. 10365	— 16	4
Triogem	— 27	4	Missouri 937	— 15	4
Ft. Valley 9-93	— 27	3+	Vimy	— 15	N.S.
Vanguard	— 26	N.S.	Early Haven	— 15	4+
Missouri	— 25	4	Ambergem	— 15	N.S.
Golden Jubilee	— 25	N.S.	Prairie Schooner	— 14	2-
Early Halehaven	— 25	3	Illinois K-72*		N.S.
Golden Globe	— 25	4	Colora	— 13	1(T)
V.P.I. 2	— 25	4	South Haven	— 13	2

TABLE I—Fruit Set in the Virginia Agricultural Experiment Station Peach Orchard at Blacksburg in 1950 (Continued)

Variety	Days Ripe Before or After Elberta	Fruit Set	Variety	Days Ripe Before or After Elberta	Fruit Set
Champion	— 12	3+	Shippers Late Red	— 2	2
V.P.I. 17—			Halegold	— 1	3
Nectarine	— 11	3	Fertile Hale	— 1	4
U.S.D.A. 8537	— 11	2	U.S.D.A. 7426	— 1	3+
Veteran	— 9	1(H.T.)	Elberta		N.S.
Amador	— 8	4	Texaberta	+ 1	4
V.P.I. 18—			V.P.I. 4	+ 1	4
Nectarine	— 8	4	V.P.I. 15	+ 1	2
V.P.I. 19—			Redskin	+ 1	4
Nectarine	— 8	4	Hardy Berta	+ 1	N.S.
Summercrest	— 7	N.S.	Halberta	+ 3	2-
Boston Nectarine	— 7		Wilma	+ 4	N.S.
V.P.I. 22—		4	Prairie Rambler	+ 4	N.S.
Nectarine	— 7	4	Afterglow	+ 4	2-
Early Crawford	— 7	N.S.	J. H. Hale	+ 6	4
U.S.D.A. 8605	— 7	4	White Hale	+ 6	4-
Veefreeze	— 7	N.S.	Rio Oso Gem	+ 6	4
U.S.D.A. 2-2221	— 7		Late Canadian		
Sullivan Early		4	Queen	+ 6	4-
Elberta	— 5	N.S.	Late Rose	+ ?	N.S.
Redcrest	— 4	N.S.	Honeygem	+ ?	N.S.
Ideal	— 4	4	Constitution	+ ?	N.S.
Percival	— 4	4	Goodcheer	+ ?	N.S.
Georgia Belle	— 4	4-	Frankie	+ 17	3
Sunday Elberta	— 3	2	Lizzie	+ 19	3
Quetta Nectarine	— 3	4-	Carolyn	?	N.S.
V.P.I. 14	— 3	4	Cortez	?	N.S.
V.P.I. 21	— 3	4	Corona	?	N.S.

characters on which notes are taken for our permanent records.

In view of the fact that the trees in the breeding orchards vary in age, size, and productive capacity, no measured yield records are taken on any of the material. The set of fruit relative to the productive capacity of the tree is estimated on a numerical basis. By this system a Number 1 set is given to a tree bearing a full commercial crop of fruit

for a tree of that size and age. A fruit set of 2 denotes a medium commercial crop for a tree of that size and age. A set of 3 denotes a light crop and a set of 4 indicates a few scattered fruits. A complete lack of fruit is indicated by N.S. (no set).

Table 1 presents the data on relative sets of fruit on the varieties and seedling selections of peaches included in the test planting. The

varieties are arranged in order of ripening as indicated by the number of days the variety or selection has ripened before or after Elberta at Blacksburg. Two or more trees of each kind were available for this study.

Discussion of Results

The data show that there is a real variation among peach varieties in the frost resisting or escaping ability of the blossoms. The range extends from complete lack of crop shown by Elberta, Golden Jubilee, Summercrest, Early Crawford, Sun-high and others to sets of fruit requiring thinning as shown by Veteran, Vedette, Redhaven, Eryl-Red-Fre, Colora, Fisher, N.J. 133, N.J. 137, and V.P.I. 8. Chandler (1) and Scott and Cullinan (6) have commented on the relative tenderness to frost at blossoming time of Elberta, Early Crawford, J H. Hale, Wilma, Hiley and other varieties. The latter authors reported Veteran to be among the most hardy varieties along with Viceroy, Mikado, Early Wheeler, Pallas and others.

The temperature to which the trees at Blacksburg were exposed is appreciably lower than the temperature at which other workers have reported complete killing of the crop on commercial varieties of peaches. Chandler (1) considered 22°—25° F as the killing temperature for peach blossoms in southern Missouri when the tree is just coming into full bloom. He noted some instances, however, in which nearly opened blossoms withstood

temperatures of 21°—22° F. Paddock and Whipple (5) reported that peaches at the pink stage passed safely through nights when the temperature fell to 21° F. West and Edlefsen (7) reported that 26° F kills about one-half of Elberta peach buds in full bloom and 22° about nine-tenths of them. Temperatures as low as 18° failed, however, to kill all of them under some conditions. Scott and Cullinan (6) considered 23° F to be about the greatest cold that open peach flowers could withstand but noted that Veteran, Viceroy and Mikado withstood this temperature better than most varieties. They emphasized that hardening of the flowers by gradual dropping of the temperature over a lengthy period increased their resistance to frost. Joley and Bradford (4) reported that some peach seedlings grown from seed harvested in the wild in the North Caucasus region showed blossom survival of 80% in the full bloom stage when the temperature fell to 19°. Temperature of 17° F about 2 weeks before the full bloom stage when the buds showed pink caused very little injury. Chaplin (2) reported that at 22° F all buds of Elberta were killed while Boone County, a very hardy type, showed 50 per cent survival at that temperature.

Beyond question the buds and blossoms under observation in the present study were hardened appreciably by the low temperatures that prevailed after April 6, after many had reached the full bloom

stage. It should be mentioned here that in another planting, containing the remnants of a seedling orchard of peaches in a notorious frost pocket on the V.P.I. campus, several seedling selections came through with light to medium crops of fruit even though the temperature had fallen to 15° F on April 15, as shown by a minimum recording thermometer located only a few yards from the trees.

The variations in stage of bloom or bud development shown by the different varieties probably was not the most important factor in determining the relative degree of frost hardness of the varieties in this test. Chandler (1) and Garcia and Rigney (3) noted that peach blossoms were more hardy at the full bloom stage than after they were pollinated and the ovules had become fertilized. Their resistance to frost decreased as the young fruits increased in size to a half inch in diameter. Chandler reported that blossoms in the stage just before their petals opened were more hardy than when in the fully open stage but he considered this greater hardness to be of a physiological nature rather than due to protection by the closed petals.

The spread in season of blossoming of the varieties in the Blackburg orchard was not very great in 1950. The stimulation received in early winter started all varieties to develop their blossoms. The rather long cool period in February and March probably tended to level off

the differences in degree of blossom development shown by the different varieties. Then when temperatures became appreciably warmer in late March and early April all varieties responded quickly and rather uniformly. It is doubtful, however, that many varieties had developed their blossoms beyond the stage of fertilization of the ovules. Admittedly such varieties as Veteran, Vedette, Redhaven, Afterglow, Shippers Late Red, and V.P.I. 8 had more unopened buds and blossoms than had the varieties that proved to be more tender. There were many fully opened blossoms on these varieties, however, that showed no visible indications of injury to the pistils.

It may well be pointed out here that in 1949 the crop was totally destroyed by temperatures of 27° and 24° F. In that year, however, the freezes occurred about 18 to 20 days after the full bloom stage at which times the young fruits were splitting their shucks. At that stage the injury was most apparent in the form of killing of the developing seed or ovule as was observed by Chandler (1).

No correlation appears to exist between the season of ripening of the fruit and resistance of the blossoms to frost. It is interesting to note, however, that all of the varieties that were little injured by the frosts ripened before Elberta. Several of them, including N.J. 133, Erly-Red-Fre; N.J. 137, Redhaven and Fisher are among the very early ripening varieties.

The high winds on April 14 and 15 probably eliminated the influence of frost pockets that might otherwise have occurred in the planting. Some indication of wind influence on the amount of blossom killing was observed since on trees that lost most of their crop the few surviving fruits were primarily on the south-easterly portion of the tree. The sides of the orchard which were most exposed to the prevailing northwesterly winds showed particularly this distribution of the fruit.

The variation in blossom hardness shown by this material indicates that breeding for this char-

acter may be expected to yield commercially acceptable varieties of peaches that are at least as hardy at the blossom stage as any now in existence. Several of the hardier varieties in this test, such as Veteran, Vedette, Redhaven and Eryl-Red-Fre, have assumed commercial importance in some areas. There is ample reason to believe that further breeding with such hardy material may result in the development of firm fleshed, high quality, highly colored peaches that will stand commercial handling and shipping and will be much hardier in bud than the varieties now making up the bulk of our commercial peach crop.

Literature Cited

- (1) Chandler, W. H. The killing of plant tissue by low temperature. Mo. Agr. Expt. Sta. Res. Bull. 8. 1913.
- (2) Chaplin, C. E. Some artificial freezing tests of peach fruit buds. Proc. Amer. Soc. Hort. Sci. 52: 121-129. 1948.
- (3) Garcia, F. and Rigney, J. N. Hardiness of fruit buds and flowers to frost. New Mex. Agr. Expt. Sta. Bull. 89. 1914.
- (4) Joley, L. E. and Bradford, F. C. Variations in blossom hardness within a hardy group of peaches. Proc. Amer. Soc. for Hort. Sci. 43:79-83. 1943.
- (5) Paddock, and Whipple, O. B. Fruit growing in arid regions. Macmillan Co., New York. 1910.
- (6) Scott, D. H., & Cullinan, F. P. Peach variety resistance to cold injury at blossom time. Proc. Amer. Soc. Hort. Sci. 37:209-214. 1940.
- (7) West, F. L., and Edlefsen, N. E. Freezing of fruit buds. Jour. Agr. Res. 20:655-662. 1921.

