Injury to the Buds of Grape Varieties Caused by Low Temperatures[1]

By J. Harold Clark, *New Jersey Agricultural Experiment Station, New Brunswick, N J.*

THE cold winters of 1933–34 and 1934–35 resulted in various types of winter injury to certain fruit plants in New Jersey. Some grape varieties had a rather large proportion of fruit buds killed so that there was an opportunity to secure information on varietal resistance to low temperatures.

Objectives

A systematic study of the bud injury on different varieties was undertaken for the following reasons. Information as to relative hardiness of commercial varieties would be of value in making recommendations for planting. Similar information on a rather large number of less well known varieties should be helpful to plant breeders working to produce hardy varieties. It would be desirable to know whether bud injury affects the yields of certain varieties even following mild winters. Definite information on the relative susceptibility of the primary, secondary, and tertiary buds of the compound fruit bud to injury by low temperature would be of value.

Review of Literature

There are a number of references in the literature to the resistance of grape varieties to low temperature. Most of these references discuss killing of canes or entire plants rather than killing of buds.

Gladwin (3) has recorded the percentage of injury to buds of a long list of grape varieties during the winter of 1915–16. His figures, however, are based on the percentage of buds growing and it is possible that some of the buds listed as having been killed remained dormant instead. Angelo (1) showed that on certain varieties there were many dormant buds which might be forced into growth if the earlier developed shoots were killed by frost. Gladwin (3) discussed the relative productiveness of shoots arising from primary, secondary and tertiary buds. Wiggans (5) found that shoots from primary buds were roughly three times as productive as shoots from secondary buds.

It has been brought out by Gladwin (3) and others that the relative maturity of the canes is of considerable importance in determining hardiness of the grape. Saunders (4) in 1883 wrote that "For all cultural purposes it is sufficiently accurate to assume that the hardiness of a grape simply depends upon its immunity from mildew." There are undoubtedly many factors associated with hardiness in the grape and indeed many types of hardiness, as recently brought out by Blake (2), who was dealing particularly with the peach.

In these investigations there has been no effort to make a complete study of hardiness in the grape but only to report on the bud injury

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sustained by different varieties in the vineyard on the Horticultural Farm at New Brunswick. This vineyard is located at an elevation of approximately 90 feet. The soil is a well drained Sassafras loam merging into a gravelly phase. The varieties were all given the same cultural treatment and individual vines were pruned according to the amount of growth they had made. Growth and production of most varieties have been fairly good from year to year.

The winters of 1933–34 and 1934–35 each included one especially cold night. On February 9, 1934, the temperature fell to −16 degrees F and on January 28, 1935 the temperature dropped to −14 degrees F. There were no long periods during either winter when the temperature was high enough to start cell growth. The injury recorded, therefore, may presumably be attributed to the effects of low temperature, probably that occurring on the nights mentioned.

The taking of records was continued during 1936 in order to secure data following a comparatively mild winter. The minimum temperature for 1935–36 was −4 degrees F which occurred on January 23 and again on February 20.

Procedure

Early in March of each year selected canes were taken indoors for examination. The canes secured were apparently well matured and were of the type that would normally be used for renewal at pruning time. The small buds at the base of the canes were discarded as were the buds near the tips. One hundred of the selected compound buds from each variety were examined after being sectioned transversely with a razor blade. The injured parts within the compound bud were easily distinguished by their brown color. Due to the brown pubescence inside the bud scales it was sometimes necessary to make several slices with the razor blade before the condition of the bud could be accurately determined. Injured buds had both vegetative growing point and flower primordia killed. Sterile shoots, therefore, would ordinarily arise from a secondary or tertiary bud rather than from a primary bud in which the primordia had been killed.

Results

Data pertaining to certain varieties are included in Table I with the combinations of injured and uninjured buds grouped into six classes. Other combinations not classified in the table occurred less frequently. Where the numbers recorded for a variety do not total 100, the difference is due to these other combinations of injury. Golden Muscat, for instance, had 40 per cent of its compound fruit buds with secondary and tertiary buds dead (primary alive) in 1935, and 27 per cent in 1936. In the case of most other varieties, nearly every compound bud that was injured at all had the primary dead. With most varieties the primary was definitely more susceptible to low temperature than either the secondary or tertiary.

Classification of Varieties

The fact that the buds of certain varieties were only slightly injured even in 1935 whereas others were severely injured is shown in Table I.

TABLE I—CONDITION OF GRAPE BUDS, HORTICULTURAL FARM, NEW BRUNSWICK, N. J.

Variety	Entire Compound Bud Alive	Primary Dead	Primary and Secondary Dead	Primary and Tertiary Dead	Secondary Dead	Entire Compound Bud Dead
			March, 1934			
Agawam	26	8	0	26	0	40
Beta	94	6	0	0	0	0
Brocton	90	6	0	0	0	4
Concord	96	4	0	0	0	0
Daisy	96	2	0	0	0	2
Dutchess	34	30	0	20	0	16
Fredonia	92	8	0	0	0	0
Golden Muscat	90	4	0	6	0	0
Lucile	90	8	0	2	0	0
Moore Early	96	2	0	0	0	2
Niagara	85	9	0	6	0	0
Sheridan	88	6	0	0	0	6
Wilder	82	12	0	0	0	6
Worden	100	0	0	0	0	0
			March, 1935			
Agawam	0	22	12	21	0	44
Beta	84	2	2	0	10	1
Brocton	31	52	1	0	3	13
Concord	63	15	1	3	11	2
Daisy	100	0	0	0	0	0
Dutchess	4	10	4	9	1	71
Fredonia	91	4	0	0	5	0
Golden Muscat	9	0	0	1	0	50
Lucile	95	5	0	0	0	0
Moore Early	97	3	0	0	0	0
Niagara	30	20	0	1	6	43
Sheridan	80	13	0	4	0	3
Wilder	16	12	1	0	15	55
Worden	98	1	0	0	1	0
			March, 1936			
Agawam	90	8	1	1	0	0
Beta	100	0	0	0	0	0
Brocton	93	3	0	0	0	1
Concord	92	3	0	0	1	1
Daisy	100	0	0	0	0	0
Dutchess	91	5	0	0	1	3
Fredonia	58	24	2	2	6	4
Golden Muscat	55	0	0	0	4	13
Lucile	97	3	0	0	0	0
Moore Early	94	4	0	2	0	0
Niagara	86	6	0	3	4	0
Sheridan	96	2	0	0	1	1
Wilder	97	3	0	0	0	0
Worden	91	6	0	0	1	2

Since records were secured each year on a large number of varieties, the complete data would be too lengthy to include in detail. The varieties can be grouped, however, to indicate their relative bud hardiness. This grouping is based on the percentage of primary buds uninjured as that is undoubtedly the most important from the standpoint of production.

Class A, 1934:—Varieties with more than 66 per cent of primary buds alive: Adams, America, Beta, Brighton, Brocton, Catawba, Clinton, Clevener, Concord, Daisy, Delaware, Diamond, Dunkirk, Eclipse, Fredonia, Green Mountain, Golden Muscat, Iona, Ives, Lindley, Lucile, Melton, Merrimac, Moore Early, Niagara, Noah, Ontario, R. W. Munson, Riparia Gloire, Ripley, Salem, Sheridan, Wilder, Worden.

Class B, 1934:—Varieties with 34 to 66 per cent of primary buds alive: Campbell Early, Champion, Dutchess, Empire State, Eumelan, Highland, Mericadel, Pontiac, Portland, Urbana, Vergennes, Watkins, Wayne.

Class C, 1934:—Varieties with less than 34 per cent of primary buds alive: Agawam, Armalaga, Brilliant, Ellen Scott, Hanover, Stout Seedless.

Class A, 1935:—Varieties with more than 66 per cent of primary buds alive: Adams, Beta, Caco, Catawba, Campbell Early, Clevener, Clinton, Concord, Daisy, Delaware, Diamond, Dunkirk, Fredonia, Green Mountain, Iona, Ives, Lucile, Moore Early, Noah, Riparia Gloire, Sheridan, Worden.

Class B, 1935:—Varieties with 34 to 66 per cent of primary buds alive: Brighton, Brilliant, Brocton, Eumelan, Golden Muscat, Hanover, Highland, Melton, Merrimac, Niagara, Ontario, Pontiac, Portland, Ripley, Salem, Urbana, Watkins, Wayne.

Class C, 1935:—Varieties having less than 34 per cent of primary buds alive: Agawam, Armalaga, Champion, Dutchess, Ellen Scott, Empire State, Lindley, Stout Seedless, Vergennes, Wilder.

In 1936, following a mild winter, the same varieties were examined and most of them had more than 66 per cent of the primaries alive. Therefore, only Classes B and C will be given.

Class B, 1936:—Varieties having 34 to 66 per cent of primary buds alive: Armalaga, Bailey, Melton.

Class C, 1936:—Varieties having less than 34 per cent of primary buds alive: Stout Seedless.

If the varieties were classified according to species there would be found a great variation in bud hardiness within the species. This agrees with the observations of Gladwin (3).

INJURY TO VITIS VINIFERA

In the course of these investigations examinations were made of the buds of a number of varieties of Vitis vinifera most of which had been surviving the winters, unprotected, and with little or no injury, previous to 1933–34. In 1934, however, there was a complete bud kill on the following varieties: Bellino, Black Monukka, Corinthe Rose, Foster, Frankenthal Precoce, Gros Sapot, Tokay, Lignan Blanc, Pedro Ximines, Purple Damascus, Rose de Italia, Trentham Black and White Luglienga. Two varieties, Chasselas Rose de Falleau and Madeline Celine were the only ones to have some live buds but even these varieties produced very little fruit.

In 1935 there was a practically complete kill of all buds on all vinifera varieties.

In 1936 there were some buds alive on all vinifera varieties except Tokay and Rose de Italia but very little fruit was produced except by Madeline Celine and Chasselas Rose de Falleau.

Relation of Bud Injury to Growth and Production

In most cases the wood of the canes examined seemed to be less susceptible to injury than the buds. Wood that was apparently uninjured was quite often found between nodes where all the buds were killed and only a few varieties, except the viniferas, showed any definite injury to canes at the time the buds were examined. It is recognized, of course, that there were some variations in wood maturity between different varieties even under the same cultural conditions.

No attempt has been made to definitely correlate yield records with the percentage of bud injury. It was quite evident, however, that a comparatively large number of buds could be killed without greatly reducing the crop below what would be expected from a normal, uninjured vine. Observations made each summer and compared with the results of the bud examinations of the previous March indicate that, on many varieties, a considerable number of uninjured buds may remain dormant. When there are a large number of buds injured, however, some of the buds which would otherwise remain dormant may be forced into growth. Furthermore, the killing of a few buds may have somewhat the same effect as thinning and may result in larger clusters from the buds that are left. It would require considerable study to determine just what percentage of the buds could be killed without materially affecting the total yield. In some cases, however, certain varieties have produced a good commercial crop, when as many as 33 per cent of the primary buds were killed.

From the data secured in 1936, it would seem that very few varieties survive such winters with 100 per cent of the buds uninjured even though the temperature was no lower than —4 degrees F. This may be a factor in crop production during some years when no winter injury is suspected, especially when unproductive shoots from secondary buds give the vine an appearance of normal growth. Maturity of the buds may have an important bearing on their ability to survive during mild winters but since the extent of winter injury is usually affected by the maturity of the tissues, it would be difficult, if not impossible, to distinguish between injury due primarily to cold and that due to tissue immaturity. The important thing is the ability of a variety to survive with a minimum of any kind of injury.

Summary

A number of grape varieties are classified according to the percentage of primary buds alive after minimum temperatures of —16, —14, and —4 degrees F. With most varieties the primary bud was more susceptible to injury by low temperature than was the secondary or tertiary. Buds of most varieties of Vitis vinifera were killed during the winter of 1935–36 by a temperature of —4 degrees F. The wood of grape canes was generally more resistant to injury from low temperatures than were the buds. There was considerable injury to buds of some varieties during the winter of 1935–36 when the minimum temperature was —4 degrees F. The yield, however, was not greatly affected in some cases even when as many as 33 per cent of the primary buds were killed.

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