

Final Report of 2004 and 2005 Research to
The Viticulture Consortium East Research Grants Program
and The New York Wine & Grape Foundation

**Effects of Crop Load Adjustment on Bud Fruitfulness, Return Bloom,
and Bud Cold Hardiness in Concord Grapevine**

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PROJECT OBJECTIVES:

During two growing seasons (2004, 2005) at the Viticulture Lab in Fredonia, New York, we investigated the effect of adjusting crop thinning on the current crop and on the following season's productivity. We used mature Concord vines pruned to 120 nodes. Vines had fruit removed at 30 days post bloom to leave 0%, 50%, 75%, or 100% of calculated harvestable crop. Specific objectives were:

1. Determine the effects of fruit thinning level on bud development and bud "fruitfulness" relative to node position along the shoot and the cane.
2. Determine possible effects of decreased thinning on subsequent bud cold hardiness.
3. Determine how intensity of thinning affects return bloom the next season, and parameters of yield and fruit quality in both the season of thinning and the next season.

PROJECT SUMMARY:

Concord juice growers have increased their use of constant-node pruning in recent years. Constant node number, such as 100 or 120 nodes per vine, has increased fruit yields over balance pruning, while avoiding the lower fruit quality often seen with minimal pruning. However, there is the danger in constant-node systems that hang more fruit on the vine than can fully mature, with the added concern that much of the vine's reserves for next season may be removed by the current crop. The high fruiting potential in constant-node systems can be controlled by thinning fruit, often about 30 days after bloom, when estimates of final fruit weight at harvest can be predicted. Our goal was to provide growers information about what proportion of the estimated crop should be retained so as to maximize yield and fruit quality, while allowing optimal vine maturation, adequate supplies of reserve carbohydrate, deep-winter cold hardiness, and full development of cluster primordia within winter buds for next season's flowering.

Our results for both 2004 and 2005 indicated that 120-node vines should be thinned between 50% and 75% potential crop if growers are to gain benefits in fruit quality and enhance vine maturation and return bloom potential, while sustaining optimal yields. In July both years, we thinned 120-node vines to retain 0%, 50%, 75%, and 100% of the calculated crop at harvest (taken as twice the fruit weight of completely defruited vines at 30 days post bloom). Vines with no crop retained produced double the number of nodes of mature wood (periderm) and weight of prunings than did unthinned vines. Vines with 50% or 75% potential crop retained were intermediate in both characteristics. In both years, unthinned vines had significantly less developed clusters in their overwintering primary buds than did vines without a previous crop or with 50% crop. However, the cold hardiness of winter buds measured in the early winter of both 2004 and 2005 did not vary significantly relative to the proportion of crop retained. Also, buds along the overwintering cane did not show obvious positional effects relative to cold acclimation within a cropping level or between cropping treatments. Regardless, buds of all treatments easily withstood the long-term average daily cold temperature on the date the buds were collected.

Vines fully cropped in 2003 developed significantly shorter shoots with fewer "flat leaves" measured on 29 June in 2004. However, we did not see such a clear effect of 2004 thinning level and early shoot development in 2005. Shoot growth was better in 2004 than in 2005. In both 2004 and 2005, node-3 shoots had the highest percentage of flowers that actually persisted as fruit (% fruit set), even though this node's shoots produced the fewest flowers. Percentage fruit set, in general, did not appear to be correlated with the proportion of crop left on the vines the previous year. Percentage fruit set was better in 2005 than in 2004, even though flowers per shoot were greater in 2004 than in 2005.

By harvest date, vines unthinned in 2004 had 10.6 tons/acre equivalent, vines thinned to retain 75% crop had 8.2 tons, while those with 50% crop had 6.0 tons. Berry weight of unthinned vines was significantly less than berry weight of vines thinned to 50%, but not to 75% crop. Juice soluble solids (°Brix) of unthinned vines were significantly less than those of any vine thinned more heavily. Vines crop adjusted in July 2005 yielded 3.8 tons/acre at 50% of potential crop, 7.4 at 75% crop, and 10.5 at 100% crop (which was lower than the predicted 11.5 tons/acre). Juice soluble solids were high in 2005 relative to other years because of warm and dry summer conditions and smaller than average berry weight. Berry weight was the same for all treatments in 2005.

PROCEDURES:

Concord grapevines (30+ years old) of similar vine size were pruned to 120 nodes and hand crop-adjusted (thinned) at approximately 30-days after bloom. At thinning time in 2004 and 2005, we defruited eight vines for the 0% crop treatment and recorded the total fruit weight, with double that weight calculated as full harvest weight for unthinned vines. Eight vines (100% crop, unthinned) were not crop adjusted. Eight other vines had fruit thinned to either 50% of expected crop (50% crop) or to 75% crop. After leaf fall in both seasons we counted the total number of nodes with brown periderm as a measure of wood maturation. Vine size was determined as the weight removed in the winter pruning cycle. For all treatments but the 75% crop, we removed two canes from each vine in early winter (2 Dec 04 and 28 Nov 05). We then dissected the dormant buds at nodes 3, 6, and 9 from the cane base to determine stage of development of their embryonic flower clusters (Defined in Fig. 1 in Appendix). Well-developed Concord buds produce three clusters. We summed the stages of the three clusters within a bud to exaggerate potential differences in reproductive capacity between treatments. We tested the buds at nodes 2, 5, and 8 of these same canes for cold hardiness via Differential Thermal Analysis, using a freezer programmed to record bud lethal freezing as temperature was reduced. Methods are those of Wolf and Pool (HortScience, 1986, Vol. 2, pp. 1447–48). All buds eventually released a low temperature exotherm (LTE), which signaled bud death, which was recorded on a computer program. The mean median LTE₅₀ for a group of frozen buds was the mean temperature at which 50% of them were killed.

Prior to the 2004 and 2005 growing seasons, two canes per vine were flagged to be retained at the time of winter pruning in order to determine how new shoots and clusters emerging from cane nodes 3, 6, and 9 were affected by prior year's treatments. On June 29 in both seasons we counted all "flat leaves" on these shoots and recorded shoot lengths. At immediate pre-bloom we counted flowers on the three clusters emerging on these shoots, and at the time of crop thinning in July, we counted all their fruits. We also recorded return yield of fruit, berry weights, and juice soluble solids (°Brix) after harvest. In 2005 we also studied vines not previously in the study to provide a second year data on the effects of adjusting crop level in the current season on harvest yield and solids, wood maturation, acclimation of buds to winter temperatures, and on development of clusters within those buds. Bloom occurred 8 June 2004 and on 13 June 2005. Wet weather accompanied post-veraison development in 2004, while the summer and early fall of 2005 was extremely hot and dry.

RESULTS:

Return Crop Information. The 2004 yield ranged from 0 to 10.6 tons/acre because of crop adjustment at 30-days-after bloom (Table 1). This range in yield had an effect on 2004 juice soluble solids (See 2004 report). Namely, yields and berry weight decreased with progressive fruit thinning, while soluble solids rose by about 1 to 1.5 °Brix. The range of yield also had an effect on final 2004 vegetative growth (Table 1). Ripe nodes of periderm at season's end ranged from 446 nodes on fully cropped vines to 738 nodes on completely defruited vines. Pruning weight at season's end and the change in pruning weight from 2003 to 2004 also followed a similar pattern. Thinning in July 2004 tended to yield more clusters/vine (or clusters/node) and heavier clusters having more berries/cluster. Fruit thinning in 2004 had no effect on 2005 berry weight. Mean values notwithstanding, the discontinuous thinning treatments of 0, 50, 75, and 100% crop displayed a continuous array of yield values from 0 to 14 tons/acre. Therefore, correlation coefficients were calculated to compare continuous 2004 and 2005 data (Table 2 in Appendix). Again, there was a high correlation between the 2004 and 2005 yield. However,

there appears to be two mechanisms at work. Decreasing yield in 2004 increased vine vegetative growth, leading to increased bud fruitfulness (clusters/node), and also increased berries/cluster in 2005.

Table 1. The effect of 2004 yield on vine growth and 2005 return crop. Letters in columns show mean separation by Duncan's new multiple range test at the 5% level.

2004 Retained Crop	2003		2004		Change In Pruning Wt	2005 Yield Tons/Acre	2005 Clusters Per Vine	2005 Clusters Per Node	2005 Cluster Wt (g)	2005 Berries Per Cluster	2005 Berry Wt (g)	2005 Juice Soluble Solids (°Brix)
	Grown Pruning Wt Lbs/vine	2004 Yield Tons/acre	2004 Grown Periderm	2004 Pruning Wt Lbs/vine								
0%	2.30 a	0.0 a	738 a	3.3 a	1.0 a	17.9 a	295 a	2.5 a	91.0 a	34.0 a	2.7 a	16.8 a
50%	2.25 a	6.0 b	658 ab	2.3 b	0.1 b	13.7 b	271 ab	2.3 ab	76.0 b	28.0 b	2.7 a	17.7 b
75%	2.20 a	8.2 c	559 bc	2.4 b	0.2 b	13.7 b	254 b	2.1 b	80.9 b	29.9 b	2.7 a	17.6 b
100%	2.18 a	10.6 d	446 c	2.0 b	-0.2 b	11.9 b	241 b	2.0 b	73.9 b	28.1 b	2.6 a	17.5 b

Effects of 2005 Crop Adjustment on 2005 Crop. Vines pruned to 120 nodes and crop adjusted at 30-days-after bloom in 2005 yielded 3.8 tons/acre at 50% adjusted crop, 7.4 at 75% crop, and 10.5 at 100% crop, while crop estimated for 2005 unthinned vines was 11.5 tons/acre (Figure 2A in Appendix). Actual yield for 50% and 100% treatments thus fell short of yield predicted by their category. Juice soluble solids were high in 2005 relative to other years because of warm and dry summer conditions and smaller than average berry weight (Fig. 2B and Fig. 3 in Appendix). All vines in the 2005 thinning trial reached between 18 and 20 °Brix, while return crop on 2005 vines that were thinned in 2004 attained between 16–18.5 °Brix. Nevertheless, there was a significant negative linear relationship between °Brix plotted against vine yield when all vines were plotted (Fig. 3 in Appendix).

Effects of Crop Thinning on Bud Fruitfulness. After the 2003 season, the winter buds of unthinned vines had significantly less developed embryonic clusters than did vines without a previous crop or with 50% crop. This has also proved to be the case for reproductive status in buds dissected after the 2004 and 2005 growing seasons. (Table 3 in Appendix). Cane node 3 tended to have less developed embryonic clusters than did other nodes in both 2003 and 2004 dormant buds; although in 2005 buds it was cane node 9 that was least fruitful (Table 3 in Appendix).

Effects of Crop Thinning on Winter Bud Cold Acclimation. After the 2003 growing season, buds at cane node 2 were significantly more cold hardy (by 2 to 3 °C) than buds at more distal nodes, regardless of thinning level. After the 2004 and 2005 growing seasons, there was only a slight and insignificant difference in bud cold hardiness between thinning levels and between bud position along the canes (Table 4 in Appendix). At the time of bud assessment on 2 December 2004, all buds could withstand a temperature of at least -26.3 °C (-15.3 °F). At time of assessment on 28 November 2005, all buds were cold tolerant to at least -25.1 (-13.2 °F). At the time of writing this report in late December 2005, Concord buds at Geneva could withstand -29 °C (-20 °F).

Effects of Crop Thinning on Next Season's Shoot Emergence. Shoot length and the number of "flat leaves" emerging from buds in 2004 were significantly affected by level of thinning in 2003. Shoot length measured on 29 June 2004 was reduced at cane nodes 3, 6, and 9 for previously unthinned vines compared to length measured for previously thinned vines (Table 5 in Appendix). Shoot length decreased significantly as more crop was left on the vines the

previous year. In the 2005 growing season, however shoot lengths measured on 29 June could not be related to prior year's thinning level (Table 5 in Appendix). This was unexpected, as the hot dry 2005 season should have increased the effect of the previous year's crop on vine performance. Number of "flat leaves" (i.e., leaves showing flattened blades below the shoot tip) per shoot for shoots at cane nodes 3, 6, and 9. This number did not vary between treatments at cane node 3, but heavy cropping appeared to significantly hinder leaf production at nodes 6 and 9. The mean effect across all nodes within a treatment was that vines hanging 100% crop produced one less leaf on their shoots that did vines with less fruit or with no fruit (Table 6 in Appendix). In 2005 the number of "flat leaves" produced by 29 June could not be related to level of thinning across all nodes nor to position along the shoot (Table 6 in Appendix). Surprisingly, unthinned vines had significantly more nodes produced by late June (approximately one more leaf) than did vines at 50% crop or no crop. Again, this was surprising, as the summer weather was expected to have a much heavier impact on shoot growth in the most heavily cropped vines the preceding year.

Effects of Crop Thinning on Return Bloom and Fruit Set the Next Season. The greater the proportion of crop retained in 2003, the lower the number of flowers per shoot at bloom in 2004 (Table 7 in Appendix). Node 3 shoots produced significantly fewer flowers (from 62 to 86 fewer flowers) per shoot than did node 6 or 9 shoots in all treatments. We had previously found that node 3 also produced the least developed clusters in fall of 2003, which can help explain shoot flower numbers at bloom 2004. We have seen in other studies of Concord and Niagara vines that the more developed the clusters are in winter buds, the more flowers produced per shoot the next season, no matter the pruning system. Flowers per shoot in 2005 were not significantly related to the vine's thinning level the preceding year (Table 7 in Appendix). The fully cropped vines in fact contained at least as many flowers per shoot than did the uncropped or 50%-cropped vines. In both 2004 and 2005, shoots erupting at cane node 3 had a significantly greater percentage fruit set than did clusters on shoots at cane node 6 and 9 (Table 8 in Appendix). However, fruit set, in general, did not seem to be directly correlated with the amount of crop left on the vine the preceding year. Our view is that fruit retention (as % flowers setting fruit) is less determined by prior year's thinning level than is flower production up through bloom. After bloom there are many other factors that affect vine performance, whereas, before bloom the vine relies heavily on reserve carbohydrate and nitrogenous compounds carried in the woody organs over the winter.

NOTE. DETAILED FIGURES AND TABLES MENTIONED IN THE REPORT CAN BE FOUND IN THE APPENDIX, OBTAINED BY CONTACTING:

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APPENDIX

Effects of Crop Load Adjustment on Bud Fruitfulness, Return Bloom, and Bud Cold Hardiness in Concord Grapevine

PRINCIPAL INVESTIGATORS: Martin C. Goffinet and Terry Bates

Impact Statement

This investigation is developed around the concept that improvements in the amount and timing of fruit thinning for Concord juice-grape production will benefit growers economically through improving the overall quantity of high-quality fruit desired by processors. We have shown in this in related reports how thinning intensity affects grapevine productivity via its effects on canopy development, autumn maturation of winter-hardy canes and buds, return bloom, fruit set, and development of fruit clusters within primary buds. Findings will help growers refine their current practices in pruning vines and managing crop loads. Results will help guide growers toward a sustainable and economical production of efficiently managed grape production systems. Our research has demonstrated that for constant-node pruning to be effective, such production depends on the grower's ability to thin fruit to an optimal level.

PUBLICATIONS RELATIVE TO THE PROJECT

Web-Accessible Publications on Grapevine Thinning:

<http://lenewa.netsync.net/public/bates/BatesEffect.htm>

Bates, Terry. 2003. Effect of Pruning, Training, Thinning, and Shoot Positioning on the Yield and Quality of 'Concord' Grapevines

http://lenewa.netsync.net/public/bates/BatesThinning_Report.htm

Bates, Terry. 2003. Effect of Thinning Time, Thinning Level, and Vine Size on Concord Juice Quality

Journals, Proceedings, Abstracts, Trade Publications on Vine Development/Productivity:

Goffinet, M.C. 1997. The reproductive cycle in grapevines. Proc. Washington State Grape Soc. 26: 67–79.

Goffinet, M.C. 2000. The anatomy of low-temperature injury of grapevines. Am. J. Enol. Vitic. 51 (No. 5): 1–7.

Goffinet, M.C. 2001. Grapevine buds: construction, development, and potential for cropping. Wine East Magazine, Sept.-Oct., pp. 14–23. L&H Photojournalism, Lancaster, PA.

Goffinet, M.C. 2004. Relation of applied crop stress to next season's inflorescence development, shoot growth characteristics, and cane starch reserves in 'Concord' grapevine. Acta Horticulturae 640: 189–200.

Goffinet, M.C., A.N. Lakso, and M.J. Welser. 1994. Relationship between winter bud construction and flower and fruit number in 'Concord' and 'Niagara' grapevines. ASHS 1994 Annu. Mtg., Oregon State University, Corvallis, OR, Prog. & Abstr. HortScience 29(5): 788 [134].

Goffinet, M.C., R.M. Pool, and M.J. Welser. 1992. Developmental Aspects of Grapevine Shoots and Buds during Fall Acclimation to Cold. Am. J. Enol. Vitic. 43(4): 390 [Abstr.].

- Goffinet, M.C., and M.J. Welser. 1995. Relationship of winter stage of 'Concord' grapevine buds, previous season, and return bloom. ASHS 1995 Annu. Mtg., Montreal Convention Center, Quebec, Ontario, Canada, Prog. & Abstr. HortScience 30(4): 208 [87].
- Pool, R.M., T.K. Wolf, M.J. Welser, and M.C. Goffinet. 1992. Environmental factors affecting dormant bud cold acclimation of three *Vitis* cultivars. P. 611–616, Proc. IV Intl. Symp. Physiol. Vine, San Michele All'Adige, Italy, 10–15 May, 1992.

Appended Data for Report

NOTE: The Figures and tables below are data gathered between late 2003 to late 2005. They include data for Concord shoot growth, fruit maturation, vine size, bud development and cold hardiness, return crop and fruit quality assessments for vines pruned to 120 nodes. Groups of vines were thinned in July to a percentage of the estimated crop potential of vines having no crop removal (100% crop), that is, 0%, 50%, 75%, and 100%. Determination of tabled values and methods of deriving them are given in the Procedures section of the main Progress Report.

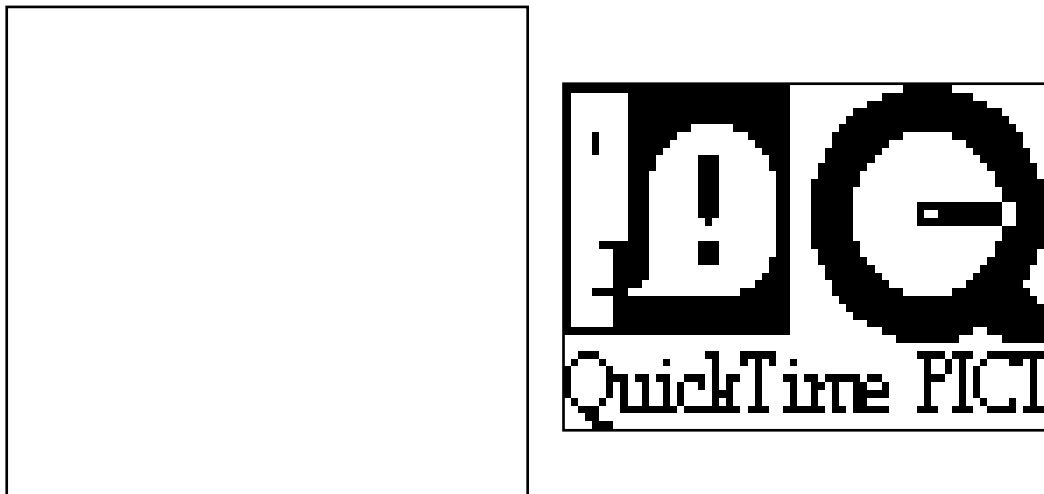


Fig. 1. Developmental stages of embryonic clusters in primary buds. Above left. Stages defined: Stage 0, The expected cluster was not found or not yet initiated at its expected site; Stage 1, The cluster was initiated on the flank of the primary bud's stem but not yet branched; Stage 2, The cluster initiated its first branch, the outer arm or "wing"; Stage 3, The main rachis of the cluster initiated 1st-order branches; Stage 4, The basal half of the main rachis initiated 2nd-order branches; Stage 5, The distal half of the main rachis initiated 2nd-order branches; Stage 6, The basal half of the main rachis initiated 3rd-order branches. Small arrows show critical events. Above right. Scanning electron micrograph of dissected bud showing robust development of its three clusters (C1 to C3) before winter. C1 at stage 6; C2 at stage 5; C3 at stage 4. Sum of cluster stages = 15, the bud's reproductive status. A, apex of primary shoot; L, leaf or location of a removed leaf.

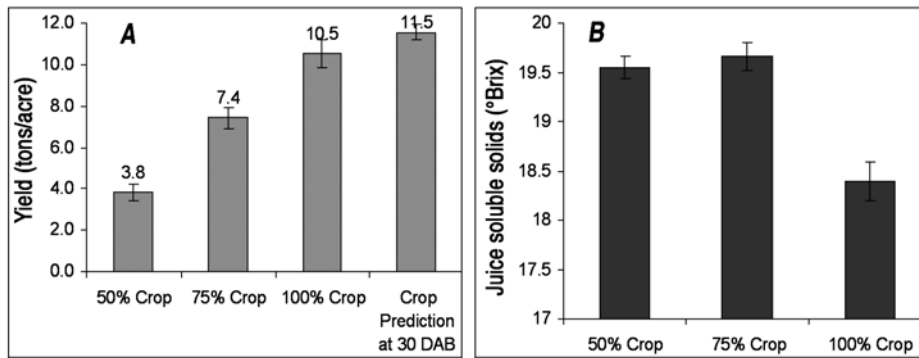


Figure 2. 2005 yield (A) and juice soluble solids (B) of 2005 crop adjusted Concord grapevines at the Fredonia Vineyard Lab. $n = 8$, bars = st. errors.

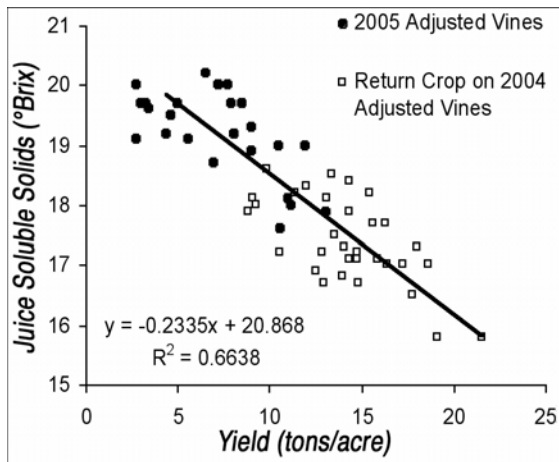


Figure 3. Yield and juice soluble solids of individual Concord vines in 2005. Data includes vines crop adjusted in 2005 and return crop on vines thinned in 2004.

Table 2. Correlation coefficients¹ between 2004 yield and 2005 return crop attributes.

	2004 Yield tons/ acre	2004 Grown Pruning Wt lbs/vine	2005 Yield tons/ acre	2005 Clusters per Vine	2005 Cluster Wt (g)	2005 Berries per Cluster	2005 Berry Wt (g)	2005 Juice Soluble Solids (°Brix)
2004 yield (tons/acre)	1.0000	-0.4839 0.0050	-0.7117 <.0001	-0.4945 0.0040	-0.6210 0.0001	-0.6630 <.0001	-0.1014 0.5808	0.3620 0.0417
2004 grown pruning weight (#/vine)		1.0000	0.7025 <.0001	0.4541 0.0090	0.6784 <.0001	0.5827 0.0005	0.3834 0.0303	-0.6087 0.0002
2005 yield (tons/acre)			1.0000	0.8233 <.0001	0.7440 <.0001	0.8135 <.0001	0.0786 0.6688	-0.6432 <.0001
2005 clusters/vine				1.0000	0.2404 0.1852	0.4014 0.0228	-0.2423 0.1815	-0.4059 0.0212
2005 cluster weight (g)					1.0000	0.9078 <.0001	0.4712 0.0065	-0.6040 0.0003
2005 berries/cluster						1.0000	0.0607 0.7416	-0.6505 <.0001
2005 berry weight							1.0000	-0.0665 0.7177
2005 juice soluble solids (°Brix)								1.0000

¹High positive value indicates a positive relationship between parameters in column vs. row, and a high negative value indicates an inverse relationship. Number below each coefficient is the probability level.

Table 3. Reproductive status of Concord clusters developed in dormant primary buds at cane nodes 3, 6, and 9 taken on 2 Dec 2004 and on 28 Nov 2005, from vines previously thinned 30 days after bloom in July to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the grand mean (\pm standard error) for the sum of the reproductive stages measured on the three clusters within each primary bud of two canes on each of eight vines per treatment. See Fig. 1 in Appendix for derivation of stage of development and stage summations.

Year	Retained Crop (%)	Sum Stages Cane Node 3	Sum Stages Cane Node 6	Sum Stages Cane Node 9	Mean Across All Nodes
2004	0%	13.0 \pm 0.5	14.0 \pm 0.4	13.7 \pm 0.7	13.6
	50%	10.7 \pm 0.7	12.1 \pm 0.7	12.9 \pm 0.4	11.9
	100%	8.7 \pm 0.5	12.4 \pm 0.5	12.7 \pm 0.6	11.2
2005	0%	11.9 \pm 0.9	13.8 \pm 0.6	10.9 \pm 0.7	13.6
	50%	12.6 \pm 0.7	13.8 \pm 0.5	11.0 \pm 0.8	12.5
	100%	10.4 \pm 0.7	13.6 \pm 0.5	10.8 \pm 0.9	11.6

Table 4. Cold hardiness (in °C) of dormant Concord buds at cane nodes 2, 5, and 8 taken on 2 Dec 2004 and on 28 Nov 2005 from vines previously thinned 30 days after bloom in July 2004 to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the mean median low-temperature exotherm (LTE₅₀) of three plates of buds, eight buds per plate, at which half the buds had been killed by freezing.

2004 Retained Crop (%)	Cane Node 2	Cane Node 5	Cane Node 8	Mean Median LTE ₅₀ Across All Nodes
0%	-27.2 °C	-26.4 °C	-26.3 °C	-26.6 °C
50%	-28.3 °C	-26.8 °C	-27.0 °C	-27.4 °C
100%	-28.8 °C	-28.0 °C	-27.8 °C	-28.2 °C
Mean LTE ₅₀ Across All Treatments	-28.1 °C	-27.1 °C	-27.0 °C	

2005 Retained Crop (%)	Cane Node 2	Cane Node 5	Cane Node 8	Mean Median LTE ₅₀ Across All Nodes
0%	-27.4 °C	-25.1 °C	-26.5 °C	-26.3 °C
50%	-26.2 °C	-25.7 °C	-27.3 °C	-26.4 °C
100%	-27.4 °C	-26.6 °C	-27.0 °C	-27.0 °C
Mean LTE ₅₀ Across All Treatments	-27.0 °C	-25.8 °C	-26.9 °C	

Table 5. Average shoot length developed in late June 2004 and 2005 at cane nodes 3, 6, and 9 of Concord vines fruit thinned in July the previous year to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the mean ± standard error for 16 shoots (2 shoots per each of 8 vines) per treatment.

Date	2003 Retained Crop (%)	Node 3 Shoot	Node 6 Shoot	Node 9 Shoot	Mean Across All Nodes
29 June 2004 (Bloom + 21 Days)	0%	84.3 ± 9.6	104 ± 16	94.3 ± 10	94.2
	50%	85.5 ± 11	84.3 ± 8.2	98.7 ± 12	89.5
	100%	76.4 ± 7.7	63.7 ± 11	76.3 ± 8	72.1
	Mean Across All Treatments	82.1	84.0	89.8	

	2004 Retained Crop (%)	Node 3 Shoot	Node 6 Shoot	Node 9 Shoot	Mean Across All Nodes
29 June 2005 (Bloom + 16 Days)	0%	60.3 ± 11.9	54.0 ± 8.0	60.2 ± 12.8	58.2
	50%	40.7 ± 6.9	36.5 ± 7.9	50.5 ± 6.9	42.6
	100%	67.0 ± 9.3	67.2 ± 9.4	65.4 ± 7.2	66.5
	Mean Across All Treatments	56.0	52.6	58.7	

Table 6. Average number of “flat leaves” developed in 2004 and 2005 at cane nodes 3, 6, and 9 of Concord vines fruit thinned in July the previous year to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the mean \pm standard error for 16 shoots (2 shoots per each of 8 vines) per treatment.

Date	2003 Retained Crop (%)	Node 3 Shoot	Node 6 Shoot	Node 9 Shoot	Mean Across All Nodes
29 June 2004 (Bloom + 21 Days)	0%	11.6 \pm 0.5	12.7 \pm 1.1	11.5 \pm 0.4	11.9
	50%	11.3 \pm 0.9	11.3 \pm 0.7	11.7 \pm 0.8	11.4
	100%	11.6 \pm 0.5	9.8 \pm 0.8	10.9 \pm 0.6	10.8
	Mean Across All Treatments	11.5	11.3	11.4	

	2004 Retained Crop (%)	Node 3 Shoot	Node 6 Shoot	Node 9 Shoot	Mean Across All Nodes
29 June 2005 (Bloom + 16 Days)	0%	9.4 \pm 0.7	9.0 \pm 0.6	8.6 \pm 0.8	9.0
	50%	8.2 \pm 0.7	7.1 \pm 0.8	8.6 \pm 0.6	8.0
	100%	10.0 \pm 0.6	10.2 \pm 0.7	9.4 \pm 0.5	9.9
	Mean Across All Treatments	9.2	8.8	8.9	

Table 7. Effect of previous year’s retained crop on return bloom, as flowers per shoot, counted immediately pre-bloom on 2004 and 2005 shoots developing at cane nodes 3, 6, and 9. Vines were fruit-thinned in July the previous year to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the mean number \pm standard error of all flowers counted on all three clusters per shoot of two tagged shoots on each of six vines per treatment in 2004 and on each of eight vines per treatment in 2005.

2003 Retained Crop (%)	2004 Node 3 Shoot	2004 Node 6 Shoot	2004 Node 9 Shoot	Mean Across All Nodes
0%	248 \pm 23	312 \pm 37	289 \pm 34	283
50%	212 \pm 26	266 \pm 24	279 \pm 23	252
100%	162 \pm 26	226 \pm 24	247 \pm 24	212
Mean Across All Treatments	207	268	272	

2004 Retained Crop (%)	2005 Node 3 Shoot	2005 Node 6 Shoot	2005 Node 9 Shoot	Mean Across All Nodes
0%	195 \pm 23	242 \pm 18	195 \pm 26	211
50%	194 \pm 30	227 \pm 36	182 \pm 27	201
100%	203 \pm 25	244 \pm 21	235 \pm 18	227
Mean Across All Treatments	197	238	204	

Table 8. Effect of previous year's retained crop on percentage of flowers set as fruit 30 days after bloom on 2004 and 2005 shoots developing at cane nodes 3, 6, and 9. Vines were fruit-thinned in July the previous year to retain 0% crop, 50% crop, or 100% crop (unthinned). Each value is the mean percentage of all flowers retained as fruit. This was based on all counts of flowers (see table 5) and fruit on all three clusters per shoot of two tagged shoots on each of six vines per treatment in 2004 and on each of eight vines per treatment in 2005. All fruit on the 0% treatment was then removed.

2003 Retained Crop (%)	2004 Node 3 Shoot	2004 Node 6 Shoot	2004 Node 9 Shoot	Mean Across All Nodes
0%	30	25	30	28.3
50%	34	24	27	28.3
100%	37	25	26	29.3
Mean % Set Across All Treatments	33.7	24.7	27.7	

2004 Retained Crop (%)	2005 Node 3 Shoot	2005 Node 6 Shoot	2005 Node 9 Shoot	Mean Across All Nodes
0%	46	35	35	39
50%	34	30	32	32
100%	46	38	33	39
Mean % Set Across All Treatments	42.0	34.3	33.3	