SWMREC Report #17

CROP CONTROL IN GRAPEVINES

a report from the

Southwest Michigan
Research and Extension
Center

Michigan State University

MSU Extension   Agricultural Experiment Station

CROP CONTROL IN GRAPEVINES

by

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I. INTRODUCTION

Crop control in grapevines is the reduction of either the cropping potential before bloom or the actual crop level after bloom. Pruning of vines during their period of dormancy is the most common approach to crop control in grapevines. However, crop control is also practiced during the growing season in many viticultural situations. That is the topic of this presentation.

A review of some of the terms used when discussing crop control of grapevines will help avoid confusion. **Yield** is the harvested crop per vine or per unit of land area. It is often expressed in units of pounds per vine or tons per acre or in metric equivalents of kilograms per vine or tonnes per hectare. **Crop level** is essentially the same as yield except that it does not imply that all of that crop will be harvestable. **Crop load**, which is often confused with crop level, is a precise viticultural term expressing the relationship between cane pruning weight and crop level on a vine. It can be expressed in units of pounds of crop per unit per pound of cane pruning weight or kilograms of crop per kilogram of cane pruning weight. This ratio was devised because cane pruning weight is very highly correlated with the amount of leaf area that develops on a vine. Therefore, the crop load actually expresses the relationship between the leaf area and crop level of the vine. Similar to the term crop load, **leaf area/crop ratio** is used in viticultural literature to express this relationship. There is a minimum requirement for the amount of leaf area required to acceptably ripen a grape crop (Fig. 1). A value of 10 to 14 cm^2 of leaf area per gram of fruit is often quoted as the minimum requirement for maturing a crop in a temperate climate such as the northeastern U.S. Managing vines to meet that minimum leaf area/crop ratio requirement is the basis for practicing crop control in grapevines. **Thinning** is the actual process of removing crop from the vine. **Flower cluster thinning** is performed before bloom while **cluster thinning** is performed after bloom.

Vine capacity is the total vegetative crop of which a vine is capable of producing. This is related to **vine size** which is expressed quantitatively as the pounds or kilograms of cane prunings per vine. Vine capacity has also been defined as the maximum crop a vine can bear without delaying fruit maturity. **Overcropping** is a crop level which exceeds vine capacity. Characteristics of overcropping include delayed fruit maturity, possible reduced fruit quality, reduced vegetative growth of the vine and reduced maturation of shoots into canes.

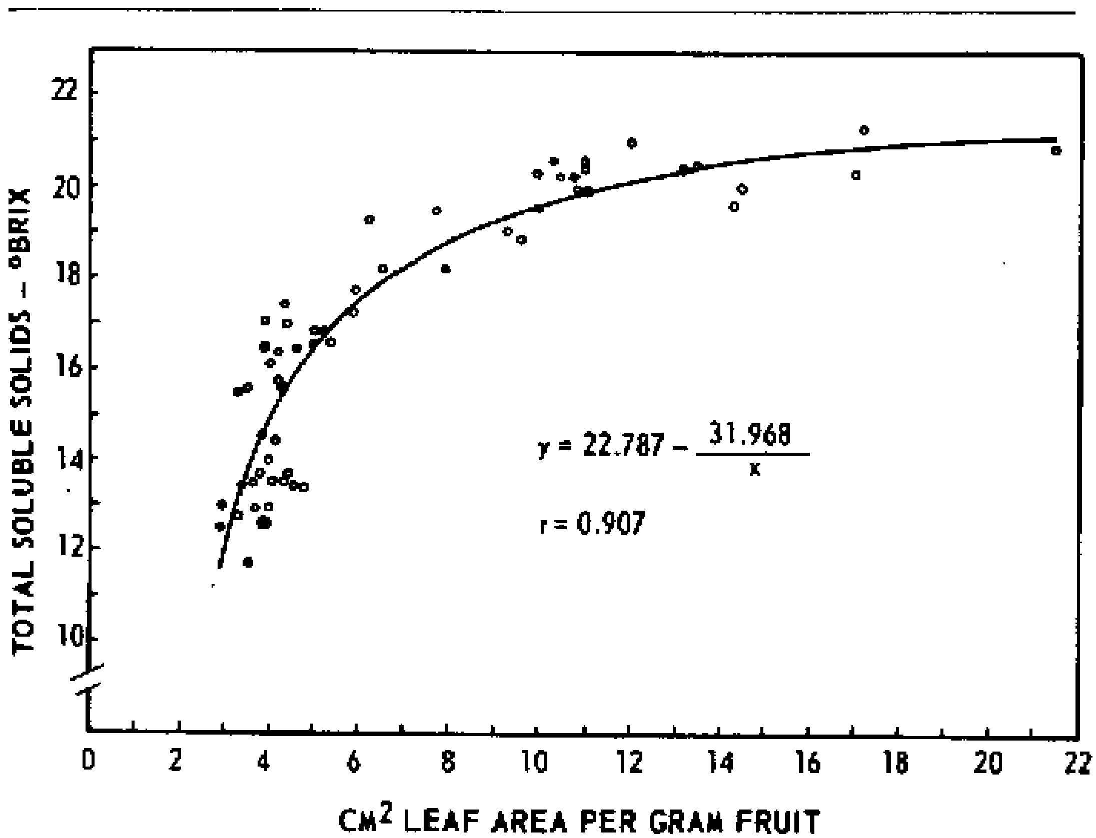

Figure 1. The relationship between fruit soluble solids (°Brix) for 'Tokay' berry juice and leaf area per gram of fruit weight (from Kliwer and Weaver, 1971).

II. SITUATIONS THAT JUSTIFY CROP CONTROL

1. <u>To balance leaf area and crop level of vines</u>. If vines are pruned lightly during the dormant period, they may have more crop potential than the vine has a capacity to mature acceptably. Some varieties of grapes typically develop highly fruitful buds that promote overcropping. For example, the French-American hybrid varieties Seyval blanc and Chancellor produce relatively large clusters and relatively small-to-moderate sized leaves. This often results in an imbalance between crop level and leaf area. Therefore, crop control is routinely recommended for these varieties.

2. <u>To promote larger vine size</u>. Chronically small, stunted vines can be trapped in a cycle of overcropping which keeps them small. This is because small vines expose shoots well to sunlight, thus promoting bud fruitfulness. This high level of fruitfulness leads to excessive crop levels, i.e., overcropping, which keeps the vines small. This cycle repeats itself. Crop control can be used to promote an increase in vine size by adjusting the relationship between crop level and leaf area on the vine.

3. <u>To improve fruit quality in warm climates</u>. One strategy to increase the fruit soluble solids on vines in warm climates is simply to delay harvest. However, such a delay

can also reduce acidity of the fruit causing undesirable sugar/acid ratios in the fruit. Therefore, crop control can be used to influence this ratio and improve fruit quality.

4. To maintain cropping potential of vines through the bloom period. Dormant pruning severity in temperate climate vineyards often targets a desired crop level. However, an excessive reduction of cropping may occur when the pruning task is followed by winter injury, spring freeze injury, or cool weather during bloom. Therefore, it is desirable at times to use less severe dormant pruning in combination with in-season crop control practices to maintain more cropping potential on vines through bloom. Then the crop is adjusted to a desired level.

III. STRATEGIES FOR CROP CONTROL

1. Chemical crop control - Numerous chemical compounds (Table 1) have been evaluated in many experiments in an effort to find a compound that would provide effective crop control for grapevines. However, for a variety of reasons (Table 1) none of these compounds has ultimately proven effective. In our research at the MSU Southwest Michigan Research and Extension Center, we have evaluated ammonium nitrate sprays at the start of bloom as a means of chemical crop control on Concord grapevines. We were able to both reduce crop level as well as increase fruit soluble solids of treated vines (Table 2). Nevertheless, this approach to chemical crop control has not been used commercially to any extent thus far. We continue to pursue new compounds that will be effective for chemical crop control.

Table 1. Some chemicals evaluated for crop control in grapevines and the reasons for unsatisfactory results:

Chemical	Reason For Unsatisfactory Results
Ethephon	Temperature sensitive Highly variable response
Gibberellic Acid	Reduced bud break Delayed bud break Bud kill
Monocarbamide Dihydrogensulfate	Ineffective
3-CPA	Shot berries Delay in maturation
4-CPA	Shot berries
Pennthin	Ineffective
IT 5732	Necrosis of tissues
IT 4433	Variable results
IT 5735	Ineffective
Salicylic Acid	Ineffective
Ascorbic Acid	Ineffective
Iso-Ascorbic Acid	Ineffective
Idoacetic Acid	Phytotoxic
Potassium Iodide	Precision required for time of application
Abscisic Acid	Ineffective
Benzyladenine	Ineffective

Table 2. Yield, clusters per vine, cluster weight and °Brix for 'Concord' grapevines subjected to seven treatments involving differences in pruning severity and crop adjustment. SWMREC vineyard. Harvest 10/03/93.

Treatment description					
Pruning	Crop adjust[1]	Yield (t/a)	Clusters per vine	Cluster weight (g)	°Brix
20 + 20 balance prune	-	7.0 bc[2]	189 b	55 a	15.3 b
14 nodes/ft of trellis	-	8.1 b	212 b	56 a	15.3 b
21 nodes/ft of trellis	-	10.6 a	345 a	45 b	41.1 c
Minimal prune	-	10.5 a	333 a	46 b	14.4 c
14 nodes/ft of trellis	+	3.3 e	100 c	47 b	15.6 ab
21 nodes/ft of trellis	+	6.1 cd	183 b	49 ab	15.8 ab
Minimal prune	+	5.2 d	171 b	43 b	16.4 a

[1] Crop adjust = spray 1/2 of trellis length with ammonium nitrate solution.
[2] Mean separation according to Fisher's Test for least significance. P <= 0.05.

2. Mechanical crop control - Dr. Robert Pool and his colleagues at Cornell University have developed a technique using a mechanical grape harvester to adjust crop level after bloom. This technique involves sampling berries when they are approximately 50% of their full weight which is estimated to be about 1200 growing degree days into the growing season, or approximately 25-30 days after bloom.

3. Manual crop control - Manual removal of grape clusters to improve crop quality has long been practiced both for table grape production as well as for premium winegrape production. Pioneering work in thinning in northeastern North America occurred in Ontario, Canada, at the Vineland Research Station. It was shown that the fruit quality of the precocious, French-American hybrid variety DeChaunac would greatly benefit from hand-thinning of vines to one cluster per shoot (Table 3). Since that time, manual thinning has been practiced extensively on many premium winegrape varieties in temperate-climate vineyards.

Table 3. Response of 'de Chaunac' grapevines to flower cluster thinning. (Adapted from Fisher et al., 1977)

Treatment	Yield [1] (kg/vine)	Soluble [2] Solids (%)	Pruning Weight [1] (kg/vine)	Clusters Produced per vine [2]	Clusters Removed per vine [1]
Thinned [3]	8.64	17.3*	1.25*	183*	58
Control	8.80	15.6	0.78	116	0

[1] Mean for the years 1957-1971.
[2] Mean for the years 1970-1971.
[3] Thinned = flower cluster thinned to 1 cluster per shoot.
* Difference statistically significant at 1% level.

IV. GROWER METHODS OF CROP CONTROL

1. Mechanical Crop Control (Adapted from Vineyard Notes #6, 6/16/94, by Bob Pool and Jim Kamas)

   When berries are at 50% of their full weight (1200 GDD or 25-30 days after bloom):

   A. Select a trellis length which approximates 1/100 acre.
   B. Run harvester at 1 mph and 325 rpms to harvest and weigh the entire crop.
   C. Weigh a 100 berry sample to determine average berry weight. (A check on the 50% total weight of the berries.)
   D. Calculate anticipated yield (wt. of fruit x 100).
   E. Determine proportion of crop to remove.
   F. Begin at 2-2.5 mph and 240-280 rpms to collect samples to determine level of crop removed.
   G. Adjust beater speed as needed and reevaluate.

2. Manual Crop Control

   A. Crop Estimation - Yield can be calculated as follows:

   YIELD/ACRE = (VINES/ACRE) X (CLUSTERS/VINE) X (BERRIES/CLUSTER) X (WEIGHT/BERRY)

Therefore, in theory, to accurately calculate yield, a grower would have to obtain values for all the components of this equation. That is unrealistic. Therefore, to make the process of crop estimation workable for growers, cluster counts per vine are often used with average cluster weights to make a crop estimate according to this equation:

YIELD/ACRE = (VINES/ACRE) X (CLUSTERS/VINE) X (AVERAGE CLUSTER WEIGHT)

For example, the 4-year average cluster weight for a Michigan Cabernet franc vineyard managed with several types of training systems was 0.21 pounds. For a Cabernet franc vineyard planted with 9-foot rows and a 6-foot vine spacing there would be approximately 807 vines per acre. If a count of 10 randomly selected vines averaged 83 clusters per vine, our crop estimate would be:

YIELD = (VINES/ACRE) X (CLUSTERS/VINE) X (AVERAGE CLUSTER WEIGHT)
= (807) x (83) x (0.21) = 14,066 pounds = 7.0 tons/acre

A major challenge to using this approach to crop estimation is one's choice of an average cluster weight. When no other information is available, it may be possible to obtain an average cluster weight for a variety from literature. However, this will serve only as a rough approximation because even the same variety being grown on the same vineyard site will produce significantly different size clusters depending upon how vines are managed. For example, the vines grown in the Michigan Cabernet franc vineyard mentioned above were actually managed with varying combinations of training systems and rootstocks (Table 4). These data indicate that vines managed with Pendlebogen training consistently produced smaller clusters than those managed with either 4-Arm Kniffin or Scott Henry training. Using an average cluster weight value of 0.21 pounds would make estimates 31% high for the vines managed with Pendlebogen training and 24% low for vines managed with Scott Henry training. These data illustrate that the only reliable information on average cluster weight are those which a grower should gather over a period of years from his or her particular vineyard site/variety/vine management combination. This can be done relatively easily.

Table 4. Average cluster weights for 'Cabernet franc' grapes grown with five treatments varying in training system and rootstock. Data for the years 1995 to 1998 and the average of these years. Vineyard near Baroda, Michigan.

Treatment		Cluster weight (lb)				
Training system	Rootstock	95	96	97	98	Avg
Pendlebogen	C3309	.19	.17	.16	.14	.16
Pendlebogen	5C	.22	__[1]	.15	.13	.16
4-Arm Kniffin	C3309	.28	.18	.22	.24	.23
4-Arm Kniffin	5C	.26	.24	.24	.27	.25
Scott Henry	5C	.28	.25	.23	.28	.26
Average		.25	.21	.20	.21	.21

[1] Data insufficient

Select 12 vines in each vineyard block that are typical of the average condition of vines. Harvest by hand while counting the clusters. Use post-it notes or something similar to record that count and possibly the vine location. Place this slip in the box under a cluster of grapes so it won't blow away. Weigh the net weight of fruit in the picking box. This can be done as easily as weighing yourself and the picking lug with fruit on a bathroom scale and then subtracting your weight plus and empty picking lug. Divide the number of clusters into the net weight of fruit to get the average weight of clusters on that vine. Data so gathered over a period of four or five years will be the basis for making useful crop estimates. The form in Appendix A can be copied and used to keep the necessary records.

B. <u>Calculation of Amount of Thinning</u>

The procedures above for making a crop estimate should be made immediately after fruit set. One must then decide whether any thinning should be performed, and if so, how much? No attempt will be made here to suggest target crop levels. This decision often results from a complex of factors which are only partially viticultural in nature. The level of cropping for a vineyard is often a balance between a grower's goal of profit and a processor's desire for fruit quality. Each grower must resolve a target yield based on his own circumstances. When that decision has been made, estimate the number of clusters required per vine for a desired crop level as follows:

$$\text{DESIRED CLUSTERS PER VINE} = \frac{\text{DESIRED YIELD (TONS/ACRE)} \times 2000\ \text{(LB/TON)} \times \_\_\_\ \text{ROW SPACING (FT)} \times \_\_\_\ \text{VINE SPACING (FT)}}{43{,}560\ (\text{FT}^2\text{/ACRE}) \times \_\_\_\ \text{AVERAGE CLUSTER WT (LB)}}$$

For example, if a 3-ton yield were desired in the Cabernet franc vineyard mentioned above and Scott Henry training was used with an average cluster weight of 0.26 pounds, the calculation would be as follows:

$$\text{DESIRED CLUSTERS PER VINE} = \frac{3\ \text{(TONS/ACRE)} \times 2000\ \text{(LB/TON)} \times 9\ \text{ROW SPACING (FT)} \times 6\ \text{VINE SPACING (FT)}}{43{,}560\ (\text{FT}^2\text{/ACRE}) \times 0.26\ \text{AVERAGE CLUSTER WT (LB)}}$$

$$= \frac{324{,}000}{11{,}325} = 28.60 = 29\ \text{CLUSTERS/VINE}$$

The equation above was used to calculate the number of clusters that would be required per vine to produce a ton of grapes per acre for the vine management systems represented in Table 4. They indicate that on average, it would take 12 clusters per vine to produce a yield of one ton per acre (Table 5) for the two treatments involving Pendlebogen training. However, for the other three treatments it would only take 8 clusters per vine to produce a yield of one ton per acre. The average for all five treatments was 10 clusters per vine to produce a ton of grapes per acre. Were that used, the crop estimate would be approximately 25% high or low depending upon the actual training system being utilized. Once again, this illustrates the importance of obtaining multi-year data on cluster weight for the specific variety/vineyard/vine management combination.

Table 5. Estimates of the number of clusters per vine needed to produce 1 ton of grapes per acre for a Cabernet franc vineyard with 9-foot row spacing, 6-foot vine spacing and

average cluster weights as represented in Table 4. Data for five vine management training systems representing difference in training system and rootstock. Vineyard near Baroda, Michigan.

Treatment		Clusters/vine/ton/acre				
Training system	Rootstock	95	96	97	98	Avg
Pendlebogen	C3309	10	11	12	14	12
Pendlebogen	5C	9	--[1]	13	15	12
4-Arm Kniffin	C3309	7	11	9	8	8
4-Arm Kniffin	5C	8	8	8	7	8
Scott Henry	5C	7	8	9	7	8
Average		8	10	10	10	10

[1] Data insufficient

Lastly, it should be noted that the average weight of a cluster will tend to decrease as the number of clusters per vine increases. Therefore, use of cluster weight data, which were gathered on vines with small-to-moderate levels of cropping, will tend to over-estimate calculations for high yields and the actual yields will tend to be below estimates. Nevertheless, this technique provides the means of cropping within 20% of an estimate and often more accurately. It will prevent massive overcropping, leading to poor fruit quality and long term decline in vineyard productivity.

C. Hand Thinning Methods

Excess clusters may be thinned from vines either before or after bloom. Flower cluster thinning before bloom is more efficient, especially when it is performed when the shoots are only 8-12" long because clusters can be readily seen, counted and removed. However, thinning at this time will promote additional cluster compactness for the clusters remaining on the vine. When growing tight-clustered varieties, this can lead to an increased incidence of fruit rot. Cluster thinning after bloom is more difficult but it does have the advantages of reducing cluster compactness and allowing selection of clusters in exposed positions on the vine while removing more shaded clusters. This is often desirable in temperate-climate vineyards. Thinning after bloom can also adjust for deviations in fruit set.

Years ago, meticulous cluster thinning to one cluster per shoot with the retention of the most basal cluster was a common practice. Today, such precise thinning is less common. One approach to cluster thinning of vines, which can make this vineyard task more labor efficient, is as follows:

1. Count clusters on 10 "average" vines to determine clusters per vine.

2. Determine the number of clusters to be retained per vine for the desired yield using the equation above.

3. Determine proportion of clusters to be removed. In the Cabernet franc vineyard described above, 83 clusters per vine were counted. For a desired crop of 3 tons/acre, 29 clusters per vine were calculated. Therefore, 83 - 29 = 54 clusters per vine or 54/83 = 65%, or approximately 2/3 of the clusters need to be removed.

4. The tendency is not to see all clusters when moving rapidly through vines to thin clusters. Therefore, one will often thin less severely than intended. Therefore, in this example to remove 2/3 of the clusters, initially target to remove 3/4 of those readily seen. Perform this task rapidly on 4 to 6 vines.

5. Carefully count the clusters remaining on these vines to determine if the desired level of thinning is approximately correct.

6. If necessary, make an adjustment to the thinning proportion and reevaluate your procedure.

When removing clusters, seek out and remove those in the most shaded locations of the vine so that the retained clusters are in favored exposed positions.

V. STIMULATING VINE SIZE DEVELOPMENT THROUGH CROP CONTROL

In many vineyards there will be individual vines that will be considerably smaller than the average for the vineyard. A common strategy when managing such small vines is to prune them severely so that relatively little crop develops on them. However, such severe pruning can jeopardize the development of leaf area needed to promote an increase in vine size. Therefore, a second strategy for managing undersized vines is to retain more live nodes, often in the range of 20 - 30 nodes per vine, and then reduce the number of clusters on the vine or completely defruit the vine to promote vegetative development of the vine. However, such thinning will not be possible during the growing season unless such undersized vines are identified at the time of pruning. Therefore, to make this possible, surveyor's tape can be applied around the trunk of such vines at the time of pruning. As early as labor is available during the growing season, clusters on these vines should be thinned. Most often, one color of surveyor's tape is used and all marked vines are completely defruited. However, the use of two colors of surveyor's tape has also been used, with one color indicating partial thinning and the other, complete defruiting.

Appendix A
Multi-Year Cluster Weight Data Form

Vineyard Location or Number ____________________________ Variety ____________________________

Comments ____

Vine Location (optional)				**Year ________**			**Year ________**			**Year ________**			**Year ________**			**Year ________**		
	Row	**Post**	**Vine**	**Vine yield (lb)**	**Clusters /vine**	**Cluster wt (lb)**	**Vine yield (lb)**	**Clusters /vine**	**Cluster wt (lb)**	**Vine yield (lb)**	**Clusters /vine**	**Cluster wt (lb)**	**Vine yield (lb)**	**Clusters /vine**	**Cluster wt (lb)**	**Vine yield (lb)**	**Clusters /vine**	**Cluster wt (lb)**
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
		Yearly	**Totals**															

MULTI-YEAR ANALYSIS

(A)	(B)	(A/B)
Total yield (lb)	Total clusters	Average cluster wt (lb)
______________	______________	______________

(enter in pencil to allow annual update)

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