LEAF REMOVAL IN WINEGRAPE PRODUCTION

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4/30/93

Canopy management includes such practices as leaf removal, shoot thinning, and shoot positioning. Canopy management along with decisions in pruning, trellising, irrigation and fertilization are well recognized as tools for maximizing quality as well as yield of winegrapes. All of these factors can affect to some degree the ultimate canopy and, therefore, the micro-climate of a grapevine.

One of the most direct (and obvious in results) of these practices is leaf removal. In the early 1980's, researchers and vineyardists began to look at leaf removal as used in the table grape industry as a transferable practice to wine grape production to improve quality and reduce disease problems.

Leaf removal creates a "window" or "tunnel" by removing the leaves and laterals opposite, above and below each cluster, post bloom. In practice, the actual number of leaves removed can vary as a hand crew moves through vines. Also, leaf removal around clusters can be done on one or both sides of a vine.

Costs can range from $90 to $200 per acre for hand removal of leaves. This cost has encouraged interest in mechanical leaf removal, using either a blower or leaf plucker type machine. Various individuals have also built prototype machines to meet their particular requirements. Machines can run in cost from $7,000 to $30,000. Although relatively expensive, they can reduce leaf removal costs to less than $20 per acre.

Vigor and Problem Canopied

Bunch rot incidence increases with dense canopies and fruit composition is affected, although not always consistently. Delayed maturity is seen. There are higher levels of malate, increased pH and potassium levels. Anthocyanin (color) and phenol are reduced in shaded conditions. In some field trials, sugar levels, pH and potassium have been less affected by shade, depending on whether shading was done on clusters only, leaves only or both. This question is still being studied. Shade has been found to depress fruit bud initiation and to slow or cause irregular wood maturity.

More recently, integrated pest management (IPM) work has shown reduced populations of insect pests, mites and (to some degree) powdery mildew.

Benefits vs Costs

Leaf removal improves the micro climate within the vine canopy by increasing light, wind speed and temperature along with decreasing relative humidity. From various studies the benefits from these changes have included:

Diseases & Pests Effects	*Quality Effects*
less bunch rot	higher or equal sugar levels
less leafhoppers	less malic acid
less mites	lower pH
less or no spray needed	lower potassium levels
more effective spray results	higher anthocyanins & phenols
	better wood maturity
	higher bud fruitfulness

In addition, harvest is easier for both hand crews and machines. The biggest disadvantage is the labor cost. Also, leaf removal is best suited to T-trellis type systems that orient the shoot growth more upward and require hedging for vigorous growing vines. While bunch rot incidence has been consistently reduced, the effects on quality have been less so. In some cases, there has been no statistical difference between sugar, pH or potassium levels, but the trend have been consistent with studies where significance is seen. Besides other vineyard factors that may influence the fruit composition, there is the question of cluster shade and leaf shade effects.

The possibility of mechanical leaf removal would increase the rate of adoption of this practice. The advantages of improved quality and less disease can benefit the winegrape grower, the vintner and the concerned consumer of wine.

The following pages include articles from around the state and locally with respect to the benefits seen from leaf removal.

Project: *89-06* Leaf Removal vs Shoot Thinning for Quality and Disease Control

Objective: To determine benefits of shoot thinning as an alternative to leaf removal for improved fruit quality and/or disease control.

Cooperator: J. Cotta, Las Vinas Winery; R. Lange and B. Lange, Lange Twins Vineyards; Lodi Farming; and M.A.C. Vineyard

Methods: Two trials were established in Zinfandel, and an additional trial with Cabernet Sauvignon. Immediately adjacent to the Lodi district a fourth trial was also in progress on Chenin blanc.

Both Zinfandel and the Chenin blanc trials consisted of three treatments: Leaf Removal, Shoot Thinning, and a Control Check. Each was replicated 6 times with 8 vines per plot, for a total of 144 vines in each trial. The Cabernet Sauvignon trial consists of four treatments, but won't consider bunch rot. In this case, the quality and yield effects only will be evaluated.

There is no question as to the disease benefits of leaf removal, but this is more expensive than shoot thinning. The Zinfandel and Chenin blanc trials demonstrated the effectiveness of leaf removal over shoot thinning, although shoot thinning did reduce rot problems compared to the control.

The 1989 harvest was the first year for the Cabernet Sauvignon trial to determine the effects of leaf removal, shoot thinning, and a combination of both with respect to fruit and wine quality.

CABERNET SAUVIGNON
Short Thinning vs Leaf Removal 1989

Treatment	Yield vine/lbs	Cluster per vine	Cluster weight/lbs	Berry Wt/g	Brix	pH	%TA
Shoot Thin	19.8 a	68 a	0.29 a	1.17 a	22.1 a	3.67 a	0.52 b
Leaf Removal	19.6 a	79 a	0.25 a	1.10 a	22.0 ab	3.44 b	0.59 a
Shoot Thin & Leaf Removal	20.8 a	74 a	0.29 a	1.10 a	22.1 a	3.53 ab	0.54 b
Control	21.6 a	95 a	0.25 a	1.10 a	21.4 b	3.52 ab	0.53 b

ZINFANDEL
Short Thinning vs Leaf Removal 1989*

Treatment	Yield vine/lbs	Clusters	Rot Yield vine/lbs
Shoot Thin	18.9 a	30 a	7.5 a
Leaf Removal	23.1 a	36 a	4.2 b
Control	19.5 a	32 a	9.5 a

*No differences in 1988 for all data. No differences in 1989 for Brix, T.A., pH, or berry weight.

From: Winegrowers of California Research Report
Kleiwer et al., 1987

EFFECT OF LEAF REMOVAL AND FUNGICIDE SPRAYS ON BOTRYTIS BUNCH ROT OF ZINFANDEL VINES, LAKE COUNTY, 1986

PERCENT ROT PER CLUSTER

	NONSPRAYED CONTROL	BLOOM	BLOOM, POST-BLOOM	PRE-BLOOM, BLOOM, POST-BLOOM	MEAN
NO LEAF REMOVAL	10.7	14.2	11.2	8.2	11.1 A
LEAF REMOVAL	1.2	1.0	1.1	2.9	1.6 B
MEAN	5.9	7.6	6.1	5.6	

EFFECT OF LEAF REMOVAL AND FUNGICIDE SPRAYS ON BOTRYTIS BUNCH ROT OF ZINFANDEL VINES, LAKE COUNTY, 1986

PERCENT CLUSTERS WITH ROT

	NONSPRAYED CONTROL	BLOOM	BLOOM, POST-BLOOM	PRE-BLOOM, BLOOM, POST-BLOOM	MEAN
NO LEAF REMOVAL	28.2	31.1	22.7	18.7	25.2 A
LEAF REMOVAL	5.7	5.9	3.4	6.4	5.4 B
MEAN	16.9	18.5	13.0	12.6	

Sprayed with Rovral at 1.5 lbs/Acre at the above indicated times.

Table 1. Effect of canopy management and fungicide applications on the incidence of Botrytis bunch rot of Chenin blanc grapes in Monterey County, 1985.

	Percent Diseased Clusters				
	Hedged	Leaf removal	Shoot removal	Control	Mean
Sprayed[a]	44.1	16.9	47.0	46.8	38.7
Nonsprayed	47.4	23.9	42.9	55.0	42.3
Mean	45.7	20.4*	44.9	50.9	

[a] Sprayed with Rovral at 2 lb/acre at bloom preclose and veraison.

* Significantly different from other treatments at this level (P .05).

Table 2. Effect of basal leaf removal and timing of fungicide application on the incidence of Botrytis bunch rot of Chenin blanc grapes in Napa County, 1985.

	Percent Diseased Clusters					
	Timing of Fungicide Application[a]					
	Control	Bloom	Preclose	Veraison	All three	Mean
Leaf removal	6.2	7.1	4.0	18.2	5.1	8.1*
No leaf removal	30.5	29.2	29.2	47.6	20.7	31.4
Mean	18.4	18.1	16.6	32.9	12.9	

[a] Sprayed with Benlate + Captan at 1 and 2 lb/acre, respectively.

* Significantly different from other treatments at this level (P .05).

EFFECT OF LEAF REMOVAL AND FUNGICIDE SPRAYS ON YIELD

OF CHARDONNAY VINES, SONOMA COUNTY, 1986

YIELD (CROP WEIGHT IN LBS/VINE)

	NONSPRAYED	BLOOM	PRE-CLOSE	VERAISON	ALL 3 SPRAYS*	MEAN
NO LEAF REMOVAL	19.9	25.2	19.9	23.8	22.1	22.1
LEAF REMOVAL	21.8	19.9	20.2	20.4	20.8	20.6
MEAN	20.8	22.5	20.0	21.9	21.4	

* Sprayed with Rovral at 2 lbs/Acre at bloom, pre-close and veraison.

EFFECT OF LEAF REMOVAL AND FUNGICIDE SPRAYS ON BOTRYTIS BUNCH ROT

OF CHARDONNAY VINES, SONOMA COUNTY, 1986

PERCENT CLUSTERS WITH ROT

	NONSPRAYED	BLOOM	PRE-CLOSE	VERAISON	ALL 3 SPRAYS*	MEAN
NO LEAF REMOVAL	30.7	16.2	33.5	28.8	10.5	23.7 A
LEAF REMOVAL	23.9	7.5	15.6	12.6	12.4	14.4 B
MEAN	27.3 A	11.8 B	25.6 A	19.8 AB	11.5 B	

* Sprayed with Rovral at 2 lbs/Acre at bloom, pre-close and veraison.

Results showed that incidence and severity of Botrytis bunch rot, other fungal fruit rots, sour rot, or "total" rot was significantly reduced after leaf removal in 5 of the 6 experimental vineyards (3). Partial results are given in Table 1. Numerical decreases in disease were found at all of the sites. A trend toward reduced populations of arthropod pests, including leafhoppers and spider mites, and reduced cluster damage and rot associated with omnivorous leafroller (OLR) and grape mealybug also was found after leaf removal.

Although additional trials will be conducted to verify 1988 results and to optimize treatment, leaf removal is likely to become a routine cultural, practice for California grape producers who wish to achieve efficient, low-pesticide disease and pest management.

Table 1. Influence of basal leaf removal on one or both sides of vines on incidence of bunch rots and sunburn, and on yield of Chenin blanc wine grapes (San Joaquin Valley - 1988)[1].

	% of Clusters Diseased and Damaged			Yield
Location Treatment	Bunch rot[2]	Sunburn	Undesirable[3]	(lb/vine)
Ceres, leafed (both sides)	7.5[4]**	4.8	14.0**	16.8
Control	27.0	0.1	34.5	17.3
Livingston, leafed (one side)	27.0*	0	ND[5]	14.1
Control	48.0	0	ND	16.1

[1] Experimental vineyards were bilateral cordon-trained. No bunch rot fungicides were applied.

[2] Includes Botrytis rot, other fungal rots, and sour rot.

[3] Includes bunch rots, sunburn, and cluster damage due to arthropod pests.
Table 1 continued

[4] Values followed by asterisks are different from control value at P = 0.05 (*) or P = 0.01 (**).

[5] ND = No data.

Table 1. Comparison of Nairn Industries Leaf Blower Machine and hand-leaf removal on incidence and severity of Botrytis bunch rot - variety JR, Napa County, 1988.

	Disease	
Treatment[1]	Incidence[2]	Severity[3]
Leaf blower	7.01 A	1.36 A
Hand leafed	10.03 A	1.94 A
Control	20.15 B	5.44 B

[1] Treatments were performed on 2-wire cordon-pruned JR at pea-sized berries. The Nairn Leaf Blower was used on both sides of the vine. Hand-leaf removal was done on both sides of the vine and the control treatment was not leafed.

[2] Figures are average percent disease from the center eight vines of each 10-vine replicate and four replications.

[3] Figures are average percent rot per cluster from all clusters on the center eight vines of each 10-vine replicate and four replications. Figures followed by the same letter are not significantly different using the Waller-Duncan K-ratio T test.

Table 2. Effect of leaf removal using the Gallagher Leaf Plucker on incidence and severity of Botrytis bunch rot - variety JR, Napa County, 1988.

	Disease	
Treatment[1]	Incidence[2]	Severity[3]
Leaf removal - 2 sides	4.07 A	0.55 A
Leaf removal - 1 side	7.93 A	1.58 A
Control	16.88 B	4.91 B

[1] Leaves were removed at pea-size berry from both sides of the canopy (2-sides) and on north side only (1 side). Control vines were not leafed. Prior to leafing the vines in all treatments were trained vertically by lifting and holding in position with plastic twine on each side.