Lodi Woodbridge Winegrape Growers
1998 FINAL PROJECT REPORT

**PROJECT TITLE: Management of Zinfandel to Modify Vine and Wine Characteristics**

**PROJECT PERSONNEL**

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Co-Investigators:
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Scott Robison and Steve Burch, Woodbridge Winery by Robert Mondavi

Cooperators:
Craig & Leonard Thompson, E.J.Gallo Winery, Modesto

Involvement of Investigators:

T. Prichard (20% of time). Coordinate project activities. Direct Staff Research Associate and Post Graduate Researcher activities in collection of data, analysis of data and preparation of reports.

P. Verdegaal (10% of time). Direct viticultural operations. Plan and supervise collection of vine physiological data.

S. Burch and S. Robison (5% of time). Crush fruit, provide chemical and organoleptic wine analysis.

All investigators will cooperate to determine treatments and provide a meaningful report.

**OBJECTIVES**

(1) Measure effects of management regimes on must and wine parameters
(2) Measure physiological effects of management regimes on vines and fruit
(3) Utilize developed information to formulate regulated deficit coefficients for Zinfandel in the Lodi District

**RESEARCH PLAN**

Experimental techniques to accomplish objectives include soil moisture use determined by neutron probe. Comparison of actual water use to the reference evapotranspiration values will be done to further define estimated water use and crop coefficients (Kc). Plant water stress measured as mid-day leaf-water potential using a pressure chamber is used to determine when to begin irrigation. Estimates of the volume of irrigation will be made using the developed regulated deficit coefficients (Krdi). Vine growth, fruit quality, and yield are to be evaluated by: shoot growth rate, petiole analysis, total pruning weights, berry size, cluster weight, percent rot, total yield, degrees brix, total acid, pH, malic acid, and potassium content. Wine quality will be evaluated by chemical as well as organoleptic methods.

The site selected is the Thompson vineyard located at the intersection of Highway 12 and Tecklenberg Road, Lodi, California. It satisfies the research criteria needed to create stress at various stages of vine growth and maturity. The Zinfandel vineyard is mature and bilateral cordon trained. The cooperating grower is willing to arrange cultural practices including harvest to facilitate data acquisition. The experimental area contains 1200 vines.

The soil at the site has a moderate water-holding capacity. A drip irrigation system is used. The system will have been able to deliver water to each replicated treatment independently. The well water supply is of good quality and contains less than 150 ppm total dissolved solids. The experimental design is a randomized block with 4 replications of each of the 10 treatments.

**TREATMENTS**

Irrigation Strategy Treatments. There are three irrigation strategy treatments. Treatments 1 through 3 were supplied with adequate water so as to maintain favorable vine water status throughout the season. Water use is measured by soil water disappearance using a neutron probe. Water use of these treatments will be considered full potential water use or 100 percent.

Treatments 4 through 8 are managed in a fashion to utilize near 70 percent of full potential water use by harvest. These treatments are subjected to water deficits as soon as the soil moisture reservoir and rainfall permits. Following veraison, they were subjected to moderate water deficits until harvest.

Treatments 9 and 10 were irrigated with a schedule, which resulted in greater plant water deficits through harvest than treatments 4 through 8.

All treatments, with the exception of the full water use, did not receive irrigation from first berry color through full cluster color.

Crop Load Treatments. In order to limit the crop to a manageable yield, two pruning levels will be used across the irrigation level treatments. The levels are 10 and 14 two-bud spurs. The purpose of a larger number of spurs combined with cluster thinning was to provide an adequate crop in light set years and to select clusters for removal that may contribute to bunch rot

Canopy Management Treatments. Canopy management treatments use leaf removal in the fruit zone on the north side of the vine. The early leaf removal treatment (4) was leafed on May 2, which was followed by the remainder of the leafing treatments on July 21. A single treatment (7) has 14 spurs and no leaf removal.

Dual Picking Treatments. A late crop adjustment treatment where about 60 percent of the full crop is removed near 17 °brix allowing near 40 percent of the full crop to mature. The amount of crop removed may vary according to the total crop set. In low set years, less crop as a percentage of the total is be removed. The first crop removal would be used as white zinfandel. This strategy is combined with irrigation strategy treatments to constitute treatments 2 and 6, which are across the two irrigation strategies.

A late season crop adjustment treatment is included where the crop in excess of an estimated 6 ton/acre was removed near 17 °brix. The remaining crop is taken to full maturity. The first crop removal is to be used as white zinfandel. This strategy is combined with irrigation strategy treatments to constitute treatments 2 and 6. The white zinfandel was removed September 11. The remainder of the crop was berry sampled to measure the progression of maturity. In 1997, the remainder of the red zinfandel crop ripened at a faster rate than the comparative treatment. This season was very late with cool ripening conditions, which resulted in the same, slow ripening in the comparable treatments. As harvest approached, the decision was made not to harvest the remainder of the red zinfandel crop since it did not vary in maturity from the comparable treatments

Cover Crop Treatments. Treatment 5 adds the use of a cover crop with a 70% irrigation strategy. The goal is to deplete soil moisture at a more rapidly rate in the spring causing deficits to occur earlier and thus gain more control of the vines water status. A cover crop was established in the fall of 1997. It consisted of annual and perennial ryegrass.

Table 1. 1998 Zinfandel Treatments, Lodi

| Treatment No. | % Water | Pruning | Thinning | Leaf Removal | 2 Crop | Cover |
|---|---|---|---|---|---|---|
| 1 | 100 | 14 | Yes | Yes | No | No |
| 2* | 100 | 14 | Yes | Yes | Yes | No |
| 3* | 100 | 10 | No | Yes | No | No |
| 4 | 70 | 14 | Yes | Yes | No | no |
| 5 | 70 | 14 | Yes | Yes | No | yes |
| 6* | 70 | 14 | Yes | Yes | Yes | No |
| 7 | 70 | 14 | Yes | No | No | No |
| 8* | 70 | 10 | No | Yes | No | No |
| 9 | 70 | 10 | Yes | Yes | No | No |
| 10 | variable | 14 | Yes | Yes | No | No |

*Note: These treatments were not harvested in 1998. See text.

**1998 RESULTS**

Treatments were imposed beginning fall 1997 by planting a ryegrass cover crop in Treatment 10 in the row centers on both sides of the experimental vines. Differential pruning was performed in January 1998 followed by differential irrigation, and leaf removal. Pruning weights were collected at pruning to assess differences in vegetative growth.

Data collected include vegetative growth measured as shoot growth, canopies measured as land surface shaded and canopy penetrating light at the fruit level measured biweekly from veraison through harvest, and water use is measured by neutron probe. Leaf water potential was measured weekly pre-veraison through harvest.

Cluster thinning in the 14-spur treatment was done on July 21st. Clusters were removed from each vine until an estimated 7-tons/acre-crop load target was reached. The average number of clusters removed per treatment was 61(table 10). Treatment 5 was thinned to an estimated 5-ton crop load target to investigate the potential in further crop reduction. Treatment 5 was reduced by 138 clusters 8-vine plot, which was about twice the number of clusters removed in the other thinned treatments.

Treatments 2 and 6 (double harvest treatments) were harvested for white zinfandel on September 11 by removing approximately 50 percent of the total crop. Care was taken to harvest green fruit, rotted fruit or closely positioned clusters leaving the best quality fruit for the red zinfandel harvest. Nearly 50 percent of the crop removed contained rot.

Water Use

The amount of water consumed by each treatment was the summation of water volumes extracted from the stored rootzone moisture, effective in-season rainfall and irrigation. Figure 1 and Table 2 show the amounts of each component to reach the total water consumed by the average of each treatment.

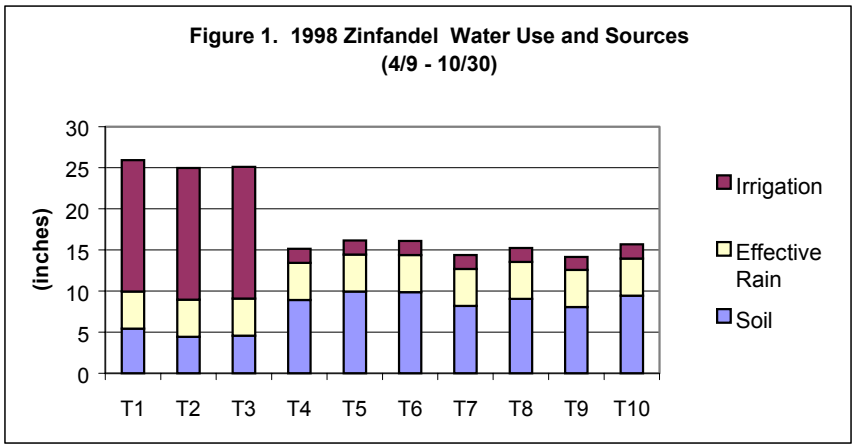



Table 2. Water Volumes Consumed and
Relative Volumes of Each Treatment in Comparison to Treatment One
1998 Zinfandel, Lodi

| Treatment | Soil Inches | Effective Rain Inches | Irrigation inches | TOTAL inches | % of the Average of T1, T2, T3 |
|---|---|---|---|---|---|
| T1 | 5.4 | 4.5 | 16.0 | 25.9 | 102 |
| T2 | 4.5 | 4.5 | 16.0 | 25.0 | 99 |
| T3 | 4.6 | 4.5 | 16.0 | 25.1 | 99 |
| T4 | 8.9 | 4.5 | 1.7 | 15.1 | 60 |
| T5 | 9.9 | 4.5 | 1.7 | 16.2 | 64 |
| T6 | 9.9 | 4.5 | 1.7 | 16.1 | 63 |
| T7 | 8.2 | 4.5 | 1.7 | 14.4 | 57 |
| T8 | 9.1 | 4.5 | 1.7 | 15.2 | 60 |
| T9 | 8.1 | 4.5 | 1.6 | 14.2 | 56 |
| T10 | 9.4 | 4.5 | 1.8 | 15.7 | 62 |

Weekly berry samples are collected to assess the fruit ripening process and to estimate harvest date. Each treatment will be harvested as results of sugar sampling to ensure all treatments were at similar °brix. Harvest, based on the average treatment harvest date, was nearly 40 days later than the 1997 season harvest. When all treatments were harvested (September 30), a small postharvest irrigation in an amount to cover one week's water was applied. Significant rainfall occurred on October 24, 1998.

Harvest

The harvest date was determined by °brix of berry samples with a target of 17 °brix for the white zinfandel late crop adjustment treatments (2 and 6) and a target of 24º for red zinfandel. Harvest of the white zinfandel crop occurred September 21 at 17.5 ºbrix. Harvest of red zinfandel crop spanned a 3-day period from September 27 to 30 (Table 3). The target was never reached with the average of all treatments being 22.2 °brix. Treatment 1 was significantly lower than the other treatments at 20.6 °brix. Repeated berry sampling indicated no further increase was possible considering the lateness of the season and the need to have adequate fruit to make wine from the treatments.

Table 3. Red Zinfandel Harvest 1998, Lodi

| Treatment | Harvest Date | ºBrix |
|---|---|---|
| 1 | Sept. 27 | 20.6 |
| 4 | Sept. 30 | 22.1 |
| 5 | Sept. 27 | 23.3 |
| 7 | Sept. 30 | 21.8 |
| 9 | Sept. 30 | 22.3 |
| 10 | Sept. 30 | 22.8 |

Yield

Red Zinfandel. No significant differences in vine yield were found between irrigation or pruning strategies when rot-free yields are compared (Table 4). The largest single influence on treatment yields is the amount of rot (Table 5). Rot levels were as high as 17.2 pounds/vine or on the average, 60 percent of the total yields. In 1997, the treatments with the most rot were influenced by the treatment effect of (1) pruning/thinning level, and to a lesser extent, (3) leaf removal. In 1998, there does not seem to be a clear-cut relationship since there were no significant differences in red zinfandel yield, rot yield or the total yield. The 1998 season began to shape up poorly in later June when sour rot began. Rot developed as a result of the short compact clusters combined with a period of high temperatures. These results show clearly that was no treatment effect on the occurrence of rot measured at harvest. It should be noted that sour rot began in mid season and that rot at harvest was "all rot" not just Botrytis rot, which has been shown to be related to treatment variables.

Table 4. 1998 Red Zinfandel Rot-Free Yield, Lodi

| Treatment | Yield (lbs/vine) | Clusters per vine | Cluster Wt (lbs) | Berries per vine | Berry Size (gms) |
|---|---|---|---|---|---|
| 1 | 10.2 | 19.4 | 0.53 | 2811 | 2.0 |
| 4 | 12.1 | 22.0 | 0.54 | 3313 | 1.9 |
| 5 | 11.5 | 21.6 | 0.54 | 2500 | 2.0 |
| 7 | 8.4 | 18.5 | 0.45 | 2956 | 1.6 |
| 9 | 8.7 | 17.2 | 0.50 | 2687 | 1.8 |
| 10 | 10.8 | 21.5 | 0.50 | 3534 | 1.7 |
| P = | 0.1183 | 0.3754 | 0.0645 | 0.6916 | 0.3723 |
| | n.s. | n.s. | n.s. | n.s. | n.s. |

Table 5. 1998 Red Zinfandel Rot Yield, Lodi

| Treatment | Yield (lbs/vine) | Clusters per vine | Cluster Wt (lbs) |
|---|---|---|---|
| 1 | 17.2 | 40.1 ab | 0.43 a |
| 4 | 15.1 | 34.8 ab | 0.43 a |
| 5 | 12.0 | 26.3 b | 0.46 a |
| 7 | 15.6 | 45.4 a | 0.34 b |
| 9 | 16.1 | 36.8 ab | 0.44 a |
| 10 | 15.9 | 37.6 ab | 0.43 a |
| P = | 0.2559 n.s. | 0.0071 | 0.0048 |

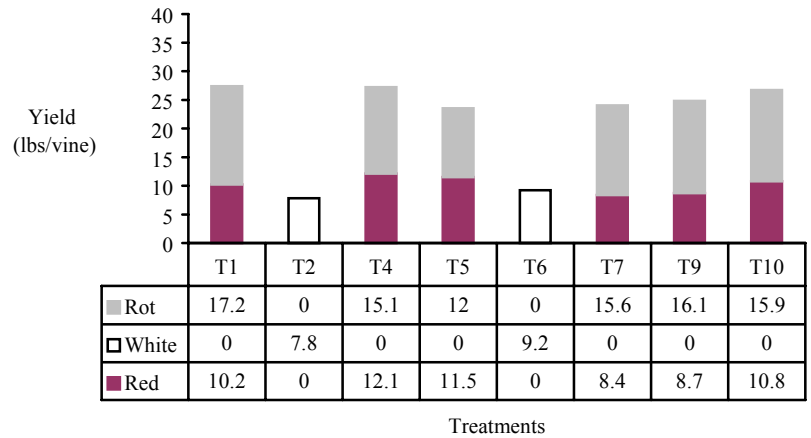
Total Yield.

When comparing treatments on a total yield (rot-free red zinfandel and rot), no significant differences were found (Table 6). Treatment 5 (cover crop) resulted in a significantly reduced total cluster number as a result of more severe cluster thinning. Figure 2 shows the components of the total yield measured in 1998.

Table 6. 1998 Red Zinfandel Yield (including rot), Lodi

| Treatment | Yield (lbs/vine) | Clusters per vine |
|---|---|---|
| 1 | 27.4 | 59.5 ab |
| 4 | 27.2 | 56.7 abc |
| 5 | 23.5 | 47.9 c |
| 7 | 24.0 | 63.9 a |
| 9 | 24.8 | 53.9 bc |
| 10 | 26.6 | 59.1 ab |
| P = | 0.5205 n.s. | 0.0218 |

**Figure 2. 1998 Zinfandel Yield, Lodi**




Vine Canopy Response

Vine canopy response to water deficits are measured as the percentage of land surface shaded by the canopy, pruning weights and the amount of photosyntheticaly active radiation (light) at the fruiting level.

*Land Surface Shading*. Land surface shading by the canopy was measured at midday throughout the season by midseason (July 15). The canopy size was maximized at 55-64 percent (Table 10). The shaded area exceeded the 1997 season values indicating a good vegetative growth season encouraged by mild spring temperatures and higher than normal spring rainfall.

Table 10. 1998 Zinfandel, Lodi

| Treatment | Land Surface Shading (%) | Pruning Mass lbs./vine | Crop:Pruning Ratio | Spur Diameter (mm) | Clusters Removed |
|---|---|---|---|---|---|
| 1 | 63 a | 5.6 abc | 4.9 | 12.5 | 57.0 b |
| 2 | 64 a | 5.8 ab | | | 45.5 b |
| 3 | 62 a | 5.3 bcd | | 12.8 | |
| 4 | 57 | 5.5 bcd | 5.0 | 12.4 | 45.8 b |
| 5 | 58 | 4.9 d | 4.8 | | 138.3 a |
| 6 | 56 b | 6.2 a | | | |
| 7 | 57 b | 5.5 abc | 4.3 | | 44.3 b |
| 8 | 60 a | 5.1 cd | | 12.4 | |
| 9 | 61 a | 5.3 bcd | 4.7 | | 49.3 b |
| 10 | 55 b | 5.6 abc | 4.7 | 12.1 | 48.5 b |
| P = | 0.0411 | 0.00061 | 0.8380 n.s. | 0.2149 n.s. | 0.000 |

*Prunings*. The weights of prunings were found to be significantly different as a result of the imposed treatments. Necessary hedging of the vines midseason to improve access for cultural operations and prior to mechanical harvest no doubt influenced this parameter. There is no clear pattern to the differences however in 1997 there were no significant differences. This is a typical pattern of continued treatment effects. Work done in Cabernet indicates spur diameter between the first two primary buds is a sensitive measure of vegetative growth as it relates well with shoot length. Measuring shoot diameters did not find significant differences between treatments.

*Crop Yield to Pruning Ratio*. The relationship of yield per unit of prunings was developed to assess the balance of vegetative to reproductive structures. Comparing the total of red zinfandel harvests combined with the weight of rot to pruning weights finds no significant differences due to treatment. However, since pruning weights were comprised by hedging, this result could be expected. Treatments varied from 4.3 to 5.0 pounds of crop per pound of prunings (Table 10). These results are far off the 1997 values of 5.4 to7.5 pounds of crop per pound of prunings due in the most part to lower yields and higher vegetative growth in 1998.

Juice Analysis

Harvest was delayed as long as possible to allow the sugar to increase towards the 24° brix target. The decision to harvest at differential sugar was made to save the remainder of the crop. This makes the comparison of treatments difficult; however, some striking differences occurred when compared to previous work. The malic acid concentration of the full water treatments (100%) is usually 30 to 50% higher than the water deficit treatments. The titratable acidity was abnormally low at an average of the treatments (without T1) of 6.4 g/L. The 1997 average was 7.8 g/L. Of interest is treatment 5 malic acid when expressed as the percentage of total acidity. It is noticeably less at 19 %. It also was lowest in pH and highest in sugar.

Table 11. 1998 Zinfandel Juice Analysis, Lodi

| Treatment | Harvest Date | Soluble Solids °Brix | Acidity (g/L) T.A. | pH | MalicAcid (g/L) | MalicAcid % Total Acidity | K+ (ppm) |
|---|---|---|---|---|---|---|---|
| T1 | 9/27 | 20.6 | 7.1 | 3.47 | 1.805 | 25% | 1350 |
| T4 | 9/30 | 22.1 | 6.4 | 3.49 | 1.765 | 28% | 1425 |
| T5 | 9/27 | 23.3 | 6.7 | 3.42 | 1.265 | 19% | 1400 |
| T7 | 9/30 | 21.8 | 6.5 | 3.47 | 1.780 | 27% | 1375 |
| T9 | 9/30 | 22.3 | 6.1 | 3.57 | 1.880 | 30% | 1350 |
| T10 | 9/30 | 22.8 | 6.1 | 3.52 | 1.95 | 32% | 1475 |

Wine Analysis

The alcohol contents were higher than expected when comparing the juice sugar contents. This is probably due to the significant "raisining" on the harvested fruit. Treatment 5 stands out as the highest titratable acidity, lowest pH, highest phenolics, and best color density. Treatment 5 used 64% of the full water treatments was pruned to 14 2 bud spurs, was cluster thinned(17.3 clusters/vine or 42% of the total clusters), leaf removed and had a cover crop. This is the combination of all practices treatment.

Table 12. 1998 Zinfandel Wine Analysis, Lodi

| | | Titratable | | Phenolics | Wine Color Analysis | | | Standard |
|---|---|---|---|---|---|---|---|---|
| | Alcohol | Acidity | | Abs. 280 | Abs 420 | Abs 520 | | Color |
| Treatment | (%) | (g/L) T.A. | pH | (nm) | (nm) | (nm) | 420/520 | Density |
| T1 | 13.1 | 4.9 | 3.93 | 30.00 | 1.06 | 1.26 | 0.641 | 2.32 |
| T4 | 13.1 | 5.3 | 3.59 | 27.10 | 0.99 | 1.49 | 0.564 | 2.48 |
| T5 | 13.3 | 6.3 | 3.55 | 37.90 | 2.43 | 3.43 | 0.708 | 5.86 |
| T7 | 13.4 | 5.4 | 3.54 | 27.20 | 0.97 | 1.46 | 0.664 | 2.43 |
| T9 | 13.7 | 5.1 | 3.63 | 28.30 | 1.02 | 1.51 | 0.675 | 2.53 |
| T10 | 13.6 | 5.1 | 3.62 | 27.90 | 1.06 | 1.58 | 0.671 | 2.64 |

**SUMMARY**

The 1998 season started with late bud break then was followed by cool wet conditions resulting in veraison delayed by 3 weeks. With an effective (stored) in-season rainfall of 4.5 inches following a full water reservoir at bud break, water deficits were difficult to impose as early as usual. However, water deficits were imposed at near the same vine physiological stage as in previous years. The vegetative growth stage in 1998 was extended to provide very large canopies with shoots having many laterals. Water deficits had no influence on growth since they were not effect the vine until vegetative growth was complete. Water deficits did open up the canopy by crisping the lower leaves in late August and early September. The crop ran out of time in terms of growing conditions to mature the crop and was harvested early (in terms of sugar) to save what was left of the crop.

All ten treatments were imposed during the 1998 season. However due to the lateness of harvest and the early onset of rot only 6 of the treatments were harvested and made into wine. Treatments included irrigation strategy, pruning/thinning strategy, cover crop, and canopy management. No significant differences in rot free or in total yield were found between the treatments. The usual effect of deficit irrigation strategy is to reduce the berry size. That does not show in this year's results. Again this points to the lack of pre veraison water deficits. Another possible explanation is that the larger berries were on the clusters, which rotted which means the smaller "berried" clusters were harvested for wine making. Treatment 5 used 64% of the full water treatments was pruned to 14 2 bud spurs, was cluster thinned (17.3 clusters/vine or 42% of the total clusters), leaf removed and had a cover crop. This is the combination of all practices treatment. It was the preferred wine when compared to harvested treatments and was supported by having the highest titratable acidity, lowest pH, highest phenolics, and best color density.