Effects of Gypsum Applications On Established Thompson Seedless Grapes

Thomas A. Doerge, Lowell True, Mike Kilby

Introduction

Like all producers, growers of high value specialty crops are concerned with maximizing plant growth and yields. However, they are often able to afford the applications of extra, potentially yield enhancing materials due to their greater net returns per acre. The use of gypsum ($CaSO_4 \cdot 2H_2O$) in the reclamation of sodium affected soils is well-established and the mechanism for improving water penetration in soils following gypsum applications is well documented.

Other factors such as soil compaction can also result in reduced water penetration. The potential benefits of gypsum applications to soils characterized by moderate sodium levels and significant soil compaction are not well understood and need further study. A two year field experiment was initiated in 1989 to evaluate the effect of soil-applied gypsum treatments on the yield and quality of established Thompson seedless grapes at a site characterized by moderate sodium levels and serious soil compaction due to repeated vehicle traffic. In addition, the effect of gypsum treatments on plant nutrient content and soil chemical parameters will also be evaluated.

Materials and Methods

The site selected for this study was an established Thompson seedless grape vineyard in Queen Creek, AZ operated by Empire Fruit Company. A downward trend in production at this site had been observed by the farm manager in recent years. Reduced yields were largely attributed to reduced water penetration and soil compaction although other problems in water and pest management may also be contributing factors. A two year study with annual applications of two tons gypsum per acre was proposed with the realization that beneficial effects of gypsum applications may not be observed in an established perennial crop, such as grapes, in the first season. Analyses and interpretations of irrigation water and pretreatment soil samples are attached to this report.

Applications of gypsum were made to individual plots in mid-March 1989. Plots were the full length of the vine rows, or about one fourth of a mile long. The soil on both the east and west sides of the experimental rows were treated with either 0 or 2 tons of gypsum per acre with one additional untreated buffer row left between individual plots to eliminate border effects. Gypsum was surface applied to the entire inter-row areas with no subsequent mechanical encorporation. A randomized complete block experimental design with four replications was used.

On 11 April composite grape petiole samples were taken from all plots. Each sample consisted of 40 to 50 petioles taken from leaves opposite the main clusters on primary canes. The vines were at the full bloom (cluster cap fall) stage on the sampling date. Petioles were placed in paper bags, dried at 60°C and submitted to I.A.S. Laboratories in Phoenix for extractable NO_3-N and total N, P, K, Ca, Mg, S, Na, Fe, Zn, Mn, Cu and B analysis according to the guidelines used in California.

On 19 July soil samples were obtained from each plot by compositing 20 to 25 cores of the surface 0 to 6 inches of soil. An equal number of cores were taken on both sides of the treated rows from sampling points located halfway between the center of the interrow area and the wheel track closest to the row. Samples were air dried and submitted to I.A.S. Laboratories for determination of pH, E.C., and concentrations of Ca, Mg and Na in the saturated paste extract. The soluble cation values were then used to calculate Sodium Adsorption Ratios (SAR) for each sample.

Three days prior to commercial harvesting, refractometer readings were made on three random samples taken within each plot to estimate sugar content and fruit quality. Yields were estimated by counting boxes (22 lb. capacity) harvested from the middle 1/3 of each plot row on 19 June. All other field operations were conducted uniformly over the entire experimental area at the discretion of the farm manager.

Results and Discussion

The application of gypsum increased soluble calcium by about 100% and soluble Mg by 40% compared to the untreated control. Because of the variation observed in this experiment these differences were not statistically significant at the 5% level of probability. In addition there were no significant differences measured in SAR, E.C. or soil pH (see Table 1).

The measurable but non-significant increase in soluble Ca probably indicates that the two ton per acre application rate of gypsum was almost but not quite completely dissolved during the growing season. It appears that this rate closely approximates the annual gypsum needs based on the amount of irrigation water applied.

Of some concern is the moderately high level of soil salinity measured in these plots. Salinities of 3-4 dS/m (2000-2600 ppm) would normally be expected to result in yield reductions of 15-25%. The application of gypsum did increase soil salinity slightly but previous analysis of the Roosevelt Water Conservation District irrigation water suggests that it is the primary source of salinity at this site.

The SAR values measured were all below 5, suggesting that sodicity at this site is not particularly high. However, the presence of high levels of potassium (K) in this soil (730 ppm ammonium acetate extractable K) could result in soil physical problems that normally are attributed to sodicity.

The application of gypsum had no statistically significant effect on the nutrient content in grape petiole tissue (Tables 2 and 3). However, slight increases in P, K, Ca, Mg, Fe, Zn and Cu content were observed in response to gypsum application. The concentration of Na in the petiole tissue did decrease (though the difference was not "significant") when gypsum was applied.

The data in Table 4 show that during the first year of treatment with gypsum, there was no significant effect on fruit yield or fruit quality.

Conclusions

While no statistically significant treatment effects were measured, several important observations can be made. The application of two tons of gypsum per acre appears to very nearly equal the amount of gypsum that is soluble in one season's irrigation water application. The absence of a yield response this year could perhaps, be the result of one or more other adverse conditions which may be depressing yields and masking a response to gypsum. In order of likelihood, these factors are: excess salinity, soil compaction, irrigation management, nematodes, and weed infestation.

Acknowledgments

We are grateful to Jerry Higginbotham and the Pinal Gypsum Corporation for their financial assistance and provision of gypsum used in this research. We are also indebted to Rim Simone and Henry Moreno, of Empire Fruits for their cooperation in this research.

Table 1. The effects of gypsum treatments on soil chemical factors from an established grape vineyard site measured four months after gypsum application.

Gypsum Rate	Saturated Paste Cations Ca	Mg	Na	SAR	E.C.	pH
tons/acre	------- mg/l -------				dS/m	
0	190	50	223	3.7	2.8	8.2
2	389	70	236	2.9	3.8	8.0

Table 2. The effects of gypsum treatments on macronutrient content in grape petioles measured in an established vineyard at the full bloom stage.

Gypsum Rate	NO_3-N	N	P	K	Ca	Mg	S	Na
tons/acre	ppm	----------------------- % -----------------------						
0	5320	1.88	0.48	3.7	1.1	0.35	0.10	0.52
2	5230	1.80	0.51	3.8	1.2	0.39	0.10	0.48

Table 3. The effect of gypsum treatments on micronutrient content in grape petioles measured in an established vineyard at the full bloom stage.

Gypsum Rate	Fe	Zn	Mn	Cu	B
tons/acre	---------------- ppm ----------------				
0	32	149	88	11.7	25
2	36	155	87	11.8	24

Table 4. The effects of gypsum treatments on yield and quality of Thompson seedless grapes.

Gypsum Rate	Fruit Yield	Sugar Content
tons/acre	boxes/plot	°Brix
0	18.2	15.2
2	17.2	15.1