ABSTRACT

POTASSIUM FERTILIZATION OF GRAPEVINES USING DRIP IRRIGATION

William L. Peacock and L. Peter Christensen

A Thompson Seedless raisin vineyard, severely deficient in K, was used to test the efficacy of K fertilization with a drip system. The K deficiency was reduced by applying K with drip irrigation and using much less K then would be required with conventional high volume irrigation methods. Fertilizer partitioned and applied over an eight-week period appeared to be more effective than a slug treatment. There was little difference comparing chloride and sulfate salts of K. The research will continue to determine the longevity of treatments and expanded to include additional soil types.

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Introduction

Potassium (K) deficiency in California vineyards is considered third in overall importance, following that of nitrogen and zinc. K deficiency is usually confined to small areas in a vineyard - seldom larger than 1 to 3 acres. Deficiency is likely to occur in cut areas, where the K rich surface soil was removed during land leveling, or on very sandy soils that have low native K fertility.

Vines severely deficient in K tend to have fewer and smaller, tight clusters with unevenly colored, small berries. With Thompson Seedless the lower portion of the bunch may collapse by midsummer, resulting in raisined, immature berries by harvest. Much of the effect of K deficiency on the fruit is the result of reduced vine growth and premature leaf fall, and accounts for lower vine yields and fruit maturity.

With furrow/flood irrigation methods, research results in California for both fruit trees and vines have shown that, when a deficiency exists, massive rates of K fertilizer are necessary to obtain vine or tree recovery and yield response. These massive rates are necessary to overcome the high fixation of K in most California soils. Typical application rates for mild to severe deficiencies range from 600 to 1200 lbs K per acre respectively. This amounts to approximately 1 1/3 to 2 2/3 lbs K per vine. Deep placement of K fertilizer in a concentrated band close to the vine is the recommended application approach. Treatment can correct deficiency for up to 8-10 years.

Little information is available on correction of K deficiency in vineyards by fertilizer injection through a drip system. Drip irrigation is particularly suitable to injection of water soluble fertilizers because of the ease and uniformity of application. Multiple applications of fertilizer is practical when injected in the system. High fertilizer efficiency is possible with drip since fertilizer can be placed where root density is highest and irrigations can be accurately scheduled corresponding with the vines evapotranspiration. The purpose of this research is to determine rates and frequency of K application through the drip system necessary to correct deficiency in vineyards.

Materials and Methods

A Thompson Seedless raisin vineyard was selected for this trial on its own roots and planted in 1981. The vineyard exhibited severe K deficiency in 1983, a condition not uncommon with vineyards on Delhi loamy sand.

The experimental design was a randomized complete block with eight treatments, six blocks and using eight vine plots. Treatments were as follows:

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1) Check, no K fertilizer

2) K_2SO_4, .44 lb K/vine applied 4/25/84

3) K_2SO_4, .88 lb K/vine applied 4/25/84

4) K_2SO_4, 1.76 lbs K/vine applied 4/25/84

5) K_2SO_4,0.22 lb K/vine partitioned into eight increments applied for eight weeks starting 4/25/84

6) K_2SO_4, 0.44 lb K/vine partitioned into eight increments applied for eight weeks starting 4/25/84

7) KCl, 0.22 lb K/vine partitioned into eight increments applied for eight weeks starting 4/25/84

8) KCl, 0.44 lb K/vine partitioned into eight increments applied for eight weeks starting 4/25/84

Material was applied to a cup-sized excavation made in the soil directly under the dripper. The drip system was operated a few hours prior to treatment creating a slight puddle in the bottom. The K fertilizer was dissolved in a stock solution and then the proper amount of solution poured into the excavation. This technique closely simulated injection through the system and gave flexibility in the experimental design.

Irrigation occurred 2-4 days a week. Irrigation schedule developed by U.C. for vineyards in the San Joaquin Valley based on historical weather data was used to schedule irrigations.

To evaluate the fertilizer treatments, leaf petioles were sampled at bloom (5/4/84) and at veraison (7/18/84). Samples were analyzed for K% and CL% on a dry weight basis. Additionally, vines were graded for visual deficiency symptoms on 7/31/84.

Results and Discussion

Leaf petioles sampled at bloom showed that the slug treatments of K on 4/25/84 had significantly elevated K levels compared to the check and the partitioned treatments, table 1. Bloom samples were taken on 5/4 and partitioned treatments were not completed until 6/20. Therefore, when bloom samples were taken only a small percentage of the K had been applied in the partitioned treatments.

Petiole samples were again taken on 7/18 when fruit began to soften, veraison. At this point the partitioned treatments had been completed for three weeks. K levels in the petioles showed that applying 0.44 lb K per vine partitioned over eight weeks was equally effective as applying a slug of 1.76 lbs K per vine on 4/25/84, table 1. All fertilizer treatments significantly raised the K levels in the petiole compared to the check and to a level that would not be considered deficient, >1%. Although this work is not conclusive, it indicates that K uptake is more efficiently accomplished by multiple applications through the drip system than slug treatments.

There appeared to be little difference in potassium uptake comparing chloride and sulfate salts. The chloride level in leaf petioles at the 0.44 lb K/vine potassium chloride treatment was significantly elevated, table 2. However, 0.44% chloride is within the safe limits for grapevines.

The vine grading for visual deficiency symptoms on 7/31/84 are shown in table 3. The 1.76 lbs K/vine slug treatment showed the fewest symptoms. There was no significant difference comparing the .88 lb slug with the .44 lb partitioned treatment using K_2SO_4. All treatments showed less visual symptoms compared to the check.

It appears from this research that it is possible to reduce severe K deficiency applying K through the drip system and using much less fertilizer than required with conventional irrigation systems. Research has shown that at least 2 lbs/vine of K would be required to correct the severity of the deficiency in this trial and under furrow/flood irrigation methods. We had good results using as little as .22 lb K per vine under drip irrigation. However, still to be determined is how long these treatments will be effective. This project will be continued to determine the longevity of treatments and expanded to include varying soil types.

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Table 1. Drip Irrigation Potassium Fertilization Trial

1984 Petiole Potassium Levels,
Bloom and Veraison

	K, % dry wt.		
Treatment	Bloom, 5/4	Veraison, 7/18	Avg. effect of treatment
1. Check, no fertilizer	.67 c[1/]	.51 d	.59 e
2. K_2SO_4, .44 lb K/vine 1X	1.38 b	1.35 bc	1.36 c
3. K_2SO_4, .88 lb K/vine 1X	1.95 a	1.55 b	1.75 b
4. K_2SO_4, 1.76 lbs K/vine 1X	2.18 a	1.92 a	2.05 a
5. K_2SO_4, .22 lb K/vine 8X	.86 c	1.22 c	1.04 d
6. K_2SO_4, .44 lb K/vine 8X	.86 c	1.93 a	1.40 c
7. KCl, .22 lb K/vine 8X	.75 c	1.45 bc	1.10 d
8. KCl, .44 lb K/vine 8X	.84 c	1.38 bc	1.11 d
Average effect of date	1.19	1.41	
LSD, .05: Date = .10	Treatment = .21	Interaction = .29	

1/ Mean separation within columns by Duncan's Multiple Range Test at .05 level.

Table 2. Drip Irrigation Potassium Fertilization Trial

1984 Petiole Chloride Levels,
Bloom and Veraison

Treatment	Cl, % dry wt. Bloom, 5/4	Veraison, 7/18	Avg. effect of treatment
1. Check, no fertilizer	.45 b 1/	.30 bc	.37 a
2. K_2SO_4, .44 lb K/vine 1X	.49 ab	.25 c	.37 a
3. K_2SO_4, .88 lb K/vine 1X	.50 ab	.27 c	.38 a
4. K_2SO_4, 1.76 lbs K/vine 1X	.48 ab	.25 c	.37 a
5 K_2SO_4, .22 lb K/vine 8X	.52 ab	.25 c	.38 a
6. K_2SO_4, .44 lb K/vine 8X	.52 ab	.23 c	.37 a
7. KCl, .22 lb K/vine 8X	.55 a	.36 b	.45 b
8. KCl, .44 lb K/vine 8X	.56 a	.44 a	.50 b
Average effect of date	.51	.29	

LSD, .05: Date = .024 Treatment = .048 Interaction = .068

1/ Mean separation within columns by Duncan's Multiple Range Test at .05 level.

Table 3. Drip Irrigation Potassium Fertilization Trial

1984 Vine Grades [1/] for Visual Deficiency Symptoms

July 31, 1984 readings

Treatment	Vine Grades
1. Check, no fertilizer	3.76 a [2/]
2. K_2SO_4, .44 lb K/vine 1X	1.60 cd
3. K_2SO_4, .88 lb K/vine 1X	1.28 de
4. K_2SO_4, 1.76 lbs K/vine 1X	0.97 e
5. K_2SO_4, .22 lb K/vine 8X	1.98 bc
6. K_2SO_4, .44 lb K/vine 8X	1.49 cde
7. KCl, .22 lb K/vine 8X	2.21 b
8. KCl, .44 lb K/vine 8X	2.30 b

1/ **Grades:** 0 = no symptoms
1 = slight symptoms
2 = mild symptoms
3 = moderate symptoms
4 = moderately severe symptoms
5 = severe symptoms

2/ Mean separation by Duncan's Multiple Range test at .05 level.