Additives don't improve zinc uptake in grapevines

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Growers can choose zinc compounds on the basis of cost alone

Zinc deficiency, the most widespread micronutrient problem in California vineyards, has commonly been treated by daubing of fresh pruning cuts or foliar spraying with zinc compounds. Foliar spraying has gradually become the most popular of the two methods, because it requires less labor.

The increased importance of zinc sprays has led to continuing research to maximize response while minimizing cost. This research has resulted in the following zinc spray recommendations:

☐ Spray method: A dilute, full-wetting spray provides more zinc uptake than a concentrate, low-volume spray.

☐ Timing: Two weeks before bloom to full bloom (80 percent cap fall), any time during day or night.

☐ Material: Neutral zinc or basic zinc sulfate (50 to 52 percent zinc) at maximum label recommendation or 4 to 6 pounds product per acre.

Many zinc products are available and used by growers. Some contain chelating or "complexing" agents (lignosulfonate) or other nutritional elements, which increase their cost. Vineyard zinc spray trials to date have yet to show a cost benefit from some of these products as compared with the high-analysis neutral zinc (50 to 52 percent zinc). The two trials reported here are a continuation of research to determine the most cost-effective zinc foliar spray materials and methods for vineyards. One trial compares five zinc compounds at label rates and at equal rates of elemental zinc per acre; the second trial examines possible benefits of adding urea to zinc foliar sprays.

Two zinc-deficient Fresno County Thompson Seedless raisin vineyards were used for study. Applications were at approximately 80 percent bloom on May 7 and 8, 1984, as a full-wetting dilute spray at 200 gallons per acre. In each trial, the eight-vine plots were replicated six times in a complete, randomized block design.

Uptake was estimated from analysis of zinc in shoot tips. Shoot tips were analyzed to avoid zinc spray deposit that would be present on leaves and petioles. Spray contamination also was avoided by a long enough wait after treatment for the shoot tips to grow beyond the sprayed tissue. Post-treatment shoot tip samples were taken weekly on May 17, 24, and 31 and analyzed for zinc.

Berry weight, berry set (number of berries per centimeter of lateral length), and percent soluble solids (°Brix) were determined at harvest on 48 randomly selected cluster laterals (second lateral from top of each cluster) per plot.

Compound and rate comparisons

Five compounds were compared at equal rates of zinc per acre (0.72 pound). Three were completely soluble — zinc sulfate (36 percent zinc powder), zinc EDTA chelate (6.5 percent zinc liquid), and zinc lignosulfonate "complex" (7 percent zinc liquid) — and two were of low solubility — neutral zinc (52 percent zinc) and zinc oxide (75 percent zinc). The 0.72-pound rate was based on the maximum recommended rate of zinc lignosulfonate. This rate is about twice the maximum label recommendation of zinc EDTA and one-fifth that of neutral zinc and zinc oxide. Additionally, neutral zinc and zinc oxide were compared at their maximum label recommendation of 4 pounds zinc per acre.

When zinc was applied at the same rates (0.72 pound per acre), all vines except those treated with zinc EDTA had more zinc in the shoot tips than did the untreated check vines (average of three sample dates, table 1). The zinc level was similar in all of the 0.72-pound-zinc vines, except that those treated with zinc EDTA had less than those treated with neutral zinc. Neutral zinc at the 4-pound rate gave the greatest initial and overall uptake (average of three sampling dates). Zinc oxide at the high rate (4 pounds) was second in uptake and better than all of the lower rate treatments at the first sampling.

Fruit measurements showed that zinc EDTA produced the greatest berry set (table 2). The other compounds also improved berry set over the untreated check but with no differences among them. Treatment also increased berry weight, except from vines that received the zinc EDTA and lignosulfonate compounds.

Fruit from untreated vines had the highest soluble solids (°Brix), while fruit from vines treated with EDTA, neutral zinc (4-pound rate), and zinc oxide (4-pound rate) had lower soluble solids. This result is not surprising, since correction of zinc deficiency increases berry set, berry size, and total fruit volume, which in turn can lower the concentrations of soluble solids.

These results indicate that neutral zinc or zinc oxide at the high rate would be the preferred treatment for maximum foliage uptake, as in serious cases of zinc

TABLE 1. Zinc compound and rate comparisons, post-treatment shoot-tip zinc (Zn) levels

Treatments	Zn/acre	Zinc dry weight*			
		May 17	May 24	May 31	Average effect of treatment
	lb	*ppm*			
Untreated check	—	51 e	41 d	38 a	43 e
Zn EDTA chelate	0.72	69 cde	39 d	32 a	47 de
Zn lignosulfonate	0.72	76 cd	48 cd	39 a	54 cde
Zn sulfate	0.72	79 cd	49 cd	39 a	54 cde
Neutral Zn	0.72	82 c	50 cd	45 a	59 c
Zn oxide	0.72	81 cd	50 cd	38 a	56 cd
Neutral Zn	4	214 a	77 ab	47 a	113 a
Zn oxide	4	194 b	60 bc	44 a	100 b

* Figures with like letters within a column are not significantly different at 5% level, Duncan's Multiple Range Test.

deficiency. These two treatments produced the highest levels of zinc uptake through a 17-day period after treatment. They also produced favorable fruit response in increased berry set and berry size, although the increased fruit volume contributed to lower fruit soluble solids.

Whether soluble or insoluble or containing chelating or complexing compounds, all zinc sources gave some, but variable, responses. Zinc EDTA was least effective in increasing shoot-tip zinc levels and increasing berry size, but it improved berry set the most.

Zinc plus urea

In the second trial, two compounds, neutral zinc (52 percent zinc) and zinc sulfate (36 percent zinc), were compared with and without urea added to the spray solution. Neutral zinc and zinc sulfate were used at 4 pounds and 1 pound zinc per acre, respectively, and urea (46 percent nitrogen) at 4 pounds nitrogen per acre (7.7 pounds product).

The addition of urea had no effect on zinc levels of shoot tips except on the first sampling date, when the addition of urea to the neutral zinc product actually decreased shoot tip zinc levels (table 3). Berry weights (table 4) were not improved with any zinc treatment and were smaller in the neutral zinc-urea combination than in the untreated check (no zinc). Overall, the 4-pound rate of neutral zinc per acre gave the greatest improvement in berry set. The smaller berry size possibly resulted from the effects of increased berry set and berry numbers per cluster.

Conclusions

The inclusion of chelate, "complexing" agent, or urea to zinc sprays did not improve zinc uptake in this study. This finding corresponds to earlier work showing that the addition of phosphorus and nitrate compounds to zinc sprays does not improve zinc uptake by vine foliage. Such additives thus are not beneficial and only add to treatment cost. Zinc solubility also did not influence uptake. The low-solubility neutral zinc and zinc oxide gave responses similar to the other fully soluble compounds.

Growers therefore can choose zinc compounds on the basis of cost alone. Neutral zinc and zinc oxide at maximum recommended rates would be expected to provide the greatest potential for correction. Lower rates may be sufficient in mild cases of deficiency.

None of the compounds at rates used caused visible vine foliage toxicity. Higher rates of the soluble compounds should be used with caution.

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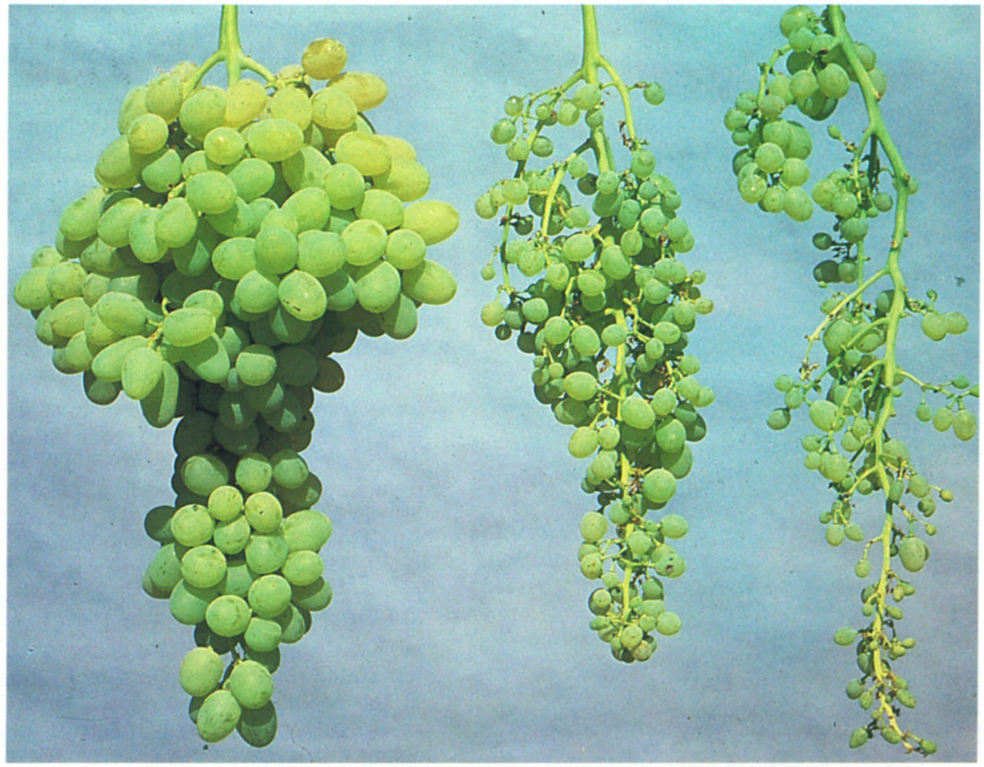

Zinc deficiency in Thompson Seedless grapes reduces fruit set and causes "shot" berries (clusters at right). The addition of chelate, "complexing" agent, or urea to zinc sprays did not improve zinc uptake by grapevines.

TABLE 2. Zinc compound and rate comparisons, fruit measurements

Treatments	Zn/acre	Avg. berry wt.	Number berries per cm lateral	°Brix
	lb	*g*		
Check	—	1.07 d	3.69 c	19.9 a
ZnEDTA chelate	0.72	1.20 cd	5.14 a	17.2 d
Zn lignosulfonate	0.72	1.25 bcd	4.34 b	18.3 bc
Zn sulfate	0.72	1.37 abc	4.14 bc	18.8 b
Neutral Zn	0.72	1.42 ab	4.26 b	18.4 b
Zn oxide	0.72	1.49 a	4.15 bc	18.8 b
Neutral Zn	4	1.51 a	4.61 b	17.8 bcd
Zn oxide	4	1.49 a	4.55 b	17.4 cd

TABLE 3. Zinc plus urea posttreatment shoot-tip Zn levels

		Zinc dry weight			
Treatment	Rate*	May 17	May 24	May 31	Avg. effect of treatment
	lb	*ppm*			
Check	—	67 d	55 d	51 a	58 c
Neutral Zn	4	194 a	90 ab	56 a	113 a
Neutral Zn + urea	4 + 1	162 b	82 bc	58 a	101 a
Zn sulfate	1	116 c	66 cd	52 a	78 b
Zn sulfate + urea	1 + 1	110 c	64 cd	51 a	75 b

* Pounds of zinc or nitrogen per acre.

TABLE 4. Zinc plus urea fruit measurements

Treatment	Rate*	Avg. berry wt., grams	Berry set number berries per cm lateral	°Brix
	lb.			
Check	—	1.45 a	4.34 b	17.1 a
Neutral Zn	4	1.32 ab	5.72 a	16.6 a
Neutral Zn + urea	4 + 1	1.21 b	5.61 a	16.3 a
Zn sulfate	1	1.49 a	4.68 b	14.1 a
Zn sulfate + urea	1 + 1	1.40 a	4.65 b	15.7 a

*Pounds of zinc or nitrogen per acre.