Soil and Foliar Applications of Calcium Chloride and Calcium Nitrate to Control Tipburn of Head Lettuce

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ABSTRACT

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Different amounts of calcium chloride and calcium nitrate were applied to the soil or to plants in field plots throughout Arizona and California during 1976 and 1980. Plants were rated for incidence and severity of tipburn in the field and in the laboratory. Tissue samples from plants in control and treated plots were also analyzed for calcium content. In only one of six trials, soil applications of calcium chloride at 224 or 448 kg/ha resulted in significant increases in tissue calcium and significant decreases in tipburn incidence and severity. In all field trials, however, soil and foliar applications of calcium nitrate and foliar application of calcium chloride at different levels did not significantly change tissue calcium and severity of tipburn.

Tipburn, a nonparasitic disease of lettuce that occurs throughout the world, is most damaging when crops are grown under moderately high temperatures. The disease is sporadic, but it often results in complete loss of head lettuce grown in Arizona and California. Our studies (13) and others (1,10,16) have established a direct correlation between calcium deficiency and incidence of tipburn.

As with other calcium-related disorders, attempts have been made to reduce the incidence of lettuce tipburn through soil and foliar application of calcium salts. Kruger (10) and Thibodeau and Minotti (16) controlled tipburn of lettuce grown in containers under controlled conditions by applying foliar sprays of calcium nitrate or calcium chloride solution. Sonneveld and van den Ende (15) reported that calcium chloride applied to the soil of lettuce grown in containers reduced tipburn incidence. We were also able to suppress tipburn development in mature, detached heads of lettuce by placing cut stems in a 1% solution of calcium chloride during exposure to tipburn-inducing temperatures in the laboratory (13).

Despite successful control of tipburn in the laboratory, foliar applications of calcium salts have not been effective in controlling the disease in the field (4,8). Nevertheless, some growers in Arizona and California apply calcium salts, particularly calcium nitrate, to soil and plants to reduce the incidence of tipburn. We undertook this study to ascertain whether this practice of applying calcium salts for tipburn control is justified.

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MATERIALS AND METHODS

We established nine field plots during 1976 and 1980 in Yuma, AZ, and in the Salinas Valley of California. Each field plot was set up in a completely randomized design with four replicates (each 150–200 lettuce plants) of each treatment.

Calcium chloride and calcium nitrate were added to the soil either before or after planting at rates of 112, 224, or 448 kg/ha. In preplant applications, the granular salts were placed in 8- to 10-cm-deep furrows at the top of the beds 1–3 days before direct seeding. In postplant applications, granular salts were placed

Table 1. Effect of soil applications of calcium chloride and calcium nitrate on levels of tissue calcium and severity of tipburn of head lettuce in six field trials

Cultivar Trial	Material	Rate (kg/ha)	Increase (+) or decrease (−)[a] in tissue calcium (%)	Increase (+) or decrease (−)[a] in tipburn severity (%)
		Salinas, CA		
Calmer				
1	$CaCl_2$	224[c]	+29[b]	−207[b]
		448[c]	+27[b]	−223[b]
	$Ca(NO3)_2$	112[c]	−3	−7
		224[c]	−10	−12
		448[d]	+12	−9
2	$CaCl_2$	224[d]	−4	+11
		448[d]	−7	−12
	$Ca(NO3)_2$	112[d]	+11	−13
		224[d]	+14	−16
		448[d]	+15	−18
3	$CaCl_2$	224[d]	+9	−6
		448[d]	+14	−14
	$Ca(NO3)_2$	112[d]	+11	−7
		224[d]	+7	+6
		448[d]	+12	−11
		Yuma, AZ		
Vanguard				
4	$CaCl_2$	224[c]	+13	−16
		448[c]	+9	−10
5	$CaCl_2$	224[d]	+8	+5
		448[d]	+10	−9
Climax				
	$Ca(NO3)_2$	112[c]	+12	+2
		224[c]	+14	−17
		448[c]	+7	−3
6	$CaCl_2$	224[c]	+7	−10
		448[c]	−3	−3

[a] When compared with the control; figures are averages of four replicates.
[b] Differences between plants in treated and control plots were significant at the 1% level, using *t*-test.
[c] Calcium salts were placed in 8- to 10-cm-deep furrows at the top of the beds 1–3 days before direct seeding.
[d] Calcium salts were placed in 8- to 10-cm-deep furrows cut halfway between the top and the bottom on both sides of the beds 4–6 weeks after direct seedling.

in 8- to 10-cm-deep furrows cut halfway between the top and the bottom on both sides of the beds 4–6 wk after direct seeding.

Plants were sprayed with aqueous solutions of calcium chloride (4.7 g/L) and calcium nitrate (7.1 g/L) at a rate of 940 L/ha about 4, 6, 8, and 10 wk after planting. The first three treatments were applied before head formation and the final spray was applied after heads had formed.

We rated plants for tipburn incidence and severity at the time of commercial harvest. Tipburn severity was estimated on a scale from 0.5 to 5.0 to indicate slight to severe symptoms. When disease incidence in untreated sections was less than 15%, plants in the field plot were rated for tipburn incidence and severity by a laboratory method described earlier (12). For the laboratory rating, we collected about 20 lettuce heads from each treatment replicate at random at the time of commercial harvest and exposed them in growth chambers to a constant temperature at 30 C and 40–60% relative humidity in the dark (12). Tipburn severity was estimated according to the rating scale. For the calcium analysis, we collected 100-g samples, including inner, middle, and outer leaves, from each of eight to 10 plants in each treatment replicate. Calcium content of the tissues was analyzed according to a procedure described earlier (13).

RESULTS AND DISCUSSION

In only one of six trials, soil application of calcium chloride at 224 or 448 kg/ha resulted in statistically significant increases in tissue calcium and significant decreases in tipburn incidence and severity (Table 1). In all field trials, soil and foliar applications of calcium nitrate and foliar applications of calcium chloride resulted in no significant changes in the levels of tissue calcium or severity of tipburn (Table 1). Data for foliar treatments are not shown.

These results do not support the view held by some lettuce growers and agricultural experts that the salts are effective in controlling tipburn of head lettuce.

We do not know why soil application of calcium chloride increased tissue calcium and decreased tipburn severity in one of the six trials. The presence in the soil of different levels of other elements that influence the availability and uptake of calcium (7,9,19) could have contributed to the different response. Soil conditions that influence the availability, uptake, and translocation of calcium are not fully understood, but results suggest that the soil in most fields did not favor the uptake and translocation of supplemental calcium.

Timely sprays of calcium salts have been reported to reduce the incidence of several other calcium-related disorders, such as bitter pit of apple (2), internal breakdown of apple (3), blossom-end rot of tomato (6), brownheart of escarole (11), and blackheart of chicory (18) and celery (5). We do not know why calcium treatments are effective in controlling these diseases but not tipburn of head lettuce. Susceptible tissues of the other plants can be sprayed with calcium salts throughout the growing season, whereas the susceptible inner and middle leaves of head lettuce are not exposed after head formation. Calcium, which is not readily translocated in plants (14,17), may be effective only when applied directly to tissues a short time before symptoms of calcium-related disorders develop.

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