Research Note

FAILURE OF CALCIUM SOURCES TO CONTROL BLOSSOM-END ROT IN WATERMELONS[1]

The watermelon (*Citrullus lanatus* [Thumb] Matsum Nakai) is cultivated for its fruit, known botanically as pepo. As are other cucurbits, the watermelon is subject to disease, physiological disorders, and the attack of insects that can damage a potentially promising crop. Total production in the island in 1985–86 was 31,200 hundredweight (cwt) with a farm value of $448,000 and a mean value of $14.36 per hundredweight.[2]

Blossom-end rot (BER), described as a physiological disorder of several vegetable crops, is frequently observed in Charleston Gray, the cultivar most frequently planted in Puerto Rico. In studies in the AES-UPR Lajas Substation, up to 59% of its fruits indicated BER symptoms.[3] Other investigators have also reported high BER susceptibility of Charleston Gray.[4]

This disorder is first noticed as a water-soaked region beneath the outer fruit wall of the blossom end, or acropetal distal portion of the maturing fruit. Affected tissues form a blackened, desiccated, locally-sunken spot.[5]

Calcium, as calcium pectate, is a constituent of the middle lamella layer of plant cell walls. It therefore contributes to cell wall structure.[4] Insufficient supply of calcium for the synthesis of cell walls, together with moisture stress, has been associated with BER in tomato, pepper and watermelon.[4,5,7,8,9,10,11]

Under water-stress conditions, calcium transport to the apex of the plant is thought to be constrained, and therefore a possible factor affecting fruit tissue growth and development.[4] Calcium content of normal vegetable fruits is reportedly higher than BER-affected fruits.[6,7] Calcium levels below 0.20% are commonly associated with BER symptoms.[8] Some authors[6,9] have suggested that calcium deficiency is a primary cause of

[1] Manuscript submitted to Editorial Board 20 September 1988.

[2] Anonymous, 1987. Ingreso Agrícola de Puerto Rico 1986-87. Commonwealth of Puerto Rico, Department of Agriculture, Santurce, P.R.

[3] Ramírez, C. T. and R. del Valle, Jr., 1988. Watermelon yield and incidence of blossom-end rot response to levels of N, P and K fertilizers. (Manuscript under revision).

[4] Cirulli, M. and F. Ciccarese, 1981. Effect of mineral fertilizer in the incidence of blossom-end rot of watermelon. The Am. Phytopath. Soc. 71 (1): 50–2.

[5] Gerard, C. J., B. W. Hipp and W. R. Cowley, 1971. Tomatoes: irrigation, spacing, blossom-end rot. Texas A & M Agric. Exp. Stn. B-1113.

[6] Greenleaf, W. H. and F. Adams, 1969. Genetic control of blossom-end rot disease in tomatoes through calcium metabolism. *J. Am. Soc. Hortic. Sci.* 248–59.

[7] Gerard C. J. and W. R. Cowley, 1966. A study of blossom-end rot of pear-shaped tomatoes. Texas Agric. Exp. Stn. MP-814.

[8] Shaykewich, C. F., M. Yamaguchi and J. D. Campbell, 1971. Nutrition and blossom-end rot of tomatoes as influenced by soil water regime. *Can. J. Plant Sci.* 51: 505–11.

[9] Hamilton, L. C. and W. L. Ogle, 1962. The influence of nutrition on blossom-end rot of pimiento peppers. *Am. Soc. Hort. Sci. Proc.* 80: 457–61.

[10] Shear, C. B., 1975. Calcium-related disorders of fruits and vegetables. *Hort. Science* 10 (4): 361–65.

[11] Evans, H. J. and R. V. Toxler, 1963. Relation of calcium nutrition to the incidence of blossom-end rot in tomatoes. *Am. Soc. Hort. Sci. Proc.* 69: 309–17.

BER, while others[4,5,10] attribute it to complex interactions of empirical and fundamental factors affecting growth. The latter include unfavorable weather conditions, supply of K and NH_4 fertilizers, and soil-moisture stress. Calcium has been used in the control of BER in tomato, pimiento pepper, and watermelon.[4,6,9,11]

An experiment with Ca sources for control of BER in Charleston Gray watermelon was begun in 1982. Plants were propagated in a Fraternidad clay soil, a Vertisol, Udic Chromusterts, very fine, montmonillionitic, isohyperthermic soil[12] at the semiarid, AES-UPR Lajas Substation. The soil was contained in concrete boxes, each one divided into two "plots." Plants were established at a 91 × 91 cm spacing that totalled 18 plants per treatment. There were four treatments and three replications in a randomized block design. The four treatments consisted of three Ca sources, administered in aqueous solutions, and a control (table 1). The soil was fertilized before planting. We used a complete N-P-K mixture that supplied N, P_2O_5, and K_2O at rates of 134, 122, and 134 kg/ha, respectively. Aqueous calcium sulfate solution was applied with a watering can five days before planting and mixed with the soil. Calcium chloride and calcium nitrate, in 1.0% solutions, were administered weekly with a knapsack sprayer. The treatments were begun when initial flowers were seen, and continued until the fruits were harvested. Water stress was prevented by periodic irrigation in accordance with monitored tensiometer readings. During the crop cycle, maximum and minimum temperatures were 31.6 and 19.7°C, respectively. A total of 483 mm of rainfall and 309 mm pan evaporation were registered during this period.

Beginning at fruit set, symptoms of BER were observed in some fruits of all treatments. Other fruits showed symptoms as the crop progressed. Finally, BER symptoms were present in all of the treatments, including control plants, affecting approximately 60% of the fruits. The calcium treatments failed to control BER in this study. BER incidence and severity was similar to that of a field trial with the same cultivar at Lajas.[3] Table 1 shows nutrient contents of the soil following harvest. Table 2 shows nutrient contents of normal and BER-affected fruits.

Fruit bearing BER symptoms contained less Ca than normal fruit in the affected portions. These data are consistent with those of Shaykewich et al., who reported that tomatoes with Ca concentrations below 0.20% in their blossom-end portions develop BER symptoms.[8] The content of K was relatively high in central and distal parts of affected fruits. Gerard et al.[5] associated high incidence of BER in tomato with low Ca and high K:Ca ratio for distal portions of the fruit.

Because of continued BER prevalence in watermelon planted in south and southwest

TABLE 1.—*Mineral content and pH of soil used in the study of BER in watermelon at Lajas, P. R.*[1]

Treatment[2]	Soil content (ppm) of mineral					Soil pH
	P	K	Ca	Mg	NO_3-N	
$Ca(NO_3)_2$	208	555	3376	1204	30	7.24
$CaCl_2$	82	369	3486	1160	20	7.55
$CaSO_4 \cdot H_2O$	168	656	3384	1177	32	7.43
Control	84	345	3415	1107	18	7.75

[1]For soil samples taken after harvest.
[2]Each Ca source was administered in 1.0% solution.

[12]Lugo-López, M. A. and L. H. Rivera, 1976. Taxonomic classification of the soils of Puerto Rico. Agric. Exp. Stn. Univ. P. R. Bull. 245.

TABLE 2.—*Nutrient contents of normal and BER-affected watermelons*

Fruit BER status	Fruit section analyzed	Watermelon fruit contents of mineral %				
		N	P	K	Ca	Mg
Normal	Basal	3.75	0.53	4.87	0.25	0.30
	Central	3.30	0.55	3.67	0.11	0.18
	Blossom end	4.05	0.59	4.25	0.20	0.22
	Fruit mean	3.70	0.56	4.26	0.18	0.23
Affected	Basal	3.45	0.65	4.94	0.10	0.24
	Central	3.60	0.72	4.82	0.11	0.27
	Blossom end	3.45	0.60	5.31	0.12	0.20
	Fruit mean	3.50	0.66	5.03	0.11	0.24

Puerto Rico, additional research is needed to attain satisfactory control measures. Supplying Ca formulations to the soil does not control BER.

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