MICRONUTRIENT DEFICIENCIES OF COPIC BAY SOILS IN TULELAKE BASIN

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Under greenhouse conditions, iron and manganese deficiencies in potato and sorghum test plants have been identified when grown in soils from Copic Bay. However, correction of these micronutrient deficiencies in the potato and enhancement of tuber yields have not been realized under field conditions. Cultural practices, frost damage, and severity of Rhizoctonia infection have minimized plant response to fertilizer treatments.

A GRADUAL DECLINE in potato yields has occurred in Tulelake's Copic Bay area for many years. Today it is difficult to raise a profitable commercial crop of Russet Burbank potatoes. Soils in this area of the Tulelake Basin are also low in available phosphorus. But even with optimum phosphorus fertilization, potato plant growth was not normal. Since the soil reaction is alkaline (pH 7.8 to 8.2) and high in organic matter (10 to 13%) and available cations, a deficiency of iron and manganese was suspected.

Field observations

Studies conducted under field conditions to identify and correct the micronutrient deficiency have proven to be only partially successful. Early plant growth was more vigorous following soil application of iron and manganese salts, but tuber yields were not materially higher. Frost damage may occur at any time during the growth period. Plants most lush in growth sustain more severe foliar damage than do smaller, less vigorous plants. Analysis of petiole tissue following such damage revealed little difference in nutrient concentrations. Before such damage, marked differences were found (table 1). Rhizoctonia infection may be severe enough to interfere with tuber production (photo 1) even where frost damage is negligible. Severity of infection may range from die-back of an initial, sprouted stem with regrowth from a new bud to reducing the number of stolons and lowering the number of tubers per plant, despite the appearance of an otherwise healthy plant above ground. In extreme cases, when the stem is girdled, a new root system may develop above the diseased area, but the plant is stunted and the vigor is impaired.

Certain observations were made, despite the interference of weather and disease, which indicated that some changes in cultural practices could partially alleviate the problem. The incidence of Rhizoctonia infection may be lowered by delaying planting until the soil has warmed, and by planting shallow and ridging later. Large seed potato pieces (1½ to 2 oz) that are well suberized and green-sprouted could be used to reduce the potential loss to rot while in wet, cold soil. Seed that remains sound insures a reserve supply of nutrients for the developing plant. If the seed piece decomposes before the plant is well established, the plant must utilize what nutrients are available in the soil. A more vigorous plant will be insured from a large seed piece than from a small one (photo 2), leading to higher tuber yields (table 2).

Where the soil was not properly irrigated and a low soil moisture content was present during growth, plants appeared stunted and exhibited severe loss in green color of foliage. The determination of source and levels of iron and manganese fertilization necessary to return these soils to optimum potato productivity is a complex problem.

Soils taken from Copic Bay are being studied in detail under greenhouse growing conditions. Sorghum plants grown in soil held in rusting containers produced normal plants with no visible

Photo 1. Russet Burbank plants 54 days after seed planting, showing extensive stem damage from Rhizoctonia infection. Girdled plant to the right has developed a new root system above the area of infection. Note difference in foliar growth and stolon development despite soundness of seed pieces. Background grid lines spaced 3 inches apart.

deficiency symptoms. However, plants grown in soil held in plastic containers were comparatively retarded in growth and expressed visible symptoms of iron deficiency (photo 3). Loss of green coloration in new, developing leaves became acute in time until the last leaf developed was almost devoid of green color. Additions to the soil of zinc as $ZnSO_4$ hastened the development of iron deficiency symptoms in the plants. Application of zinc in the field and greenhouse did not improve plant growth of any test crop (table 1).

With potatoes, manganese and iron deficiency symptoms became noticeable following a week of high temperatures (90°F or higher) in the greenhouse. When the temperature returned to 80°F or less, new growth appeared normal. Evidently the supply of iron—and probably manganese—was lower than required by the rapidly growing plants during high temperatures. Additions to the soil of manganese as $MnSO_4$ resulted in an increase in the Mn content of plants. However, additions of iron did not always result in an increase in the Fe content of plants; or if an increase was found through chemical analysis, there was little difference in Fe content between iron-deficient and normal plants.

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Photo 2. Comparison of Russet Burbank potato plant growth 54 days after planting. Background grid lines spaced 3 inches apart. (A) Plants in left row from seed handled by grower. Plants in right row from the same seed lot but treated and handled before planting by procedures recommended by the University of California. (B) Side view of right row in A, where the three larger plants are from seed that received handling recommended by the University of California, and the three smaller plants are from seed handled by grower.

TABLE 1. CHEMICAL COMPOSITION AND FOLIAR GROWTH OF RUSSET BURBANK POTATO PLANTS 40 DAYS AFTER PLANTING

Field trial location	Leaf petiole*							Foliage	
	Zn	Fe	Mn	K	Na	Ca	Mg	Height (cm)	Dry wt. (%)
	Parts per million			Per cent					
1 R† Copic Bay	43	198	16	11.3	0.07	1.76	0.85	28‡	9.1
2 A† "	26	93	19	10.5	0.06	1.44	1.29	41‡	9.5
3 M† "	22	160	13	10.2	0.08	1.81	1.01	–	–
4 S† "	24	187	13	10.6	0.05	1.47	1.19	–	–
5 S Stronghold	33	127	38	11.9	0.03	1.30	0.73	–	–
6 S Tulelake Field Station	17	129	24	11.2	0.07	1.37	0.75	102	7.6

* Mean of three replications and based on dry weight yield. All plants grown with 120 lb N and 105 lb P per acre.
† Plants showed symptoms of nutritional disorder during growth.
‡ Light frost occurred in this area shortly after measurement.

TABLE 2. COMPARISON OF RUSSET BURBANK TUBER YIELD OBTAINED FROM SIDE-BY-SIDE PLANTINGS OF SEED POTATOES HALF GROWER HANDLED AND THE OTHER HALF HANDLED BY U.C.-RECOMMENDED PROCEDURES.

Treatment No.	Yield cwt sacks/A	
	Seed handled by grower*	Seed handled as U.C recommended
1	93	220
2	110	204
3	84	165
4	84	157
5	84	139
6	93	148
7	116	218
8	130	235
Mean	99	188

* Seed handled by grower had less than 5% of sound seed pieces. Seed handled as U.C. recommended were 98% sound 54 days after planting.
† Seed held at 68°F to facilitate suberization and sprouting after being cut into 1½- to 2-oz pieces following treatment with a mercuric solution to kill surface-borne microorganisms.

Photo 3. Sorghum plant growth is retarded in soil held in plastic liner (left) as compared with the flush growth in soil held in a rusty can (right). Typical iron deficiency (yellow stripes the length of the leaves) is evident in the newer leaves of the smaller plant. Soil investigated was from a field at Copic Bay.