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THE INFLUENCE OF SPECIFIC IONS ON THE TOTAL SOLUBLE SALT AND pH LEVELS OF COMMERCIAL TOMATO FIELDS IN SOUTHWEST FLORIDA[1]

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Abstract. **Soil test data generated from a 2 year soluble salt survey of commercial tomato fields in southwest Florida were subjected to correlation analysis to assess the relationship of 7 specific ions on the total salt level and pH of the soil solution. Readings from samples taken at 3 depths from 4 portions of full bed mulched tomatoes from 23 farms indicate that K, NH_4, Ca, and Mg were highly correlated with salt levels, and that K, Ca, NO_3, and Mg possessed the highest negative correlations with pH. Total salts and pH were negatively correlated. Soluble salt values decreased and pH values increased with depth of sampling. Salt levels increased with consecutive cropping indicating the danger of salt damage to successive crops.**

Results of a soluble salt survey of commercial tomato fields in southwest Florida in 1976 indicated that salt levels have accumulated in fields cropped for 2 or more consecutive years (1, 2). This survey was continued and expanded during 1977, resulting in a total of 276 individual analyses from which to characterize the total soluble salt level, pH, and concentration of 7 specific ions in the soil solution of 23 fields surveyed in this 4-county area.

This survey, using 2484 discrete analytical inputs, provided a unique opportunity to assess the influence of specific ions on soil pH and total soluble salt level. In both years all sampling was done at the request and assistance of the County Extension Agents in Collier (D. W. Lander), Hillsborough (M. T. Pospichal), Lee (V. W. Yingst) and Manatee (R. T. Montgomery).

Methods

Soil samples were taken from 23 commercial tomato fields in Collier, Hillsborough, Lee, and Manatee counties during 1976 and 1977 to assess the soluble salt status of land used for tomatoes for 2 or more consecutive years. Random soil samples were taken at 3 depths (0-2, 2-4, and 4-8 inches) at each of 4 positions in or near the mulched bed (between bed, fertilizer band, near plant row, and plant row).

In all 4 counties the 'Walter' cultivar, full bed mulch, seep irrigation, and staked culture was used. Fertilizer application, including starter and band, averaged 322 lbs of N, 219 lbs of P_2O_5, and 525 lbs of K_2O per acre.[2] Plant spacing averaged 25 inches between plants with rows spaced 8.6 feet apart with an average population of 2407 plants per acre. A per plant average yield of 13.0 lbs of marketable fruit resulted in an average yield of 1043 cartons (30 lb) per acre.

All samples were submitted to IFAS Soils Laboratories for routine determination of total soluble salts, pH, K, Ca, NO_3 and NH_4 nitrogen, Mg, Cl, and Na from a saturated paste extract which is standard for the Intensity and Balance soil analysis procedure (4). For each field a case history was taken which included previous crops, fertilizer program, plant population, irrigation and drainage information, and pest management program.

The soil samples collected at the 4 positions at 4 depths for 23 fields during the 2-year survey generated 2484 observations which were subjected to correlation analyses by the IFAS Department of Statistics Laboratory. It may be noted that this high population level provided small differences that were significant at the 0.001 level of significance.

Results

In the first year it was noted that the salt level of virgin fields in the 4 counties averaged 476, 382, and 379 at the 0-2, 2-4, and 4-8 inch depth (3). The average level of total soluble salts (TSS) in the soil soln of between-bed areas of fields used for 2 or more consecutive years is presented in Table 1. Current levels in between-bed areas were found to be 2 to 3 times greater than soils in non-cropped fields.

Table 1. Between row mean values, intensity and balance survey, 276 commercial tomato soil tests[z], southwest Florida, 1976-77.

Depth, inches	pH value	Soil solution, ppm							
		TSS	K	Ca	Na	NO_3	NH_4	Mg	Cl
0-2	6.9	2287	164	146	148	95	12	102	264
2-4	6.7	1015	60	84	54	98	10	31	109
4-8	6.5	848	59	62	51	127	13	25	82

[z]Determinations made by IFAS Soils Laboratory, standard I & B procedures.

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[2]For metric equivalents see Table near the front of this Volume. Ed.

Total salt levels and pH decreased with depth in this sample area.

Mean values of the 3 bed regions (fertilizer band, near plant row, and plant row) are presented in Table 2. In general, most salt values decreased and pH values increased with depth of soil sampled. This inverted relationship of pH and salt level is reflected in the negative correlation ($r = 0.23$) shown in Table 3. The highest r values associated with total salt level were found with K, Mg, NH_4, and Ca. Several low, significant correlations were associated with pH; the largest of which were nitrate N, Ca and Mg. The r value squared indicates the potential assignment of variation due to regression of one factor on another (5). In a sample of the size used in this survey many significant correlations were noted without having specific cause and effect relationships. One would expect total salts to be strongly modified by such specific ions as K, Mg, NH_4, and Ca, and this is shown by the high r^2 values obtained; but the statistical association between K on Ca, NH_4, and Mg may represent chance correlations.

Select correlations of specific ions on total soluble salts and on pH are presented in Tables 4 and 5 for the 4 sample areas at 3 depths. These data focus on the strong association of K, Ca, and Mg on total salts, and the variable negative correlations of K, Ca, Mg, and nitrate N on pH.

The results of this two-year survey indicate that the salt levels of consecutively cropped fields are increasing and that certain specific ions are associated most with these increases. Field histories of the farms surveyed showed that fertilizer rates in excess of those recommended by the University of Florida are being used.

Characterization of the soil solution in the average commercial tomato bed of the area is expressed in Table 6.

Table 4. Correlation coefficients[z] of the 3 major cations with total soluble salts, I and B survey, 1976-77.

Position	Depth, in.	K	Ca	Mg
Between beds	0-2	.77	.76	.95
	2-4	.86	.88	.87
	4-8	.88	.91	.84
Fertilizer band	0-2	.73	.51	NS[y]
	2-4	.49	NS	NS
	4-8	.79	.61	.92
Near plant row	0-2	.64	NS	NS
	2-4	.86	NS	.89
	4-8	.83	.86	.94
Plant hole	0-2	.79	.74	.65
	2-4	.67	.69	.93
	4-8	.59	.60	.90

[z]Correlations significant at the 0.01 level of significance.
[y]Entries denoted by NS were not significant at the 0.05 level.

The K, Na, Cl levels reflect slightly higher than desired levels, whereas the Ca is slightly lower than suggested by Geraldson (1, 2).

This survey should serve as an indication to tomato growers, fertilizer sales representatives, and Extension Agents that attention must be given to closer adherence to recommended rates of fertilizer, use of low salt index materials, and improved leaching if we are to avoid serious soluble salt problems and potential criticism for non-point

Table 2. Bed position mean values, intensity and balance survey[z], 276 commercial tomato soil tests, southwest Florida, 1976-77.

Position in bed	Depth, inches	pH value	Soil solution, ppm							
			TSS	K	Ca	Na	NO_3	NH_4	Mg	Cl
Band	0-2	6.2	42,083	6599	749	392	946	547	675	603
	2-4	6.4	12,499	1242	435	268	601	127	263	356
	4-8	6.6	2,254	223	147	117	224	13	67	188
Near plant row	0-2	6.1	10,807	1579	534	362	756	271	478	455
	2-4	6.5	5,243	542	382	262	430	84	198	283
	4-8	6.6	2,527	197	192	178	272	20	86	206
Plant row	0-2	6.4	8,846	697	417	398	504	175	436	401
	2-4	6.7	3,142	223	172	197	273	37	118	224
	4-8	6.8	1,973	130	148	123	158	13	61	171

[z]Determinations made by IFAS Soils Laboratory, standard I & B procedures.

Table 3. Correlation coefficients[z] of the 9 major factors of an intensity and balance survey of tomato fields in southwest Florida, 1976-77.

Factors	TSS	pH	K	Ca	Na	NO_3	NH_4	Mg	Cl
TSS	1.00	−.23	.86	.64	.30	.49	.69	.63	.40
pH	—	1.00	−.28	−.33	NS[y]	−.45	−.22	−.33	NS
K	—	—	1.00	.65	.24	.48	.66	.64	.35
Ca	—	—	—	1.00	.44	.68	.52	.76	.44
Na	—	—	—	—	1.00	.20	.20	.58	.68
NO_3	—	—	—	—	—	1.00	.51	.61	.31
NH_4	—	—	—	—	—	—	1.00	.51	.33
Mg	—	—	—	—	—	—	—	1.00	.60
Cl	—	—	—	—	—	—	—	—	1.00

[z]Correlations significant at the 0.01 level of significance.
[y]Entries denoted by NS were not significant at the 0.05 level.

Table 5. Correlation coefficients[z] of the 3 major cations and nitrate anion on soil test values for pH, I & B survey, 1976-77.

Position	Depth, in.	K	Ca	NO_3	Mg
Between rows	0-2	NS[y]	NS	.17	NS
	2-4	NS	NS	.31	NS
	4-8	.27	.18	NS	NS
Fertilizer band	0-2	—.27	—.25	NS	—.24
	2-4	—.50	—.71	—.77	—.71
	4-8	—.57	—.47	—.51	—.56
Near plant row	0-2	—.30	NS	—.46	—.37
	2-4	—.37	—.60	—.65	—.59
	4-8	—.18	—.24	—.48	—.31
Plant row	0-2	—.27	NS	—.45	NS
	2-4	—.20	—.51	—.42	—.51
	4-8	—.27	—.49	—.43	—.42

[z]Correlations significant at the .01 level of significance.
[y]Entries denoted by NS were not significant at the 0.05 level.

Table 6. Bed mean values, intensity and balance survey, 276 commercial tomato soil tests, southwest Florida, 1976-77.

Factor evaluated	Value noted	Percent of total	Acceptable range[z], or percent of total
Total soluble salts	10,269 ppm	100.0	4500-5500
pH	6.5	—	5.5-6.5
Potassium	1,270	12.4	8-10
Calcium	353	3.4	8-10
Sodium	255	2.5	0-10
Nitrate nitrogen	463	4.5	3-10
Ammonium nitrogen	143	1.4	0-10
Magnesium	265	2.6	3-5
Chlorine	321	3.1	0-10

[z]Acceptable range for tomatoes from Geraldson (2).

pollution. Perhaps the increasing cost of fertilizer will provide this needed governance.

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CONTROLLED RELEASE FERTILIZERS: EFFECT OF RATES AND PLACEMENTS ON PLANT STAND, EARLY GROWTH AND FRUIT YIELD OF PEPPERS[1]

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Abstract. **Osmocote (15-5-21)[2] and a blended fertilizer (10-12-11)[3] containing 50% Osmocote were used in 2 tests as starter fertilizer to evaluate their effect at different rates and placements on plant stand, early plant growth and yield of mulched sweet pepper** (Capsicum annum **L.). Included for comparison was 1 rate and 1 placement of a highly soluble fertilizer. In the first test (fall 1976), early plant growth was retarded with the soluble fertilizer and yields were significantly influenced by source, rate and placement of starter fertilizer. Plant stand was not affected by any treatment. In the second test (spring 1977), only the rate of controlled release starter fertilizers had a significant influence on yield. Both plant stand and yield were lower with soluble fertilizer than with either of the controlled release fertilizers.**

Two problems have become evident with the advent of the plastic mulch system for pepper production where seep-irrigation is used. Both problems, which appear to be associated with source and placement of starter fertilizer, have their main effect when plants are in the seedling stage.

The first problem, which is most serious during dry weather, results when excessive salts from readily soluble starter fertilizers are placed too close to the seedling and are held there by water moving upward from a perched water table (2). This causes injury and/or death of the seedling, which necessitates considerable re-setting, non-uniformity of plant growth and yield reduction. Excessive salts near seedlings have been successfully reduced by overhead or top watering, but this requires extra expense in equipment, labor and energy (3, 5).

The second problem, which develops mainly during wet weather, occurs when water from frequent rains enters the planting holes and moves soluble plant nutrients down and away from the limited root system of seedlings (unpublished data). With this situation the seedlings usually do not die but become chlorotic and early growth is retarded. If not corrected, this stunted condition can last for several weeks during the rainy season. When the frequency of rains decreases and seep-irrigation is applied, soluble nutrients move upward nearer the roots and the seedlings resume growth. However, by this time, plants seldom attain a desired size prior to fruit-set.

Although the 2 problems outlined above are opposite in their effect on seedlings, both are associated with soluble nutrients (excess or deficiency) early in the life of the plant. Since controlled release fertilizers have both the properties

[1]Florida Agricultural Experiment Stations Journal Series No. 841.
[2]Furnished by Sierra Chemical Company, Milpitas, CA.
[3]Furnished by Florida East Coast Fertilizer Company, Homestead, FL.