A FERTILITY EXPERIMENT WITH TOMATOES ON IMMOKALEE SAND IN ST. LUCIE COUNTY

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As has been indicated in the preceding discussion, the survey of tomato crops in St. Lucie County conducted during the 1946 fall cropping season indicated the need for additional amounts of available calcium and magnesium in the soil and the beneficial effects of minor elements. A series of fertility plots was set up for the 1947 spring tomato crop in order to evaluate these factors in the production of tomatoes.

The location chosen for this experiment was an area of Immokalee sand of very low fertility. The surface soil was a light grey sand with a pH of 4.75 and an organic matter content of 0.8 percent. The "B" horizon was a very light grey or light yellow sand underlain by an acid clay, pH 4.95, at a depth of 30 to 36 inches. A fall crop of tomatoes grown on this field showed many symptoms of severe nutritional deficiencies and was almost a total failure.

Four main treatments consisting of three liming materials and a check were laid out in a 4 x 4 Latin square design. The liming materials, basic slag, dolomite and hydrated lime, were broadcast at the respective rates of 2000, 2000, and 1000 pounds per acre. Each of the sixteen main plots was split into three sub-plots consisting of the following three sub-treatments:

(1) 4-8-8 fertilizer (check).

(2) 4-8-8 fertilizer containing 2 percent soluble MgO.

(3) 4-8-8 fertilizer containing 2 percent soluble MgO plus 0.3, 0.4, 0.2, 0.15 and 0.3 units respectively of CuO, MnO, ZnO, B_2O_3 and Fe_2O_3 using the sulfates of copper, manganese, zinc and iron and borax as the source of these materials.

The liming materials were broadcast and disced into the soil in December. In January narrow beds were plowed up seven feet apart and fertilized at the rate of 500 pounds per acre with the mixed fertilizer according to sub-treatments 1, 2 or 3. The first lot of tomato seedlings transplanted to the plots was destroyed by the February freeze. Another lot of seedlings of the Grothen's Globe variety was transplanted to the plots in March. The tomatoes received three side dressings at 500 pounds per acre with this same fertilizer during the subsequent growth of the crop making a total application of 2000 pounds per acre. Approximately three months after application of the liming materials, soil samples were collected from each of the sixteen main plots. The samples were taken from the unturned strips of soil between the beds so as to avoid contamination with the side dressed fertilizer applications. The results of soil analyses for pH, calcium and magnesium made on these samples are recorded in Table 1. The liming materials had raised the pH values and the calcium levels. In addition, the magnesium levels on the dolomite plots were much higher and somewhat higher on the plots receiving basic slag. The soil levels of available calcium and magnesium had their influence on plant composition as determined by tissue analyses made on stem tissue samples collected during the growth of the tomatoes.

Samples of plant stem tissue were collected for analysis from all the sub-plots about the time of the first picking of to-

matoes. Each sample was cut from a position near the end of a growing branch of the plant. The branch was first cut about twelve inches from the end and about six inches of the growing point was discarded along with all the leaves. Twelve stem sections from as many plants were collected from each plot and were composited to make up a representative sample. Cross sections of these stem tissue samples were processed with an extracting solution in a Waring Blendor and the filtered extracts analyzed for calcium magnesium, phosphorus and potassium.

The results of calcium tests on the tomato stem tissue extracts are recorded in Table 2 according to averages for the twelve main treatment x sub-treatment combinations. An analysis of variance showed the calcium content of the stem tissue to vary significantly with the soil amendment used. Samples from the check treatment (main plot treatment) were the lowest with those from the slag and lime treatments highest and dolomite intermediate. This correlates quite well with the calcium in soil samples from these same plots (see Table 1.)

The results of magnesium tests are recorded in Table 2. An analysis of variance showed highly significant differences between both the four main treatments and the three subtreatments. Samples from the main treatment check plots were significantly lower in magnesium than those from any of the plots receiving a liming material. The dolomite treatment was significantly higher than the other treatments. This is in good agreement with the soil tests for magnesium (see Table 1). In addition to the magnesium variable due to main treatments there is also a magnesium variable due to sub-treatments. Samples from the check sub-treatment were significantly lower in magnesium than those from the other two sub-treatments which included 2 percent soluble MgO in the fertilizer.

The first picking of fruit was made fifty days after the seedlings had been transplanted to the field. A total of five pickings was made from these plots during the following month. No sorting or grading of the fruit was attempted. A careful check of the accumulated yield totals after the third picking showed that for the first three pickings the plots receiving some form of lime treatment had yielded an average of 130 field crates per acre as compared to 50 field crates for the check plots, a ratio of almost 3 to 1. Since these three pickings were made during the period of high market and subsequent pickings during a much

TABLE 1—ANALYSES[1] OF SOIL SAMPLES COLLECTED FROM PLOTS APPROXIMATELY THREE MONTHS AFTER APPLICATION OF SOIL AMENDMENTS

Treatment	pH[2]	Ca[3] lbs. per A.	Mg[3] lbs. per A.	P[4] lbs. per A.	K[3] lbs. per A.	Organic Matter,[5] Percent
Check	4.75	169	10	8	34	0.83
Basic Slag	6.13	495	35	9	36	0.78
Hydrated Lime	6.56	497	18	9	36	0.82
Dolomite	6.31	413	113	10	35	0.76

[1] Average of four replicated plots.
[2] Glass electrode method.
[3] Extracted with 0.5 N. acetic acid.
[4] Water soluble.
[5] Dichromate—ferrous sulfate method.

lower market, there was a large monetary return from the use of liming materials to produce heavy yields of early maturing fruit. During the fourth and fifth pickings there was a slight leveling off in the comparative yields between treatments. This was because the vines on the check plots died early and the exposed green fruit ripened somewhat prematurely and gave abnormally heavy yields, particularly during the fourth picking. The superior vegetative condition of the treated plots as compared to the check plots became obvious about the time of the first picking. This difference became greater as the picking season progressed.

The average yields in field crates per acre of the five combined pickings are listed in Table 3 according to main and sub-treatment combinations. An analysis of variance of the original data showed the differences between main treatments to be highly significant. The check treatment gave a significantly lower yield than the other three main treatments. Basic slag and hydrated lime gave the highest yields but their increase over dolomite was not significant. There were no differences in yields between the sub-treatments, however, at the end of the third picking the check sub-treatment had yielded approximately 12 percent less fruit than the other two treatments.

There are two characteristics that are sometimes exhibited by tomatoes in the Ft. Pierce area that lower quality. One is lack of firmness due to puffy interiors and the other is an internal browning and hardening of small sections within the fruit with no evidence of damage on the exterior. These necrotic sections have the appearance of granules of brown, cork-like material, During the third picking of tomatoes six fruit samples were collected at random from each of the sub-plots. These samples were brought to the laboratory and cut in half in order to study the above mentioned internal qualities more carefully.

The samples were scored for puffiness on the basis of solid =0, average =1

TABLE 2.—Calcium and Magnesium Analyses[1] of Stem Tissue Samples from Tomato Fertility Plots

Main Treatment	PERCENT CALCIUM				PERCENT MAGNESIUM			
	Sub-Treatment No.[2]			Average[3]	Sub-Treatment No.[2]			Average[4]
	(1)	(2)	(3)		(1)	(2)	(3)	
Check	0.62	0.49	0.65	0.59	0.23	0.33	0.43	0.33
Basic Slag	0.77	0.73	0.76	0.75	0.37	0.46	0.43	0.42
Hydrated Lime	0.76	0.75	0.68	0.73	0.37	0.48	0.46	0.44
Dolomite	0.64	0.60	0.67	0.64	0.52	0.54	0.65	0.57
Average[5]	0.70	0.64	0.69	0.68	0.37	0.45	0.49	0.44

[1] Averages of the four replicated plots of each treatment combination. Reported on the basis of oven-dry tissue.
[2] Sub-treatments are (1) check, (2) soluble MgO and (3) soluble MgO plus minor elements with an over-all application of a 4-8-8 fertilizer.
[3] Difference required for significance = 0.11.
[4] Difference required for significance = 0.06.
[5] Differences between calicum values are not significant. Difference between magnesium values required for significance = 0.05.

and puffy =2. The total scores for the fruit from each treatment are recorded in Table 4. A low score indicates a more solid fruit. According to an analysis of variance, the differences are not significant. However, with the extreme variability and small number of fruits in each sample, such differences would have to be outstanding in order to hold up statistically. The fruit from plots receiving minor elements averaged somewhat less puffy than that from the check sub-treatment. This is in agreement with quality estimates made on fruit from the field of a commercial grower who had fertilized some with minor elements and treatment than in that from the liming treatments. The differences between the slag, hydrated lime and dolomite treatments were not significant. However, the order of increasing internal browning among these three liming treatments was the same as that of decreasing yields (See Table 3).

Some general conclusions as to recommended fertilizer practices may be drawn from this experiment and the crop survey that preceded it. The fertilizer program on the thinner soils of the Immokalee, Sunniland and Charlotte series, which are mostly used for tomatoes in the Martin-St. Lucie County area, should be such as to produce

TABLE 3.—AVERAGE YIELD[1] OF FRUIT FROM TOMATO FERTILITY PLOTS

Main Treatment	YIELD[1] OF TOMATOES, FIELD CRATES PER ACRE			
	Sub-Treatments			Average[2]
	Check	Mg0	Mg0 Plus Minor Elements	
Check	134	152	167	151
Basic Slag	271	261	288	273
Hydrated Lime	267	262	259	263
Dolomite	245	224	238	235
Average[3]	229	225	238	231

[1]Average yield of ungraded fruit from four replications.
[2]Difference between main treatment averages necessary for significance = 48.
[3]Difference between sub-treatment averages are not significant.

some without. In this test the same minor element mixture improved the external appearance of the fruit as well as firmness.

The fruit samples were also scored for the internal browning condition according to the basis of none = 0, slight = 1, medium = 2 and severe = 3. The total scores for each treatment are recorded in Table 4. As in the case of puffiness, a high score indicates a large amount of the necrotic condition with its resultant poor quality. An analysis of variance of these data showed significant differences between main treatment averages. There was more necrotic tissue in the fruit from the check

a soil pH of approximately 6.00 - 6.50, an available calcium content of 500 pounds per acre and a magnesium content of 50 pounds per acre. If the soil pH is below 5.00, one ton of dolomite, calcic limestone or basic slag, or one-half ton of hydrated lime may be safely used. The use of soluble magnesium in mixed fertilizer should be determined by the magnesium content of the soil and the liming material to be used. The use of minor elements in the mixed fertilizer seems to be advisable on these soils. The maximum amounts recommended on the first crop are 0.3, 0.4, 0.2, 0.15, and 0.3 units of Cu0, Mn0, Zn0, B_2O_3 and Fe_2O_3,

respectively, per one hundred pounds of fertilizer. These amounts may be reduced after the initial crop. These recommendations are approximate and further experimentation may suggest certain changes.

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TABLE 4.—SCORE OF FRUIT SAMPLES FOR PUFFINESS AND INTERNAL NECROTIC TISSUE

Main Treatment	Score[1] For Puffiness				Score[2] For Internal Necrotic Tissue			
	Sub-Treatment No.			Total	Sub-Treatment No.			Total[3]
	(1)	(2)	(3)		(1)	(2)	(3)	
Check	36	24	31	91	17	13	13	43
Basic Slag	35	32	31	98	5	3	2	10
Hydrated Lime	30	27	20	77	8	4	3	15
Dolomite	25	33	25	83	4	7	9	20
Total	126	116	107		34	27	27	

[1]Six fruit from each sub-plot scored on the basis of solid = 0; average = 1; puffy, = 2. The total score for the twenty-four fruit from each treatment (4 plots) is entered in the tabulations.
[2]Scored on the basis of none = 0; slight = 1; medium = 2; severe = 3.
[3]Difference between main treatment totals necessary for significance = 23.