FERTILIZATION OF FRESH MARKET TOMATOES GROWN UNDER TRELLIS AND CAGE CULTURE

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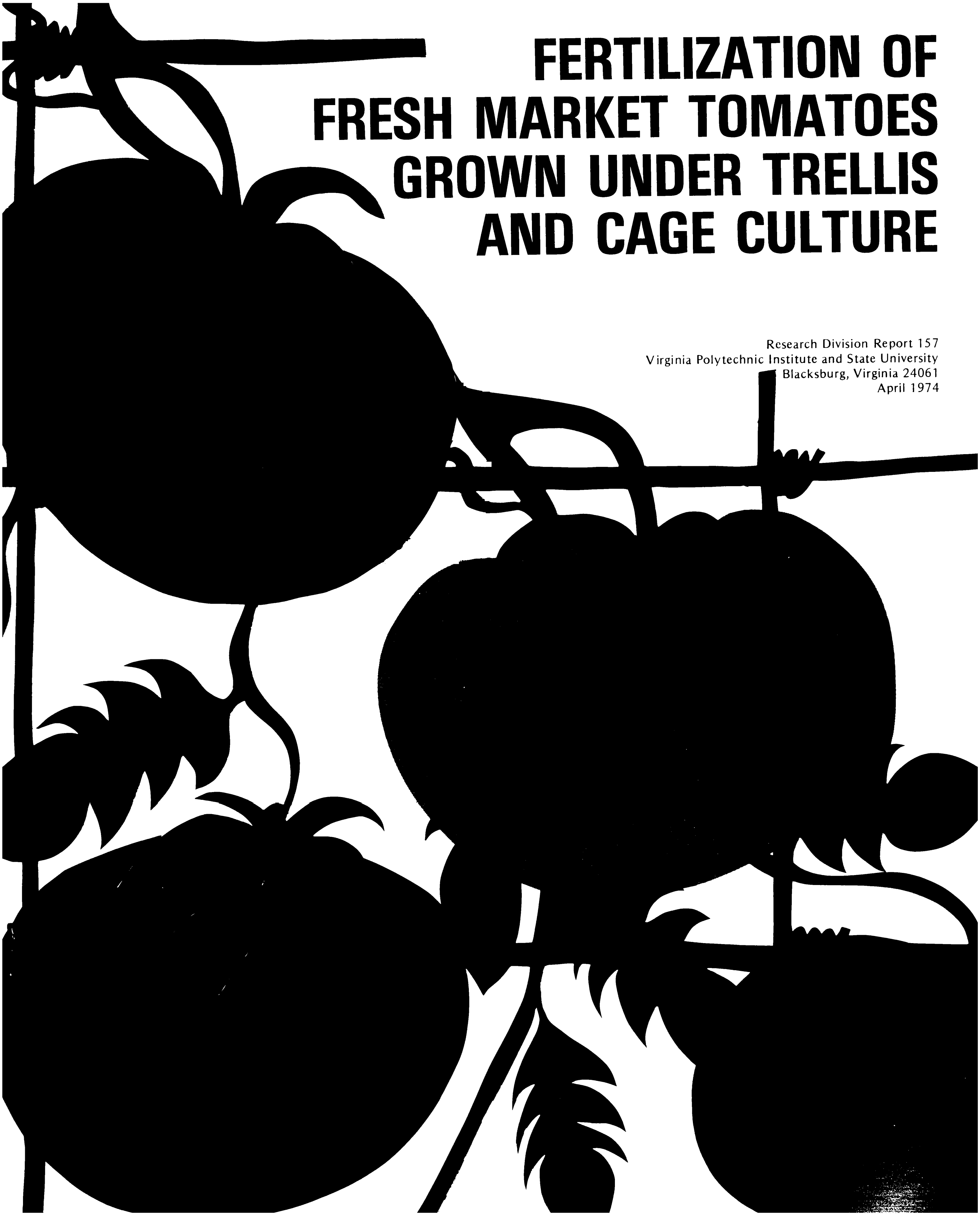

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Fertilization of Fresh Market Tomatoes Grown Under Trellis and Cage Culture in Western Virginia

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INTRODUCTION:

Fresh market vine ripened tomatoes became important as a commercial crop in Southwest Virginia when a small group of growers formed a grading and marketing cooperative in 1967. The production of tomatoes as a source of income has continued to be of interest to many small farm families in addition to the production of burley tobacco, the traditional cash crop in the region. Acreage of fresh market tomatoes has increased to approximately 90 acres, which is about one-third the potential that could be handled by the Cooperative Packing Plant at Nickelsville. With a net income potential of $3,000 to $5,000 dollars per acre to family labor, one quarter to one-half million dollars could annually be added to the local economy from this crop alone.

A factor limiting the rate of increase in tomato acreage has been difficulty in producing a high proportion of grade #1 tomatoes for shipment to more distant markets. Much fruit was rejected in 1968, 1969, and 1970 because of softness, cracking, and air pockets in fruit locules. Such problems are possibly related to improper nutrition, inadequate liming, extreme fluctuations in soil moisture and varietal characteristics, as well as other factors. With labor requirements for trellised tomatoes approximating 1100 hours per acre, poor quality reduces net returns to family labor and discourages future interest in growing tomatoes. In addition, the poor performance of one grower adversely influences others, such as neighbors who otherwise might become interested in growing tomatoes or other marketable vegetables. On a larger scale, family

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1/ Extension Specialist, Small Fruit and Vegetable Production (20% research) and Extension Specialist, Soil Fertility, respectively.

farm success and satisfaction with tomatoes and other marketable vegetable crops could help accelerate rural development in the region.

The success of Western North Carolina growers in producing profitable yields of high quality fruit is well known. Growers in Southwest Virginia adopted most of the cultural methods, including lime and fertilization practices, of the North Carolina growers. Southwest Virginia growers have not been as successful, however, as their North Carolina neighbors in producing high yields of marketable fruit. Early harvest dates have been delayed and the percentage of culls high. High fertilization rates, especially nitrogen, for the 20- to 30-ton yields obtained in Virginia, possibly have influenced yield and quality of fruit. Trellised tomato yields in North Carolina average around 40-to-50 tons per acre.

Many of the tomato producing areas in western North Carolina are above the elevations in the Scott County area of Southwest Virginia. Virginia growers who followed the higher rates used by some growers in western North Carolina and in Florida produced inferior fruit with delayed ripening. These fertilizer rates included up to 2 tons per acre of 1:3:2 or 1:2:2 ratio of mixed fertilizers, plus sidedressings with 50 pounds actual nitrogen per acre every 3 weeks during the growing season, starting when first fruit was visible and continuing through the harvest season.

Because of these grower problems in the Southwest region of Virginia, and because plant nutrition is basic to the production of good quality fruit and high yields, and due to the need for information on production of vine ripened tomatoes in the new cage system, in 1971 the authors planned a 3-year fertilization study with the Manapal variety in cages and on trellises.

LITERATURE REVIEW

In North Carolina, soils used in tomato production are limed to pH 6.8 and are fertilized to supply 300-350 pounds per acre each of actual N,P_2O_5 and K_2O (Shelton, 1973). Based on soil tests, phosphate applications in North Carolina range from 300 to 1175 lbs/acre; potash from 200 to 580 lbs/acre, and nitrogen 300-350 lbs. A response to nitrogen at these levels is obtained when soil phosphorus levels are adequate. With low phosphorus levels, response to nitrogen is reduced (Shelton, 1965).

Geraldson (1963), using average composition of plants and fruit as an indicator, observed that approximately 320 lbs. nitrogen, 60 lbs. phosphorus and 440 lbs. of potassium would be required for a 30-ton crop of tomatoes. Fertilizer trials conducted with trellis tomatoes by Dunton (1957) on a sassafras sandy loam indicated that 500 pounds of 10-10-10 fertilizer per acre at planting and 500 pounds sidedressed was adequate for production of tomatoes on the Eastern Shore soils of Virginia. Yields ranged from 15.5-to-17.2 tons per acre in 1956, and from 19.4-to-22.6 tons in 1957.

Shelton (1965) found that when adequate moisture and other nutrients are present nitrogen sidedressings increased yields as much as 16 tons per acre. Marlowe (1955) found that field grown plants contained 55 mg total nitrogen, 2 mg phosphorus, 30 mg potassium, and 7 mg of magnesium per gm of leaf tissue at the time of greatest fruit production. Average yields of marketable fruit grown under field conditions were 19 tons per acre.

Balance of the required plant nutrients in the soil solution is essential for highest yields and best quality of tomatoes as grown in Florida (Geraldson, 1963). Balance of nutrients would likely be more critical in the sandy textured soils of the tomato producing area in Florida than for the finer textured soils found in Southwest Virginia, Northeastern Tennessee, and Western North Carolina. Geraldson (1963) indicates that the total soluble salt concentration in the soil solution of the rooting zone should be 2000 to 3000 ppm, of which 15 percent should be calcium, 10 percent potassium, and 3-to-10 percent nitrate nitrogen.

Knudt (1970) conducted experiments to determine the effects of applying varying rates of potassium on tomatoes grown on a high potassium fixing vermiculitic soil. Potassium applications increased yields as well as size and color quality of the fruit. In his study, soil applications of potassium reduced "blotchy" ripening in tomatoes. Wilcox (1964) found the best yields of tomatoes were obtained when the leaves contained a minimum of 2.3 percent potassium at the time of heavy fruit load.

A typical fertilization program used on better soils in Virginia in 1968, 1969, and 1970 involved broadcasting 300 pounds of 0-0-60, 1,000 pounds of 5-10-10, and 1,000 pounds of 0-20-0 per acre before transplanting. At transplanting an additional 500 pounds of 5-10-10 per acre was banded near the plant rows. Sidedressing with 300 pounds per acre of nitrate of soda or calcium nitrate five times during the growing season was generally practiced, for a total volume of some 4300 pounds of fertilizer per acre on better soils. Soils testing low in fertility received proportionally higher fertilizer rates. It is hoped that results of this study will help improve market quality of vine ripened tomatoes in Southwest Virginia and will accelerate grower acceptance of this new cash crop in the area. Also, it is hoped that results of this project will help speed rural development in the region.

MATERIALS AND METHODS:

This study was conducted at the VPI & SU Horticultural Research Farm near Blacksburg at an elevation of about 2200 feet above sea level. Soil type was a Lodi silt loam with heavy clay subsoil. A different site was used each year in order to correspond with the recommended practice of not planting successive crops of tomatoes on the same field. Such a practice is recommended to minimize the build-up of soil borne diseases and nematodes which attack tomatoes.

Soil tests were taken at each new site each year and lime was added to adjust soil pH to about 6.8. Sites selected had a medium fertility level of phosphate and potash as shown by soil tests.

Plot size was 15 feet long and 15 feet wide, consisting of three rows on 5-foot centers. Treatments were replicated four times each season. Design was a split, split plot, and all data were statistically analyzed each year for results. Each treatment row from which records were taken was separated on each side by guard rows which were trellised, caged, and fertilized in a manner identical to the treatment row.

Trellised plants were trained to an overhead wire supported by heavy posts, using heavy baler twine tied to the stem of each plant just above ground level. Plants were pruned to a single stem, and spaced 10 inches apart x 5-foot row centers, or approximately 10,000 plants per acre, as outlined in VPI & SU Extension Division Publication.[2/] Caged plants were pruned once, to four-five main stems at time of first fruit set, and spaced 3 feet x 5 feet, or about 3,000 plants per acre. Cages were constructed

[2/] O'Dell, C. R., Production of Trellised Tomatoes in SW Virginia, Extension Division, Publication 242, VPI & SU, Blacksburg, Va. 1970.

of heavy concrete reinforcing wire mesh, 6 x 6 inch mesh size, by cutting mesh into 4½-foot lengths, and then bending or hooking ends together into a cylinder about 16 inches in diameter. The bottom rung was snipped off each wire cage leaving 6-inch wires which were pushed into the soil to support the 5-foot-tall cage, as outlined in VPI & SU Extension Division Publication 420.[3/]

Adequate disease and insect control were obtained by spraying once per week with Difolatan fungicide and endosulfan insecticide in 1971, and with Bravo fungicide and endosulfan in 1972 and 1973. A high pressure tank sprayer was used with hand-gun and trailing-hose, wetting both sides of each row of plants to the point of run-off. Volume of spray on larger vines from early harvest in late July until frost in early October was about 150 gallons per acre each week.

To reduce hand weeding, diphenamid herbicide was applied as a broadcast spray immediately after transplanting. Row middles were mulched with straw in early July each year to help conserve moisture, retard weed growth, and facilitate harvest of fruit in periods of wet weather. Irrigation was applied whenever plots had not received 1 inch of water in the previous 2 weeks. This approximates the rainfall pattern in much of Southwest Virginia which normally receives abundant rainfall during the growing season. Dry weather of over 2-weeks duration there is rare.

Fruit was harvested once each week, picking all pinks and ripes, followed by grading, counting, and weighing marketable and cull fruit for each

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[3/] O'Dell, C. R., Production of Caged Tomatoes, Extension Division, Publication 420, VPI & SU, Blacksburg, Va. 1972.

treatment.

Fertilizer treatments were as follows:

First Year Rates

Treatment 1 - Cage - low rate (compared to commercial rates in use at that time) of 1650 lbs. per acre of 5-20-10 fertilizer broadcast and disked in before transplanting, plus a low rate of 16½ lbs. actual nitrogen per acre, sidedressed once per month as ammonium nitrate beginning with first fruit set, three applications total.

Treatment 2 - Cage - medium rate of 3300 lbs. per acre of 5-20-10 broadcast and disked in before transplanting, plus a medium rate of 33 lbs. actual nitrogen per acre, sidedressed once per month beginning with first fruit set, three applications total.

Treatment 3 - Cage - high rate of 4950 lbs. per acre of 5-20-10 broadcast and disked in before transplanting, plus a high rate of 49.5 lbs. per acre actual nitrogen, sidedressed once per month beginning with first fruit set, three applications total.

Treatment 4 - Trellis - low rate, as in treatment #1.

Treatment 5 - Trellis - medium rate, as in treatment #2.

Treatment 6 - Trellis - high rate, as in treatment #3.

Second and Third Year Rates

Treatment rates were reduced for the second and third years of the study by one third, since it was felt, after studying data from the first year's results, that the 1971 high rate was obviously too high for our soils and climate. First-year highest rates actually produced a greater number of cull fruit than marketable fruit, as shown in Table 2.

For the second-and third-year tests, rates were 1,100, 2,200 and 3,300 pounds per acre of 5-20-10 for low, medium, and high treatments, respectively.

Calcium nitrate containing 15½ percent nitrate nitrogen and 20 percent water soluble calcium was used as a sidedressing source of nitrogen for the second and third years of the study. This material became the most commonly used source of sidedressing nitrogen used by commercial growers in the Southwest area of Virginia, since the calcium thus supplied seems to reduce the incidence of blossom-end rot on the fruit. Ammonium nitrate was used as a source of sidedressing nitrogen in the first year of the study, previous to local availability of calicum nitrate for grower use in southwest Virginia.

Results and Discussion

The primary objective of this study was to find a fertilization level for vine ripened tomatoes that would increase the proportion of salable fruit as well as total yields. Preliminary or first-year studies in 1971 showed that the lower rates increased yields of marketable fruit as compared to high rates in use at that time in Southwestern Virginia. Second-and third-year studies using reduced rates showed that decreasing rates down to 1100 pounds per acre of 5-20-10 fertilizer were just as effective as rates up to 3300 pounds per acre in producing high quality tomatoes grown either on trellises or in cages. A very low incidence of blossom-end rot occurred in all plots, and is thought to be due to mulching plus use of calicum nitrate. Both practices should reduce the amount of blossom-end rot.

As shown by the data in Table 1, the medium fertilization rate produced greater yields of fruit on both trellises and cages in 1971, but the difference was not statistically valid. Also, cull fruit percentages were lowest with this treatment. The highest fertilization treatment actually produced the highest percentage of unmarketable, low-grade fruit, as shown in Table 1. A suitable balance in the uptake of nutrients at this higher level, or higher intensity of nutrients in the highest rate treatments is evidently more difficult to maintain, and could adversely affect fruit development and ripening, with higher proportions of fruit being cracked, rough-shaped, and puffy.

In 1971, the cage system produced more pounds of marketable fruit than the trellis system, as shown in Table 1, but there were no differences in 1972 and 1973. Total yields were much greater in 1971 at all treatment levels than in 1972 and 1973. The authors feel that differences in seasonal growing conditions contributed to the yield and quality differences among years. In 1971, moisture, temperatures, and amounts of sunlight were nearly ideal for optimum growth of tomatoes at Blacksburg. In 1972, a late frost on June 12 killed many plants. Replanting was accomplished but caused delayed harvests and decreased the total yields. In 1973, early season wet weather and cool temperatures appeared to depress total yields. There seems to be a possible trend in hotter weather towards more cull fruit at the high trellis fertilization rate, but not at high rates in the cage system, as shown in Table 5 and 8. This also appears true in the hotter areas of Southwest Virginia in commercial production, such as lower Scott County, as compared to cooler, higher elevation areas of Wise County.

There were significant differences in 1971 in marketable fruit yields for dates of harvest vs. treatment combinations; ie., increasing treatment rates delayed earliness of harvest and reduced pounds of marketable fruit for both caged and trellised cultural methods.

After lowering fertilizer rates by one third for second-and-third year studies, Tables 4 and 7 show no effect of fertilization rates or cultural methods of trellising vs. caging on pounds of marketable fruit for 1972 or 1973.

However, there were differences in fruit quality, which would also be significant for growers. Pounds of cull fruit increased with higher rates of fertilization in trellised tomatoes in both 1972 and 1973. This fact substantiates the observations made in Southwest Virginia for many seasons that higher fertilization levels often adversely affect fruit quality. It was also of interest to the authors to note (Tables 4 and 7) that fruit quality in cages was not adversely affected by higher fertilization levels. This fact also substantiates observations by many in Southwest Virginia in commercial tomato fields that quality of fruit under the cage system was not adversely affected by high fertilization rates.

In 1972, an increase in number of cull fruit occurred at the highest fertilization level for trellised plots, but did not hold true for 1973, as shown in Tables 5 and 8, respectively.

In 1973, under the trellis system, increasing fertilization levels appeared to increase size of fruit slightly, but not in the cage system, as shown in Table 9. Increased vegetative growth possibly contributed to greater numbers of small size fruit, as shown in Tables 2 and 3 through increased competition for light and moisture among the larger, more crowded, caged plants. The higher fertilization rate promoted extra-heavy vegetative growth, as shown in Figure 1 (1972). The heavy vegetation retarded early fruit set and delayed ripening, especially in cages, and greatly increased the pruning labor and frequency of pruning on trellises. As shown in Tables 1, 4 and 7, first significant harvests in cages were usually about 2 weeks later than first harvests from plants trellised to a single stem, for the medium and high fertilization levels. At the low fertilization level, caged fruit ripened about a week later than trellised plants. Fruit size and firmness, as measured on a Asco Firmness Meter, proved to be similar for fruit from cages and from trellises in 1971 and 1972 except that ripe fruit was measurably softer at the full fertilization rate in 1971, but not in 1972. Firmness was not measured in 1973. Only trellised fruit from the lowest fertilization level appeared slightly smaller than in other treatments, and the difference is not significant. Caged fruit from the lowest fertilization treatment was actually as large or larger than fruit from cages at higher rates.

The lowest fertilization rate produced smaller sized vines in all three seasons, on trellises and with cages, which is actually an advantage since pruning and harvesting chores are lessened when vines are not so highly vegetative. Comparative vine sizes for all three treatments are shown in Figures 1, 2 and 3; photographs were from the second year of the study (1972).

In 1972 and 1973, shoulder checking of fruit, fruit cracking, and fruit sunburn were worse on trellis fruit at the higher fertilization levels in late summer harvests as compared to the higher rates of fertilization of caged fruit, and is evidently related to more sunlight exposure or absence of protective foliage shade over the fruit or trellises. The increasing visibility of fruit on trellises promotes somewhat poorer fruit quality at all trellis fertilization rates, as shown in Tables 2, 5, and 8. At the higher elevations and cooler temperatures of western North Carolina, trellised fruit is apparently not as adversely affected by high fertilization rates and exposure to sunlight.

Harvest labor is greater in cages since seeing and removing fruit from dense, bushy plants is more difficult than picking the highly visible trellised fruit. This difficulty is even greater when picking fruit at the breaker or early pink stages for distant markets than when picking ripes from cages for local sales.

Caging eliminates the labor of trellising and tying plants and also reduces labor and expense of growing transplants. Cages reduce transplanting effort since only one-third as many plants are needed, but substitutes a high initial investment of about 50 cents per cage or 1,500 dollars per acre, plus the somewhat higher labor input for harvesting. Since cages last several years, the initial investment looks better, but is prohibitive for small, limited resource growers. Other forms of plant support are under study as substitutes for trellising or caging. A "string trellis" or "Florida weave" system of plant support using tobacco stakes and heavy baler twine seems promising and is shown in Figure 5.

SUMMARY

Fertilization of vine ripened tomatoes had not been studied in western Virginia prior to this project. Earlier recommendations were based on research results and grower experiences in western North Carolina which were obtained at cooler temperatures, high altitudes, and on different soils and, to a certain extent, on Florida results with sandy soils. The

cage system was altogether new to commercial growers. In order to obtain more information on cultural methods and fertilization rates, and thus help growers maximize production of better quality fruit, a 3-year fertilization study was conducted, using the variety Manapal, at the Horticultural Research Farm at Blacksburg and was completed in 1973.

In 1971, a randomized split, split plot design was used with fertilization rates of approximately 1/3, 2/3, and 3/3 of grower rates used in 1970 in Southwest Virginia, comparing the response of trellised and caged plants. In 1972 and 1973, with similar plot design, all rates were reduced to 2/3 of the 1971 test in order to improve probability of delineating an optimum fertilization level for our climate and soils.

In each of the 3 years, yields of marketable fruit and percentage of unmarketable fruit were statistically as good from the low fertilization rate as from higher rates. The use of 1100 pounds per acre of 5-20-10 fertilizer, plus a sidedressing level of 16.5 pounds per acre of nitrogen applied once per month, beginning at first fruit set as calcium nitrate, appears adequate for production of high quality caged or trellised vine ripened tomatoes in Southwestern Virginia on medium-fertility silt-loam soils.

In addition, vegetative growth was favorably reduced at the lower fertilization rate under both systems of culture. The percentage of cull fruit on trellises was reduced at the low fertilization rate. A trend towards slightly larger fruit was shown on trellises at the medium rate, and on cages at the lower rate, for all three years. For 2 out of 3 years (1972 and 1973) there were no differences in yields between the cage and the trellis system of culture.

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Fig. 1. Favorable reduction in vine growth is shown at lower fertilization rate of 1100 lbs. per acre 5-20-10.

Fig. 2. A reduction in vegetative growth is also shown when fertilization rate is reduced from 3300 lbs. per acre to 2200 lbs. per acre of 5-20-10.

Fig. 3. Pruning caged vines to 4-5 main stems, a once-over operation at 1st fruit set improves fruit visibility and harvest ease.

Fig. 4 Harvesting, grading, and weighing fruit from Research plots was performed weekly.

Fig. 5. String trellising, or "Florida Weave" appears promising as a low cost, labor saving alternate to trellising or caging.

Table 1. Mean Treatment Combination Effect on Pounds of Marketable and Cull Fruit, 15' Plots, 1971.

	CAGED						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/10)	0.50	0.50	0.00	0.00	0.37	0.50	13.65	2.12	13.25	2.77	11.75	7.15
D_2	5.50	0.35	9.87	1.30	3.62	1.87	18.75	4.12	14.25	3.25	12.00	4.87
D_3	9.80	1.67	25.57	6.90	5.65	3.27	16.27	7.57	16.25	8.10	6.25	7.05
D_4	17.55	6.67	34.25	16.22	15.42	8.12	13.42	6.37	18.00	6.25	6.25	4.00
D_5	34.32	10.75	43.75	15.90	36.77	16.32	16.12	5.17	17.47	4.82	15.60	6.17
D_6	32.50	12.87	30.25	20.47	33.50	24.32	17.50	6.87	16.25	8.92	12.22	8.20
D_7	22.65	19.57	22.55	18.67	25.62	28.00	6.10	10.10	6.50	12.77	6.02	9.57
D_8	7.62	16.12	6.25	12.00	7.67	19.92	4.6	11.12	2.30	10.00	4.80	9.17
D_9 (10/5)	4.62	16.87	4.12	9.67	4.00	17.12	2.05	9.75	1.30	11.17	1.97	7.62
Total	135.06[a]	85.37[b]	176.61[a]	101.13[b]	132.62[a]	120.44[b]	108.48[b]	63.19[c]	105.57[b]	68.05[c]	76.86[b]	63.80[c]
Overall Total	220.43		277.74		253.06		171.67		173.62		140.66	
Total	61	39	64	36	52	48	63	37	61	39	55	45

[a]numbers followed by the same letter are not significantly different from each other at the 5% level of probability.

Table 2. Effect of Treatment Combination on Mean Number of Marketable and Cull Fruit, 15' Plots, 1971

		CAGE						TRELLIS					
		Low		Med.		High		Low		Med.		High	
		Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1	(8/10)	4	0	0	0	6	9	140	31	123	47	127	151
D_2		48	3	81	20	35	35	174	39	132	39	108	80
D_3		83	22	207	63	55	44	143	89	139	116	57	107
D_4		153	84	304	217	150	133	125	78	157	76	67	72
D_5		354	188	506	272	435	258	158	67	171	62	177	91
D_6		375	242	363	271	401	385	111	71	161	125	124	107
D_7		267	367	284	390	307	465	61	126	54	151	67	152
D_8		87	235	73	211	93	341	41	157	18	118	50	137
D_9	(10/5)	52	281	49	211	47	307	21	145	13	156	20	114
Total		1428[a]	1422[a]	1867[a]	1655[a]	1529[a]	1977[a]	974[b]	803[b]	968[b]	880[b]	707[b]	1011[b]
Overall Total		2850		3522		3506		1777		1848		1808	
% Total		50	50	53	47	44	56	55	45	52	48	44	56

[a]Numbers followed by the same letter are not significantly different from each other at the 5% level of probability.

Table 3. Effect of Treatment Combination on Mean Size in pounds, of marketable and cull fruit, 1971.

		CAGE						TRELLIS					
		Low		Med.		High		Low		Med.		High	
		Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1	(8/10)	0.50	0.00	0.00	0.00	0.25	0.22	0.39	0.26	0.43	0.24	0.37	0.19
D_2		0.46	0.46	0.49	0.26	0.41	0.21	0.43	0.42	0.43	0.33	0.44	0.24
D_3		0.44	0.30	0.49	0.44	0.41	0.30	0.46	0.34	0.47	0.31	0.44	0.26
D_4		0.46	0.32	0.45	0.30	0.41	0.27	0.43	0.33	0.46	0.33	0.37	0.22
D_5		0.39	0.23	0.35	0.23	0.34	0.25	0.41	0.31	0.41	0.31	0.35	0.27
D_6		0.35	0.21	0.33	0.30	0.33	0.25	0.63	0.39	0.40	0.28	0.39	0.31
D_7		0.34	0.21	0.32	0.19	0.33	0.24	0.40	0.32	0.48	0.34	0.36	0.25
D_8		0.35	0.27	0.34	0.22	0.33	0.23	0.45	0.28	0.51	0.34	0.38	0.27
D_9	(10/5)	0.36	0.24	0.34	0.18	0.34	0.22	0.39	0.27	0.40	0.29	0.39	0.27
	MEAN	0.40	0.28	0.39	0.27	0.35	0.24	0.44	0.32	0.44	0.31	0.39	0.25

Table 4. Mean Treatment Combination Effect on Pounds of Marketable and Cull Fruit, 15' plots, 1972.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/17)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00
D_2	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.05	0.00	0.00	0.00	0.17
D_3	0.00	0.00	0.07	0.00	0.30	0.00	0.22	0.05	3.75	0.00	0.35	0.50
D_4	0.27	0.20	0.87	1.12	0.82	0.32	2.85	0.97	5.70	3.01	4.82	3.72
D_5	1.10	0.48	1.75	0.78	2.10	2.22	5.80	1.67	3.75	4.47	6.35	3.92
D_6	1.95	0.40	2.20	0.90	3.50	0.52	4.87	0.50	8.05	1.47	4.57	0.92
D_7	7.82	2.25	9.16	3.12	10.30	4.15	8.95	4.45	10.72	4.20	7.60	5.02
D_8	9.95	14.85	11.17	15.67	16.55	11.35	7.82	15.60	18.18	17.10	4.17	18.27
D_9 (10/17)	26.50	6.10	24.75	5.05	14.95	2.85	10.50	3.70	19.37	3.00	18.00	5.25
Total	47.59[a]	24.28[b]	49.97[a]	26.64[b]	48.52[a]	21.41[b]	41.28[a]	26.99[b]	69.52[a]	33.25[c]	45.98[a]	37.77[c]
Overall Total	71.87		76.61		69.93		68.27		102.77		83.75	
% Total	66	34	65	35	69	31	60	40	68	32	55	45

[a]Numbers followed by the same letter are not significantly different at the 5% level of probability.

NOTE: A severe frost on June 12 killed many plants; replanting was accomplished, but harvest were delayed for the 1972 season.

Table 7 Mean Treatment Combination Effect on Pounds of Marketable and Cull Fruit, 15' plots, 1973.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/9)	0.70	0.30	0.52	0.05	0.67	0.72	2.07	0.52	3.10	0.60	2.62	1.07
D_2	2.60	0.77	3.05	0.22	2.60	0.47	8.47	3.02	10.37	3.77	9.25	1.92
D_3	5.47	0.22	4.17	0.57	4.15	0.62	8.12	1.62	12.45	1.47	9.65	2.22
D_4	5.07	0.97	8.57	2.62	5.70	3.30	7.87	4.07	11.15	3.60	8.60	8.17
D_5	9.00	2.20	14.57	3.00	14.65	5.30	6.22	3.87	8.85	2.20	8.42	7.45
D_6	18.47	7.00	19.55	7.50	16.80	5.60	5.25	5.07	11.67	6.77	5.32	4.35
D_7	10.07	3.27	10.95	1.62	7.90	0.35	4.92	3.85	4.27	4.50	2.17	4.48
D_8	6.07	4.57	6.45	3.65	4.80	4.10	1.85	2.47	4.27	4.50	2.17	4.48
D_9 (10/11)	3.50	0.37	3.85	1.35	1.12	1.12	1.75	1.75	4.90	1.75	2.82	2.05
Total	60.95[a]	19.67[b]	71.68[a]	20.58[b]	60.34[a]	21.58[b]	46.52[a]	26.24[b]	72.43[a]	28.03[c]	51.65[a]	33.38[c]
Overall Total	80.62		92.26		81.92		72.76		100.46		85.03	
% Total	76	24	78	22	74	26	64	36	72	28	61	39

[a]Numbers followed by the same letter are not significantly different from each other at the 5% level of probability.

Table 5. Effect of Treatment Combination on Mean Number of Marketable and Cull Fruit, 15' plots, 1972.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/17)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
D_2	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.22	0.00	0.00	0.00	0.50
D_3	0.00	0.00	0.50	0.00	0.75	0.00	0.50	0.22	0.75	0.00	0.75	1.00
D_4	0.50	0.50	1.75	2.25	1.50	1.00	6.50	2.00	10.25	6.50	8.75	7.75
D_5	2.25	1.50	3.75	2.00	4.75	5.00	10.00	4.25	7.00	10.50	1.25	8.75
D_6	4.50	1.25	5.00	2.50	8.00	1.00	9.25	1.50	16.25	3.50	10.00	2.25
D_7	17.00	6.50	21.00	10.25	25.50	10.75	17.75	11.50	20.75	10.25	15.00	12.25
D_8	22.75	41.50	25.00	44.50	40.75	38.00	15.75	36.75	15.00	43.75	8.50	44.00
D_9 (10/17)	53.00	15.25	51.50	13.00	35.5	10.50	26.25	9.25	38.75	10.00	36.00	13.00
Total	100.00[a]	66.50[b]	108.25[a]	74.50[b]	116.75[a]	66.25[b]	86.00[a]	65.75[b]	108.75[a]	84.50[a]	90.50[a]	89.50[a]
% of Total	60	40	59	41	64	36	57	43	56	44	50	50

[a]Numbers followed by the same letter are not significantly different from each other at the 5% level of probability.

Table 6. Effect of Treatment Combination on Mean Size of Marketable and Cull Fruit, in pounds, 1972.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/17)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D_2	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.20	0.00	0.00	0.00	0.35
D_3	0.00	0.00	0.30	0.00	0.40	0.00	0.45	0.00	0.50	0.00	0.47	0.50
D_4	0.55	0.35	0.50	0.50	0.55	0.33	0.44	0.49	0.56	0.47	0.55	0.48
D_5	0.49	0.32	0.47	0.39	0.44	0.44	0.58	0.39	0.53	0.43	0.56	0.45
D_6	0.43	0.32	0.44	0.36	0.44	0.52	0.53	0.33	0.50	0.42	0.46	0.41
D_7	0.46	0.35	0.44	0.30	0.40	0.39	0.50	0.39	0.52	0.41	0.51	0.41
D_8	0.49	0.33	0.45	0.35	0.41	0.30	0.50	0.42	0.48	0.39	0.49	0.42
D_9 (10/17)	0.50	0.40	0.48	0.39	0.52	0.27	0.40	0.40	0.50	0.30	0.50	0.40
Mean	0.49	0.34	0.44	0.38	0.44	0.37	0.49	0.37	0.51	0.40	0.51	0.43

Table 8. Effect of Treatment Combination on Mean Number of Marketable and Cull Fruit, 15' plots, 1973.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1 (8/9)	2.25	1.75	2.00	0.25	2.25	4.00	5.75	3.00	8.50	2.75	6.50	4.00
D_2	6.50	3.25	7.50	0.75	6.00	2.00	18.75	9.75	21.00	11.25	18.00	5.50
D_3	11.75	1.50	9.25	2.00	8.75	2.00	17.50	4.25	24.00	3.50	16.50	4.25
D_4	10.00	3.50	17.75	5.25	12.00	8.75	16.50	10.50	20.75	7.50	15.75	16.25
D_5	16.75	5.50	29.00	8.00	40.00	11.00	12.00	8.00	14.75	4.00	13.50	12.00
D_6	36.25	22.25	41.50	23.00	33.25	16.00	10.75	12.75	19.75	12.75	9.50	8.75
D_7	24.75	10.50	27.50	6.50	19.25	1.75	10.75	9.50	10.25	7.50	6.50	3.75
D_8	14.50	14.75	15.75	10.25	11.75	11.25	5.00	5.50	9.50	10.00	4.75	8.75
D_9 (10/11)	8.75	6.50	9.50	4.50	8.25	4.50	4.50	4.75	9.25	4.00	6.75	5.50
Total	131.50[a]	69.50[b]	159.75[a]	60.50[b]	141.50[a]	61.25[b]	101.50[a]	68.00[b]	137.75[a]	63.25[b]	97.75[a]	68.75[b]
% of Total	65	35	73	27	69	31	60	40	69	31	59	41

[a]Numbers followed by the same letter are not significantly different from each other at the 5% level of probability.

Table 9. Effect of Treatment Combination on Mean Size of Marketable and Cull Fruit, in pounds, 1973.

	CAGE						TRELLIS					
	Low		Med.		High		Low		Med.		High	
	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull	Mkt.	Cull
D_1	0.28	0.17	0.26	0.26	0.30	0.18	0.36	0.17	0.38	0.22	0.42	0.27
D_2	0.40	0.24	0.41	0.30	0.43	0.24	0.45	0.31	0.49	0.34	0.51	0.35
D_3	0.47	0.15	0.45	0.30	0.47	0.31	0.46	0.38	0.52	0.42	0.58	0.52
D_4	0.51	0.28	0.48	0.50	0.48	0.38	0.48	0.39	0.54	0.46	0.55	0.50
D_5	0.54	0.40	0.50	0.37	0.49	0.48	0.52	0.48	0.60	0.55	0.62	0.62
D_6	0.51	0.31	0.47	0.33	0.51	0.35	0.48	0.40	0.59	0.53	0.56	0.50
D_7	0.41	0.31	0.40	0.25	0.41	0.20	0.46	0.41	0.55	0.45	0.43	0.45
D_8	0.42	0.31	0.41	0.36	0.41	0.36	0.37	0.45	0.45	0.45	0.46	0.51
D_9 (10/11)	0.40	0.25	0.41	0.30	0.37	0.25	0.38	0.37	0.58	0.44	0.45	0.37
Mean	0.44	0.27	0.42	0.33	0.43	0.31	0.44	0.37	0.52	0.43	0.51	0.45

Selected Statistical Data Summary by Years

A. First Year, 1971 Summary, Marketable Fruit, Pounds

Source	df	SS	MS	F
Reps	3	677.30	225.77	--
Trt. Comb.	5	2,557.67	511.53	2.26
Methods	1	1,743.08	1,743.08	7.70*
Rates	2	587.63	293.82	1.30
(MxR)	2	226.96	113.48	--
(T.C. x R)	15	3,396.25	226.42	--
Hvst. Data	8	13,021.24	1,627.66	19.25**
(DxR)	24	2,029.71	84.57	--
(DxT.C.)	40	8,703.36	217.58	3.65**
(DxM)	8	6,720.39	840.05	14.08**
(DxR)	16	1,577.23	98.58	1.65
(DxMxR)	16	405.74	25.36	--
(DxT.C x Reps)	120	7,160.63	59.67	
Total	215	37,546.16		

NOTE:

* = Significant differences were found at the 5% level of probability

** = Significant differences were found at 1% level of probability

B. Second Year, 1972 Summary, marketable fruit, pounds

Source	df	SS	MS	F
Reps	3	56.22	18.74	1.09
Trt. Comb.	5	46.88	8.40	--
Meth.	1	.94	.94	--
Rates	2	30.57	15.29	--
MxR	2	15.48	7.74	--
Trt. Comb. x R	15	258.30	17.22	
Dates	8	7,519.46	939.93	51.33**
DxR	24	439.46	18.31	--
DxT.C.	40	1,358.89	33.97	4.31**
DxM	8	680.17	85.02	10.79**
DxR	16	150.65	9.92	1.20
DxMxR	16	528.07	33.00	4.19**
DxT.C. x R	120	945.42	7.88	
Total	215	10,624.74		

NOTE: ** = significant differences were found at the 1% level of probability.

C. Third Year, 1973 Summary, Marketable Fruit, Pounds

Source	df	SS	MS	F
Reps	3	253.85	84.62	2.16
Trt. Comb.	5	240.31	48.08	1.23
Meth.	1	37.00	37.00	--
Rates	2	177.31	88.66	2.27
MxR	2	26.08	13.04	--
T.C.xR	15	586.97	39.13	
Dates	8	2,304.88	288.11	16.90**
DxR	24	409.10	17.05	--
DxTC	40	1,746.38	43.66	3.27**
DxM	8	1,541.95	192.74	14.44**
DxR	16	139.01	8.69	--
DxMxR	16	65.42	4.09	--
DxT.C.xR	120	1,601.68	13.35	
Total	215	1,143.25		

NOTE: ** = Significant differences were found at the 1% level of probability.