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TOMATO PRODUCTION IN TENNESSEE

–Cultivars
–Training
–Ripening
–Fertilization

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ABSTRACT

Cultivar, training systems, ripening and fertilization studies have been conducted on tomatoes at different locations in Tennessee. Several cultivars have produced extremely well and possess desirable characteristics of quality, fruit size, and disease resistance. Seven cultivars, Setmore, Big Seven, Supersonic B, Ramapo, Creole, Big Boy, and Sunlight, have yielded over 23 tons per acre of marketable fruit each year.

At three locations early yields of Better Boy, Setmore, and Walter were greater from a staked-pruned system of culture than from a weave-unpruned system while total marketable yields were slightly greater from the latter training system. The incidence of fruit cracking was greater from the staked-pruned system but incidence of misshappen fruit and locular scarring could not be associated with training system.

On four cultivars studied, ripening was enhanced in a stepwise manner with increasing rates of ethephon applied at the proper stage. Foliage applications of 0.4 to 0.8 pounds per acre appear most promising for accelerating ripening of stake grown tomatoes.

The yields of tomatoes on soils of medium to high fertility were not influenced by fertilizing with greater than 90, 120, and 120 pounds per acre of nitrogen, phosphorus, and potassium, respectively. These results suggest that tomatoes under Tennessee conditions may not require fertilization with high levels of these nutrients for optimum yields.

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TOMATO PRODUCTION IN TENNESSEE– CULTIVARS, TRAINING, RIPENING, FERTILIZATION

by David L. Coffey, James F. Brown, Charles A. Mullins, and Homer D. Swingle*

TOMATO CULTIVARS

Tomatoes are an important fresh market as well as home garden crop. A cultivar testing program has been an important phase of the research with this crop. One phase of the program has been to cooperate with other southern research workers in evaluating unnamed lines developed by breeders at the various experiment stations. Superior lines are named and released.

The evaluation of commercial seed company cultivars available to the growers is another phase of these trials. Some of these cultivars are a result of the seed company's breeding program and some are a product of the experiment stations. This report concerns the evaluation of named tomato cultivars that were included in the trials at the Main Experiment Station, Knoxville, during the 1972-74 period.

Procedure

Each year seeds were sown in flats between March 10-15. Seedlings were pricked to 3-inch peat pots in late March or early April. Field planting dates in 1972, 1973 and 1974 were April 20, April 30, and April 30, respectively.

Trials were on Huntington soils testing medium to high in P and K and initial fertilizers were broadcast and varied from 48-60 pounds of N per acre, 72-208 pounds of P_2O_5 per acre and 72-168 pounds of K_2O per acre. Two side dressings of 30 pounds of N per acre each were given in 1972 and 1974. One application of 30 pounds of N per acre was used in 1973.

Plots were one row 20 feet in length, replicated four times. Plants were spaced 2 feet apart in 4-foot rows. Weeds were controlled with diphenamid plus a single cultivation. University of Tennessee recommendations were followed for insect and disease control. Weekly applications of pest control materials were made throughout the growing period and control was rated good to excellent.

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Determinate (self-topping) cultivars were unpruned and supported on stakes by the Florida-weave system. Indeterminate cultivars were pruned to two stems and each plant tied to a stake.

Fruits were harvested in the pink stage usually two or three times per week. Grading was on the basis of U.S. Standards. The minimum size fruit graded marketable was 1-7/8 inches in diameter. Fruit rated marketable but not meeting Number 1 standards were those having defects such as growth cracks or catfacing. The marketable grade would usually meet local, nearby market standards, but the packinghouses would only pack a more strictly graded product such as those referred to as Number 1 grade. The main reasons for fruit failing to meet either the Number 1 or the marketable grade were small size (below 1-7/8 inches), excessive catface or locular scar (larger than 1/2 inch in diameter), or having cracks in the aggregate of more than 1 inch.

Results & Discussion

Tables 1 and 2 list cultivars tested and they are grouped by the number of years they have been in the trials during the 1972-74 period. Generally, cultivars were fairly consistent in yield from year to year. The 1972 yield was often less than in either of the other years, especially in yield of early fruits (Table 2). This was due to an excess of blossom-end rot likely resulting from a low pH soil along with great moisture fluctuation especially in the early fruiting period. Locular scars and catfacing were also more severe in 1972. In comparing yields of cultivars grown early in 1972 with those of other years, one should keep this in mind. It is interesting to note in Table 1, that of the cultivars tested all three years, Creole is the only non-hybrid in the nine top yielding cultivars. Also, the last five in marketable yield are all non-hybrids.

Percentage of the marketable yield that graded Number 1 varied with cultivars. Fewer defects were found in Creole, Floradel, Monte Carlo, and Big Seven. Traveler, a pink-skinned cultivar, and Harris OCHF—in the trials 2 and 1 years, respectively—graded very high in Number 1 fruits (Table 1).

The average size of Number 1 fruit is shown for each variety (Table 1). Different sizes are desired by different markets. Most cultivars were of sufficient size except Early Girl and Machine Harvest-1.

Earliness of fruiting is important to many growers. Yields of marketable fruit the first 2 weeks are shown in Table 2. Big Seven,

Table 1. Yield and size of marketable tomatoes at Main Experiment Station, Knoxville, 1972-74

Cultivar	1972	1973	1974	Average	No. 1 Grading	No. 1 fruit Avg. size
	Tons per acre				Percent	Oz.
In trial 3 years						
Setmore	27.22	26.09	25.46	26.26	70	6.8
Big Seven	21.16	27.25	27.84	25.42	74	8.0
Supersonic B	23.61	26.23	24.88	24.91	62	8.1
Ramapo	22.55	28.02	23.20	24.59	71	8.6
Creole	21.72	25.07	24.97	23.92	79	7.1
Big Boy	21.19	27.59	22.63	23.80	72	8.1
Sunlight	18.11	24.79	27.76	23.55	69	7.3
Monte Carlo	22.65	24.02	23.19	23.29	75	7.9
Better Boy	20.80	25.09	22.58	22.82	67	8.5
Walter	15.77	20.95	30.03	22.25	70	6.2
Floradel	19.38	23.39	23.49	22.09	78	7.4
Campbell 1327	18.67	17.65	19.40	18.57	73	7.1
Homestead 24	13.58	19.47	22.56	18.54	66	6.6
Manapal	17.89	18.76	18.31	18.32	72	7.3
In trial 2 years						
Traveler	20.78	25.19	—	22.99*	83	6.7
Early Girl	—	23.44	18.03	20.74*	63	5.4
Dessert No. 7	16.00	19.30	—	17.65*	57	10.3
Big Early	14.22	18.42	—	16.32*	51	7.4
Machine Harvest-1	14.88	15.82	—	15.35*	61	5.6
In trial 1 year						
Harris OCHF	—	—	26.10		91	7.2
Super M	20.85	—	—		52	7.6
Midsummer	18.43	—	—		44	7.5
Bradley	18.12	—	—		47	6.7
Terrific	17.57	—	—		36	7.7
Moreton	17.51	—	—		50	7.1
Jet Star	16.87	—	—		60	7.5
Late Summer	16.72	—	—		33	8.7
Climax	—	—	15.86		77	6.1
Cal Ace	15.86	—	—		30	9.2
ArKing	15.86	—	—		50	6.0
Stakeless	8.67	—	—		46	6.7
LSD @ .05	3.85	4.74	4.19		—	—

*Two-year average.

Campbell 1327, Early Girl, and Harris OCHF were earliest of the cultivars tested.

Determinate or self-topping cultivars are Setmore, Sunlight, Walter, Campbell 1327, and Homestead 24. Advantages of these are most of the fruit are borne in a relatively short period and plants occupy the ground a shorter time. Usually the first fruits to ripen are from determinate plants, but as shown in Table 2, yields of early fruits are not always greater. Stakes or means for supporting plants need not be as tall for determinate varieties.

Walter has been the outstanding cultivar in this group for shipping markets. It has very firm fruit that is usually medium size, free of cracks and rather smooth. It is not as early as others of this group. Setmore has produced high early and normal yields. Fruits are rather flat and are less firm than Walter. For local market that will accept a small to medium size fruit, Setmore appears promising. Campbell 1327 and Sunlight had less total yield but higher early yields and fruits of larger size than Setmore. One could in-

Table 2. Yield of early marketable tomatoes at Main Experiment Station, Knoxville, 1972-74 (first 2 weeks)

Cultivar	1972	1973	1974	Average
		Tons per acre		
In trial 3 years				
Big Seven	5.78	10.32	8.56	8.22
Campbell 1327	2.80	9.54	10.09	7.48
Sunlight	7.03	6.82	4.89	6.25
Supersonic B	3.81	7.94	6.51	6.09
Monte Carlo	3.66	6.89	6.79	5.78
Setmore	3.78	6.47	5.20	5.15
Better Boy	3.39	7.32	4.31	5.01
Creole	3.81	4.52	4.63	4.32
Big Boy	3.64	5.22	4.05	4.30
Walter	2.21	5.61	4.21	4.01
Homestead 24	4.48	5.17	1.97	3.87
Ramapo	2.22	5.21	3.58	3.67
Floradel	3.78	2.64	4.17	3.53
Manapal	3.57	3.54	2.34	3.15
In trial 2 years				
Early Girl	—	11.88	13.78	12.84*
Dessert No. 7	4.67	8.88	—	6.77*
Big Early	3.36	6.36	—	4.86*
Machine Harvest-1	3.45	6.15	—	4.80*
Traveler	1.14	3.37	—	2.26*
In trial 1 year				
Harris OCHF	—	—	9.28	
Climax	—	—	8.16	
Moreton	6.35	—	—	
Super M	4.95	—	—	
Jet Star	4.78	—	—	
Midsummer	4.40	—	—	
Late Summer	3.11	—	—	
Bradley	2.71	—	—	
Terrific	2.69	—	—	
ArKing	2.45	—	—	
Stakeless	.83	—	—	
Cal Ace	.03	—	—	
LSD @ .05	1.23	1.49	1.67	

*Two-year average.

crease the average fruit size with any of these determinate cultivars by pruning to a two-stem system.

All cultivars tested 3 years are resistant to fusarium wilt except Big Boy. Big Seven, Monte Carlo, and Better Boy are both wilt and nematode resistant. Big Seven was unusual in vigor—bearing large, early, as well as a great number of fruit throughout the season. Better Boy and Monte Carlo were very similar in growth habits and fruit characteristics. Both were impressive in vigor and general performance. The fruit lack firmness for distant shipping. Ramapo was another very vigorous growing cultivar and produced a high yield of very large fruit. However, its lateness woud be a disadvantage for many markets. It may well be used in home gardens and for those who desire large fruit.

Early Girl produced high yields of early tomatoes of small to medium size. Since it is wilt susceptible it has limited use. Traveler is the most impressive pink-skinned cultivar tried in several years. It had very smooth fruits, reflected in the high percentage of Number 1 fruits (Table 1). It is not early maturing.

Summary

Excellent tomato cultivars are available for meeting many needs. In choosing a cultivar one should consider plant characters, market demands, presence of nematodes or wilt, yield, earliness, and system of culture to be used.

TRAINING SYSTEMS

Training systems for tomatoes vary greatly from one growing region to another and even within production areas in Tennessee. In West Tennessee, individual tomato plants are usually tied to stakes and pruned to two stems whereas in extreme East Tennessee plants are frequently supported by trellises. Posts are set 15-20 feet apart with wires strung between the posts. Plant stems are anchored to the wires with string or plastic devices. Unpruned plants grown under this system grow very large and produce fruit over a long harvest season.

Another system being used by many growers in the Central and Eastern part of the state was introduced from Florida and is known as the Florida-weave system. With this system, plants are not individually pruned and tied as in the stake-prune system, but are supported by string that is stretched horizontally on each side of the plants, enclosing stems and foliage. String is woven between the plants and wrapped around support stakes which are placed between every second or third plant. The weaving is started

Figure 1. Many commercial growers are using the weave system to support tomatoes. Weaving, as illustrated above, is begun when plants are 12-15 inches tall and continued until plants reach their final height.

when the plants are about 14-18 inches tall and a strand is placed at 10-12 inch intervals until the plants reach their final height. Three to five strands are needed, depending on the cultivar. Growers have invented aids to speed up the weaving operation. One device often used allows the grower to control tension on the string as he weaves the string between plants and around the support stakes.

It has been well established that pruning tomato plants influences size and earliness of fruit maturity. Training systems may also influence marketable yield, length of harvest season, ease of harvesting, and certain quality factors. This study was designed to compare certain yield and quality factors of tomatoes grown under two training systems, the stake-prune and Florida-weave system.

Procedure

Tests were conducted with three important or potentially-important fresh-market cultivars described below. Better Boy is an indeterminate cultivar, which is vigorous growing, high yielding, and has recently gained acceptance with many growers in Tennes-

Figure 2. Tomato plants that have just been woven with the second strand of string. Note that the plants are supported on both sides. Tension on the string is maintained by tightly wrapping it around the support stake.

see. It matures early and produces large, attractive fruits which are desirable for local market, but not firm enough for long distance shipping. Walter, a short, determinate (self-topping) variety, is an outstanding variety for shipping markets. It produces very firm fruits that are medium size, relatively free from cracks, and unusually smooth. Setmore is a taller, determinate variety which has consistently yielded well in variety trials conducted in Tennessee. It matures early, but fruits are rather flat and less firm than Walter. For local markets that will accept small- to medium-size fruit, Setmore appears promising.

Tests were conducted in 1973 and 1974 at three locations as follows: WTES denotes West Tennessee Experiment Station, Jackson; PES denotes Plateau Experiment Station, Crossville; and KNOX denotes Main Experiment Station, Knoxville.

A split plot experimental design with four replications was used with systems comprising the main plots and cultivars the subplots. Plots at Jackson were on a Memphis silt loam soil, plots at Knoxville were on a Sequatchie loam, and plots at Crossville

were on a Hartsells sandy loam. Fertilizer was applied on the basis of soil tests at the rate recommended by the University of Tennessee for a 30-ton per acre yield. University of Tennessee recommendations were also followed for control of weed, insect, and disease pests.

Plants were greenhouse-grown in 3-inch peat pots at WTES and KNOX and in 2-1/4-inch pots at PES. Plants were set in the field the last week in April at WTES and KNOX and the third week in May at PES. In 1974 at WTES, plants were destroyed by hail May 10. Plants were set again May 27. Individual one-row plots were 3-3/4 to 4 x 20 feet. Better Boy plants were spaced 2 feet apart in the rows and Walter and Setmore plants were spaced 1-1/2 feet apart. Fruits were harvested in the pink stage two or three times per week. Grading was on the basis of U.S. Standards. The minimum size fruit graded marketable was 1-7/8 inch diameter. Percentage of fruits with various defects was determined by count at selected times during the harvest season. Average fruit weight was calculated for all fruits in the U.S. No. 1 grade throughout the harvest season. Yield data were statistically analyzed by the analysis of variance method.

Results and Discussion

The influence of cultivars and training systems on marketable yield is shown in Table 1 and Table 2. Marketable yield is comprised of U.S. Grades No. 1 and No. 2. The portion of the harvest season designated as "early" was the first three harvest weeks at WTES and KNOX and the first two harvest weeks at PES. In 1974 at WTES only the first harvest week was included since the crop ripened late and a short harvest season was anticipated. Data in Table 1 and Table 2 are pooled for cultivars and training systems in the center and lower sections, respectively. Setmore generally produced the highest early marketable yield. Table 1 shows that in four of the six tests, early yield from Setmore was significantly greater than from Better Boy or Walter. Differences in early marketable yield among cultivars were large in tests at KNOX in 1973 and 1974 and at WTES in 1973. Tests at PES in 1973 and 1974 and at WTES in 1974 matured later and differences in early marketable yield among cultivars were smaller. At KNOX early marketable yield of Walter was greater than Better Boy. In tests at PES and WTES, differences in early marketable yield were negligible between these cultivars.

Early marketable yield was significantly greater with the stake-prune system in both tests at Knoxville and from one test each at

PES and WTES. In the remaining two tests at PES and WTES, yields of early marketable fruit were larger from the stake-prune system, but differences between training systems were not statistically significant at the .05 level of probability.

Differences in total marketable yield were not large among the three cultivars and varied with location (Table 2). Setmore produced the highest yield of marketable fruit in both tests at KNOX whereas Better Boy was the highest-yielding variety at WTES. Differences in total marketable yield were not significant among cultivars in either test at PES. Yields of total marketable fruit were slightly larger at all locations with the Florida-weave system, but differences were statistically significant in only one of six tests.

Table 3 shows that the average weight of Better Boy fruits graded U.S. No. 1 was significantly larger than Walter or Setmore. Setmore usually produced fruits larger than Walter. Size of fruits in the U.S. No. 1 grade was larger from the stake-prune training system in five of the tests, four of which were statistically different.

Other fruit characteristics which affect tomato quality are presented in Table 4. The percentage of fruits with radial and/or concentric cracks in the aggregate of more than 1 inch is shown for each test in Table 4. Fruit cracking was severe at WTES and moderate at PES and KNOX. The percentage of cracked fruits was highest with Better Boy. Setmore was usually intermediate among cultivars with regard to fruit cracking. Walter fruits cracked less than either Better Boy or Setmore. The percentage of fruits with cracks was considerably higher with the stake-prune training system than with the Florida-weave system in all tests.

Data presented in Table 4 indicate that usually fewer fruits from Setmore had excessive locular scarring than Better Boy or Walter. This was most evident at KNOX in 1973 and at PES in 1973 and 1974 where excessive locular scar or catfacing was a serious problem. In the 1974 test at PES the percentage of catfaced fruits was highest from the stake-prune system. Differences in catfacing were negligible between the two training systems in other tests.

Percentages of misshapen fruits (angularity) ranged from an average of less than 5 percent in one test to about 15 percent in other tests. The number of misshapen fruits was moderately high at WTES and at PES in 1973. At WTES this appeared to be related to cultivar with Better Boy having the highest percentage of

Table 3. Yield of early marketable tomatoes from three cultivars grown under two training systems at Main Experiment Station, Knoxville, Plateau Experiment Station, Crossville, and West Tennessee Experiment Station, Jackson, 1973-74

		Early Marketable Yield—Tons Per Acre					
		KNOX		PES		WTES	
Cultivar	Training System	1973	1974	1973	1974	1973	1974
Better Boy	Staked-pruned	7.6	9.0	5.7	4.3	8.2	2.7
Setmore	" "	14.6	24.0	7.5	2.5	11.9	2.9
Walter	" "	10.7	16.1	5.3	4.7	8.0	0.9
Better Boy	Florida-weave	5.4	6.9	5.7	2.5	5.7	1.8
Setmore	" "	9.4	16.6	6.3	1.5	8.9	2.3
Walter	" "	7.9	12.4	5.5	2.2	4.8	1.1
LSD @ .05		2.2	2.8	N.S.	N.S.	N.S.	N.S.
Cultivar-Better Boy		6.5	7.9	5.7	3.4	7.0	2.2
Setmore		12.0	20.3	6.9	2.0	10.3	2.6
Walter		9.3	14.3	5.4	3.5	6.4	1.0
LSD @ .05		1.6	2.0	1.1	0.8	1.0	0.7
Training System							
Staked, Pruned		11.0	16.4	6.2	3.9	9.4	2.1
Florida-weave		7.5	12.0	5.8	2.1	6.5	1.7
LSD @ .05		1.2	3.3	N.S.	1.4	1.5	N.S.

Table 4. Yield of marketable tomatoes from three cultivars grown under two training at Main Station, Knoxville, Plateau Experiment Station, Crossville, and West Tennessee Experiment Station, Jackson, 1973-74

		Total Marketable Yield—Tons Per Acre					
		KNOX		PES		WTES	
Cultivar	Training System	1973	1974	1973	1974	1973	1974
Better Boy	Staked-pruned	26.9	22.9	11.5	13.9	25.6	28.9
Setmore	" "	29.4	34.1	11.4	9.2	18.7	21.6
Walter	" "	23.3	28.5	12.2	13.5	16.3	21.7
Better Boy	Florida-weave	28.1	28.3	17.4	14.3	25.6	25.0
Setmore	" "	29.0	32.5	19.3	13.6	22.4	28.5
Walter	" "	23.4	30.4	18.0	15.7	24.3	27.6
LSD @ .05		3.7	N.S.	N.S.	N.S.	2.3	N.S.
Cultivar							
Better Boy		27.5	25.6	14.5	14.1	25.6	26.9
Setmore		29.2	33.3	16.5	11.4	20.6	25.0
Walter		23.4	29.4	15.1	14.6	19.5	24.6
LSD @ .05		2.6	3.9	N.S.	N.S.	1.6	N.S.
Cultural System							
Staked, Pruned		26.5	28.5	12.4	12.2	20.3	24.0
Florida-weave		26.8	30.4	18.2	14.5	23.5	27.0
LSD @ .05		N.S.	N.S.	5.0	N.S.	N.S.	N.S.

Table 5. Weights of U.S. No. 1 grade tomatoes from three cultivars grown under two training systems at Main Station, Knoxville, Plateau Experiment Station, Crossville, and West Tennessee Experiment Station, Jackson, 1973-74

		Average Wt. of U.S. No. 1 Grade Fruit in Ounces					
		KNOX		PES		WTES	
Cultivar	Training System	1973	1974	1973	1974	1973	1974
Better Boy	Stakod-pruned	8.8	9.9	4.3	7.0	7.9	7.7
Setmore	" "	7.6	7.3	4.1	5.4	6.9	5.9
Walter	" "	6.4	7.0	4.0	6.1	6.6	6.1
Better Boy	Florida-weave	6.9	7.1	4.8	5.6	7.2	6.8
Setmore	" "	6.2	5.6	4.0	4.1	6.6	5.9
Walter	" "	5.7	5.4	3.9	4.6	6.3	5.6
LSD @ .05		0.6	N.S.	N.S.	N.S.	N.S.	N.S.
Cultivar							
Better Boy		7.9	8.5	4.5	6.3	7.6	7.3
Setmore		6.9	6.5	4.1	4.8	6.7	5.9
Walter		6.1	6.2	4.0	5.4	6.5	5.9
LSD @ .05		0.4	0.7	0.3	0.4	0.3	0.4
Training System							
Staked, Pruned		7.6	8.1	4.1	6.2	7.1	6.6
Florida-weave		6.3	6.0	4.2	4.8	6.7	6.1
LSD @ .05		0.2	1.0	N.S.	0.4	0.3	N.S.

Table 6. Fruit characteristics of tomatoes from three cultivars grown under two training systems at Main Station, Knoxville, Plateau Experiment Station, Crossville, and West Tennessee Experiment Station, Jackson, 1973-74

System & Cultivar	Cracked Fruits						Catfaced Fruits						Misshapen Fruits					
	KNOX		PES		WTES		KNOX		PES		WTES		KNOX		PES		WTES	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
	PERCENT																	
Stake-prune																		
Better Boy	18	5	30	40	51	63	26	11	27	35	3	4	1	2	12	4	19	23
Setmore	5	5	2	46	40	52	19	6	24	34	3	2	2	0	20	4	14	15
Walter	4	2	13	17	39	48	17	10	37	37	4	1	3	1	22	5	14	10
Florida-weave																		
Better Boy	6	1	11	20	19	46	31	6	30	31	4	2	8	2	10	0	10	13
Setmore	2	0	2	17	12	38	22	3	12	10	3	1	7	2	6	1	3	8
Walter	1	0	1	4	10	32	16	7	35	15	5	1	12	1	6	2	1	6
Cultivar response																		
Better Boy	12	3	21	30	35	55	29	8	29	33	3	3	5	2	11	2	15	18
Setmore	4	3	2	32	26	45	21	6	18	22	3	1	5	1	13	3	9	12
Walter	3	1	7	11	25	40	27	9	36	26	5	1	8	1	14	4	8	8
Training system response																		
Stake-prune	9	4	15	34	43	54	21	9	29	35	3	2	2	1	18	4	16	16
Florida-weave	3	3	5	14	14	39	23	5	26	19	4	2	9	2	7	1	5	9

misshapen fruits, whereas at PES the percentage of misshapen fruits was similar among cultivars. In all tests where the percentage of misshapen fruits was relatively high, plants grown under the Florida-weave system had fewer misshapen fruits.

Summary

The performance of three tomato cultivars, Better Boy, Setmore, and Walter, was compared under stake-prune and Florida-weave training systems. At all three locations tested, early yields were greater from the stake-prune system than they were from the weave-unpruned system. Setmore usually produced the highest early yield. Total marketable yields appeared to be influenced more by test location than by training system or cultivar, but were slightly higher from the Florida-weave system than from the stake-prune system.

Fruit cracking was more severe at WTES than at other locations. The percentage of cracked fruits was considerably higher from plants grown under the stake-prune system than from plants grown under the weave-unpruned system. Walter had fewer cracked fruits than Setmore or Better Boy. In tests where locular scarring or catfacing was serious, Setmore had fewer fruits with this defect than other cultivars. In all but one test, training system did not seem to influence locular scarring. The percentage of misshapen fruits was negligible in three of six tests. In the remaining three tests, plants grown under the Florida-weave system produced fewer misshapen fruits. At WTES, Better Boy produced more misshapen fruits than Setmore or Walter.

RESPONSE TO ETHEPHON

Applied as a foliar spray, Ethephon (2-chloroethyl phosphonic acid), is thought to accelerate the ripening of tomatoes by releasing ethylene in the plant tissue. Ethephon thus provides a convenient means of applying ethylene, a natural growth substance involved with ripening, to field-grown tomatoes. For the commercial grower who depends on hand harvesting, use of this material may provide a means of making more efficient use of labor with fewer harvests and at the same time obtaining higher early yields of ripe tomatoes.

Experiments were initiated at the Main Experiment Station, Knoxville, and the West Tennessee Experiment Station (WTES), Jackson, to study the yield response of four tomato cultivars to differing rates of ethephon application. Results of these studies conducted during 1972 and 1973 are reported here.

Procedure

Greenhouse-grown plants were transplanted in the field in mid-April at both locations. Plants, spaced 2 feet apart in the row, were staked and pruned to two stems. Tennessee recommended cultural practices were followed.

A factorial arrangement of treatments was laid out in a randomized complete block design with four replications. The four cultivars, 'Manapal,' 'Walter,' 'Bradley,' and 'Jet Star,' were treated with four levels of ethephon: 0, 0.4, 0.8, and 1.60 pounds per acre. Ethephon[1] was sprayed on the whole plants in 86 gallons of water per acre. To insure foliage wetting, a .5% by volume surfactant[2] was added. Each plot was 20 feet long and consisted of 10 plants. In all tests, ethephon was applied to the plants when about 10% of the fruits in the first cluster were at the pink stage. Harvesting was begun about 4 days after ethephon application at WTES and 7 days after ethephon application at Knoxville, respectively. All fruits which had ripened to the light red stage and beyond were harvested. Harvesting was conducted three times a week over a 5-week period. Fruits were graded according to U.S. Standards and weights were recorded.

Results and Discussion

Yields of marketable fruits by cultivars for the first week of harvest are shown in Table 7. The yields from the controls from all cultivars are considerably greater at WTES, especially in 1972. This can be expected since temperatures are considerably warmer earlier in the season at WTES than at Knoxville. Jet Star, an early-maturing cultivar, yielded the highest the first week for both test years at Knoxville and for 1 year at WTES. By comparing the yields from the controls with those from the ethephon treatments, it can be readily seen that ethephon accelerated ripening in a stepwise manner with increasing rates of application.

The early yields from all ethephon treatments were greater than those from the controls. The ripening effect of ethephon was more pronounced at WTES where the temperatures were higher than at Knoxville. The ripening of all cultivars was enhanced by ethephon. It appears that Jet Star, which is an early-maturing cultivar, responded to a greater degree than the other three cultivars. This is to be expected since at the time of application the fruits may have been nearer natural ripening than those from the later-maturing cultivars. Fruits that are mature but not yet ripe will

[1] Ethrel, Amchem Products, Inc., Ambler, Pa.

[2] Tween 20, ICN Pharmaceuticals, Inc., Cleveland, Ohio.

Table 7. Yield of early marketable tomatoes when ethephon was applied at three rates to four cultivars grown at Main Station, Knoxville, and West Tennessee Experiment Station, Jackson, 1972-1973

	Cultivar								Ethephon Mean	
	Manapal		Walter		Bradley		Jet Star			
Ethephon	Knox	WTES	Knox	WTES	Knox	WTES	Knox	WTES	Knox	WTES
Lb./A	Tons/acre									
1972										
Control	0.9	7.0	0.6	8.0	0.6	6.9	1.9	6.4	1.0	7.1
0.4	1.1	9.8	0.9	11.2	0.5	8.3	3.7	7.0	1.6	9.1
0.8	1.7	9.0	1.5	11.3	0.7	9.1	5.3	9.1	2.3	9.6
1.6	1.5	10.7	1.2	13.8	1.0	11.3	6.3	10.3	2.5	11.5
LSD @ .05									0.5	1.1
1973										
Control	2.8	1.8	3.3	3.0	2.7	2.2	6.3	4.6	3.8	2.9
0.4	3.1	1.7	4.7	3.8	4.3	2.2	6.8	4.2	5.3	3.0
0.8	5.1	2.1	4.5	4.5	5.1	2.9	9.1	5.1	5.4	3.6
1.6	7.3	2.6	5.6	5.1	8.0	3.4	8.8	6.6	7.4	4.4
LSD @ .05									0.4	0.6

respond to ethephon application. Other studies where ethephon was applied to plants when fruits were at the mature green stage have given similar results. The acceleration of ripening from Bradley, a pink fruit cultivar, appeared to be less at Knoxville in 1972 than from the other cultivars. The degree of foliage senescence that occurred, especially from the 1.6 pound per acre application, was considerably less on Bradley than on the red-fruited cultivars. This probably was due to Bradley being a later-maturing cultivar.

Ethephon accelerated the early ripening of all cultivars but it had a somewhat depressing effect on total marketable yield as is illustrated in Table 8. The yields from the 1.6 pound per acre application were reduced 4.8 tons for Knoxville in 1972 and 5.1 tons for WTES in 1973. Although not statistically different, the same trend follows for the other years and locations. The 0.4- and 0.8-pound per acre levels appear to differ little from each other in their effect on total marketable yields. The total yields for all cultivars varied somewhat between years and locations. The yields from Jet Star were higher both years at Knoxville while those from Manapal were higher both years at WTES.

The combined data for cultivars, years, and locations are graphically illustrated in Figure 3. The mean yields for the first week of harvest range from 3.7 tons per acre for the control to 6.4 tons per acre for the 1.6-pound per acre treatment. Total marketable yields range from 16.0 tons per acre for the control to 12.7 tons per acre for the 1.6 pound per acre treatment.

The mean early and total marketable yields from all cultivars receiving the 0.5 pound per acre treatment, the level which appears near the optimum for growing conditions in Tennessee, is illustrated in Figure 4. The overall early-ripening response from Walter, the determinate type, and Jet Star were about 1 ton per acre greater than those from the other two cultivars. Manapal had a slightly greater total marketable yield than the other cultivars.

Summary

Research at the University of Tennessee has shown that ethephon will accelerate the ripening of stake-grown tomatoes. This material is approved for use on tomatoes, but commercial growers should take several factors into consideration before using it in Tennessee. If there is enough of a unit price advantage for fruit ripened 7-14 days earlier than normal, then the added return would probably more than compensate for the cost of the material and any reduction in total yield which may result from ethephon usage.

Table 8. Yield of marketable tomatoes when ethephon was applied at three rates to four cultivars grown at Main Station, Knoxville, and West Tennessee Experiment Station, Jackson, 1973-73

Ethephon	Cultivar								Mean Ethephon	
	Manapal		Walter		Bradley		Jet Star			
	Knox	WTES	Knox	WTES	Knox	WTES	Knox	WTES	Knox	WTES
Lb./A	Tons/acre									
1972										
Control	18.1	22.5	14.6	17.6	16.0	17.3	19.6	15.9	17.0	18.3
0.4	13.2	22.5	12.9	18.9	13.2	17.3	12.3	16.1	12.9	18.7
0.8	16.5	20.1	12.0	18.7	11.9	16.9	12.5	15.4	13.2	17.8
1.6	11.1	18.6	13.9	17.8	13.2	15.9	10.8	14.6	12.2	16.7
LSD @ .05									1.5	NS
1973										
Control	12.0	17.2	12.2	15.0	11.0	15.0	17.9	14.4	13.3	15.4
0.4	11.1	14.5	9.8	13.9	13.6	10.0	15.3	13.6	12.5	13.1
0.8	12.1	15.5	9.3	12.3	9.5	10.8	10.1	10.6	11.6	12.3
1.6	12.7	11.5	10.1	10.3	12.3	7.8	12.6	11.6	11.9	10.3
LSD @ .05									NS	1.2

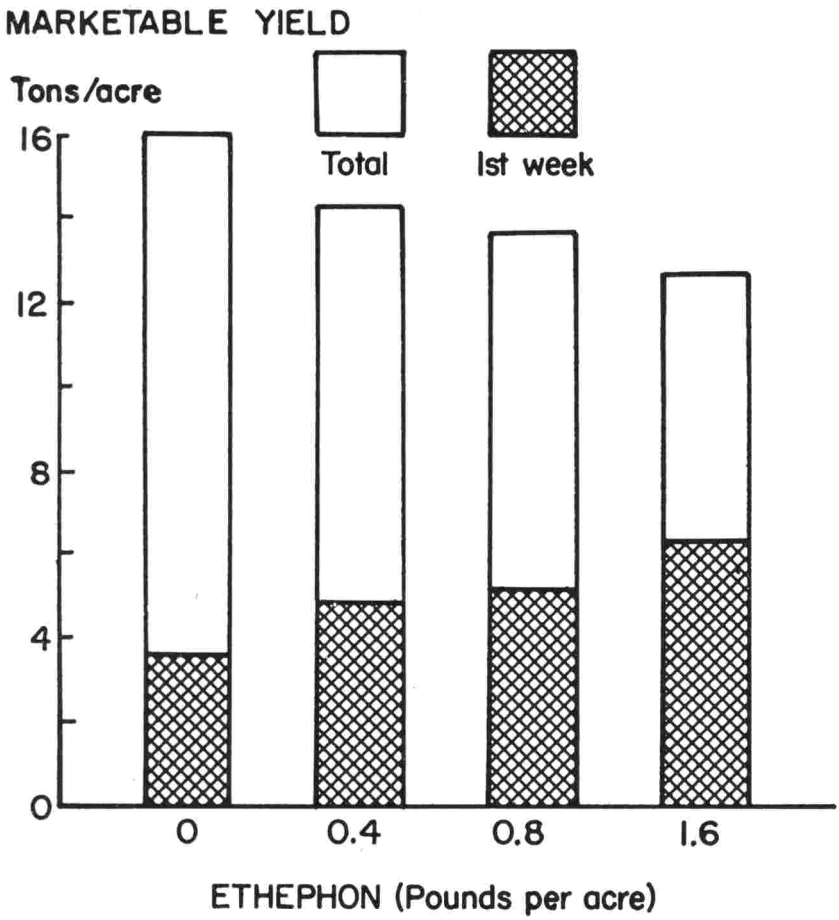

Figure 3. Mean early and total marketable yields of tomatoes treated with four levels of ethephon.

The proper rates and time of application must be adhered to as both can greatly influence the ripening response. For example, 1.6 pounds per acre applied to tomatoes in West Tennessee where high temperatures are often encountered in late June or early July when harvesting is started may result in foliage burn. Ripening fruits may then be exposed to sunscald which results in a reduction in both quality and yield. When applied too early to immature fruits, ethephon may reduce total yield substantially without significantly hastening ripening.

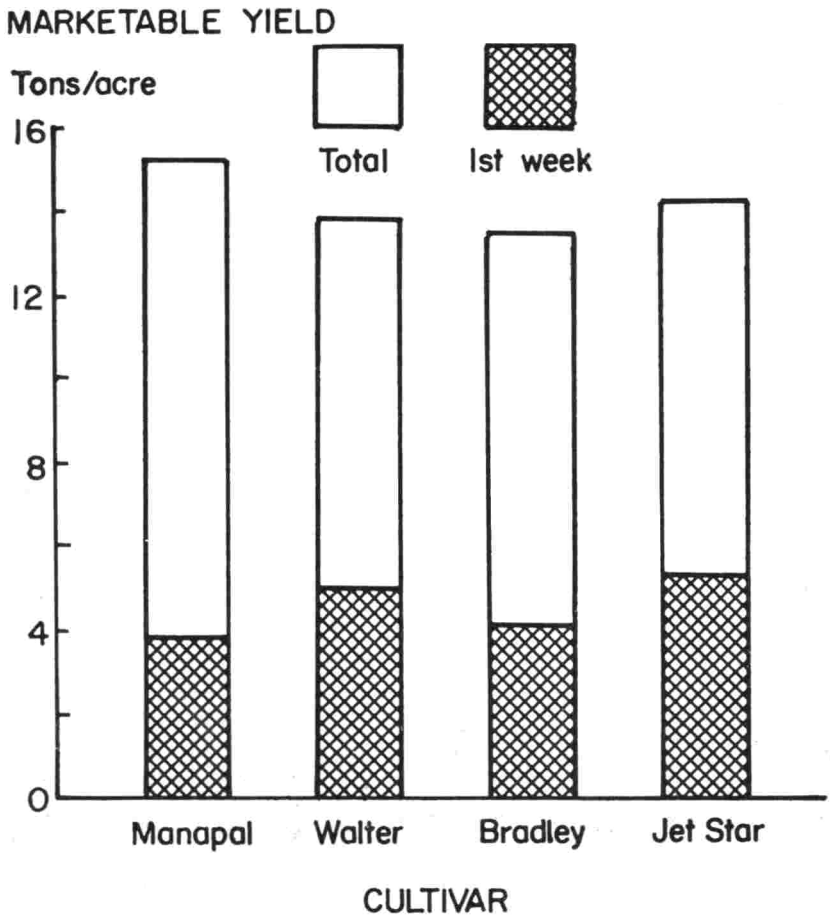

Figure 4. Mean early and total marketable yields of four tomato cultivars treated with 0.4 pound per acre of ethephon.

The cultivars being grown would have some influence on the use on ethephon. The determinate types, i.e. Walter which is grown widely in East Tennessee, have a more concentrated and somewhat later ripening habit than do some of the indeterminate types. If earliness is a primary factor, use of ethephon may be more advantageous on indeterminate than on determinate types, and on indeterminate types it may be more advantageous to use on early maturing cultivars.

Labor availability for harvesting should also be considered. With

the concentrated ripening from ethephon, there is a greater demand for harvesting labor in a shorter period of time than from normal ripening. Harvest can be scheduled a little more precisely when ethephon is used, which may enable more efficient utilization of the labor force.

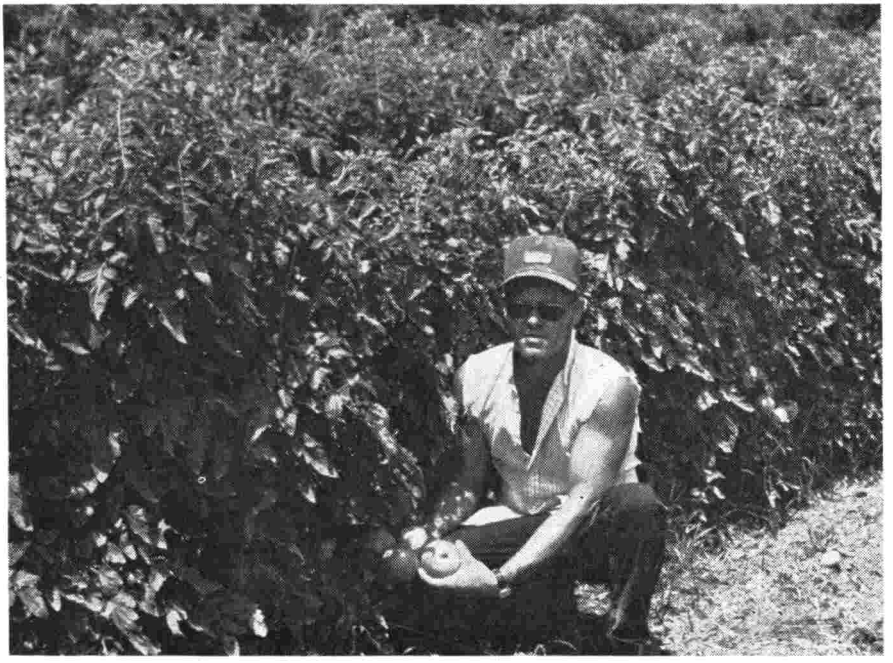

Figure 5. Good healthy plants are essential to staked tomato production. A fertilization program which provides for vigorous vine growth is necessary for optimum yields of quality fruit.

TOMATO FERTILIZATION

Tomato fertilization practices vary greatly between Tennessee and surrounding states and within production areas in Tennessee. Tomatoes are grown in several areas within the state; therefore, recommendations are based partially on location, cultural practices, fertility levels, cultivars, and harvest period. Experiments were initiated at the University of Tennessee to determine if the current recommendations for fertilization of tomatoes could be improved for maximizing yields. The results of experi-

ments conducted during 1973 and 1974 at the West Tennessee Experiment Station (WTES), Jackson, and the Plateau Experiment Station (PES), Crossville, are reported here.

Procedure

All possible combinations of three levels of nitrogen, phosphorus, and potassium were studied in a factorial arrangement in a randomized complete block design with three replications. This experiment was comprised of 27 treatments. Part of the fertilizer was broadcast at planting and the remainder was applied as sidedress applications. The schedule of applications and levels of nitrogen, phosphorus, and potassium studied are presented in Table 9. To simulate commercial conditions, soils that had been intensively

Table 9. Time and rate of application of nitrogen, phosphorus, and potassium to tomato experiments at West Tennessee Experiment Station, Jackson, and Plateau Experiment Station, Crossville, 1973-74

Fertlizer	Time of Application				Total Applied
	at Planting	Sidedress 1[a]	Sidedress 2[b]	Sidedress 3[c]	
	Pounds per acre				
Nitrogen (N)	60	30	—	—	90
	60	30	45	—	135
	60	30	45	45	180
Phosphorus (P_2O_5)	120	—	—	—	120
	240	—	—	—	240
	360	—	—	—	360
Potassium (K_2O)	120	—	—	—	120
	120	60	60	—	240
	120	80	30	80	360

[a] First fruits 1 inch in diameter.
[b] Three weeks after sidedress 1.
[c] Six weeks after sidedress 1.

cropped were selected each year at each location. The soil selected at WTES was Memphis silt loam and the soil selected at PES was Hartsells sandy loam. The reaction of the soils varied from pH 6.0 to pH 6.2. Soil tests indicated high and medium levels of phosphorus and potassium at WTES and PES, respectively.

Better Boy, a vigorous-growing and high-yielding hybrid, was selected as the test cultivar. The Florida-weave system, a cultural system where no pruning is done, was used. With this system, plants are supported by strings stretched horizontally on each side of the plants and the strings are supported by stakes placed between every two or three plants. High yields over a long har-

vest season are being obtained from this cultural system.

Greenhouse plants grown in 3-inch and 2-1/4-inch pots at WTES and PES, respectively, were transplanted in the field in late April at WTES and in late May at PES. The April planting in 1974 at WTES was destroyed by hail and was replanted on May 27. Individual plots consisted of three rows, the center was used for records. Rows were spaced 3-1/2 feet apart and plants were spaced 2 feet apart in the row. Harvesting was started when first fruits were in the mature green to pink stages and harvesting was conducted two to three times a week throughout the season. Grading was on the basis of U.S. Standard grades and fruit weights were recorded. Percentage of fruits with defects was also recorded.

Results and Discussion

Early marketable yields for both years at WTES and PES are shown in Table 10. These values, except those for 1974 at WTES, are for the first half (3 weeks) of the harvest season. The values for the 1974 WTES experiment are only for the first week of harvest; therefore, yields would naturally be lower than those from 3 weeks of harvest. Since no significant treatment effects or interactions were found, yield data from all treatment combinations are not reported in this paper. The values in Table 10 are means for the three levels of each nutrient. Each value is a mean of all treatments where that particular nutrient and level appeared. For example, yields for nitrogen at 90 pounds per acre is a mean for all nine treatments where nitrogen at 90 pounds per acre appeared in the treatment. Presentation in this manner is to illustrate trends which may be present with the various nutrients and rates on tomato yields.

The total marketable yields for both years at both locations are presented in Table 11. As can be seen from these data, total marketable yields of tomatoes grown on these medium and high testing soils differed little with additional rates of nitrogen, phosphorus, and potassium above the basic levels of 90-120-120 pounds per acre, respectively. In fact, yields seemed to have been depressed somewhat by the high rate of nitrogen, especially in 1973. Quality factors of fruit size, shape, cracking, and locular scarring were not influenced significantly by fertilizer treatments.

The cultivar and cultural system used in this experiment probably requires more fertilization than some other systems where heavy pruning and shorter harvest periods are followed.

Table 10. Yield of early marketable tomatoes fertilized with three levels of nitrogen, phosphorus, and potassium at West Tennessee Experiment Station, and Plateau Experiment Station, Crossville, 1973-74. [1]

Nutrient	Rate	WTES		PES	
		1973	1974	1973	1974
	Lb./A	Tons per acre			
Nitrogen (N)	90	16.3	3.9	9.6	12.1
	135	17.0	3.9	10.0	12.3
	180	15.1	4.0	9.0	12.2
Phosphorus (P_2O_5)	120	15.0	4.4	9.1	12.3
	240	16.9	3.7	9.8	12.8
	360	16.7	3.7	9.8	11.5
Potassium (K_2O)	120	16.2	3.8	9.5	12.4
	240	16.9	4.1	10.0	12.0
	360	15.4	3.9	9.3	12.3

[1] Each value is the mean for all treatments where a particular nutrient and level appeared in the experiment.

Summary

Soils that are relatively fertile, inherently or from intensive cropping and heavy fertilization, may require little additional fertilizer to produce high yields of tomatoes for any 1 year. More tests are needed to determine what levels of fertilization are needed to maintain high yields of tomatoes over a longer period of time.

These results do not substantiate the recommendation for more than 90 pounds of nitrogen and 120 pounds each of phosphorus and potassium. Therefore, it appears that careful consideration of soil tests and production practices should be made before extremely high rates of fertilizer are applied to stake-grown tomatoes under Tennessee conditions.

Table 11. Yield of marketable tomatoes fertilized with three levels of nitrogen, phosphorus, and potassium at West Tennessee Experiment Station, Jackson, and Plateau Experiment Station, Crossville, 1973-74. [1]

Nutrient	Rate	WTES		PES	
		1973	1974	1973	1974
	Lb./A	Tons per acre			
Nitrogen (N)	90	30.6	22.9	15.0	22.2
	135	30.9	23.8	16.0	21.4
	180	26.3	23.4	14.2	21.8
Phosphorus (P_2O_5)	120	28.9	23.5	14.8	21.8
	240	29.8	23.5	15.3	22.6
	360	29.1	23.2	15.3	21.0
Potassium (K_2O)	120	30.1	22.8	14.3	21.9
	240	28.5	23.7	15.7	22.1
	360	29.2	23.7	15.3	21.3

[1] Each value is the mean for all treatments where a particular nutrient and level appeared in the experiment.