3-1-1944

Tomato production in Mississippi

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BULLETIN 399 MARCH 1944

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War-time tomato pickers harvesting the fall crop.

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AGRICULTURAL EXPERIMENT STATION
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Summary and Recommendations

1. The tomato may be grown in many types of soil, but must have good drainage for early production.

2. A complete fertilizer, such as 5-10-5 or 4-8-4, is recommended for most of the hill soils of the State. An application of 1000 to 1200 pounds per acre of the complete fertilizer before planting, plus 150 or 200 pounds of nitrate of soda or its equivalent as a side dressing at blooming time, is needed for a great many of the soils in the State.

3. Strong stocky plants with partial hardening are highly desirable for the early crop. These are produced in pots or cold frames after being started in hot beds.

4. Plants for the early tomato crop are set in the field just as soon as it appears that the danger of frost is over. It is better to set them in a settled seedbed.

5. Fall tomatoes should be set in the field in central Mississippi during the first half of July.

6. Close spacings for pruned and staked tomatoes produce higher total yields and much higher early yields. If pruned to one stem, they should be spaced 18 inches or closer in the row.

7. Two stems per plant are more profitable in Mississippi than one stem per plant, and they should be spaced from 18 to 24 inches in the row when pruned to two stems and staked.

8. Fall tomatoes usually do better if left on the ground than if pruned and staked. They can stand the hot dry weather better on the ground.

9. Scarlet Dawn is a good early smooth variety, but it is not resistant to fusarium wilt. However, it can be grown successfully if a long-time rotation system is practiced.

10. Stokesdale, Rutgers, and Marglobe are fairly good varieties that are partially resistant to fusarium wilt.

11. Pan America is a new variety that is highly resistant to fusarium wilt; it has good eating quality, but the yield on wilt-free soil has not been as high as those mentioned above.

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Tomato Production in Mississippi

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Tomatoes have been grown for the fresh market in this State for almost half a century and have become an important truck crop in Copiah and adjacent counties. The tomato fruits in this area have been harvested in the green mature stage for shipment to the northern markets. They were usually allowed to partially ripen in the cars before being unloaded, but more recently the trend has been toward harvesting in the pink stage and unloading immediately after arrival at the terminals. Some tomatoes have been grown in other parts of the State for local fresh markets, and they are grown throughout the State for home consumption. In recent years, a limited acreage of canning tomatoes has been grown in the southern part of the State.

Tomato plantings have been made on many kinds of soil, and some of these were not properly drained for early tomatoes. Many plantings have been made on poor hill soils which were too low in organic matter and nutrients for profitable tomato production, and some commercial growers make the mistake of not growing cover crops to supply this badly needed organic matter.

Fertilization has varied from no fertilizer to more than a ton of complete fertilizer per acre, and in some cases the grower did not realize enough income from the crop to pay for the fertilizer.

In many instances weak and spindling plants have been set, which would not be expected to produce good yields, and in other instances the plants were set too late for the greatest profits. Sometimes plants improperly set fail to grow normally.

*Editor's note: Mr. Farish was formerly associate horticulturist for the Mississippi Agricultural Experiment Station, and conducted the experiments herein reported from State College.

Practically all the tomatoes grown in the Copiah County area for shipment to distant markets have been pruned to a single stem and staked; and, previous to 1940, the tops were pinched out above the third cluster in many of the plantings. In some instances pruning and staking of tomato plants have been practiced when grown for home use and for the local market, while in other instances the plants were allowed to sprawl on the ground. Planting distances of the pruned and staked plants have varied in the row from 24 to 36 inches.

A number of tomato varieties have been grown in this State in past years. Some of these varieties were not adapted to the soil and climatic conditions where grown, which resulted in great losses to the growers.

Disease and insect pests are oftentimes not kept under control, and complete crop failures have often been the result.

It is the purpose of this bulletin to discuss the various practices in tomato culture which have led to successful production on experimental fields located in three sections of Mississippi.

Soil Management, Preparation, and Fertilization

Tomatoes are grown on many soil types but are quite sensitive to soil drainage. They cannot stand a poorly drained or "water-logged" soil, and the proper drainage must be given before planting the crop. The tomato plant is not very sensitive to soil reaction, but benefits from liming have been reported where the soil is very acid and deficient in calcium and magnesium. If lime is used, it is usually better to apply it before planting a winter cover crop in the fall and let the tomatoes follow the cover crop. Silt, silt loam, and sandy loam

soils are considered more desirable for tomatoes than light sandy or heavy clay soils.

Most soils in this State are deficient in organic matter, indicating the need for a cropping system which will add organic matter to such soils before planting them to tomatoes. When available, manure is a good source of organic matter; but, if it is not available, some kind of green manure crop should be grown previous to the tomato crop. Sometimes it is more convenient to grow a summer cover crop, while at other times an early winter cover crop fits better into the cropping system. The objection to planting vetch or winter peas or other fall-planted legumes as a cover crop is that they usually do not produce sufficient growth before turning is necessary in preparation for an early tomato crop. Cutworms are also apt to give trouble if tomato plants are set immediately after plowing under a winter legume.

A practice which has proven satisfactory among some growers in the trucking area is to plow under either manure or summer legume cover crop and broadcast either oats or rye before bedding the land in the early fall. The oats or rye help to prevent soil erosion during the rainy winter months. Then 1000 to 1200 pounds of a complete fertilizer (such as 4-8-4 or 5-10-5) is applied per acre in the drill before rebedding the land in preparation for setting the early crop of tomatoes. The fertilizer should be placed rather deep and several inches to the side of the row's center, where the plants are to be set. Roots of the young plants should not be placed in direct contact with heavy applications of complete fertilizers. A side dressing of 150 or 200 pounds per acre of nitrate of soda, or its equivalent, is made about the time the plants are blooming. Some sections, such as the Delta, do not need the above specified amounts of fertilizer applied for tomatoes.

Plant Production

Securing strong stocky plants that are ready to be set in the field at the proper time is a most important factor in early tomato production. The type of plants does not seem to be so important for the fall crop, provided they survive the transplanting; but this is extremely important for the early crop. If long tender hotbed plants, which have been crowded in the bed and have had no hardening, are set in the field in the early spring, the shock seems to be so great that many of them never produce a good yield of early fruits.

Crist (1) reported from Michigan that for greenhouse conditions, hardening the plants before setting did not give any beneficial results in the total or early yield of marketable tomato fruits; and Porter (7) of Connecticut reported somewhat similar results for field tomatoes under Connecticut conditions. However, potted plants were used in both these experiments, and the conditions under which they were grown were different from those usually experienced by most growers of early tomatoes in Mississippi. Bare-rooted plants, taken directly from the hotbed or greenhouse and set in the field, have not given satisfactory results for the early tomato crop at Mississippi State College. Notes taken from the planting of such plants over a period of several years at State College indicate that a high percent of mortality, or badly stunted plants, can be expected from the early spring setting of them in this locality.

When tender, bare-rooted hotbed plants were set out in the spring adjacent to slightly hardened potted plants of similar height, the time of fruit setting of the hotbed plants at State College has been from 2 to 3 weeks later than the potted ones. Plants grown in the cold frame, after being started in the hotbed, usually set fruit about 10 to 15 days earlier than succulent hotbed plants of the same height at time of setting. The

one transplanting from the hotbed to cold frame or pots seems to be beneficial for later field setting due partially to root branching.

If tomatoes are grown for the early crop and a premium is paid for earliness, if often pays to pot the plants before time for field setting; but, if potting is not practiced, it usually pays to transfer the early plants from the hotbed to the cold frame before setting them in the field. Plants which are grown for the later crop may be seeded directly in the cold frame, but they must not be crowded in the bed if good stocky plants are to be produced.

The beginner in commercial tomato production will naturally want to know how many seed and how much hotbed and cold frame space to allow for each acre of tomatoes to be grown. If the plants are to be set 2 feet apart in the row, and the rows are to be 4 feet wide, it will require approximately 1½ ounces of seed and about 30 to 36 square feet of hotbed space (or two hotbed sashes) for each acre of tomatoes grown. This will require a cold frame 11 by 60 feet to grow the plants for an acre if the plants are set 4 by 4 inches in the cold frame. If the plants are set less than 2 feet apart in the row, perhaps 18 or 20 inches, which recent studies indicate are satisfactory planting distances, about 2 ounces of seed will need to be planted. The 2 ounces of seed can be planted under the two hotbed sashes, and the young plants can be set in the same cold frame by setting them 3 by 4 inches apart.

If the plants are to be potted instead of transferring them to the cold frame 6,000 pots will be required when the plants are set 2 by 4 feet in the field and 8,000 pots will be required if the plants are set 1½ by 4 feet. This will allow some extra plants to permit culling out of the poorer ones.

The seed may be sown broadcast or planted in rows 3 or 4 inches apart; but in either case the bed should be thoroughly watered before planting, and the seed covered lightly with sand or loose soil. It is usually better not to water the bed again until the seed begin to germinate, unless the bed begins to dry out too rapidly, and then water should be applied only in the forenoon of sunny days. Plants should be kept as dry as possible at night and on cloudy days. This helps to keep down diseases of seedlings.

Plants grown for the early market should be started in the hotbeds the latter part of January in central Mississippi and transferred to the cold frame or pots about the time the permanent leaves are beginning to develop, which is usually about 5 or 6 weeks after planting. They are then ready to be set in the field as soon as most of the danger of frost is over, which is usually about the first of April.

If the plants are grown for the late summer or fall crop, they can be planted directly in the cold frame about 6 weeks before time for setting in the field; but the seeds must not be planted as thickly if the plants are to be left in the bed until ready to set in the field. However, if the plants are to be potted, they may be planted thickly in the bed as for the early crop.

Time and Method of Setting Plants

Most commercial tomatoes in this State are produced for the early fresh market, and earliness is a most important factor. Therefore, the grower tries to have good stocky plants 8 or 10 inches high ready to set in the field as early in the spring as the danger of frost is over. This is usually the last week in March or first week in April through the central part of Mississippi. During some years tomatoes are set in the Copiah County area the third week in March, but more often they are set the fourth week in March and sometimes not until April. It is usually not safe to set tomato plants in the field north

of Meridian and Jackson before late March or early April unless some kind of protection is given.

If "hot kaps" or some other plant protectors are used on a small number of plants, they may be set in the field a week or 10 days earlier. The "hot kaps" need to be used only on frosty or cool nights. If a late frost occurs after the plants are set, they may be covered with some other material if "hot kaps" are not available. Straw or leaves are sometimes used on a small scale. Commercial growers often cover the plants with soil; this is fairly satisfactory if the soil is not wet, but the covering and uncovering with wet soil often does more damage than a light frost would do to the plants. If wet or moist soil is used to cover the plants, they should not be uncovered until 3 or 4 o'clock in the afternoon, because when uncovered from moist soil in the forenoon, the midday sun is apt to kill a high percentage of the plants.

Fall tomatoes should be set in the field in central Mississippi about the first week in July. Some years, especially when rains occur frequently during the summer months, the plants set in the field earlier than July 1 become badly infected with leafspot, and the yield is greatly reduced. Plants set at State College after July 1 have not been damaged badly with this disease, especially if dipped before transplanting in a rather strong suspension of Yellow Cuprocide or some other "fixed" copper compound. Dipping the plants in a copper solution disinfects the leaves and stems, protecting the plants against leafspot until they become established in the field. The plants may be sprayed or dusted after being transplanted, but it is difficult and expensive to cover the foliage thoroughly by this method, while the dipping is an inexpensive method of application.

Plants set at State College as late as August 1 usually are killed by frost in the fall before maturing a high percentage of their fruits, and some years when an early frost occurs they are caught before maturing any of their fruits. This happened in 1943. Therefore, the first week in July appears to be the best transplanting date for fall tomatoes at State College and perhaps for most of the central part of the State. This would suggest a little earlier planting date for the northern part of the State, and perhaps later for the southern part.

A number of methods may be used in setting tomatoes, but the majority of commercial tomatoes grown in this State are set with hand trowels in bedded rows. The row should be prepared 10 or 15 days prior to planting time and preferably should be settled by a rain before setting the plants. Then, it is desirable to harrow the row at planting time and open it with some kind of small plow that will loosen the center of the bed to make transplanting easier, and at the same time will not make a deep furrow in the center of the row. A small shovel or "bull tongue" on a plow stock may be used, but some growers remove the moldboard from a small turn plow and use it with only the share.

Plants set early in the spring in a firm seedbed that has been thoroughly prepared seldom require watering. But if the weather is dry and warm and no rains occur after preparing the land, it may be necessary to water the plants even in the early spring. In all cases where the plants are watered, care must be taken not to pour water on the foliage because it is apt to wash the leaves into the soil, which usually results in death if the plant is exposed to the bright sun with mud on its leaves. Many of the leading growers make a practice of "muddying" the roots of bare-rooted plants immediately before setting them. This practice helps to supply the newly set plants with moisture until new roots can be formed. However, where this practice of "muddying" the roots is done, the operator must be careful not to get mud on the leaves, for the reason given above.

If potted plants or blocked plants (those taken with blocks of soil from the cold frame) are used, they seldom require watering early in the season, and often do not require watering later in the season. Bare-rooted plants, however, often require watering when set in warm weather even if the soil is moist; and they usually require watering when set in dry soil or loose soil regardless of the temperature.

When late tomatoes are grown in a loose sandy or sandy loam soil, it is preferable to set them deeply. This is especially true if the plants have long shanks and will lend themselves to deep transplanting in the late spring or summer season. Plants seem to stand the drought better if set deep, especially in a loose soil. If the soil is a heavy clay, deep transplanting is not recommended; the lower part of the stem does not develop roots freely in such soil, especially if heavy rains occur shortly after transplanting.

Spacing and Pruning

Severe pruning to one stem per plant and topping above the third cluster has been practiced in the Copiah County area for a number of years. This severe pruning was believed by the growers in that area to increase the early yields, but previous studies made by the U.S.D.A. Bureau of Plant Industry in cooperation with the Mississippi Experiment Station (4) indicated that this was not true. In these studies, plants pruned to one stem did not mature fruits earlier than those pruned to two stems, nor did topping the plants increase earliness.

It was observed during these earlier studies that topping at the third cluster greatly shortened the life of the plant; this was due principally to leaf diseases which killed the bottom leaves, and where the top leaves had been removed by topping there remained few or no leaves to support the plant. These leaf diseases start on the bottom leaves and work upward, killing most of the leaves as they go. The diseases work faster during rainy or moist weather, and sometimes kill the leaves below the third cluster before fruits on that cluster mature. If the plant is topped at the third cluster, the fruits on that cluster are picked from partially dead plants, resulting in poor quality fruit. When the fruits are exposed directly to the hot sun on such plants, a high percentage of them are damaged from "sunscald" and the grower is docked on quality as well as quantity.

If the tops are allowed to grow, however, new green leaves are continually being formed which function to help mature the fruits on the lower clusters. The growing top also gives some sun protection to the fruits; and if two stems are left instead of one, much more protection is provided. Tomato growers in certain areas practice staking the plants without pruning, and some of the home gardeners of this State make this practice.

Investigations have been conducted in other states on the pruning and staking of tomatoes and on the spacing of tomato plants. Some of the spacing work was done with unpruned and unstaked tomatoes and some with pruned and staked plants. Yields of pruned and staked tomatoes have been compared with yields of unpruned and unstaked plants, but in most cases only the total marketable fruits were reported and earliness was not given consideration. Earliness is a most important factor in commercial tomato production in this State, and was given due consideration in the studies herein reported.

Tomato Investigations

In 1939, investigations were initiated at State College and at the Truck Crops Branch Station at Crystal Springs to study the effect of spacing and pruning on the quality, earliness, and total yield of marketable fruit. This work was extended to the Delta Branch Station in 1942, and was continued at all three locations through 1943. However, the experiment

Figure 2. The Rutgers variety pruned to a single stem.

failed at Crystal Springs in 1942 and was ruined with nematodes at the Delta Station in 1943, so that this report includes 4 years of study at Crystal Springs, 1 year at Stoneville, and 5 years at State College.

The spacings studied were 12, 18, 24, and 30 inches between plants in the row, and plants pruned to one stem and staked for each of these spacings. In addition to these treatments, there was one with unpruned staked plants spaced 30 inches in the row, and another with staked plants pruned to two stems and spaced 24 inches in the row. The rows were 48 inches wide.

In 1941, a treatment of pruning to two stems and spacing 18 inches in the row was added to the State College test. Each treatment was repeated five times (occurring a total of six times) in each experiment, the plot arrangement being such that variability due to soil differences was reduced.

18-inch to 24-inch Spacing

Table 1 shows the total yields per acre of marketable fruit for each treatment for each of the 4 years at Crystal Springs and the treatment averages for these years. This table shows that on the average, there was an increased production per acre when the number of plants was increased as spacings were decreased. The differences between spacings for each of the 4 years were significant in practically all cases. The 12-inch spacing did not produce greater yields of total marketable fruit in 1939 than the 18-inch spacing with one stem, but did during each of the other 3 years. Data for the 4-year average show that greater yields of total marketable fruit were produced from the 12-inch spacing than from any of the wider spacings of one stem. Yields were increased as the number of plants per acre was increased, provided the

Figure 3. The Rutgers variety pruned to two stems (note the good protection of foliage on this plant).

plants were pruned to one stem and staked.

One or Two Stems Per Plant

The treatment with two stems per plant and 24-inch spacing produced consistently higher total yields of marketable fruit each of the 4 years than plants of one stem having the same spacing. Data of the 4-year average indicate that two stems are better than one stem at Crystal Springs. The data show that the treatment with unpruned but staked plants and 30-inch spacing yielded about as much total marketable fruit as the 24-inch spacing with two stems. However, the early harvests from the unpruned plants (as shown in table 3 from State College), was greatly reduced.

Table 2 shows the total yields of marketable fruit for each of the treatments and for each year from 1939 through 1943 at State College. It also shows the 5-year average for certain treatments and the 3-year average for all treatments. These results at State College follow the same trend as those described above for Crystal Springs. The closer spaced plants produced higher total yields of marketable fruit than wider spaced plants when pruned to one stem and staked.

Table 3 shows the early yields (first half of the pickings) at State College for each treatment by years and averages for all years. These data show that the early yields were also increased as the plants per acre were increased when pruned to a single stem. This table likewise shows that two stems were superior to one stem in the production of early fruits. This was true with both the 18-inch and the 24-inch spacings when each was compared with the single stems of the respective spacings. In other words, at each location two stems were better than one

Table 1. Effect of spacing and pruning on total yield (pounds per acre) of marketable tomatoes, Crystal Springs, 1939-1943.

Treatment	1939	1940	1941	1943	Average
12-inch (1 stem)	6,744	7,921	14,095	14,141	10,725
18-inch (1 stem)	6,953	6,102	10,227	11,730	8,753
24-inch (1 stem)	6,350	5,645	9,892	9,908	7,948
24-inch (2 stems)	7,600	6,793	10,222	11,962	9,144
30-inch (1 stem)	4,340	5,209	8,520	8,517	6,646
30-inch (no pruning)	7,699	5,542	11,795	11,140	9,044

Table 2. Effect of spacing and pruning on total yields (pounds per acre) of marketable tomatoes, State College, 1939-1943.

Treatment	1939	1940	1941	1942	1943	5-year average	3-year. av. (1941-43)
12-inch (1 stem)	22,072	9,345	9,574	28,165	13,368	16,505	17,035
18-inch (1 stem)	21,188	9,759	9,732	22,022	11,772	14,895	14,509
18-inch (2 stems)	——	——	9,754	29,242	15,844	——	18,280
24-inch (1 stem)	16,571	10,338	10,151	21,147	10,835	13,808	14,044
24-inch (2 stems)	20,125	11,097	9,354	25,535	14,472	16,116	16,454
30-inch (1 stem)	12,835	10,055	9,029	16,312	9,227	11,491	11,523
30-inch (no pruning)	15,601	9,717	8,767	30,607	12,210	15,380	17,195

Table 3. Effect of spacing and pruning on early yields (pounds per acre) of marketable tomatoes. State College, 1939-1943.

Treatment	1939	1940	1941	1942	1943	5-year average	3-year. av. (1941-43)
12-inch (1 stem)	13,525	5,154	5,449	11,350	6,265	8,348	7,689
18-inch (1 stem)	12,287	6,612	5,600	8,482	5,525	7,701	6,536
18-inch (2 stems)	——	——	4,745	9,072	7,131	——	6,983
24-inch (1 stem)	10,885	5,540	5,247	6,657	5,709	6,808	5,871
24-inch (2 stems)	10,087	6,257	4,721	7,540	6,404	7,002	6,333
30-inch (1 stem)	7,998	3,225	4,164	5,462	4,583	5,086	4,770
30-inch (no pruning)	7,360	5,031	4,001	3,652	4,260	4,861	3,971

stem, when spaced either 18 or 24 inches, in the production of both early and total marketable fruit.

No Pruning

The treatment with no pruning produced higher total yields than that with one stem and the same spacing (30 inches); and it also produced greater total yields of marketable fruit than some of the closer spaced pruned plants, but the early yields were reduced by this treatment (table 3), and it is not recommended in localities where earliness is of major importance.

Results of 1 year's study (1942) at the Delta Station show the same trend for the different treatments as results at the other two locations. Yields of the total marketable fruits for these treatments at this Station are as follows:

12-inch spacing (1 stem)	3,210 lbs.
18-inch spacing (1 stem)	1,750 lbs.
18-inch spacing (2 stems)	2,105 lbs.
24-inch spacing (1 stem)	1,213 lbs.
24-inch spacing (2 stems)	1,858 lbs.
30-inch spacing (1 stem)	1,170 lbs.
30-inch spacing (no pruning)	1,820 lbs.

Table 4 gives the cost per acre of production and marketing for each of the different treatments. These figures (taken from the cost levels at Crystal Springs in 1943) are based on $2 per day for labor, $2 per thousand for plants, $1 per thousand per year for stakes, and $2.30 per ton for harvesting and marketing the crop.

Profit from Various Treatments

Table 5 shows the 3-year average yields of the different treatments at State College. The yields were divided into early and late yields and each valued at the 3-year average price paid growers in Copiah County for the same period. These figures on prices were obtained from a buyer and shipper in 1934 and from a producer in 1941 and 1942 and are thought to be representative. The profits, or net income, listed in the last column of this table show that the treatment with 18-inch spacing and two stems would be most profitable under these cost and price conditions, and that the 24-inch spacing with two stems would be the next most profitable.

In table 6, the average yields of 1942 and 1943 are shown by weeks for each treatment, and the value of each week's harvest is based on the price paid for tomatoes by a Copiah County shipper during each of those weeks. The net income under these conditions for each treatment is shown in the last column of this table. The 18-inch spacing with two stems shows the highest profits, and 24-inch spacing with two stems the next highest, under these conditions, and the single stems with the wider spacings show the least profits. These latter treatments have been the ones used by a large number of growers in Copiah County in past years, and this has resulted in a great loss to the growers.

Table 4. Total cost of producing and harvesting an acre of tomatoes, Crystal Springs, 1943.

Treatment	Fixed cost[1/]	Cost of plants	Cost of setting	Pruning and staking	Cost of stakes	Cost of harvest	Total cost
12-inch (1 stem)	$47.00	$22.00	$6.00	$31.00	$6.00	$19.61	$131.61
18-inch (1 stem)	47.00	15.00	4.00	21.00	4.00	16.69	107.69
18-inch (2 stems)	47.00	15.00	4.00	21.00	4.00	21.02	112.02
24-inch (1 stem)	47.00	11.00	3.00	15.00	3.00	16.15	95.15
24-inch (2 stems)	47.00	11.00	3.00	15.00	3.00	18.92	97.92
30-inch (1 stem)	47.00	9.00	2.50	12.00	2.50	13.25	86.25
30-inch (no pruning)	47.00	9.00	2.50	9.00	2.50	19.78	88.78

1/The "fixed" costs include fertilizer, $27; land preparation, $4; three cultivations, $6; land rent and other incidentals, $10.

Table 5. Comparison of early and late yields in tons per acre and seasonal values for each treatment and computed profits.

Treatment	Early yield tons	Price received 1/	Late yield tons	Price received 2/	Gross income	Total cost	Net income
12-inch (1 stem)	3.845	$228.51	4.683	$167.23	$395.74	$131.61	$264.13
18-inch (1 stem)	3.268	194.22	3.987	142.38	336.60	107.69	228.91
18-inch (2 stems)	3.492	207.53	5.645	201.59	409.12	112.02	297.10
24-inch (1 stem)	2.936	174.49	4.086	145.91	320.40	95.15	225.25
24-inch (2 stems)	3.167	188.21	5.060	180.69	368.90	97.92	270.98
30-inch (1 stem)	2.385	141.74	3.377	120.59	262.33	86.25	176.08
30-inch (no pruning)	1.986	118.03	6.612	236.11	354.14	88.78	265.36

1/Prices of the early harvests were figured at $59.43 per ton.
2/Prices of the late harvests were figured at $35.71 per ton.

Table 6. Yield of marketable tomatoes by weeks at State College for 1942-1943 and profits computed accordingly.

Treatment	1st week		2d week		3d week		4th week		5th week		Gross income	Total cost	Net income
	tons	value	tons	value	tons	value	tons	value	tons	value			
12-inch (1 stem)	1.609	$151.81	2.171	$204.20	2.635	$205.66	1.650	$113.69	2.221	$ 74.94	$750.30	$131.61	$618.69
18-inch (1 stem)	1.132	106.80	2.142	201.48	1.516	118.32	1.800	124.02	2.377	80.20	630.82	107.69	523.13
18-inch (2 stems)	1.075	101.43	2.501	235.24	2.809	219.24	2.106	145.10	2.816	95.01	796.02	112.02	684.00
24-inch (1 stem)	1.357	128.03	1.741	163.76	1.225	95.61	1.533	105.62	2.352	79.36	572.38	95.15	477.23
24-inch (2 stems)	0.874	82.46	2.283	214.74	2.050	160.00	2.134	147.03	3.251	109.69	713.92	97.92	616.00
30-inch (1 stem)	0.902	85.10	1.309	123.12	1.348	105.21	1.226	84.47	1.683	56.78	454.68	86.25	368.43
30-inch (no pruning)	0.337	31.80	1.342	126.23	2.053	160.24	3.814	262.78	3.483	117.52	698.57	88.78	609.78

These figures on value of tomatoes of each week were obtained from a buyer and shipper in 1943, and they were as follows per ton: First week, $94.35; second week, $94.06; third week, $78.05; fourth week, $68.90; and fifth week, $33.74.

Figure 4. The Pan America pruned to two stems.

Results from these studies indicate that growers of early market tomatoes in Mississippi who plan to prune and stake their tomatoes would be wise to space the plants from 18 to 24 inches in the row and leave two stems per plant. This treatment greatly reduces injury from sunscald and increases the early and total yields of marketable fruits per acre over the old practice of pruning to a single stem and topping the plants above the third cluster.

No Staking or Pruning for Fall Tomatoes

Notes taken from observations made for several years at State College indicate that it is better not to prune or stake fall tomatoes in this locality. Plants on the ground seem to stand the hot dry weather of the late summer months better than plants tied to stakes. Under certain conditions in certain localities, it might be more economical not to prune or stake the later spring and summer tomatoes.

Varieties

There are a large number of tomato varieties and many of them have been grown to a limited extent in this State. For Mississippi conditions, tomatoes may be divided into fusarium wilt-resistant and wilt non-resistant varieties. Most of the so-called fusarium wilt-resistant varieties which have been on the market in past years are only partially resistant, and many of the plants in this group frequently fail because of this soil-borne disease. However, they are much superior to the non-resistant varieties on fusarium wilt-infested soils. When planted on a wilt-free soil, some of the non-resistant varieties are superior to many of the resistant ones in yield and quality of fruit.

During the past 5 years, a number of varieties have been tested at Crystal Spring, State College, and the Delta Station, for yield, eating quality, shipping quality, earliness, smoothness, and other factors. A number of these varieties were discarded from this test in 1941 and some

Table 7. Tomato varieties: yield in pounds of marketable fruits per acre, State College, 1939-1943.

Varieties	1939	1940	1941	1942	1943	5-year average	3-year. av. (1941-43)
Scarlet Dawn	8,865	8,880	7,107	18,160	10,529	10,708	11,932
Essary	—	—	5,980	23,360	10,869	—	13,403
Grothens Globe	6,681	10,399	4,658	—	—	—	—
Gulf State Market	9,143	10,146	6,041	19,720	10,060	11,022	11,940
John Baer	6,909	9,145	5,525	—	—	—	—
Rutgers	6,283	10,917	6,268	20,180	13,025	11,335	13,158
Louisiana Pink	4,330	8,556	4,388	—	—	—	—
Pritchard	7,798	9,789	6,369	—	—	—	—
Marglobe	6,198	7,410	6,155	20,940	10,544	10,250	12,546
Master Marglobe	6,647	11,976	5,269	20,300	10,879	11,014	12,149
Stokesdale	—	—	5,416	19,380	11,357	—	12,052

new ones added. Some were discarded because they produced low yields, some because the fruits were rough, and some because the eating quality was poor. Table 7 shows the yields per acre of marketable fruit for each year tested and the yearly average of those that were continued. Results at the other two locations were somewhat similar for these varieties. Grothen's Globe was discarded because it was a little late for the early market and the yields were not outstanding. John Baer, although a good early tomato for home use, is too soft for shipping, and Louisiana Pink and Pritchard have rather poor eating quality and are not outstanding in yields. Some other varieties which are not included in this table were discarded for these and other reasons.

Scarlet Dawn and Gulf State Market were the leading non-resistant varieties in yield and quality of fruit when grown in wilt-free soil. Gulf State Market is a little late for the early market, and plants have long internodes and grow rather tall for staking. Scarlet Dawn is early, has a fairly nice plant, and produces nice large fruit of good eating quality and good color.

Rutgers, Master Marglobe, Stokesdale, and Essary have been outstanding among the so-called wilt-resistant varieties in yield and other combined qualities

Stokesdale is earlier than any other varieties of this group, but it produces slightly smaller fruit than the others; however, this variety is rather prolific and has smooth oval-shaped fruit of fair color. It has been outstanding in the fall plantings at State College, grown without staking.

Figure 5. The Stokesdale variety grown in the fall of 1942 at State College and left on the ground without staking or pruning. Several pickings had been made when this picture was taken just after the first frost.

Plants of the **Rutgers** variety are large and stocky with short internodes and heavy, dark green foliage, which are desirable qualities for tomato plants that are to be pruned and staked. It usually produces large clusters of good size fruit, and the first three clusters, which are the most important, are produced fairly

near the ground. This variety can be produced on much shorter stakes than many of the other varieties. The fruits have thick cell walls and stand up well in shipping. However, the fruits have rather large cores and the eating quality is not as good as Marglobe and some of the other tomatoes. This variety has become rather popular in Copiah County in recent years as a shipping tomato, and its yields in the tests have been among those of the top-ranking varieties. It usually gives higher yields in wilt-infested soils than Gulf State Market, and, since much of the soil in the trucking area is more or less infected with wilt, the Rutgers variety, since the beginning of these studies, has replaced Gulf State Market to a large extent.

Marglobe has been popular for a number of years and is still popular in many sections of the country, but it is not as well adapted to the climatic conditions of this State as it is to some other localities. The fruits do not color very well during the hot summer weather of this locality, and the yields are usually not as good as Rutgers. However, the eating quality of well-colored fruit is good and the coloring is usually much better in the fall. Therefore, it has been found to be a good fall tomato for this State.

Coloring of the **Essary** variety is none too good in this State, but some workers claim that this variety will hold up under unfavorable conditions better than most varieties. It is a fairly new variety, and has not yet gained wide popularity, but its yields in these studies have been satisfactory.

Pan America is a new fusarium wilt-resistant variety developed by the U. S. Department of Agriculture, and it has a much higher degree of resistance than the varieties listed in table 7. It produces a vigorous plant with good foliage, and many of the fruit have good color and good eating quality. However, the variety was released before its characters were well fixed, and seed obtained from some of the seed houses produce small fruit. This is highly objectionable and has resulted in lower marketable yields of this variety (grown from commercial seed) than from some of the standard varieties. However, some selections of individual plants of large smooth fruit have been made by the Mississippi Experiment Station, and one of these selections will probably be released at a future date. Yields of this selection appear to be favorable.

If tomatoes are to be grown on fusarium wilt-infested soil, a variety that has a high degree of resistance is to be preferred. However, if only small plantings of tomatoes are to be made each year on an average-size Mississippi farm, a rotation system can be practiced that will permit the non-resistant varieties to be grown with safety. If the tomato plantings are rotated on the farm land in such a manner that one planting is not closer than a couple of hundred feet from the location of a previous planting made within the past 6 or 8 years, there is not much danger of running into serious trouble with fusarium wilt. Care must be taken not to carry this and other diseases into the field on young tomato plants.

Scarlet Dawn is a good variety to grow for the early crop if wilt is not present, and it can be successfully grown under the conditions described above.

Control of Insects on Tomatoes

Only a few insects usually require control on tomatoes in Mississippi, although several others may occasionally cause injury. The most important are the tomato fruitworm and tomato hornworm. Others of less importance or less frequent occurrence are the Colorado potato beetle, vegetable weevil, blister beetles, cut worms, stink bugs, and fleabeetles.

Tomato fruitworm. This insect, also known as the corn earworm and the cotton bollworm, destroys tomatoes of all

sizes, from those just formed to ripening fruits; a single worm often moving from fruit to fruit and ruining several before becoming fully grown. Control by dusting with calcium arsenate or cryolite at weekly or 10-day intervals after blooming begins, continuing until the fruits are half grown in commercial plantings, or until almost mature in home gardens where the fruits will be washed or wiped before eaten. If spraying is preferred, use 3 tablespoons cryolite in a gallon of water, or 3 pounds in 50 gallons water.

At the Truck Crops Experiment Station, Crystal Springs, a mixture of 1 pound cryolite and 9 or 10 pounds corn meal placed in pinches on the buds or scattered over the plants has given about the same control as calcium arsenate or cryolite and is cheaper, but is not effective against hornworms which are controlled by the dusts.

Tomato hornworms. Two of these large green horned worms, both of which also feed on tobacco, are common in Mississippi. They do not feed on fruits but rapidly destroy the leaves and buds. Calcium arsenate or cryolite dusts or sprays for the fruitworm will control these also. Hand-picking is practical in small gardens.

Colorado potato beetle. This beetle and its brick-red grubs may often cause serious injury to young tomato plants soon after transplanting. Dusting with calcium arsenate or cryolite will kill them quickly. Calcium arsenate is cheaper but the cryolite may give better protection if fleabeetles are also present.

Vegetable weevil. This is chiefy a pest of the tomato plant grower as it does most damage in hotbeds and cold frames in early spring. The weevil and its dirty-greenish grub about half an inch long are both most active at night or in dark

Figure 6. A planting of tomatoes on the right practically ruined with nematodes. The pests were carried to the field on the plants grown in an infested bed where sweet-potatoes were bedded the previous year.

corners and can soon destroy large numbers of plants. When noticed, spray beds or frames thoroughly with 6 teaspoons lead arsenate in 1 gallon water, hitting stems and undersides of leaves.

Blister beetles. The southern striped blister beetle, a brown species with black stripes, is most common in Mississippi, but other species may often be present on tomatoes. Shaking into shallow pans of kerosene or dusting with a mixture of one part cryolite and three parts talc or flour may be effective in many cases, but if large numbers are overrunning a garden, usually the most practical control is to drive the beetles into hay or straw piled at the edge of the garden and burn them.

Cutworms. When the garden or tomato patch is plowed in winter and is kept free of vegetation until plants are set out, cutworms are not likely to cause trouble. If a winter cover crop is turned under only a week or two before planting it will be well to use poisoned bait before setting out plants. Mix 8 tablespoons Paris green or white arsenic in 5 pounds dry wheat bran, then slowly add enough water to make thoroughly moist but not sloppy. Scatter broadcast in late afternoon.

Stink bugs. Flat green or brown stink bugs and longer plant bugs may often cluster in numbers on tomatoes and cause considerable damage by sucking the fruits. They are resistant to sprays and dusts, and hand-picking or shaking quickly into a pan of kerosene before they fall or fly away are about the only controls of any value.

Fleabeetles. These attack the young plants just after setting them out. If the garden has been well cultivated and kept free of weeds, fleabeetles are usually not so numerous as in weedy locations. Dipping or spraying the plants

Figure 7. Root-knot nematode damage to tomato roots (variety Pan America). This plant threatened to produce fruit, its owner wasting many gallons of water, time, and fertilizer on it, hopefully waiting for a crop that was never produced.

Figure 8. Typical symptoms of fusarium wilt on tomatoes.

with bordeaux mixture containing 6 teaspoons lead or calcium arsenate per gallon, or dusting thoroughly with cryolite. should give good results.

The foregoing discussion of insects on tomatoes was prepared by Dr. Clay Lyle, entomologist for the Mississippi Station

Control of Tomato Diseases

There are three major diseases of tomatoes in the mid-south area. Any one of these diseases may cause crop failure, or a combination of several diseases may render tomato production unprofitable. Once certain of these diseases become established in a soil, it may never be profitable to use it for tomatoes again.

Use certified seed whenever possible. All certified seed are produced from plants assured of being practically free from diseases. Certified seed have been treated with a fungicide to help prevent damping-off and collar rot and do not require additional treatment.

Root-knot nematode (figures 6 and 7). This is one of the most common and most destructive diseases of tomatoes in the mid-south area. The disease-producing agent is carried in soils. If present in hot bed or cold frame soils the disease may be carried to the field on roots of young plants and an entire field may be ruined, not only for tomatoes, but for nearly all warm season vegetables. The root-knot nematode attacks the roots of more than a thousand kinds of plants causing their roots to rot. No varieties of tomatoes are known to be resistant. Soil treatments with chemicals are costly. Prevention is the only practical method of dealing with this disease. Learn to identify it by the large cancerous decayed roots and avoid spreading these infested plants and soils. Fields known to be infested should be planted to grain crops and bare-fallowed in the months of July and August. Permit no weeds to grow during this period. Experiment Station Circular No. 104 contains additional information about this serious soil-borne disease.

Fusarium wilt (figure 8). This fungus parasite causes tomato plants to wilt and die. It is similar to cotton wilt and it is usually most common in sandy soils. The Pan America variety of tomato is almost immune to fusarium wilt, while Rutgers, Marglobe, and certain other varieties are somewhat resistant. A long-time rotation and the use of resistant varieties have proved quite satisfactory for the control of this disease.

Leaf spot. Small decayed spots appear on the lower leaves; these leaves later turn yellow and become useless; the disease

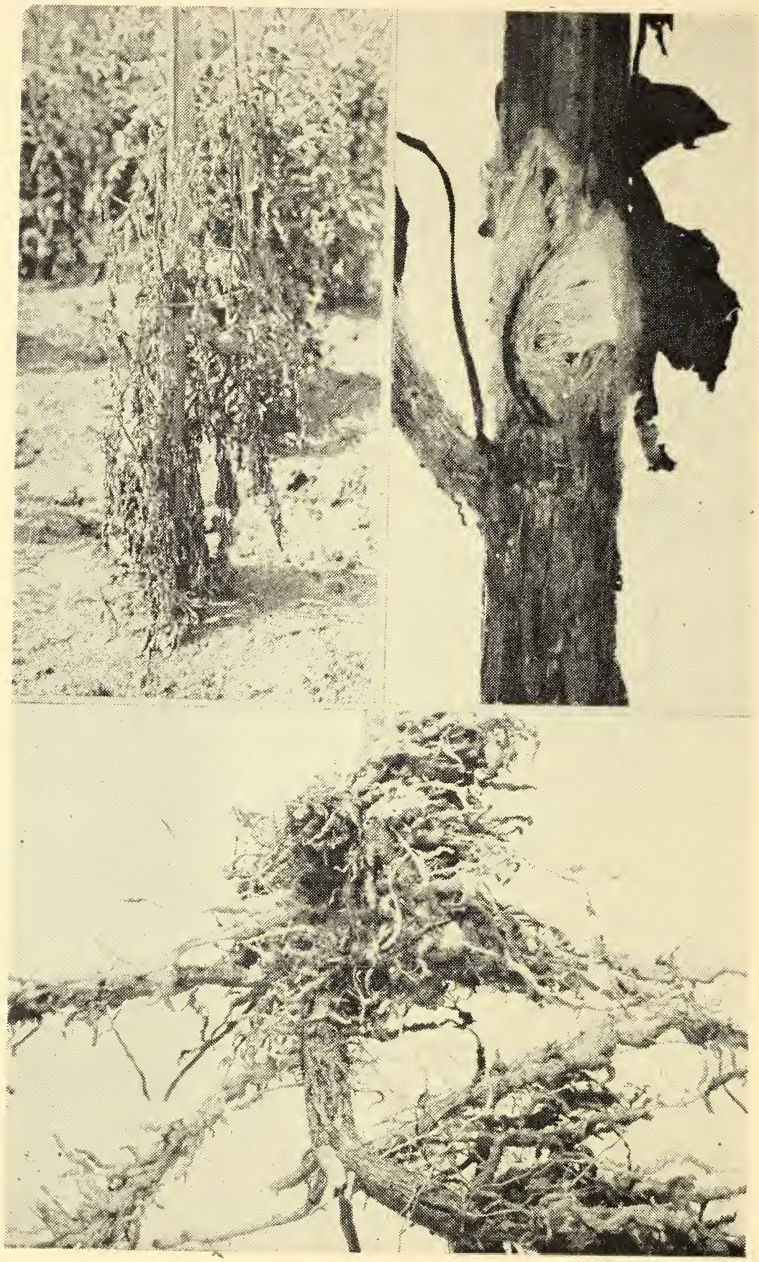

Figure 9. Upper left, tomato fusarium wilt; upper right, Southern stem-blight (common on many plants); lower, root-knot nematode on Pan America tomato roots, a fusarium wilt resistant variety.

Figure 10. Tomato mosaic. Normal healthy leaf in center, stunted virus affected plant on left. Diseased leaf on right.

progresses up the plant, causing defolia tion and stunting. Control methods consist of applying sufficient fertilizer to maintain vigorous growth, use of certified seed, spraying or dusting young plants in the cold frame with one of the "fixed" copper compounds, and spraying or dusting with a "fixed" copper fungicide in the field. These fungicides, and directions for their use, may be obtained from the larger seed houses in Mississippi.

Bacterial wilt (figure 9). This disease is very similar in appearance to fusarium wilt of tomato. If a stem is cut open, it is usually hollow, rotten, and watery. Fusarium wilt does not cause this type of stem symptom. There are no known practical methods of controlling this disease. It will live in sandy soils for at least 25 years. This disease is common in the Southeastern States and it is spread to new areas in the soil and in roots of young plants. Never use uncertified uninspected plants lest this disease be carried to the premises.

Mosaic virus (figure 10). Tomato mosaic is caused by a virus which is easily spread from plant to plant when setting, pruning, or handling. The leaves assume a mottled yellowish-green pattern which resembles a mosaic design. Young plants are stunted severely and never grow properly. The disease is extremely infectious. By simply rubbing a diseased leaf between thumb and finger, then rubbing a young leaf of a healthy plant through the same fingers

will cause the disease to reappear in the healthy plant in about two or three weeks. The infectious material can be removed from the hands by washing with strong soap. One should never handle mosaic-infected plants except to destroy them. Avoid using tobacco when working with young plants because the virus is present to some degree in nearly all forms of tobacco. Strong soap will destroy the infectious virus on the hands.

The foregoing discussion of tomato diseases was prepared by Dr. J. A. Pinckard, plant pathologist for the Mississippi Station.

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