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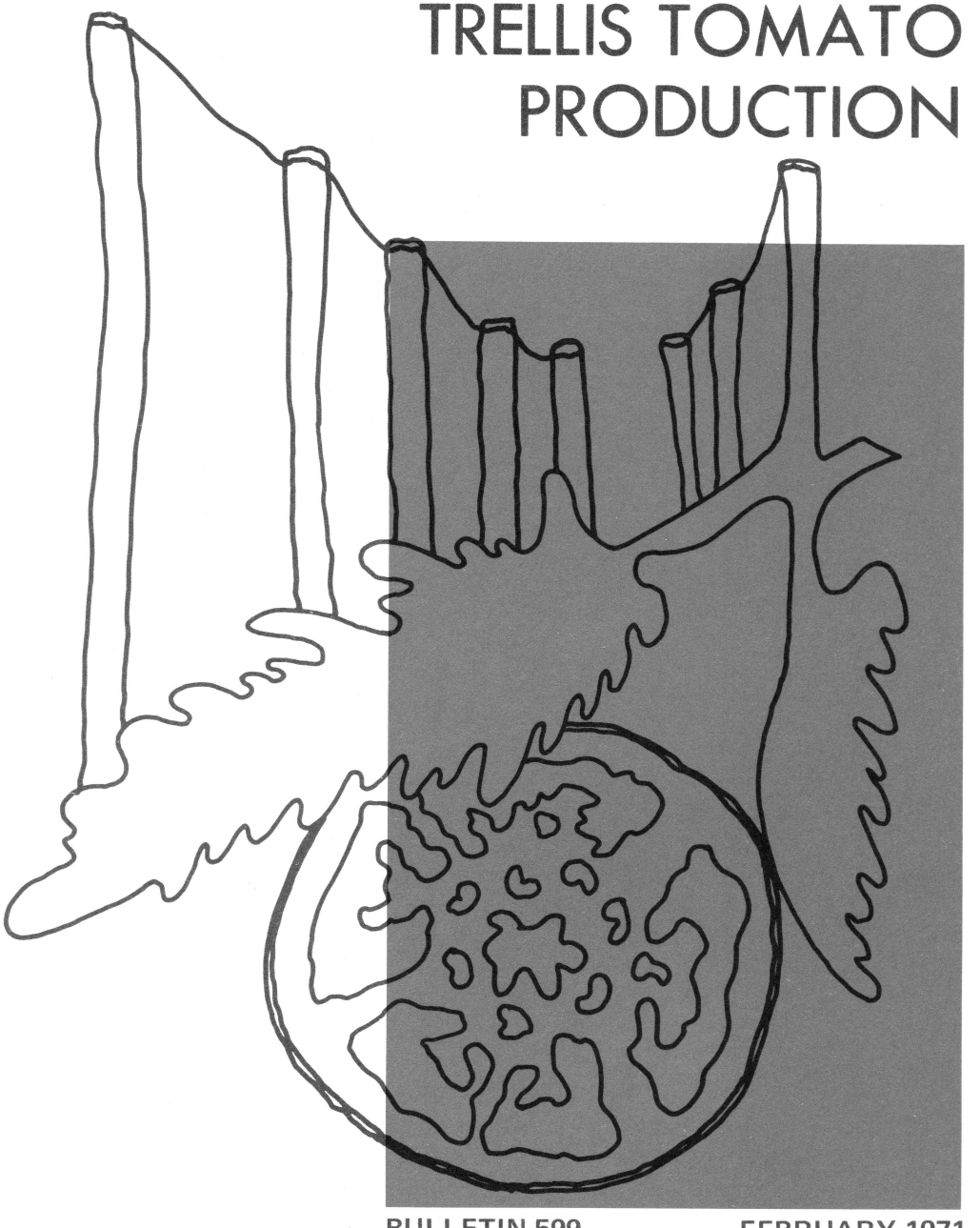

BULLETIN 599 FEBRUARY 1971
WEST VIRGINIA UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
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Trellis Tomato Production

ALLEY E. WATADA, EION G. SCOTT and N. CARL HARDIN

Introduction

TRELLIS TOMATO PRODUCTION can be a rewarding pursuit in some areas of West Virginia. The crop offers a high net return on an acre basis; however, like other high intensity crops, it does require a considerable amount of hand labor and usually a large capital investment. Family labor can be utilized effectively and continuously by growing trellis tomatoes.

Production of tomatoes on trellises or stakes has been practiced for many years. Experimental studies have shown that a plant pruned and staked will bear earlier and larger fruits than a non-pruned plant (5,6,8,9). On the other hand, a non-pruned plant will bear more fruit than a pruned plant. Yield data on a per-acre basis have varied because of differences in spacing and in cultural practices. The philosophy on spacing and cultural practices has changed considerably during the past few decades and information on productivity of trellised tomatoes with these changes is limited. Many cultural practices currently recommended for growing tomatoes on trellises or stakes have been based on studies undertaken some years ago. Since then new cultivars have been developed; an improved method of irrigation has become available; more thought has been given to the spacing of the plants in the field; and the needs of the growers and consumers have changed. As a result of these changes, some of the cultural practices for growing trellis tomatoes have been re-evaluated. The factors studied included irrigation, desired numbers of stems, duration of sucker (lateral shoots) removal and mulching.

Irrigation

Many growers in the eastern United States depend upon rainfall for moisture to maintain the growth of plants. Unfortunately, rainfall is not always sufficient nor is the timing always appropriate for the plants to attain maximum productivity. A successful high intensity crop needs a continual supply of moisture, and the amount it needs increases with growth of the plant. Moisture is needed not only as a source of water, but also to assure the availability of soil nutrients. Many growers apply a large quantity of fertilizer and do not realize that optimum utilization of soil nutrients can be limited by lack of moisture (1,7).

The benefit of irrigation on the productivity of trellised tomatoes was studied at the West Virginia University Horticulture Farm in Morgantown, West

Virginia, during the summer of 1966. In the spring during soil bed preparation, lime was applied at the rate of 600 pounds per acre and 10-20-20 fertilizer was broadcast at a rate of 800 pounds per acre. Diphenamid was sprayed and disked in at the rate of 6 pounds per acre to control the weeds.

A half-acre field plot was used for the study. One-half of the plot received moisture only from rainfall, and the other half was irrigated with an overhead sprinkler system until the soil received an average of one acre inch of water per week. The effect of irrigation was studied with three cultivars which were pruned to either one or two stems. The cultivars were Cardinal Hybrid, Fantastic, and Manhattan. Plants pruned to a single stem were set 10 inches apart, and those pruned to two stems were planted 18 inches apart in rows five feet apart. Each plot was divided into four equal blocks and six treatments were randomized within each block.

The plants were set in the field on May 16, 1966. Shortly after transplanting, the plants were sidedressed with 10-20-20 fertilizer at the rate of 800 pounds per acre. About a month after transplanting, the plants were sidedressed with 14-0-14 fertilizer at the rate of 150 pounds per acre. This treatment was repeated twice at three-week intervals. Pruning and trellising was initiated as soon as the plants began to show growth and frequency was dependent upon the rate of growth. Insects and diseases were controlled effectively by spraying at weekly intervals with malathion and maneb or zineb, respectively. The use of maneb and zineb was alternated each week to avoid accumulation of either manganese or zinc in the soil. Weeds not controlled by diphenamid were removed by shallow cultivation.

The fruits were harvested at the incipient stage of coloring. Harvesting began on July 14 and was continued two or three times a week until frost had killed the plants. The harvested fruits were graded into four categories—U.S. No. 1, U.S. No. 2, peewees (less than 1 7/8 inches in diameter), and culls. Both the number and weight of the fruits were recorded. The effect of supplemental irrigation was apparent in the very early stages of growth. The foliage of the plants in the nonirrigated plot had only a limited growth which left an open space between the plants. In the irrigated plot the foliage of adjacent plants intertwined and a mass of growth resulted. As shown in Figure 1, by mid-July the irrigated plants were considerably heavier and taller than the nonirrigated plants.

The plants in the nonirrigated plot produced an abundant supply of fruit; however, they were of limited size and many had blossom-end rot. The yields presented in Table 1 do not include fruits with blossom-end rot.

Supplementary watering increased the total yield of all the cultivars by about fivefold (Table 1). The yield increased from 4.3 to 23.8 tons per acre for the Cardinal cultivar, 6.9 to 29.4 for the Fantastic cultivar, and 4.9 to 27.8 for the Manhattan cultivar. Approximately 55 per cent of the fruits harvested from

FIGURE 1. Irrigated plants (above) are taller and have heavier foliage than the nonirrigated plants (below).

the irrigated plot was marketable. The percentage was only slightly lower for the nonirrigated plot, but would have been considerably lower if the yield of fruits with blossom-end rot had been recorded. The low percentage of marketable fruits from both plots was due to large amounts of fruit with cracks.

Table 1. Total yield (tons per acre) of irrigated and nonirrigated plants of different tomato cultivars.

	Non-Irrigated	Irrigated
Cardinal Hybrid	4.3[1]	23.8
Fantastic	6.9	29.4
Manhattan	4.9	27.8
Average	5.4	27.0

[1]Yield does not include fruits with blossom-end rot.

The benefit of irrigation was about the same whether the plants were pruned to either one or two stems (Table 2). Nonirrigated one-stem plants produced 5.1 tons per acre, whereas the irrigated plants produced 25.1. The yield from the two-stem plants was slightly greater, but the percentage difference between the irrigated and nonirrigated plots were about the same. The percentage of marketable fruits produced by the one- or two-stem plants increased by irrigation.

Table 2. Total yield (tons per acre) of irrigated and nonirrigated tomato plants pruned to one and two stems.

	Nonirrigated	Irrigated
One stem	5.1	25.1
Two stem	5.7	29.0
Average	5.4	27.0

The beneficial effect of irrigation was particularly pronounced in 1966 when rainfall throughout the season was exceptionally low. For a good productive crop, plants should receive one inch of moisture per week. During the 1966 growing period rainfall of one inch per week occurred for only three weeks. Rainfall during the remainder of the season ranged from 0 to 0.7 of an inch per week. The total rainfall was 1.4 inches during May, 0.8 in June, 3.14 in

July, and 3.77 in August. Even on a monthly basis, the amount of moisture received from rainfall was not sufficient for maximum production.

Number of Stems

Magruder (6) reported that plants pruned to one, two, or three stems had greater yield with increasing number of stems. On the other hand, the average size of the fruit and the early yield were reported to be greater on plants with less stems. It is difficult to relate these results with current growing methods since earlier studies were conducted with plants spaced 3 feet apart in rows 4 or 5 feet apart. Currently one- and two-stem plants are set 10 and 18 inches apart, respectively. Closer spacing of plants could affect the total yield, thus the productivity of one- and two-stem plants was studied under the current cultural practices.

Productivity of plants pruned to one or two stems was evaluated over a three-year period with different cultivars, different types of mulches, supplemental watering, and various degrees of sucker (lateral shoot) removal. The cultivars were Cardinal Hybrid, Fantastic, and Manhattan. The mulches used were plastic, sawdust, and straw. Supplemental irrigation was compared with nonirrigated treatments. Removal or pruning of suckers was terminated at various stages of plant growth. Pruning of the first set was terminated at the second sucker above the second flower cluster, and the remainder of treatments were terminated at later stages of plant growth.

The cultural practices of liming, fertilization, fungicide and insecticide applications, and weed control were similar to those described previously. In 1967 the soil was treated by Dr. Robert Adams* with Vorlex at a rate of 50 gallons per acre. Fruits were harvested and handled as described previously.

Productivity of marketable fruits from the one- and two-stem plants varied with time. During the early part of the season when the price was very good, the accumulative yield from the one-stem plants was significantly greater than that from two-stem plants (Figure 2). During the middle of August, the two-stem plants became more productive than the one-stem plants, but this sharp increase was maintained for only 10 days. During the remainder of the season, the daily productivity of both one- and two-stem plants was about the same. The daily yields from the various treatments differed extensively during September. Consequently, the accumulative yields of one- and two-stem plants was not significantly different during the latter part of the season.

The variables of the experiment showed an interaction. One-stem plants with no mulch or with sawdust produced higher yields than the two-stem plants (Table 3). On the other hand, the difference was reversed with plastic or straw-mulched plants. The average yields of the one- and two-stem plants were similar, 24.1 and 24.2 tons per acre, respectively.

*Robert Adams is Plant Pathologist, West Virginia Agricultural Experiment Station.

Table 3. Total yield (tons per acre) of one- and two-stem plants with different types of mulch.

	One-Stem	Two-Stem
No mulch	20.8	18.2
Plastic	22.7	27.3
Straw	22.8	26.5
Sawdust	30.0	24.7
Average	24.1	24.2

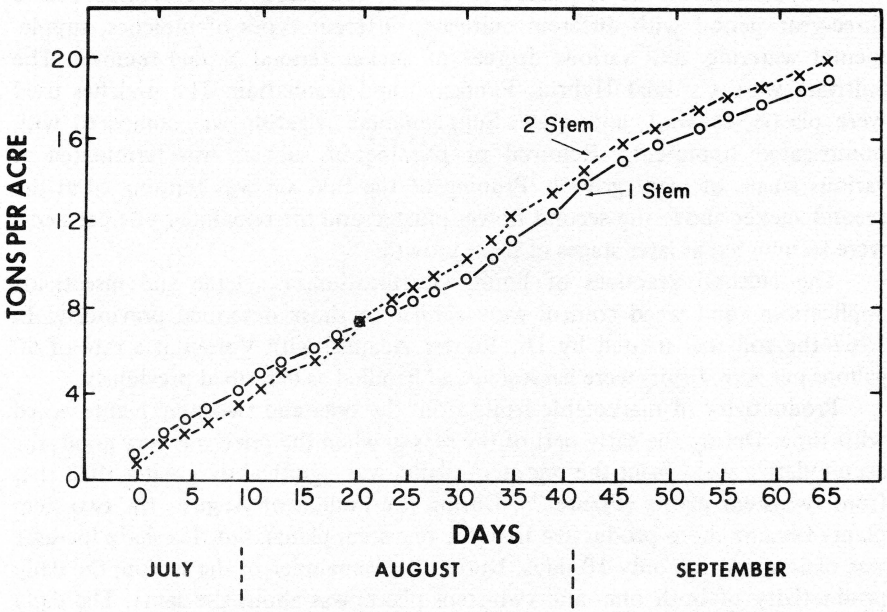

FIGURE 2. Accumulative yields of plants pruned to one and two stems. Each point represents an average over a three-year period.

A similar type of interaction resulted when pruning was terminated at various stages of growth (Table 4). A heavier yield was produced by two-stem plants than by the one-stem plants when the pruning was terminated at the second sucker above the second flower cluster and at the second sucker above the fourth flower cluster. The results reversed when pruning was terminated at the first sucker above the third flower cluster. The difference was not significant

when pruning was terminated with the fourth flower cluster. Due to the interaction, the average total production of 20.2 and 21.0 tons per acre by the one- and two-stem plants, respectively, was not significantly different.

Table 4. Total yield (tons per acre) of one- and two-stem plants pruned up to different stages of growth.*

Treatment	One-Stem	Two-Stem
2-2	21.2	25.4
3-0	21.4	16.8
4-0	18.3	18.0
4-2	20.0	23.7
Average	20.2	21.0

*Stage of growth was identified by a specific sucker (As indicated by the second digit under treatment) above a specific flower cluster (identified by the first digit).

It is interesting to note the effect of early yield on income. At the end of July, the gross accumulative income from one-stem plants was $1,302 per acre, 35 per cent greater than that from the two-stem plants. This difference diminished and reversed by the end of the season. The gross income for the season was $4,784 and $4,817 for the one- and two-stem plants, respectively. On the other hand, due to the high early yield of the one-stem plants, the net income from the one-stem plants was greater than that from the two-stem plants.

Duration of Pruning

Other workers have found that pruning and staking the plants result in larger and earlier fruits (3,4). On the other hand, a non-pruned plant will produce a greater yield than a pruned plant. In growing tomato plants on a trellis, the objective is to obtain earlier and larger fruits, with a very large total yield. If the non-pruned plants produce a larger yield than the pruned plants, the question arises as to the productivity of plants that are only partially pruned. It might be possible to maintain the production of early and large fruit with a minimal amount of pruning. With this in mind, a study was conducted to determine when the pruning of suckers can be terminated and still obtain early large fruits with a very large total yield.

The effect of termination of sucker removal was studied over a three-year period. Pruning was terminated at the following stages of plant growth: (1)

second sucker above second flower cluster, (2) first sucker above third flower cluster, (3) fourth flower cluster, and (4) second sucker above fourth flower cluster. The study was made with one- and two-stem plants. The remainder of the cultural practices followed and the method of harvesting and handling the fruit was as that described previously.

Productivity of the plants differed with the various treatments. The average yields over the three-year period for each treatment are shown in Figure 3. Differences among the treatments became apparent at about the 10th harvest when Treatment 1 (pruning terminated at the second sucker above the second flower cluster) had the highest accumulative yield, 13.26 tons per acre. Progressively lower accumulative yields were exhibited by Treatments 4, 2, and

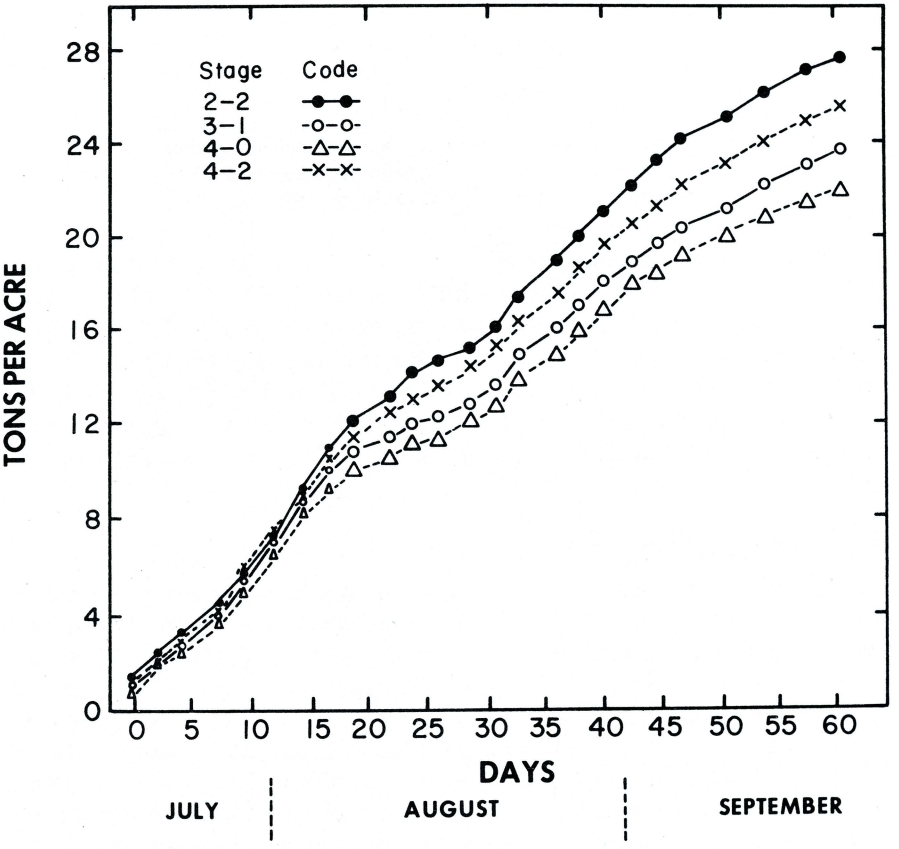

FIGURE 3. Accumulative yields of plants that were pruned to various stages of growth. Pruning was terminated at the indicated lateral shoot (identified by the second digit) located above a specific flower cluster indicated by the first digit.

3. This sequence of productivity was maintained throughout the season with a total marketable yield of 28.3, 26.2, 24.2, and 22.2 tons per acre for Treatments 1, 4, 2, and 3, respectively. Treatments 1, 2, and 3 were in the same sequence in respect to accumulative and total yield. Treatment 4 did not maintain any pattern. Its total yield was comparable to Treatment 3 in 1967, comparable to Treatment 2 in 1969, and greater than Treatment 2 in 1968. Statistical analysis showed an interaction between treatments and replications in 1968 and 1969 which was due to variations in field conditions. By random placement of treatments most of the replications of Treatment 4 were located unknowingly in the most productive part of the field. Therefore, Treatment 4 cannot be properly compared with the other treatments.

The average weight of the fruit was affected by termination of pruning and changed during the growing season. In 1969 the average weight increased from about 0.32 pound to about 0.4 pound at the beginning of the season, and then began to decrease at the 12th harvest. During midseason the weight ranged between 0.33 to 0.37 pound among the various treatments. It began to decrease at the end of the season and dropped to a weight of 0.23 pound. Differences in the average weight of the fruit were observed among the treatments, but they were not consistent throughout the season.

The percentage of No. 1 fruits changed during the growing season. Initially it varied from 52 to 68 per cent, improved during the latter part of July, and then they varied from 65 to 90 per cent during August. At the end of August the percentages of all treatments dropped very sharply and by the middle of September they ranged from 30 to 45 per cent. Differences in the percentage of No. 1 fruits were observed among the treatments, but they were not consistent throughout the season. The average for the entire season varied from 70 to 76 per cent among the treatments. Differences between the treatments were not significant.

In considering the gross income from various treatments it would appear that pruning of suckers should be terminated early. The average income over the three-year period from Treatment 1 was $8,945 per acre. Treatment 4 had a gross income of $8,170, whereas Treatment 2 grossed $7,405, and Treatment 3, $6,513. The net income from these ranged from $3,000 to $5,000 per acre among the various treatments. Both the gross and net incomes of Treatment 1 were below those of other treatments at the beginning of the season. During the latter part of July, the early yield increased sharply and exceeded that of the remainder of the treatments. By the end of the season, the gross and net incomes of Treatment 1 were the greatest. However, the net income was not proportionately larger than the gross income due to the weak start at the beginning when the market price was high. The net income was calculated on the basis of uniform growing costs. In practice, the cost would be less when pruning is terminated earlier and this was not considered in the above calculation. In

looking at all of these factors it appears as though early large fruits with a heavy total yield can be obtained from plants that are allowed to develop the lateral shoots beyond the third flower cluster.

Mulching

Research studies have shown that mulching the ground with black polyethylene film increases the productivity of plants (2). Since mulching conserves moisture, it is particularly effective for growers who depend upon rainfall as the only source of moisture. With these growers the benefit of mulching becomes greater as the period between rainfalls becomes longer. The benefits of mulching have not been thoroughly investigated for areas under irrigation. Mulching has been shown to increase the productivity of plants but the economics of the use of mulching on a large acreage has been questionable. This would not be a problem with tomatoes grown on trellises in West Virginia. In general, most of the growers produce less than an acre of tomatoes and sufficient family help is available to apply the mulch. With these thoughts in mind, the benefits of mulching trellised tomatoes under irrigation were evaluated over a three-year period.

Mulches evaluated were those that were readily available to the growers and included black polyethylene film, straw, and sawdust. The sawdust was placed 2 inches deep and 3 feet wide. The straw was placed 3 inches deep and 3 feet wide. This required 4,500 cubic feet of sawdust or 3½ tons of straw per acre. The mulches were placed shortly after the plants were set in the field. The other cultural practices observed as well as harvesting and handling of fruit were the same as described previously.

Mulching had a definite effect on the productivity of the plants. Results of the three years were similar. Results shown in Figure 4 are averages of 1968 and 1969. Nonmulched plants produced larger yields than the mulched plants in the first few harvests. However, by the fifth harvest the mulched plants began to produce heavily and the accumulative yield became comparable to the nonmulched plants. By the end of July (eighth harvest) mulched plants were producing much more heavily than the control. At this time, the control had produced 9.3 tons per acre. Plants mulched with plastic produced slightly heavier yield—10.1 tons per acre, whereas plants with straw produced 11.3 tons, and plants with sawdust produced 12.4 tons per acre. By the end of the season, the plants of the control treatment produced 22.0 tons per acre, whereas plants with plastic, straw, and sawdust produced yields about 50 per cent greater, i.e., 29.9 tons per acre, 30.2 tons per acre, and 33.4 tons per acre, respectively. In the studies of 1967 and 1968, the plants with straw or sawdust began to lose vigor during the middle of the season due to deficiency of nitrogen. The plants revived and became productive with the application of 100 pounds of ammonium nitrate per acre.

Mulches had no effect on the percentage of marketable fruits throughout the season. In the early part of 1969, the percentage of marketable fruits ranged from 73 to 90 among all the treatments. The large differences were not associated with any specific treatments. By the last week of July approximately 70 per cent of the fruits were marketable. The percentage remained at this level until the end of August at which time the figure dropped to the range of 20 to 50 per cent. The average throughout the season was 61 per cent for the control, 65 per cent for straw, 69 per cent for plastic, and 61 per cent for sawdust. These differences were not significant.

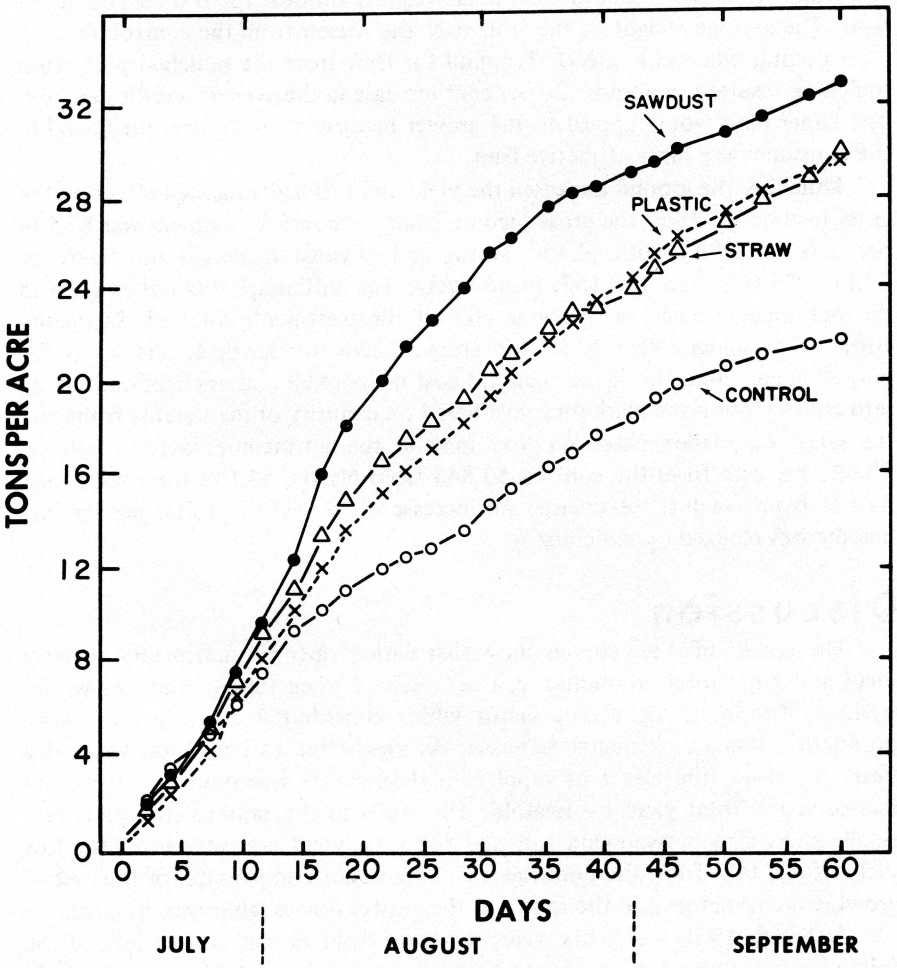

FIGURE 4. Accumulative yields of plants with different types of mulches.

Mulching affected the size of the fruit. The average weight of the fruit ranged from 0.31 to 0.39 pound among the various treatments at the beginning of the season. This increased slightly by the end of July but the differences were not consistent between any specific treatment. Specific differences between treatments became apparent by the beginning of August. The weight of the fruit of the control dropped to about 0.26 pound. The weight of the fruits from the plastic, straw, and sawdust mulch treatment dropped slightly to the range of 0.30 to 0.35 pound per fruit. The size of the fruits from all the treatments began to decrease at the end of August. By the beginning of September, the average weight of the fruits from the control was less than 0.20 pound per fruit, whereas the fruits from the mulched treatment weighed about 0.25 to 0.28 pound per fruit. The average weight of the fruit over the season from the control plot was 0.26 pound, whereas it was 0.31 pound for fruit from the mulched plot. Thus mulching resulted in about a 20 per cent increase in the average weight per fruit. The larger fruit would appeal to the grower because of the heavier yield, and to the consumer as a more attractive fruit.

Mulching the ground increased the yield and this had a marked effect on the gross income. In 1969 the gross income from the control treatment was $7,524 per acre. Mulching with plastic, straw, and sawdust increased the figure to $9,116, $9,622, and $10,157, respectively. The difference was not as great in the net income since the growing cost of the treatments differed. Estimated costs of mulching were $155 for straw, $250 for sawdust, and $175 for polyethylene film. The figure includes cost of material and application. Taking into consideration the marketing cost based on quantity of marketable fruits and the sales commission based on gross income, the net incomes were as follows: $2,922 per acre from the control, $3,843 from plastic, $4,162 from straw, and $4,531 from sawdust treatments. An increase of $1,000 to $1,500 per acre net income was realized by mulching.

Discussion

The results of these studies show that with proper cultural practices, early yield and large total production can be obtained when tomatoes are grown on trellises. The most significant factor which contributed to early and heavy production was supplemental watering. As mentioned earlier, 1966 was a dry year, therefore, the effect of supplemental irrigation was dramatic. Irrigation increased the total yield by fivefold. The fruits in the nonirrigated plot were small, many had blossom-end rot, and the total yield was very low. The low yield of 5.4 tons from the nonirrigated plot did not compensate for the cost of growing the tomatoes and the return to the grower for his labor was minimal.

Although 1966 was a dry year, moisture from rainfall during any of the following years was not sufficient for maximum production. It was particularly low in the spring when water is needed critically for the field set plants to regain

from the transplanting shock. Young transplants need water for growth as well as increased availability of soil nutrients. During the remainder of the season, only a few weeks had the minimal required rainfall of one acre inch. Many times large amounts of rainfall occurred within a very short period which was followed by a long period without rainfall. Fluctuation of soil moisture such as this limits the plant growth and results in limited size fruit and greater amounts of growth cracks. Since pruning and trellising the tomato plants favor growth cracks of fruit, soil moisture should be at optimum and fluctuation be minimized.

Past studies have shown that total production by a plant is greater with increased number of stems. However, the earliness and total production on the acreage basis is not clear. Results of these studies indicated that one-stem plants produce a larger early yield than the two-stem plants. On the other hand, the total production of the one- and two-stem plants is about the same. If the cost of the transplant is significant, then a two-stem plant system would be more economical than a one-stem plant system in that under the current spacing practices about twice as many plants are needed per acre for the one-stem plant system.

Pruning of one-stem plants is more convenient and is easier to learn. Many growers have attempted the two-stem plant system, but had difficulty in training the workers to prune properly. Many people have difficulty in identifying the lateral shoot that is allowed to grow as the second stem. When this lateral shoot is accidentally removed, the number of productive stems per acre is reduced and this, consequently, reduces the yield.

This study confirmed the results of others that a high early yield of large fruit is produced with pruning of suckers. However, continual pruning to the end of the season may not be necessary. In this study large early fruits with a heavy total yield were obtained when pruning was terminated after the formation of the third flower cluster. It was found that the gross income from early termination of sucker removal was equal to or greater than that in which sucker removal was terminated at a later date. It is visualized that the net income would be considerably greater under this system since the additional amount of labor would not be required for continual pruning.

Early termination of pruning appears to be desirable, however, it can create problems. As pruning is terminated, the upper parts of the plant become heavy with many young lateral shoots. Young tissues appeal to such insects as aphids and leafhoppers, which are potential carriers of virus. Control of insect population by spraying becomes more difficult as the growth and number of lateral shoots increase. In addition, trellising of the plant is more difficult when several shoots are emerging in several directions. Certainly less space will be available between the rows for harvesting, and as the condition becomes undesirable many good fruits might be overlooked during harvest.

This study has confirmed that mulching increases productivity of the plant. Without question the cost of materials and their application are compensated for

by the larger yields of tomatoes. The increased size of fruits resulting from mulching is highly desirable since larger fruits generally bring a premium price. The polyethylene film is perhaps the easiest mulch to obtain, however, difficulties arise in the application of the film and also in the removal and disposal of the material at the end of the season. When the polyethylene film is used, the plants should be set in a shallow furrow so that the water from rainfall or irrigation will collect toward the plant. The most effective mulches were straw and sawdust. The yields from these treatments were considerably greater than that with the polyethylene film. A large amount of nitrogen is utilized by the micro-organisms in the degradation of the sawdust and straw. Consequently, to offset the competition that occurs for the nitrogen between the micro-organism and the plant, additional amounts of nitrogen should be applied repeatedly during the season. Mulching improves the yield and quality of the fruit by minimizing water loss and fluctuation of soil moisture. In addition, it is very effective in controlling the weeds adjacent to the tomato plants.

Literature Cited

1. Cannell, Glen H., F. T. Bingham and C. W. Asbell. 1965. "Effects of irrigation and phosphorus on production of field tomatoes." *Agronomy Journal* 57:176-179.
2. Carolus, R. L. and J. D. Downes. 1958. "Studies on muskmelon and tomato responses to polyethylene mulching." Mich. Agr. Exp. Sta. *Quart. Bull.* 40(4):770-785.
3. Edmond, J. B. 1932. "Some results on the pruning, topping and staking of the Marglobe tomato." *Proc. Amer. Soc. Hort. Sci.* 29:496-500.
4. Halsey, L. H. and F. S. Jamison. 1950. "Yields of tomato varieties harvested at two stages of maturity from staked and unstaked plants." *Proc. Amer. Soc. Hort. Sci.* 56:332-336.
5. Johnson, W. A., L. M. Ware and J. L. Turner. 1966. "Response of tomatoes to staking." *Highlight of Agr. Res.* Auburn Univ. 13(2):10.
6. Magruder, Roy. 1924. "The effect of pruning and staking upon production of tomatoes." *Proc. Amer. Soc. Hort. Sci.* 21:270-273.
7. Moore, J. N., A. A. Kattan and J. W. Fleming. 1958. "Effect of supplemental irrigation, spacing and fertility on yield and quality of processing tomatoes." *Proc. Amer. Soc. Hort. Sci.* 71:356-368.
8. Schneck, H. W. 1925. "Studies in pruning and training tomatoes." *Proc. Amer. Soc. Hort. Sci.* 22:309-312.
9. Watts, Victor M. 1933. *Pruning and training tomatoes in Arkansas.* Univ. of Arkansas Agr. Exp. Sta. Bull. No. 292. 15 pp.

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