Influence of Plant Density on Yield of Process Tomatoes for Mechanical Harvest

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Abstract. Yield of process fruits from 'VF-145' tomato plants grown in twin rows on 5-ft beds was greater than from plants in single rows on 4.5-ft beds. The number of fruits per plant increased as the area per plant increased beyond 2.1 ft², but the mean weight per individual fruit was not affected. The highest number of process fruits per plant was produced by single plants spaced at 48 inches. Plant densities ranged from 2,450 to 158,816 plants per acre. Significant increases in yield were obtained by increasing the plant density from 2,450 to 9,801 plants per acre. Plants grown at densities of 19,602 to 158,816 plants produced from 36 to 42.5 tons of process tomatoes per acre.

The advent of mechanical harvesting of tomatoes has initiated changes both in cultural practices and in the cultivars planted. To be suitable for mechanical harvest, a cultivar must meet several requirements. The fruit must be firmer than the hand-harvested cultivars, to withstand the handling of the mechanical harvester. It must set all of its fruit during a short period of time, so that a high percentage of the fruit will ripen at the same time. This requires a small, determinate plant with a concentrated fruit set. It must be able to set fruit under a wide range of temperatures, and the fruit must remain on the vine in a firm condition for a long period of time. The cultivar must be resistant to Verticillium and Fusarium wilt. Closer spacing of determinate cultivars has resulted in increased yields per acre, no change in the number of ripe fruits harvested per plant, and a reduction in the weight of individual fruits (1).

This paper reports the results of field experiments in which the effect of plant density on yield of mechanically harvested processing tomatoes was evaluated.

Materials and Methods

The experiments were conducted in the field at the California Agricultural Experiment Station at Davis between 1962 and 1966. The cultivar 'VF-145' was used in both experiments. It is a determinate-type plant developed for mechanical harvesting. The plants were grown on a Yolo sandy loam soil.

A complete randomized-block design was used, with 4 replications each year in Exp. 1, and 3 replications each year in experiment 2. In both experiments, sufficient 8-24-0 (NH₄)₂HPO₄ to provide 10 lb N and 15 lb P₂O₅ per acre was placed 2 inches directly below the seed row prior to seeding. Immediately after planting, the beds were furrow irrigated. Plants were thinned to 9 inches in the row in Exp. 1 and to the desired density (Table 2) in Exp. 2, 30 days after seeding. After thinning, 90 lb N [(NH₄)₂SO₄] per acre was side-dressed along the furrow side of the plant row.

Experiment 1 (1962–1965) was conducted to compare the effect of number of rows and width of bed on yield of mechanically-harvested process tomatoes. Plants were grown in single rows and in twin rows 1 ft apart on 4.5-ft beds, in twin rows 1 ft apart on 5.0-ft beds, and in twin rows 1.7 ft apart on 5.5-ft beds. Each treatment replication consisted of 3 parallel beds 130 ft in length. Only fruits from plants in the center bed were harvested in one single harvest.

Experiment 2 (1963–1966) was designed to study the influence of plant density on grade and yield of 'VF-145' fruits. Plants were grown in clumps of 1, 2, or 4 plants, with clumps spaced 3, 6, 12, 24, or 48 inches apart in single rows on 4.5-ft beds. Each replication consisted of 3 parallel beds 53 ft in length. Fruits were harvested only from plants in the center bed.

Harvested fruits were sorted into process, green, and cull grades. Yield in each grade, number of plants harvested, and number of fruits per plant were recorded.

Results

Experiment 1. Table 1 indicates the 4-yr mean yield of process fruits for the treatments in Exp. 1. Yields from plants in twin rows on the 5.0-ft beds were significantly higher than those from plants in single rows on the 4.5-ft beds. A reduction in area per plant from 3.37 to 1.87 ft² resulted in an increase in yield of 11.0 tons. In all 3 cases in which 2 rows were planted per bed, significantly less fruit per plant was obtained than where 1 row was

<table>
<thead>
<tr>
<th>Width of bed (ft)</th>
<th>No. of rows per bed</th>
<th>Plant pop. per acre</th>
<th>Square feet per plant</th>
<th>Yield per acre (tons)</th>
<th>No. of process fruits per plant</th>
<th>Mean weight per fruit (process) (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>1</td>
<td>13,068</td>
<td>3.57</td>
<td>33.3</td>
<td>7.2</td>
<td>5.9</td>
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<td>2.10</td>
<td>39.1</td>
<td>4.8</td>
<td>5.4</td>
</tr>
<tr>
<td>5.0</td>
<td>2</td>
<td>23,436</td>
<td>1.87</td>
<td>44.3</td>
<td>5.9</td>
<td>6.8</td>
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<tr>
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<td>1.69</td>
<td>42.2</td>
<td>5.6</td>
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<td>LSD 0.05</td>
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<td>0.01</td>
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<td>N.S.</td>
<td>N.S.</td>
<td>4.0</td>
</tr>
</tbody>
</table>

planted per bed; but there was no significant change in the mean weight of individual fruits.

No marked differences were found in the yield of green or cull fruits.

Experiment 2. The area each plant occupied ranged from 0.3 to 18.0 ft² (Table 2). Yield of process tomatoes increased as the area per plant decreased (Fig. 1). High yields were obtained in all 3 treatments at spacings of 3, 6, and 12 inches. Yields declined at the 24- and 48-inch spacing with single plants, but the 2-plant clump yields declined at the 48-inch spacing. The 4-plant clump treatment showed no significant decrease in yield at the 48-inch spacing.

Plant populations obtained by actual count were within 4% of the theoretical populations. The theoretical populations are shown in Table 2 and Fig. 2. Plant densities ranged from 2,450 to 156,816 plants per acre. The highest yield of process fruits, 42.5 tons per acre, was produced at a density of 78,408 plants per acre. This was obtained with 2-plant clumps spaced 3 inches apart (Fig. 2). Plants grown at low densities produced the most process fruits per plant (Fig. 3). The weight or size of the process fruits was not affected by plant density.

Increasing the plant density by clumping plants at a constant spacing produced lower yields by individual plants. The total acre yield of process fruits, however, was not adversely affected (Figs. 1 and 3).

Two- and 4-plant clumps spaced at 48 inches produced about the same number of green fruits per plant, but the 4-plant clumps produced fewer cull fruits per plant than did the 2-plant clumps at this spacing (Table 2). With one minor exception, total yield of cull fruits decreased as plant density decreased.

**Discussion**

Higher yield of process fruits was obtained from plants grown in twin rows on 5.0-ft beds than from plants grown...
in single rows on 4.5-ft beds. This was caused mainly by the increase in number of plants per unit area, since the weight of the individual fruits was not affected (Table 1). Although more fruits per plant were produced in the single-row planting, the difference was not sufficient to offset the difference in plant number. In the present study the weight and size of 'VF-145' fruits remained relatively uniform. Therefore, yield increases resulted from increased plant density. The lower yields (below 30 tons per acre) of the single-plant treatments spaced at 24 and 48 inches plus the 2-plant clumps at 48 inches were due mainly to the decrease in plant number (Figs. 1 and 3). Plant densities of 9,801 plants per acre or more are necessary to obtain yields of 30 tons or more. Growers can increase their plant density by thinning to clumps of 3 or 4 plants and reduce their thinning costs. Tomatoes at densities of 39,204 to 158,816 plants were able to produce yields of 38.0 tons per acre (Fig. 2). The individual plants produced a small number of fruit, but the large number of plants per acre contributed to the production of the high yield.

Production of sunburn and sunscald cull fruits increased with increase in space between plants. With the increased fruit load per plant, more fruits were exposed to the sun because of the decreased foliar coverage.

**Literature Cited**