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GROWTH AND YIELD OF TOMATO AS AFFECTED BY TRANSPLANT CONTAINER CELL SIZE

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Abstract. **Tomato transplants grown commercially in a container cell size of 4.4 cm had greater dry matter accumulation at planting and 30 days after planting than plants grown in 2.5 cm cells (the industry standard.) Additionally, transplants grown commercially in a container cell size of 4.4 cm produced earlier and yielded greater than transplants grown in 2.5 cm cells. The cell size impact was more dramatic in the spring than in the fall, perhaps due to environmental complications experienced in the fall. Our recommendations at this time would be to produce tomato transplants in cells of at least 4.4 cm if economically feasible.**

Introduction

Today's competitive agricultural environment demands that FL growers produce high yields of good quality fruit to meet market demand. Global market economics have been unfavorable with respect to tomato over the past several years. Therefore when the market is favorable, growers require higher yields to compensate for the "bad" years and escalating production costs. One simple approach to augment yields may be to increase the container cell size in which the tomato transplant is grown.

As early as 1961, researchers noticed the benefits of growing vegetable transplants in larger container volumes (Peirce and Peterson, 1961). Most recently NeSmith and Duval (1997) reviewed the effect of container cell size and concluded that a reduction in container cell size increased the potential of root restriction. But root restriction alone did not account for the many conflicting results found in the literature. A grower-oriented review of cell size by Vavrina (1997) further indicated that regardless of the lack of statistical significance in some studies, there was an overwhelming trend toward earlier and greater yields with larger cells in almost all studies.

The objective of the current study was to determine the impact of container cell size on transplant growth, stand establishment, and yield of tomato in both spring and fall seasons.

Materials and Methods

Commercially-grown tomato transplants were obtained from local greenhouses in the Immokalee, FL area. Container cell sizes are commonly referred to by the measurement of a single side. This study examined 2.5 cm (or 1 inch, 200 cells of 24 cc volume), 3.8 cm (or 1.5 inch, 150 cells of 38 cc volume) and 4.4 cm (or 1.75 inch, 128 cells of 48 cc volume) cells in styrofoam trays (Speedling Inc., Sun City, FL). 'Solimar' (Asgro Seed, Kalamazoo, MI) was used in the fall trial (Barnett Partin Plants, Felda, FL) and 'FTE 30' (Petoseed, Saticoy, CA) was used in the spring trial (Johnson Plants, Immokalee, FL). These varieties were chosen specifically for their performance in the season in which they were grown.

Each season a seepage irrigation, methyl bromide fumigated (269 $kg\cdot ha^{-1}$, broadcast), granular fertilized (220N-78P-300K $kg\cdot ha^{-1}$), plastic mulched (3 mil, white in fall, black in spring), 81 cm wide bed was prepared at the Southwest FL Research and Education Center of the University of Florida in Immokalee, FL. Two weeks were allowed for fumigant action. Holes were punched in a single row, 46 cm pattern on 2-meter centers, and transplants were set on 30 Sept. 1996 and 19 Feb. 1997. Manzate and copper fungicides were applied weekly to prevent the advancement of bacterial spot. Various Bacillus thuringiensis were also applied to reduce worm pressure.

Six replications were set out in a randomized complete-block fashion. Data were taken on plant dry weight (at planting, and 30 and 45 days after planting [DAP]), developing fruit 45 DAP, and yield. Yield was separated into red and breaker fruit and mature-green fruit and further subdivided into medium, large, and extra-large size. Data were analyzed by ANOVA with mean separation by Fisher's Protected LSD (SAS, 1988).

Results and Discussion

Early Plant Growth. Total plant top growth (stems and leaves) at planting reflected the early impact of cell size (Tables 1, 2). Each successive increase in cell size resulted in an increase in plant dry matter accumulation. This result was particularly true in fall-grown transplants where environmental conditions (high temperature and high light) were more conducive to rapid growth. Stem length in both spring and fall was within acceptable limits (i.e., less than 10 cm) by grower standards (data not shown). Peterson et al. (1991) also noted shoot height and biomass reduction of tomato transplants in smaller container cells.

Thirty days after planting in the fall, the benefit of greater dry matter accumulation with larger container cell size was still evident as the plants grown in larger cells established more rapidly (Tables 1, 2). Plant growth in the spring did not mimic this response. By 45 DAP, the effect of the large cell increased dry matter accumulation had dissipated, as plants appeared to achieve similar growth rates.

Fruit initiation at 45 DAP did not show an advantage with the increased cell size in the fall trial, but larger cells resulted in greater fruit loads in the spring trial (Tables 1, 2). Environmental conditions in the spring (lower light level and lower temperature) were perhaps more conducive to fruit set and hence the impact of the larger cell more apparent.

Yield Parameters. Fruit maturity (i.e., earliness) in tomato can be generally determined by red fruit production if the

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Table 1. Field response of tomato transplants grown in container cells of varying size (and volume) Immokalee, FL., Fall, 1996 (all yields from 10 plants, 2 harvests).

Cell size (cm)	Top dry wt. at planting (g)	Top dry wt. 30 DAP[z] (g)	Top dry wt. 45 DAP (g)	Immature fruit 45 DAP (no.)	Red fruit 1st harvest (kg)	Total XL fruit[y] (kg)	Total fruit (kg)
2.5 x 2.5	0.075	29.5	128	6.3	27	43	70
3.8 x 3.8	0.114	34.4	129	7.3	28	41	69
4.4 x 4.4	0.154	40.8	137	6.8	32	41	70
LSD 0.05	0.023	6.5	NS	NS	3	NS	NS

[z]DAP = days after planting.
[y]XL = extra large (minimum diameter > 7.3 cm).

Table 2. Field response of tomato transplants grown in container cells of varying size (and volume) Immokalee, FL., Spring, 1997 (all yields from 10 plants, 3 harvests).

Cell size (cm)	Top dry wt. at planting (g)	Top dry wt. 30 DAP[z] (g)	Top dry wt. 45 DAP (g)	Immature fruit 45 DAP (no.)	Red fruit 1st harvest (kg)	Total XL fruit[y] (kg)	Total fruit (kg)
2.5 x 2.5	0.065	27.9	157	16	0.5	28	41
3.8 x 3.8	0.081	26.0	146	24	1.1	32	48
4.4 x 4.4	0.138	38.8	192	27	5.1	36	55
LSD 0.05	0.030	NS	NS	6	0.8	7	8

[z]DAP = days after planting.
[y]XL = extra large (minimum diameter > 7.3 cm).

crop is healthy. First harvest, red fruit yield in both the fall and spring showed transplant production in the 4.4 cm cell size resulted in earlier production (Tables 1, 2). This factor may be tied directly to a "larger" plant at planting. A larger, more vigorous plant may reach maturity sooner than a smaller plant, and plants grown in the 4.4-cm cell had twice the dry weight of those grown in the 2.5-cm cell at field planting. Ruff et al. (1987) noted a delay in tomato fruit maturation as influenced by restricted root growth in plants grown in small and large pots.

Marketable, extra-large (XL) fruit yield was not significantly different between treatments in the fall. However, the 4.4-cm cell size plants produced more XL fruit than the 2.5-cm cell size plants in the spring. The production of XL fruit is important to the grower as XL fruit most often commands the highest price. Fruit sizing might also be considered a sign of maturity, as larger fruit tend to be on the plant for longer periods of time.

Total marketable fruit followed the same pattern as that of XL fruit. Nothing significant in overall yield was noted in the fall, but plants grown in 4.4 cm cells had higher overall yields than plants grown in 2.5 cm cells in the spring through three harvests.

These data tend to support the larger cell size benefits purported by other vegetable researchers (Csizinsky and Shuster, 1993; Weston, 1988) and specifically tomato (Weston and Zandstra, 1989). Tomato yield and earliness of production was enhanced by larger container cell sizes in the current study. Fall trial results were less supportive of this finding, but this might have been due to a freeze that terminated the trial before a third harvest could be completed, and a late first harvest that might have obscured XL fruit production.

Though these results represent only two seasons of research, our recommendations at this time would be to produce tomato transplants in cells of at least 4.4 cm if economically feasible. The enhancement of earliness and yield may aptly cover the additional cost of production.

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