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Using Composts as Growth Media in Container Production of Tomatoes

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ABSTRACT

During the 1996 and 1997 growing seasons, soil (S), brush composts (B), leaf composts (L), N-Viro Soil (N), and 50:50 mixtures of these materials (S:B, S:L, S:N, B:L, B:N, L:N) by volume were compared for their effects on seasonal distribution and total production for four tomato (*Lycopersicon esculentum*) cultivars. Each growth medium was replicated in four containers (58 cm diameter, 38 cm depth; ca. 64 liters capacity). The cultivars were 'Celebrity', 'Patio', 'Large Red Cherry', and 'Small Red Cherry.' Results were based upon weekly production of vine-ripened fruits by each plant from mid-July to mid-October. The growth media were similar in their effects on seasonal distribution and total fruit production. All growth media/cultivar combinations gave continuous tomato production throughout the growing season. Cultivar differences were exhibited in both plant and fruit characteristics, permitting the container gardener to practice individual preferences. Overall, the results support the practice of composting waste products for use in container gardening.

INTRODUCTION

Sustainability of society is enhanced when recurring waste products are effectively substituted for diminishing natural resources. The sustainable dimension of food production is receiving public attention and tangible government support (Hudson and Harsch 1991).

Composting is an age-old process for converting organic residues into forms that are more aesthetically acceptable and more available for plant utilization. Composting is receiving renewed support as a means of waste disposal because the process reduces the volume of yard waste by a factor of five times or more and results in a product suitable for garden or landscape utilization (Fine 1989). In 1992, 85% of the 4.6 million tons of solid waste produced in Kentucky were disposed in landfills. The Environmental Protection Agency set a goal to reduce municipal solid waste going into landfills by 25% (Environmental Almanac 1994). Since yard waste accounts for ca. 18% of municipal solid waste, composting is critical to efficient waste management.

Organic gardening is based upon the substitution of organic sources for inorganic sources of nitrogen. Recent increases in demand for organically grown food have expanded markets for composted organic matter. Organic gardening varies in scale from individual plant containers to full-sized family gardens (Lindgren et al. 1990).

Urbanites have become increasingly involved in gardening during recent years. They utilize small plots or containers to provide ongoing supplies of fresh fruits and vegetable. In addition, gardening serves as a hobby that for many people is a source of pleasure, pride, and satisfaction. These benefits are not dependent on garden size (Bartholomew 1981).

Tomato (*Lycopersicon esculentum*) is the crop of choice by most urbanite gardeners. Research has shown that tomato yields from litter-enriched plots matured earlier and were larger than those grown in commercially fertilized plots (Brown et al. 1995).

The present study was part of an ongoing program sponsored by the Department of Agriculture, Western Kentucky University (WKU), to convert local municipal waste into forms usable in gardening and landscaping. Our objectives were to compare different waste composts for their effects on total and seasonal distribution of production of diverse tomato cultivars grown in containers.

MATERIALS AND PROCEDURES

Composts

Three locally available waste products were evaluated. Brush- and leaf-composts were produced from Bowling Green yard waste collected in 1994. In a tree inventory of Bowling Green, Martin (1994) identified a variety of common deciduous trees including ash, elm,

Table 1. Nutritive value of composts used in container production of tomatoes.

Compost	% N	% P	% K	Carbon: Nitrogen Ratios
Brush (B)	0.99	0.08	0.48	30:1
Leaf (L)	0.88	0.04	0.42	33:1
N-Viro soil (N)	0.96	0.36	0.67	16:1

dogwood, maple, mulberry, oak, redbud, and willow as well as numerous ornamental trees. The sewage compost, known by the trade name N-Viro Soil (Kovacik 1988), is prepared by mixing treated sewage sludge with cement kiln dust according to approved procedures. The resulting moist mixture is aerated and composted on an environmentally approved site. The Pembroke silt loam soil, obtained from the WKU farm, tested medium to high in both phosphorus and potassium.

Containers

The study was based on container-culture to permit greater experimental control of the compost mixtures and to extend the applicability of the results to container gardening. Forty plastic barrel sections (58 cm diameter, 38 cm depth) were located in an unshaded area. Containers were embedded in the soil to reduce drying and were punctured in the bottom to permit drainage. They were spaced 1.5 m apart in 5 rows and 8 columns. Each container received ca. 64 liters of compost mixture.

Growth Media

Soil and the three composts were used to make 10 growth media; four consisted of 100% each of soil (S), brush compost (B), leaf compost (L), and N-Viro Soil (N), and six consisted of 50:50 combinations by volume of the soil compost materials (S : B, S : L, S : N, B : L, B : N, L : N). All growth media were supplemented prior to transplanting with fertilizer at the rate of 56.0, 24.5, and 46.5 kg/ha-t of N, P, K, respectively. No additional fertilizer was applied.

Cultivars

Four diverse tomato cultivars—'Celebrity', 'Patio', 'Large Red Cherry', and 'Small Red Cherry'—were studied. 'Celebrity' is an indeterminate garden type that produces large plants and large fruits. 'Patio' exhibits a compact, determinate growth habit and is more suitable for urban or "patio" production. 'Large Red Cherry' and 'Small Red Cherry' are characterized by indeterminate growth habit and smaller fruits.

Production

One plant, ca. 15 cm tall, was transplanted in mid-May to each container. Vine-ripened fruits were harvested twice a week beginning in mid-July and continuing to mid-October. Fruits from each plant were counted and weighed. Data from the two harvests per week were combined and reported as production on a weekly basis. After the last regular harvest,

Table 2. Season production of tomato fruits per plant in 1996, Bowling Green, KY.

Growth Media[1]	Cultivar[2] C	P	Mean[3]	C	P	Mean[3]
	Number			Weight (kg)		
S	100	52	76	13.3	4.97	9.14
B	64	68	66	9.55	6.96	8.26
L	92	58	75	15.34	3.6	9.47
N	87	52	70	12.07	5.4	8.74
S-B	87	65	76	13.41	5.92	9.66
S-L	99	66	82	15.64	7.35	11.5
S-N	74	68	71	10.3	6.52	8.41
B-L	120	57	88	17.25	5.51	11.38
B-N	136	64	100	17.25	5.94	11.6
L-N	98	83	90	13.29	6.79	10.04
Mean[3]	95.7a	63.3b	79.4	13.74a	5.89b	9.82

[1] S = soil, B = brush compost, L = leaf compost, N = N-Viro Soil.

[2] C = 'Celebrity', P = 'Patio'.

[3] Growth mixture means were not significantly different ($P > 0.05$); Cultivar fruit number and fruit weight means followed by the same letters are not significantly different ($P > 0.05$).

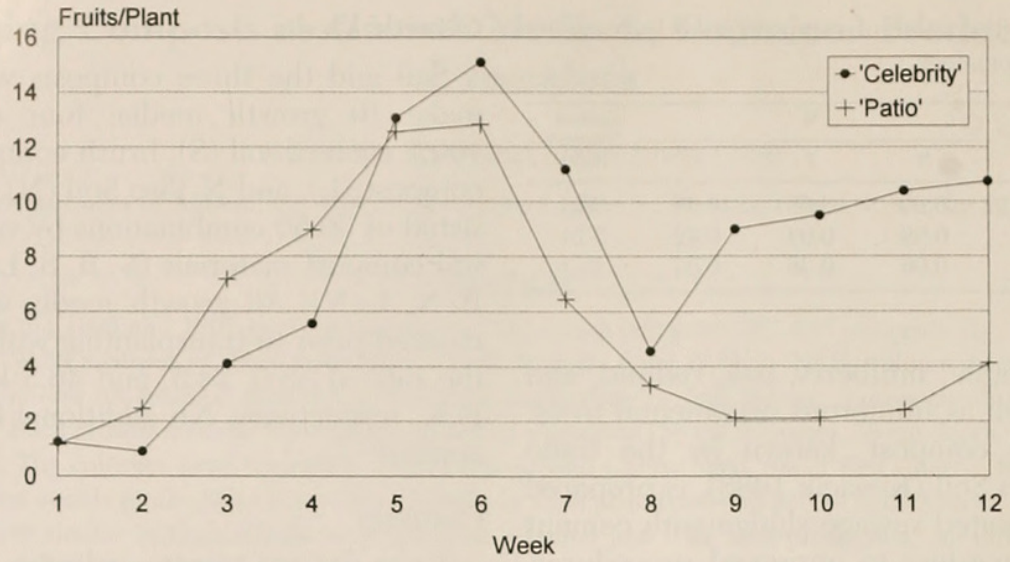

Figure 1. Season distribution of number of fruits/plant for 'Celebrity' and 'Patio' tomatoes in 1996, Bowling Green, Kentucky.

remaining green fruits were counted and weighed.

Supplemental water was applied usually once or twice per week to prevent plant wilting. Support stakes placed in the periphery of the containers were connected with loose-fitting twine to provide plant support. Plants were permitted to spread without any restrictive pruning.

Design and Analysis

The 10 growth media were replicated four times in a randomized complete block design (Steel and Torrie 1980). In 1996, 'Celebrity' and 'Patio' were studied, resulting in two replications of each cultivar per growth medium. In 1997, the addition of 'Large Red Cherry' and 'Small Red Cherry' resulted in one replication for each cultivar per growth medium. Data analyses were directed toward both seasonal distribution and total production of number and weight of fruits.

RESULTS

Compost Analysis

Nutritive values for the brush- and leaf-composts were about equal for N (ca. 1%), P (trace), and K (0.45%), whereas N-Viro Soil had a similar level of N (ca. 1%) but higher levels of P (0.56%) and K (0.67%) (Table 1). Variance among the C : N ratios was the most important difference in nutritive value of the

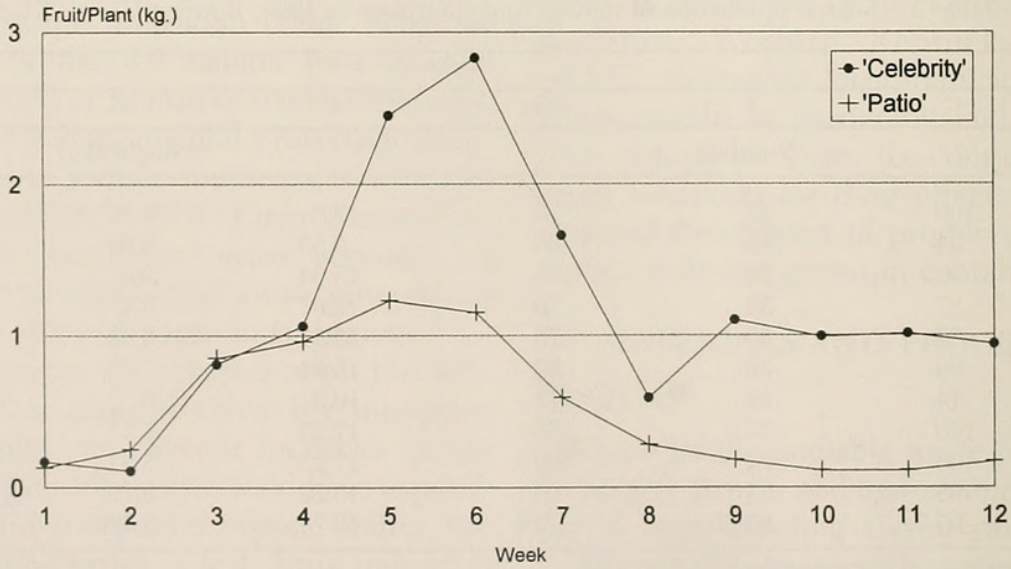

Figure 2. Season distribution of weight of fruits/plant for 'Celebrity' and 'Patio' tomatoes in 1996, Bowling Green, Kentucky.

Table 3. Season production of tomato fruits per plant in 1997, Bowling Green, KY.

Growth Mixture[1]	Cultivar[2]									
	C	P	LRC	SRC	Mean[3]	C	P	LRC	SRC	Mean[3]
	Number					Weight (kg)				
S	60	51	525	940	394	5.15	2.42	8.18	4.01	4.94
B	51	76	67	1082	319	7.19	3.21	1.26	5.2	4.22
L	91	34	383	710	304	9.68	4.44	5.94	4	6.02
N	73	34	408	980	374	10.17	3.84	6.34	4.54	6.22
S-B	45	60	362	765	308	7.56	6.08	6.06	4.13	5.96
S-L	80	28	270	786	291	9.31	1.91	4.19	3.92	4.83
S-N	47	41	320	1017	356	5.2	3.5	5.2	4.92	4.7
B-L	92	45	344	794	319	11.68	3.69	6.57	4.03	6.49
B-N	39	40	457	1077	403	4.69	3.76	7.79	5.86	5.52
L-N	57	32	353	899	335	8.91	3.75	5.71	3.88	5.56
Mean[3]	64c	44c	349b	905a	340	7.95a	3.66b	5.72ab	4.45b	5.45

[1] S = Soil, B = Brush Compost, L = Leaf Compost, N = N-Viro Soil.
[2] C = 'Celebrity', P = 'Patio', LRC = 'Large Red Cherry', SRC = 'Small Red Cherry'.
[3] Growth mixture means were not significantly different ($P > 0.05$); Cultivar fruit number and fruit weight means followed by the same letters are not significantly different ($P > 0.05$).

composts. Ratios of 30:1, as exhibited in the brush- and leaf-composts, immobilize available N and result in N starvation of the plants. The C:N ratio of 16:1 for the N-Viro Soil should not create N deficiency in plant growth. The recommended level of fertilizer for tomato production was applied to all growth mixture to compensate for nutrient differences.

1996 Season Production

Number and weight of fruits per plant are given in Table 2. 'Celebrity' plants produced significantly more fruits (ca. 96) than did 'Patio' plants (ca. 63). Average fruit weight per plant was significantly greater for 'Celebrity' (13.74 kg) than for 'Patio' (5.89 kg). Thus, 'Celebrity' plants produced significantly more and heavier fruits than did 'Patio' plants during 1996. Although there was variability among the number and weight of fruits produced on the different growth media, yield differences associated with growth media were not significant. Analyses comparing groups of means, i.e., those mixtures including soil vs. those that did not, failed to detect any significant differences. Also, comparisons of growth media means at different harvest dates during the season failed to reveal any consistent differences.

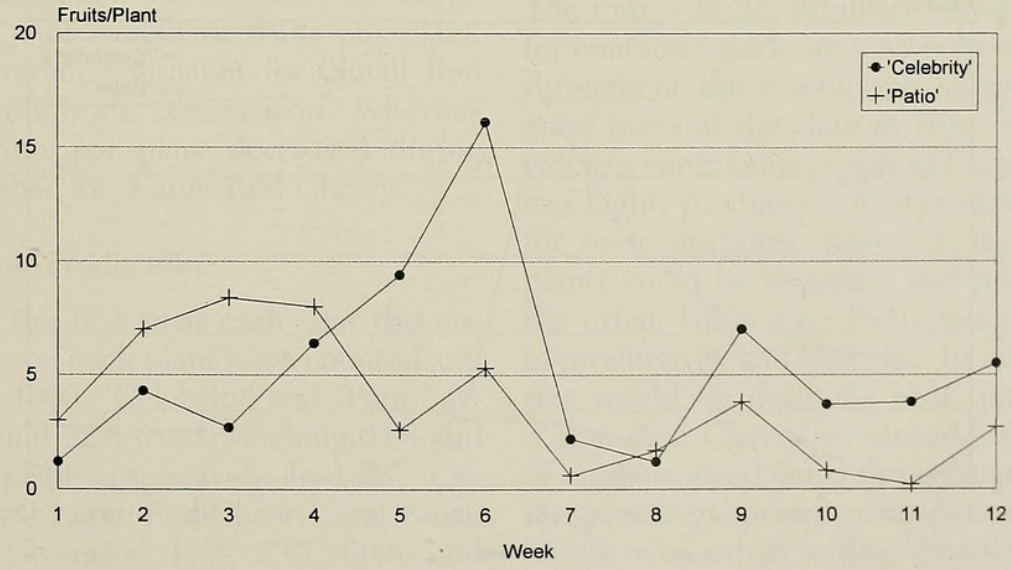

Figure 3. Season distribution of number of fruits/plant for 'Celebrity' and 'Patio' tomatoes in 1997, Bowling Green, Kentucky.

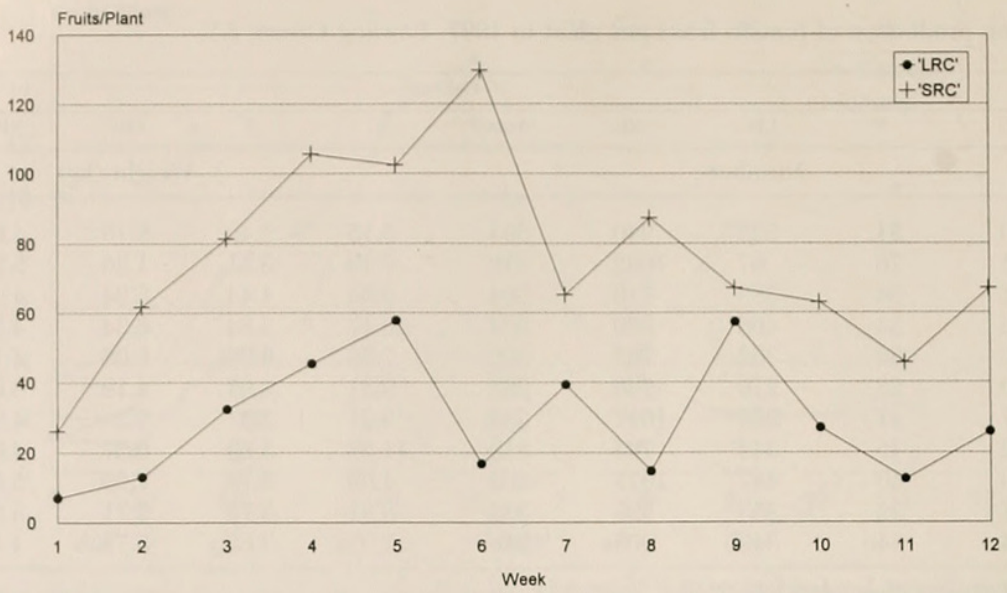

Figure 4. Season distribution of numbers of fruits/plant for 'Large Red Cherry' (LRC) and 'Small Red Cherry' (SMC) tomatoes in 1997, Bowling Green, Kentucky.

Since the growth media means did not differ significantly, yields were combined for each cultivar in determining season distributions (Figures 1, 2). Fruit ripening began in mid-July and continued until frost occurred in mid-October. Peak production for both numbers and weights of fruits occurred in late August and continued into early September. 'Celebrity' produced more and heavier fruits per plant than did 'Patio' during the second half of the season.

1997 Season Production

Number and weight of fruits per plant for each of the four cultivars are presented in Table 3. Both the number and weight of fruits per plants of 'Celebrity' and 'Patio' were lower in 1997 than in 1996. For number of fruits per plant, 'Small Red Cherry' was highest (905), 'Large Red Cherry' was intermediate (349), and 'Celebrity' and 'Patio' were lowest (64 and 44, respectively). Growth mixtures had no significant effect on number of fruits. For weight of fruits per plant. 'Celebrity' was highest (7.95 kg), 'Large Red Cherry' was intermediate (5.72 kg), and 'Patio' and 'Small Red Cherry' were lowest (3.66 and 4.45 kg, respectively). Differences among number or weight of fruits were not influenced significantly by growth mixtures when such comparisons were

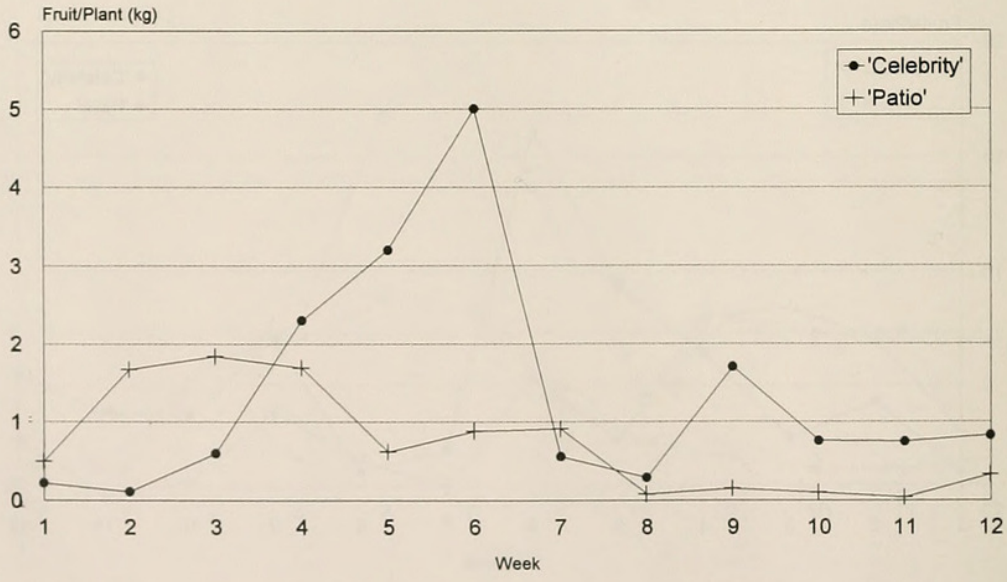

Figure 5. Season distribution of weight of fruits/plant for 'Celebrity' and 'Patio' tomatoes in 1997, Bowling Green, Kentucky.

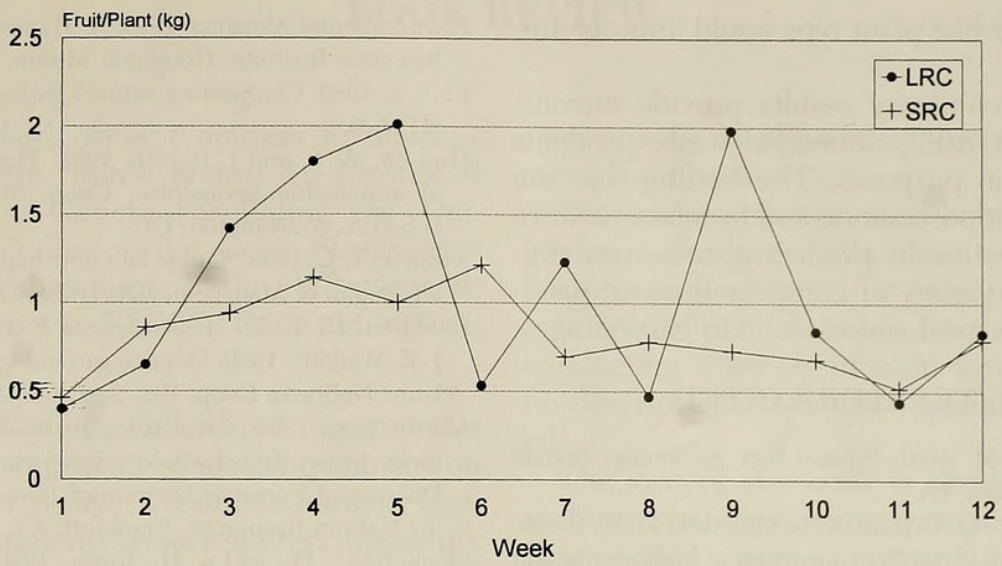

Figure 6. Season distribution of weight of fruits/plant for 'Large Red Cherry' (LRC) and 'Small Red Cherry' (SMC) tomatoes in 1997, Bowling Green, Kentucky.

based upon either total season or individual harvest period yields.

Growth mixture yields were combined for each cultivar in determining season distributions (Figures 3–6). Fruit ripening continued from mid-July throughout mid-October. For 'Celebrity' and 'Patio' the 1997 season distributions of both number and weight of fruits per plant were similar to those in 1996 with the exceptions that 'Patio' production peaked earlier in 1997 than in 1996. 'Large Red Cherry' and 'Small Red Cherry' produced an abundance of fruits throughout 1997. Peak production occurred at week 6 (end of August) for 'Small Red Cherry', but no single period of maximum production was exhibited by 'Large Red Cherry.' For weight of fruits per plant, yields were rather consistent for 'Small Red Cherry' throughout the season. whereas weight of fruits per plant decreased during early September for 'Large Red Cherry.'

End of Season Production

Following the first frost each year the unripened fruits on each plant were counted and weighed. In 1996, 'Celebrity' and 'Patio' averaged 12.8 and 22.6 fruits weighing 0.68 and 0.76 kg per plant, respectively. In 1997, 'Celebrity', 'Patio', 'Large Red Cherry', and 'Small Red Cherry' averaged 13.4, 23.7, 60.8, and 185.6 fruits weighing 0.72, 0.78, 0.48, and 0.51 kg per plant, respectively.

DISCUSSION AND SUMMARY

These results indicate that composted common waste products, either alone or in mixture, are suitable for growing tomatoes in containers. Since compost materials vary in nutritive value and C : N ratios, composted growth media need to be supplemented with a complete fertilizer (N, P, K) for protection against nutrient deficiencies.

Cultivar selection is an important consideration in container production of tomatoes. Our present results indicate that cultivar characteristics such as plant shape, plant size, and fruit number and weight are consistent whether grown in an open garden or in containers. The four cultivars exhibited different qualities for container gardening. All cultivars produced throughout the season and supported unripened fruits at the time of frost, thereby providing a continuous supply of fruits. 'Celebrity' was highly productive of large fruits as desired for some purposes. However, its large, open plants could be unsightly and problematic in the urban landscape. 'Patio' was intermediate in productivity and fruit size. Its compact plant size would be desirable in a "patio" setting. 'Large Red Cherry' produced large numbers of medium-sized fruits throughout the season. Its spreading, open plant shape could be a limitation in an urban setting. 'Small Red Cherry' was a prolific producer of small fruits throughout the season. However, smallness in fruits

and the vine-like plant type could limit its utility.

These preliminary results provide encouragement for using municipal waste products for beneficial purposes. The finding that the different composts alone and in mixtures were equally effective in producing tomatoes suggests that a variety of composted waste products may be used successfully in gardening.

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