Proc. Fla. State Hort. Soc. 123:141–146. 2010.

Postharvest Qualities and Nutrient Content of Vegetable Crops Grown with or without Compost

Nancy E. Roe*[1] and Mark A. Ritenour[2]

[1]*Farming Systems Research, Inc., P.O. Box 741112, Boynton Beach, FL 33474*

[2]*Indian River Research and Education Center, 2199 S. Rock Road, Ft. Pierce, FL 34945-3138*

Additional index words. *Lycopersicon esculentum, Cucumis sativus, Lactuca sativa*, *Capsicum annuum*, tomato, cucumber, lettuce, pepper

There have been few studies of the effects of compost on the postharvest quality and quality retention of vegetables. In this study, we grew tomato (*Lycopersicon esculentum* Mill.), pepper (*Capsicum annuum* L.), and cucumber (*Cucumis sativus* L.) fruit, and lettuce (*Lactuca sativa*) leaves with or without compost and determined tomato, pepper, and cucumber fruit and lettuce leaf nutrient uptake and tested the quality of their fruit before and after storage. The experiments were conducted over two seasons in southeastern Florida on raised beds with polyethylene mulch, drip irrigation, and fertigation. Treatments were no-compost, single-year compost, and multi-year compost. Horse manure compost was applied at 10 wet tons per acre the first season and 19 wet tons per acre the second season. Tomato fruit Ca was different only in the first season, P was different in both seasons, and K was different in the second season with similar trends in the first season. In the first season, Ca in the pepper fruit was higher from plants in the no-compost plots, Mn was lower in fruit from the multi-year compost plots, and Cu was lower in fruit from plants in the single-year compost plots than the from plants in the other two treatments. In the second season, Mn was again lower in plants from compost plots, as was Zn. There were no differences in cucumber fruit nutrients during the first season, and in the second season only P was higher in plants from the multi-year compost treatment. During the first season, lettuce leaf Ca was higher in plants from the multi-year compost plots than in plants from the single-year compost and no-compost plots, with no differences during the second season. The growth of these crops with and without compost resulted in few differences in postharvest storage quality in any of the crops and no clear trends.

Vegetable growers amend their soils with compost for many reasons: to add nutrients, increase water holding capacity, increase cation exchange capacity, and control diseases. In some cases, compost soil amendments increased yields and nutrient uptake. The use of a biosolids-yard trimming compost contributed to increased uptake of Ca, P, K, Mg, and Cu into foliage of pepper plants (Roe et al., 1997). Ozores-Hampton et al. (1997) reported that the concentrations of Cd, Cu, Ni, Pb, Zn generally increased in tomato and squash (*Cucurbita pepo*) fruit grown in soil amended with municipal solid waste (MSW) from one source, but not from another. There have been few studies, however, of compost amendments on the postharvest quality and quality retention of vegetables during storage.

Crop nutrient status can affect postharvest quality. Part of the fruit ripening process involves the movement of Ca out of the cell wall, and senescence can even be slowed by adding Ca (Mengel and Kirkby, 1987). Therefore, we chose to study the effects of compost on the postharvest qualities of vegetable crops. The objectives of this study were to determine how compost use during production affects nutrient content in tomato, pepper, and cucumber fruit and lettuce leaves at harvest, and how postharvest quality retention is affected in the harvested products.

This research was funded by a Producer Grant from the Southern Region Sustainable Agriculture Research and Education Program.

*Corresponding author; phone: (561) 683-2755; email: ner@bellsouth.net

Materials and Methods

General cultural information for both seasons. All plants were grown in Boynton Beach, FL, on Myakka sand (sandy, siliceous, hyperthermic Aeric Haplaquad). Beds were constructed 8 inches high, 36 inches wide, and were spaced 6 ft, center to center. The 100-ft-long plots were divided in half so that two different crops could be grown concurrently. Tomatoes and peppers were grown during the first part of each season (September–January), and cucumbers and lettuce were grown during the second part (February–May). Each crop was tested over two seasons. There were four replicates per treatment. Planting and harvesting dates, cultivars used, and postharvest storage durations are listed in Table 1.

One drip irrigation tape with 0.4 gal/h emitters spaced at 12 inches (Netafim, Fresno, CA) was installed in the center of each bed. Fertilizer was applied through the drip tape to all treatments at the rate of 1.50 lb/acre per day N and K for the entire growing season. White on black polyethylene mulch (0.00012 inches thick) was used on all plots.

Horse manure compost was produced on the farm by turning a horse manure/wood chip bedding mixture with a front-end loader when internal pile temperature dropped below 124 °F every 3–4 weeks for 6 months. Then compost was "cured" in a static pile for about 4 months before being applied manually to the beds. The compost used the first season was not tested, but the second season results are presented under Second Season, 2001–02.

Nutrient testing. Unless stated otherwise, nutrient tests were performed on five fruit or lettuce heads per replicate by a com-

Table 1. Crop, cultivar, planting and harvesting dates, and total days in storage before final quality evaluations were conducted.

	2000–01 Season				2001–02 Season			
Crop	Cultivar	Planting date	Harvest dates	Days in storage	Cultivar	Planting date	Harvest dates	Days in storage
Tomatoes	Agriset	5 Oct.	29 Jan.	21	Big Beef	20 Sept.	11 Dec.	22
			8 Feb.	26			7 Jan.	24
Peppers	Orion	18 Sept.	13 Dec.	35	Orion	6 Sept.	19 Nov.	42
			4 Jan.	54			7 Jan.	43
Cucumbers	Speedway	27 Feb.	24 Apr.	36	Speedway	13 Feb.	10 Apr.	23
			1 May	35			15 Apr.	28
Lettuce	Ermosa	22 Feb.	26 Mar.	23	Ermosa	5 Mar.	3 Apr.	21

mercial laboratory (Pioneer Laboratory, Fort Pierce, FL). Fruit samples were washed, cut from stem to blossom ends, and one half of each was used for nutrient analysis. The samples were dried in an oven at 194 °F for 24 h, ground, and the N concentration of 0.000176 oz of dried tissue was determined using a Flash EA1112 nitrogen/protein analyzer (ThermoQuest, Milan, Italy). The other elements were digested using a dry ash method and analyzed by an inductively coupled plasma atomic emission spectroscopy (ICP-AES) Spectro Model #M160 (Spectro Analytical Instruments, Kleve, Deutschland).

First growing season: 2000–01. All plots were covered with clear polyethylene mulch and solarized from 30 June to 6 Sept. 2000. For all compost plots, horse manure compost was applied over the beds at 10 wet tons per acre on 7 Sept. Machinery was not available to till it in so it was applied on the soil surface of the beds and covered with the polyethylene mulch. Treatments were no-compost, single-year compost, or multi-year composts. The multi-year compost plots had received a yard trimming compost at 25 wet tons per acre the year before this research began.

'Agriset' tomato transplants, with a determinant growth habit, were spaced 20 inches apart in one row slightly offset from the middle of the bed because the drip irrigation tape was in the center. Tomato fruit were harvested pink (pink or red color covering between 30% and 60% of the surface) or red (red color over >90% of fruit surface) for both harvests. Fruit were washed with a dilute (100 ppm) NaOCl solution, packed into 0.5-bushel waxed fiberboard boxes, and taken to the University of Florida Indian River Research and Education Center (IRREC) at Ft. Pierce for postharvest evaluations.

Firmness (deformation) of five red fruit per replicate was tested by positioning them on their side in a concave base and taking measurements on opposite sides of each tomato along the equatorial region, avoiding regions over the radial pericarp walls. Fruit firmness was measured using a Texture Analyzer (model TA-XT2; Stable Micro Systems, Godalming, England) equipped with an 11-mm convex probe. A 2.2-lb force was applied and the fruit deformation (mm) measured after 5 s. These five fruit were then used for nutrient analysis as described above. Remaining whole fruit were held at 60 °F with 95% relative humidity (RH), and then evaluated for decay and other disorders after cold storage.

'Orion' pepper plants were spaced 10 inches apart in two rows spaced 12 inches center to center. Mature green peppers were harvested on the first harvest date, and red peppers at the second harvest date (Table 1).

After harvest, pepper fruit were washed with a 100 ppm NaOCl solution, stored overnight at 50 °F, packed into 1.11-bushel fiberboard boxes, and then transported to the IRREC. Five fruit per replicate were used to evaluate initial fruit color, weight, length, width, outer wall thickness, and shoulder crack resistance. Fruit color measurements were taken around the sides of three fruit per replicate at three evenly spaced locations using a Minolta Chromameter (model CR-300; Minolta Camera Corp., Ramsey, NJ). Outer wall thickness of three locules was measured for each of the five fruit using a micrometer.

Shoulder crack resistance was measured by removing and positioning the top half of the pepper (shoulder side up) on the platform of a texture analyzer (model TA-XT2; Stable Micro Systems). A 0.43-inch probe was brought down on the shoulder at 0.04 mm/s and the force required to fracture the pericarp wall recorded. Fruit were stored at 50 °F and 90% RH and evaluated for decay, stem drying and shrivel (water loss), or any other disorders after cold storage.

'Speedway' cucumbers were seeded into new holes punched in the mowed pepper plots; two rows per bed at 10 inches in row, one seed per hole. Mature cucumber fruit were harvested, washed with a 100 ppm NaOCl solution, packed in 1.11-bushel waxed fiberboard boxes, and stored overnight at 50 °F before testing. Nutrient analysis was conducted only on fruit from the first harvest. Five fruit per replicate were used to evaluate initial fruit color and weight on fruit from the second harvest. External color and weight of the same fruit were measured again after storage. Fruit color measurements were taken near the stem, middle and blossom end of each fruit using the Minolta Chromameter. Color was reported as L* (lightness), a*, b*, a*/b* ratio, hue, and chroma (saturation). Lightness separates color into bright and dark while a* measures green (negative) to red (positive) and b* measures blue (negative) to yellow (positive). As fruit turn from green to yellow, a*/b* values increase from negative to positive. The hue angle is expressed in degrees and is a measure of color that, for example, from 90° to 180° spans from yellow to green. Chroma is a measure of color intensity with low values representing dull colors and high values representing vibrant colors. Fruit were stored at 50 °F with 90% RH and evaluated for decay and other disorders after cold storage.

'Ermosa' bibb lettuce transplants were transplanted in two rows per bed at 10 inches in-row into new holes punched in the mowed tomato plots. Heads were determined to be mature when they felt firm. Fifty mature heads per plot were cut, placed into individual, unsealed plastic bags, and then into waxed fiberboard boxes each holding 12 heads. The heads were transported for testing in a 55 °F truck. Lettuce heads were stored at 36 °F with 95% RH for 23 d at which point wrapper and inner leaves were evaluated separately for yellowing, decay, insect injury, and the presence of insects.

Second growing season: 2001–02. Plots used for the no-compost and single-year compost treatments were established in a different section of the field than was used during the first year. The multi-year compost plots were the same multi-year compost

Table 2. Nutrient content of first-harvest tomato fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000–01 season.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	3.52	0.54 b[z]	5.24	0.21 b	0.25	159	16	58	16	0.0008	20
Single year	3.88	0.59 b	5.80	0.22 b	0.28	195	17	40	18	0.0009	20
Multi-year	3.80	0.70 a	5.80	0.31 a	0.27	187	17	35	16	0.0008	22
Significance	NS	***	NS	*	NS	NS	NS	NS	NS	NS	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
NS, *, ***Nonsignificant or significant at $P \leq 0.05$ or 0.001, respectively.

Table 3. Nutrient content of first-harvest tomato fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2001–02 season.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	2.66	0.56 b[z]	4.18 b	0.25	0.17	63	10	35	15	0.0005	19
Single year	2.76	0.61 ab	4.81 a	0.24	0.17	70	10	36	16	0.0004	19
Multi-year	2.84	0.64 a	4.89 a	0.25	0.18	72	9	32	15	0.0004	18
Significance	NS	**	*	NS	NS	NS	NS	NS	NS	NS	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
NS, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

plots that were used during the 2000–01 season. All beds were covered with clear polyethylene mulch and solarized from 5 July to 22 Aug. 2001 before planting.

The horse manure compost was tested by Woods End Research Laboratory, Inc.(Mt. Vernon, ME) and found to contain 27.8% organic matter, 1.25% N, 0.78% P, 0.74% K, 0.17 % Na, 4.03 % Ca, and 0.30% Mg (dry basis). Carbon : nitrogen ratio was 12, and the pH was 8.3. The maturity index was 7 (mature). Both the single-year compost and multi-year compost plots were applied over the beds at 19 dry tons per acre on 23 Aug. It was tilled about 6 inches deep into the soil using a tractor-propelled rototiller.

'Big Beef' tomatoes were spaced 30 inches apart in one row slightly offset from the middle of the bed. Harvest and postharvest treatments were similar to those of the first season. In addition to firmness, external color and total soluble solids (TSS) content were also evaluated on pink and red fruit. Fruit color measurements were taken around the fruit equator at three evenly spaced locations using the Minolta Chromameter. Fruit firmness was measured using a new device (Ritenour et al., 2002) that applied 2.2-lb force to the tomato surface through an 0.43-inch convex probe. Fruit deformation (mm) was recorded after 5 s of applied force. Each of the five fruit were then cut in half lengthwise (stem to blossom end). One half was used for nutrient analysis and the other for TSS analysis using a refractometer (Spectronic Instruments, Rochester, NY). Remaining whole fruit were held at 55 °F with 95% RH, and then evaluated for decay and other disorders after cold storage.

Peppers were grown, harvested, and evaluated postharvest as in the previous season (Table 1).

Cucumbers were grown, harvested and evaluated postharvest as in the previous season; The only exceptions were that the plants were grown in the tomato plots from earlier in the season, and that the fruit from the first harvest were held at 60 °F and the second at 10 °C (50 °F) after the first and second harvests, respectively, for about 24 h before transport to IRREC.

Lettuce plants were grown as in the previous season except that they were planted into the mowed pepper plots from earlier in the season, and 24 lettuce heads per plot (if available) were harvested, and they were not bagged before being placed in the boxes. Three heads were removed from each box for nutrient analysis. Color was measured on heads used for nutrient analysis starting with the first uninjured, non-wrapper leaf, and on the next three successive leaves. The lettuce was weighed before and after storage. Storage conditions and the final evaluation were as in the previous season.

Statistical analysis. Data were analyzed by analysis of variance using SAS (PROC GLM) for PC (SAS Institute Inc, Cary, NC) as a split block because the MYC plots were in a separate area of the field from the no-compost and single-year compost plots. Percent data were transformed to arcsine values before analysis but untransformed means are presented. When differences were significant ($P < 0.05$), individual treatment means were separated using Duncan's Multiple Range Tests ($P = 0.05$). Only data sets with significant results were presented.

Results and Discussion

Tomatoes. In the first season, concentrations of P and Ca in fruit from the plants in multi-year compost plots were significantly higher than those from the no-compost or single-year compost plots (Table 2). In the second season, P was again higher in fruit from the multi-year compost plots, and K was higher in fruit from both the multi-year and single-year compost plots (Table 3). There

Table 4. Fruit softness (deformation) of second-harvest tomatoes grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2001–02 season.

Treatment	Deformation (mm)[z]
No compost	0.18[y]
Single year	0.13 b
Multi-year	0.16 ab
Significance	*

[z]Millimeters (mm) of depression from 2.2 lb of force applied for 5 s.
[y]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
*Significant at $P \leq 0.05$.

Table 5. Nutrient content of pepper fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000-01 season, first-harvest.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	2.3	0.42	3.1	0.17 a[z]	0.16	71.8	13 a	40	15 a	0.032 b	22
Single year	2.2	0.38	3.2	0.14 b	0.16	62.7	13 ab	36	13 b	0.038 ab	20
Multi-year	2.1	0.42	3.4	0.13 b	0.16	89.5	11 b	34	15 a	0.042 a	21
Significance	NS	NS	NS	*	NS	NS	*	NS	*	*	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
[NS, *]Nonsignificant or significant at $P \leq 0.05$, respectively.

Table 6. Nutrient content of pepper fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2001-02 season, second-harvest.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	2.06	0.33	2.61	0.16	0.15 a[z]	60	13.5 a	34 a	23	0.032	16
Single year	1.96	0.30	2.61	0.13	0.13 b	49	10.5 b	29 ab	25	0.030	17
Multi-year	1.72	0.31	2.49	0.14	0.13 b	89	8.0 b	24 b	19	0.030	15
Significance	NS	NS	NS	NS	*	NS	**	**	NS	NS	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
[NS, *, **]Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

were no significant differences in the concentrations of the other nutrients measured. In general, concentrations of nutrients in fruit from the second season plants were lower than in the fruit from the first season (Tables 2 and 3). This could represent normal annual variations or differences in nutrient uptake between the two tomato varieties used. Ozores-Hampton et al. (1997) reported differences in heavy metal concentrations in tomato fruit between two growing seasons, even though the same cultivar was used. While Ca was significantly different only in the first season (Table 2), P was higher in fruit from multi-year compost plots both seasons, and K was higher in fruit from compost plots in the second season and showed a similar trend in the first season (Table 3). Though not significant either season, N and Fe from no-compost plots tended to be low in both seasons (Tables 2 and 3).

Table 7. Fruit decay after 43 d storage at 50 °F of second-harvest pepper fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2001–02 season.

Treatment	Decay (%)
No compost	77.2 a[z]
Single year	74.6 a
Multi-year	40.4 b
Significance	***

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
[*]Significant at $P \leq 0.0001$.

In most cases, compost treatments had no effect on postharvest quality or quality retention of the tomato fruit. There were no significant differences between compost treatments in external tomato color or decay either year, as well as fruit softness in the first season (data not shown). In the second season, however, tomatoes from single-year compost plots were significantly firmer (less deformation) than fruit from the no-compost treatment (Table 4).

Peppers. In the first season, Ca in pepper fruit from the no-compost plots was higher than in fruit from the other plots, Mn was lower in fruit from the multi-year compost plots than in the no-compost plots, and Cu was lower in fruit from single-year compost than the other two treatments (Table 5). In the second season, only Mn and Zn were different, both being higher in no-compost plots (Table 6).

As with tomato, in most cases, compost treatments had no effect on postharvest quality or quality retention of the pepper fruit (data not shown). The only exception was in the second season where peppers from the no-compost and single-year compost treatments decayed significantly faster than those from multi-year compost treatment (Table 7).

Cucumbers. There were no differences in cucumber fruit nutrient content during the first season (data not shown), and, in the second season, only P was higher in the multi-year compost treatment (Table 8).

In the first season, first-harvest cucumbers from the single-year compost treatment had lower decay ratings than those from the

Table 8. Nutrient content of first-harvest cucumber fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2001–02 season.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	3.69	0.58 b[z]	4.85	0.44	0.26	183	192	166	28	0.085	31
Single year	3.21	0.62 b	5.10	0.38	0.25	178	134	145	23	0.087	34
Multi-year	3.88	0.71 a	5.28	0.46	0.27	172	104	116	21	0.009	40
Significance	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
[NS, **]Nonsignificant or significant at $P \leq 0.01$, respectively.

Table 9. Fruit decay after 36 d storage at 50 °F of first-harvest cucumber fruit grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000–01 season.

Treatment	Decay (%)
No compost	49.5 ab[z]
Single year	22.0 b
Multi-year	61.2 a
Significance	*

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
*Significant at $P \leq 0.05$.

Table 10. External color of first-harvest cucumber fruitafter 36 d storage at 150 °F. Plants were grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000–01 season.

Treatment	L	a*	b*	a*/b*	Hue	Chroma
No compost	43.23	–17.28	32.02 a[z]	–0.54 a	118.36 b	36.38 a
Single year	41.21	–16.21	28.04 b	–0.58 b	120.09 a	32.40 b
Multi-year	44.23	–17.79	33.85 a	–0.53 a	117.75 b	38.24 a
Significance	NS	NS	*	**	**	*

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
NS, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

Table 11. Initial fruit weight, or fruit decay after 20 d storage at 50 °F of second-harvest cucumber fruit that were grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000–01 season.

Treatment	Wt (oz)	Decay (%)
No compost	14.36 b	9.5 a
Single year	17.01 a	10.0 a
Multi-year	12.86 b	0.0 b
Significance	**	*

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
*, **Significant at $P \leq 0.05$ or 0.01, respectively.

multi-year compost treatment (Table 9). After storage, cucumber fruit from single-year treatments maintained their green color better (lower a* and a*/b* ratio, and higher hue) than fruit from the no-compost or multi-year compost treatments (Table 10). Weight of individual cucumbers from single-year compost treatments was higher than the other treatments, but fruit decay of no-compost and single-year compost treatments was significantly greater than the multi-year compost treatment (Table 11).

Lettuce. During the first season, lettuce leaf Ca was higher from multi-year compost plots MYC than in single-year or no-compost plots (Table 12). There were no differences during the second season (data not shown). Since the plant part being measured in the lettuce is the leaf, rather than the fruit, it is probably more likely to show direct differences from soil amendments of Ca. There were no differences in postharvest qualities of the lettuce in either year (data not shown).

Compost amendments have been previously reported to increase crop nutrient uptake. Roe et al. (1997) reported increased P, K, Ca, Mg, and Cu in pepper leaf tissue from plots with compost added at 224 dry $Mg \cdot ha^{-1}$. However, whether these increased leaf tissue nutrient concentrations affect harvested fruit quality and postharvest shelf life was not clear. In all cases of the current studies when there were differences in tomato fruit or lettuce foliar nutrient concentrations, nutrients were higher from compost plots, especially the multi-year compost treatments. However, these differences were not evident in the pepper fruit and only slightly in the cucumber fruit. Ozores-Hampton et al. (1997) reported that even increased loading rates of Zn and Cu from municipal waste composts did not increase concentrations of Zn and Cu in tomato fruit.

The compost used in the current studies contained about 4% Ca, so the compost added about 800 lb/acre the first season and almost twice that the second season. There were significant Ca increases in tomatoes harvested from multi-year compost plots in the first season (Table 2) and lettuce (Table 12), but the reverse was true of the peppers grown in the first season (Table 5). Additions of Ca to the soil did not always result in increased crop uptake because it may have been unavailable due to the form in which it was present. However, compost may increase Ca uptake due to increases in water holding capacity (Christou et al., 1994). Other cations in the soil or compost, such as K and NH_4, could also interfere with Ca uptake (Mengel and Kirkby, 1987).

Application of compost produced some increases in P concentration in tomato and cucumber fruits (Tables 2, 3, and 8). The major proportion of P is often in the organic matter of the soil, which may be the case in this research. Other factors such as mycorrhizal growth and chelation can contribute to increased uptake of P from soils with organic amendments (Mengel and Kirkby, 1987). Baziramakenga and Simard (2001) reported that P concentration in snap bean seed was similar when a paper sludge/poultry manure compost was added to soil at rates from 0 to 19 tons per acre.

There were no clear patterns in the other parameters we measured. There were some indications of increased firmness or storage life of tomato and cucumber fruit with single-year compost application. But multi-year compost treated fruit were actually more similar to fruit from no-compost treatment. That could be a result of the type of compost used, time of application, or differences between plant responses. Peppers from the second season were the only crop that appeared to store longer when compost had been applied, especially over multiple years (Table 7).

Although many studies compare organically grown vegetables

Table 12. Nutrient content of first-harvest lettuce leaves that were grown with no-compost, single-year horse compost, or multi-year compost treatments during the 2000–01 season.

	(%)					ppm					
Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Na	B
No compost	4.9	0.58	3.39	0.91 b[z]	0.35	294	312	82	18	0.006	33
Single year	4.6	0.54	3.56	0.84 b	0.30	235	327	69	17	0.006	33
Multi-year	4.6	0.69	3.81	1.08 a	0.37	237	382	101	20	0.056	32
Significance	NS	NS	NS	**	NS	NS	NS	NS	NS	NS	NS

[z]Values within each column followed by unlike letters are significantly different by Duncan's multiple range test at $P < 0.05$.
NS, **Nonsignificant or significant at $P \leq 0.01$, respectively.

with conventionally grown ones, few compare only the effects of compost on vegetable nutrient uptake or quality factors. DeEll and Prange (1993) reported that more conventionally grown than organically grown apples were marketable after storage. However, that could be a result of factors other than organic soil amendments, such as protection by fungicides used on the conventionally grown fruit or damage from surfactants used on the organic fruit. More studies on the postharvest effects of compost are needed to help growers make a decision about including composts in their production systems.

Literature Cited

Baziramakenga, R. and R.R. Simard. 2001. Effect of deinking paper sludge compost on nutrient uptake and yields of snap bean and potatoes grown in rotation. Compost Sci. and Util. 9(2):115–126.

Christou, M., S. Leoni, P. Cornillon, A. Gainza, Y. Dumas, A. Rodriguez, and A. Dimirkou. 1994. Influence of water and nitrogen availability on elemental composition of processing tomato fruit in EU countries. Acta Hort. 376:185–192.

DeEll, J.R. and R.K. Prange. 1993. Postharvest physiological disorders, diseases and mineral concentrations of organically and conventionally grown McIntosh and Cortland apples. Can. J. Plant Sci. 73:223–230.

Mengel, K. and E.A. Kirkby. 1987. Principles of plant nutrition. Intl. Potash Inst., Bern, Switzerland.

Ozores-Hampton, M., E. Hanlon, H. Bryan, and B. Schaffer. 1997. Cadmium, copper, lead, nickel, and zinc concentrations in tomato and squash grown in MSW compost-amended calcareous soil. Compost Sci. and Util. 5(4):40–45.

Roe, N.E., P.J. Stoffella, and D. Graetz. 1997. Composts from various municipal solid waste feedstocks affect vegetable crops. II. Growth, yields, and fruit quality. J. Amer. Soc. Hort. Sci. 123(3):433–437.

Ritenour, M.A., E.M. Lamb, P.J. Stoffella, and S.A. Sargent. 2002. A portable, digital device for measuring tomato firmness. Proc. Fla. State Hort. Soc. 115:49–52.