Proc. Fla. State Hort. Soc. 115:315-321. 2002.

EFFECT OF ORGANIC FERTILIZER APPLICATIONS ON GROWTH, YIELD AND PESTS OF VEGETABLE CROPS

DAN O. CHELLEMI[1]
USDA, ARS, U.S.
Horticultural Research Laboratory
Ft. Pierce, FL 34945

GEORGE LAZAROVITS
SCPFRC
Agriculture and Agri-Food Canada
1391 Sandford Street
London Ontario, Canada, N5V 4T3

Additional index words. cantaloupe, organic agriculture, pepper, purple nutsedge, *Sclerotium rolfsii*, soil quality, tomato, yellow nutsedge

Abstract. **Field experiments were conducted to measure the yield response of Cantaloupe (*Cucumis melo*), pepper (*Capsicum annuum*), and tomato (*Lycopersicon esculentum*) to an organic fertilizer derived from hydrolyzed feather, meat, bone, and blood meal, sulfate of potash and langeinite (Nature Safe 10-2-8). The effects on soilborne pests, soil nutrient concentrations, and soil microorganism populations were also determined. The field site had been previously cropped to tomato using conventional production practices and was judged to have low soil fertility. Application of 560 N, 110 P, 440 K (kg·ha^{-1}) resulted in an increase in soil pH, ammonia concentrations and counts of total soil fungi, but not total soil bacteria. Based on observations of growth, necrosis and mortality an application rate of 440 N, 88 P, 352 K (kg·ha^{-1}) was phytotoxic to pepper. Phytotoxicity on tomato was observed at an application rate of 1120 N, 220 P, 880 K (kg·ha^{-1}). A quadratic effect of application rate was observed for yield of pepper (r^2 = 0.83) and tomato (r^2 = 0.98). Optimum yields were projected to occur at 310 N, 62 P, 248 K (kg·ha^{-1}) for pepper and 400 N, 80 P, 320 K kg·ha^{-1} for tomato. A second location that had been previously cropped to vegetables under certified organic production guidelines and had moderate levels of soil fertility, was used to test the effect on cantaloupe yields. An application rate of 110 N, 22 P, 88 K (kg·ha^{-1}) of Nature Safe increased early yields as compared to a formulation of dried poultry manure (NOPI 5-4-5) applied at 112 N, 90 P, 112 K (kg·ha^{-1}) or an unfertilized control. However, final total yields of cantaloupe were similar among the three treatments. The effect of fertilizer rates on emergence of yellow (*Cyperus esculuntus*) and purple nutsedge (*C. rotundus*) was erratic with suppression observed at rates phytotoxic to pepper. Reductions in the incidence of southern blight, caused by *Sclerotium rolfsii*, occurred on tomato and pepper at application rates below the rates required for optimum yields. This study demonstrates that organic fertilizers can provide multiple benefits for Florida vegetable production systems including improving fertility, increasing soil microbial populations, and reducing the incidence of a soilborne disease.**

Mention of a trademark, warranty, proprietary product, or vendor does not constitute a guarantee by the United States Department of Agriculture and does not imply its approval to the exclusion of other products or vendors that may also be suitable. This research was supported by Osceola Organics and Griffin Industries, Inc.

[1]Corresponding author

In Florida, the production of high value, fresh market vegetable crops such as tomato (*Lycopersicum esculentum*) and pepper (*Capsicum annuum*) has traditionally relied on a combination of high analysis fertilizers and fumigation under raised, polyethylene mulched beds (Geraldson, 1962; Geraldson et al., 1965; Maynard and Olson, 2001). Since the 1970s, fumigation had been conducted almost exclusively with methyl bromide:chloropicrin mixtures. Florida tomato and pepper growers now account for 24% of the methyl bromide consumed in the United States for soil fumigation (U.S. EPA., 2002). Methyl bromide has been identified as a significant contributor to the destruction of the ozone layer (World Meteorological Organization, 1998) and a phaseout of its production and importation in the United States will be completed in 2005 (Federal Register, 2000). Methyl bromide has been considered essential for the production of many fresh market vegetables in Florida; and without a suitable replacement, direct losses in sales are projected to exceed $1 billion (Spreen et al., 1995).

Nonchemical alternatives to methyl bromide include host resistance, organic amendments, crop rotation, soil solarization, and other cultural practices (Chellemi, 2002). High nitrogen containing organic amendments have been used to effectively control soilborne plant pathogens and plant parasitic nematodes (Cook and Baker, 1983; Lazarovits et al., 1999; Rodriguez-Kabana, 1986; Tsao and Oster, 1981). Two distinct modes of action can be attributed to the suppression of soilborne pests using these amendments. A direct mode involves the accumulation of compounds such as ammonia (NH_3) or nitrous acid (HNO_3) at levels toxic to soilborne pests (Lazarovits et al., 2000; Tenuta and Lazorvitis, 2002). An indirect mode involves the alteration of soil microbial communities to create an environment antagonistic to soilborne pests (Jenkinson and Powelson, 1976; Lumsden et al., 1983). High nitrogen-containing organic fertilizer can also serve as a nutritional alternative to high-analysis mineral fertilizers (Blatt, 1991). The objectives of this study were to test the suitability of an organic fertilizer approved by the Organic Materials Review Institute (OMRI, Eugene, Ore.) for the production of fresh market vegetables and to measure the impact of application rates on plant health, soil quality and populations of weeds and soil microorganisms.

Materials and Methods

Fall 2000 Tomato and Pepper Experiments. In the fall of 2000, two experiments were conducted in St. Lucie County, Florida at a location that had been in conventional tomato production for 10 years. The soil type was a Pineda fine sand (loamy, siliceous, hyperthermic, Arenic Glossaqualfs) with low organic matter, cation exchange capacity, and residual levels of N and K (Table 1). Each experiment received the same fertilizer and soil disinfestations treatments. One experiment was planted to tomato and the other to pepper.

Main treatments were three application rates of an organic fertilizer and one application rate of a synthetic mineral fertilizer (Table 2). The organic fertilizer was derived from

Table 1. Chemical and physical characteristics of soils at the field experimental sites.

Site	Organic matter	ENR[z]	P	K	pH	CEC[y]	Percent base saturation K	Mg	Ca	H	Na	Soil texture sand	silt	clay
		-------kg·ha⁻¹	--------				-----------------		%		-----------------	----------%		----------
St. Lucie County	1.7%	78	287	96	6.9	4.2	3	8	87	2	0	93	4	3
Indian River County	4.3%	145	443	236	6.6	9.3	5	17	70	8	0	90	5	5

[Z]ENR = estimated nitrogen release (kg·ha^{-1}).
[y]meq/100 g soil.

hydrolyzed feather, meat, bone and blood meal, sulfate of potash and langeinite (Nature Safe 10-2-8, Griffin Industries, Inc., Cold Spring, Ky.) and approved by OMRI. Subtreatments were with or without soil solarization. Main treatments were arranged in a randomized complete block design with four replications. Main plots were 2 × 30 m and subplots were 2 × 15 m. Fertilizer treatments were broadcast applied into the main treatments and rototilled to a depth of 15 cm on 28 Aug. Raised beds, 25 cm high × 90 cm wide, were constructed and covered by low density-polyethylene plastic mulch on the same day. Clear plastic was used for the soil solarization treatment and white over black, co-extruded plastic was used for the nonsolarized treatment. The solarization period extended for 44 d and was terminated on 11 Oct. by painting the plastic mulch white with a latex paint. Both experiments were planted with 6-week-old 'Boynton Bell' pepper seedlings on 16 Oct. In the tomato experiment, pepper transplants were removed on 30 Oct. and replaced with 6-week-old 'Florida 91' tomato seedlings on 1 Nov.

Soil samples were collected 24 days after fertilizer applications to measure soil pH, nitrate levels, and populations of total bacteria and fungi. Five cores (2 x 15 cm) were removed randomly from each plot and bulked together in double plastic bags. Samples were held at 5 °C until analysis. Counts of total bacteria and total fungi were determined by adding 10 g of soil to 90 ml of sterile water agar (0.1% w/v) in a plastic pouch (17 cm × 30 cm). The pouches were heat-sealed and shaken on an orbital shaker (200 rpm) for 2 h. Then the soil mixtures were homogenized by placing the pouches in a Stomacher blender set on normal speed for 30 s. Serial 10-fold dilutions were prepared in saline solution (0.85% NaCl) and plated onto acid potato dextrose agar (fungi) and Psuedomonas-Agar F (bacteria).

Table 2. Nutrient application rates (per ha) for tomato and pepper fertilizer treatments.

Fertilizer	Rate	N	P	K
	MT/ha	-------	kg·ha⁻¹	-------
Fall 2000 Experiments				
Organic 10-2-8	2.2	220	44	176
Organic 10-2-8	5.5	550	110	440
Organic 10-2-8	11.0	1120	220	880
Synthetic 16-0-19	1.4	224	0	266
Spring 2001 Experiments				
Organic 10-2-8	0.0	0	0	0
Organic 10-2-8	2.2	220	44	176
Organic 10-2-8	4.4	440	88	352
Organic 10-2-8	6.6	660	132	528

Ammonia concentration was determined by shaking a mixture of soil (8 g) and water (40 ml) on an orbital shaker (200 rpm) for 1 h and then centrifuging for 5 min. The supernatant was analyzed for anions with a DIONEX DX-100 Ion Chromatograph. Anions were separated using an IonPac AS12A column (4 × 200 mm) with 2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$ buffer (1.5 ml·min^{-1}). Samples and standards (12.5 (L) were injected with concentrations in the 1-150 ppm range. Peaks were measured with an ion conductivity detector and quantified using Millenium™ software. Ammonia concentrations were calculated as the fraction of total (NH_3 + NH_4^+) in solutions using the Henderson-Hasselbalch equation knowing soil pH and incubation temperature.

Counts of nutsedge plants emerging through the plastic were taken 59 and 105 d after treatments were applied. Counts of the total number of weeds emerging through the plastic and present in the planting holes were taken 105 d after treatment. Plant health assessments were made at 41 and 55 d after transplanting in the tomato and pepper experiment, respectively using an index where: 0 = plant dead or moribund; 1 = no growth observed since transplanting; 2 = growth observed but plant remained stunted; 3 = slight necrosis of foliage observed; and 4 = healthy plant. Data was analyzed as a split-plot experiment using the general linear models procedure in STATISTICA (StatSoft, Tulsa, Okla.). Variance in microbial count data was normalized using the $ln\ (x + 1)$ transformation, where x equals the average number of propagules per gram of dry soil. Plant health assessments were normalized prior to analysis using the square root transformation.

Spring 2001 Cantaloupe Experiment. The 2001 cantaloupe experiment was conducted in Indian River County, Florida on a certified organic vegetable farm that had been in production for 5 years. The soil type was a Winder fine sand (fine-loamy, siliceous, hyperthermic, Typic Glossaqualfs) with moderate levels of organic matter, residual N, and cation exchange capacity and high levels of P and K (Table1). Treatments were (a) a control (no additional fertilizer), (b) the organic fertilizer derived from feather meal (Nature Safe 10-2-8), and (c) a pelletized, dried, poultry manure (NOPI 5-4-5, Natural Organics Products International, Mt. Dora, Fla.) and were replicated four times in a randomized complete block design. Nature Safe 10-2-8 was applied 1.1 ton/ha (at 112 N,10 P,74 K (kg·ha^{-1}, respectively). NOPI 5-4-5 was applied at 2.2 mt/ha (112 N, 39 P,93 K (kg·ha^{-1}, respectively). Replicate plots measured 6 m wide x 20 m long. Within plots, three rows were established on a 2 m spacing. Fertilizer was applied and raised-plastic-mulched beds were constructed on 28 Feb. using procedures described in the Fall 2000 tomato and pepper experiments. Eighteen-day-old 'Athena' cantaloupe seedlings were transplanted on 2 Mar. Plots were harvested on 7, 10, 14, and 17 May and marketable yields were determined.

Spring 2001 Tomato and Pepper Experiments. Additional tomato and pepper experiments were conducted at the St. Lucie county location described earlier. Identical fertilizer treatments were applied to both experiments. Treatments were Nature Safe 10-2-8 applied at 0, 2.2, 4.4, and 6.6 ton/ha (Table 2). Treatments were arranged in a randomized complete block with four replications. Each replicate plot was 2 × 33 m. Fertilizer was broadcast applied and rototilled to a depth of 15 cm on 7 Mar. Immediately following incorporation of the fertilizer, 25 cm high × 90 cm wide beds were constructed and covered by white over black, co-extruded, low density, polyethylene plastic mulch. Six-week-old 'Enterprise' pepper seedlings were transplanted into the pepper experiment and 6-week-old 'Florida 91' tomato seedlings were transplanted into the tomato experiment on 26 Mar., 19 d after fertilizer applications. Plant spacing within rows was 45 cm.

Plants health ratings were made 53 d after transplanting using the same 0-4 rating scale previously described. The number of nutsedge plants emerging through the plastic was counted 52 d after transplanting. Disease ratings for southern blight (*Sclerotium rolfsii*) were made 74 d after transplanting. Plants were harvested on 8 June and marketable yield determined. Disease incidence and plant health data was normalized before analysis using the arc sine transformation, and square root transformation, respectively. Data were subjected to an analysis of variance. Regression analysis was conducted to quantify the relationship between application rates and marketable yield.

Results and Discussion

Fall 2000 Tomato and Pepper Experiments. In the fall 2000 experiments, ammonia levels in the soil solution were affected by fertilizer treatments in both experiments but not by soil solarization. When the application rate of N was 224 $kg \cdot ha^{-1}$, ammonia levels in the soil solution were negligible, regardless of the source of fertilizer (Tables 3, 4). When the application rate for the organic fertilizer was increased 2.5 fold, ammonia levels increased dramatically. Similar trends were observed for soil pH in the tomato experiment (Table 3). In the pepper experiment, differences in soil pH were observed between the organic and mineral fertilizer when applied at the same N rate (Table 4).

Counts of total bacteria from soil samples taken 24 d after application were not affected by fertilizer or solarization treatments in either experiment. Counts of total fungi in soil samples were not affected by soil solarization but increased in the organic fertilizer treatments when the application rate was increased (Tables 3 and 4). Nutsedge populations emerging through the plastic mulch were a mixture of yellow (*Cyperus esculentus*) and purple nutsedge (*C. rotundus*). At 59 d after application, nutsedge counts were reduced by soil solarization in both experiments. At 105 d after application, no differences in counts of nutsedge and total weeds were observed between the solarized and nonsolarized treatments. In the tomato experiment, the organic fertilizer applications suppressed the emergence of nutsedge at 105 d after application

Table 3. Effect of fertilizer treatments on soil properties, tomato health and emergence of weeds in Fall 2000 experiment.

							Nutsedge[v]		Total weeds[v]
Fertilizer	Rate[z]	NH_3 y	pH	Total bacteria[x]	Total fungi[x]	Plant health[w]	59 d	105 d	105 d
Organic 10-2-8	2.2	0.0 a[u]	7.0 a	2.2 x 10^7 b	2.5 x 10^4 b	3.3 a	1.8 a	2.5 ab	6.9 ab
Organic 10-2-8	5.5	22.3 b	8.3 b	2.3 x 10^7 b	6.8 x 10^3 a	2.6 a	0.0 a	0.0 b	17.5 b
Organic 10-2-8	11.0	55.8 c	8.8 b	4.6 x 10^7 b	3.1 x 10^3 b	1.7 b	0.5 a	0.5 b	3.0 a
Mineral 16-0-19	1.4	0.0 a	7.1 a	7.6 x 10^6 a	2.3 x 10^4 b	2.9 a	4.9 a	12.4 a	2.2 a

[z]Metric tons/ha.
[y]mM in soil solution.
[x]Colony forming units (CFU) per gram of soil.
[w]Plant health was estimated based on an index where 0 = plant dead or moribund; 1 = no growth observed since transplanting; 2 = growth observed but plant remained stunted; 3 = slight necrosis of foliage observed; and 4 = healthy plant.
[v]Number per m^2 of row, days = days after treatment application.
[u]Mean separation by Duncan's new multiple range test, 5% level of significance.

Table 4. Effect of fertilizer treatments on soil properties, pepper health and emergence of weeds in Fall 2000 experiment.

							Nutsedge[v]		Total weeds[v]
Fertilizer	Rate[z]	NH_3 y	pH	Total bacteria[x]	Total fungi[x]	Plant Health[w]	59 d	105 d	105 d
Organic 10-2-8	2.2	1.4 a[u]	7.8 b	1.3 x 10^7 b	2.0 x 10^4 b	2.1 a	13.9 b	28.8 a	49.0 a
Organic 10-2-8	5.5	19.6 b	8.4 c	3.3 x 10^7 c	1.5 x 10^3 ab	1.51 ab	12.5 b	19.4 a	37.6 a
Organic 10-2-8	11.0	51.0 c	8.8 c	3.3 x 10^7 c	1.1 x 10^2 a	0.86 b	0.8 a	7.6 a	15.4 a
Mineral 16-0-19	1.4	0.0 a	7.3 a	4.2 x 10^6 a	1.5 x 10^4 b	2.37 a	12.5 b	14.6 a	37.1 a

[z]Metric tons/ha.
[y]mM in soil solution.
[x]Colony forming units (CFU) per gram of soil.
[w]Plant health was estimated based on an index where 0 = plant dead or moribund; 1 = no growth observed since transplanting; 2 = growth observed but plant remained stunted; 3 = slight necrosis of foliage observed; and 4 = healthy plant.
[v]Number per m^2 of row, days = days after treatment application.
[u]Mean separation by Duncan's new multiple range test, 5% level of significance.

(Table 3). However, at the same rating period, total weed counts were highest when the organic fertilizer was applied at 5.6 tons/ha. In the pepper experiment, nutsedge and total weed counts were not significantly different among the treatments at 105 d after apllication.

Ratings for plant health were similar in the solarized and nonsolarized treatments for both experiments. In the tomato experiment, plant health ratings in the mineral fertilizer application and the low and medium application rate of the organic fertilizer were similar and no phytotoxic affects were observed (Table 3). However, when the organic application was increased to 11.2 t/ha, plant health declined significantly. Phytotoxicity symptoms observed in the high application rate included seedling mortality, stunting, and necrosis of the foliar tissue. Pepper appeared to be more sensitive to the increased application rates of the organic fertilizer (Table 4). Symptoms of phytotoxicity were observed in the 5.6 ton/ha application rate. No yield data was obtained from the experiments due to an early freeze in December that severely damaged the plants.

Spring 2001 Cantaloupe Experiment. In the cantaloupe experiment, significantly higher yields of marketable fruit were obtained in the first harvest from the organic fertilizer derived from feather, meat, bone, and blood meal products (Table 5). Yields in the two to four harvest dates were similar among the three treatments. Total marketable yields reached 13.5 t/ha in the organic fertilizer treatment derived from meat and bone meal products. The incidence of soilborne pests was low in all three treatments.

Spring 2001 Pepper and Tomato Experiments. At 20 d after application of organic fertilizers, soil pH increased with increasing application rate and the response was linear (Fig. 1). Ammonia concentrations in the soil remained low until organic fertilizer applications were increased to 4.4 ton/ha hectare (Fig. 2). A quadratic response was observed between ammonia concentrations in the soil and fertilizer application rate. Counts of total fungi and total bacteria in soil samples increased in a linear fashion as fertilizer rates were increased (Figs. 3 and 4). The largest increases were observed for bacteria.

As in the fall 2000 experiments, tomato and pepper differed in their sensitivity to increasing rates of the organic fertilizer. Some symptoms of injury due to fertilizer application were observed on tomato at the high application rate, but the differences were not significant (Table 6). Plant health ratings of pepper indicated that injury occurred at the medium and high rates of fertilizer application (Table 7). An outbreak of southern blight, caused by the fungus *Sclerotium rolfsii*, occurred on both tomato and pepper. On tomato, application

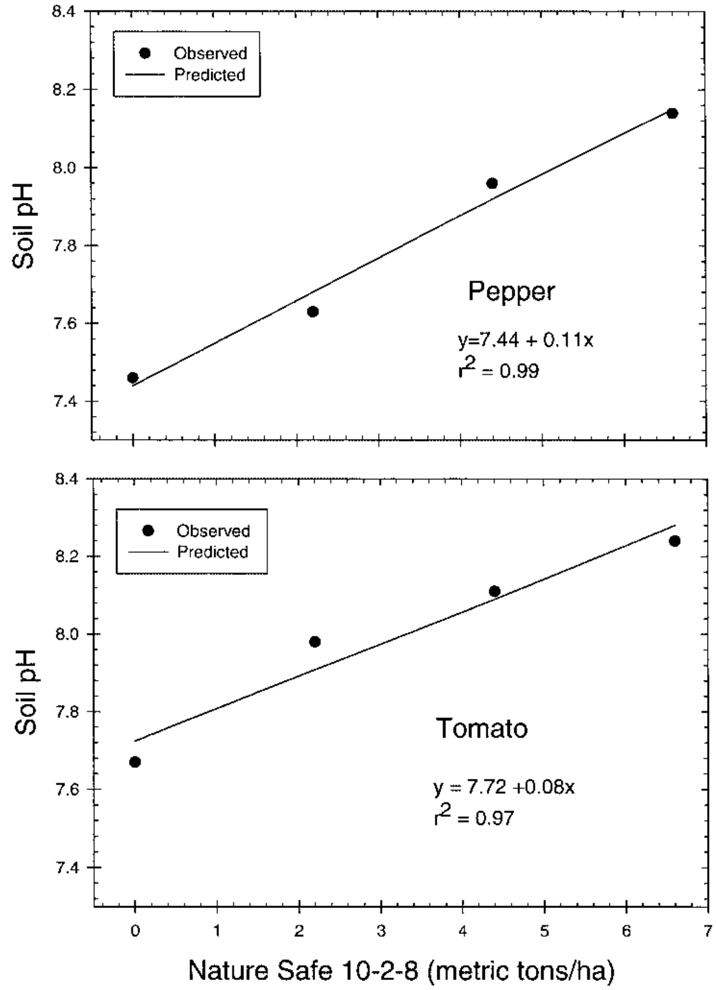

Fig. 1. Relationship between application rates of an organic fertilizer (Nature Safe 10-2-8) and soil pH measured 20 d after application.

of the low rate of organic fertilizer reduced the incidence of disease from 48% to 1% (Table 6). No disease was observed in treatments receiving the medium and high rate of fertilizer applications. Southern blight was also observed in the pepper experiment but the incidence of disease was not as high. The low application rate of the organic fertilizer reduced the incidence from 9% to 4% (Table 7). No disease was observed in the medium and high application rates of organic fertilizer. In the pepper experiment, organic fertilizer applications did

Table 5. Marketable yield (ton/ha) for 'Athena' cantaloupe grown with several organic fertilizers.

	Harvest dates				
Fertilizer	1st	2nd	3rd	4th	Total
None	0.9 a[z]	5.6 a	1.3 a	3.5 a	11.3 a
Dried poultry manure	1.5 a	6.8 a	1.4 a	3.3 a	13.0 a
Meat & bone meal	2.5 b	5.8 a	1.4 a	3.8 a	13.5 a

[z]Mean separation by Duncan's new multiple range test, 5% level of significance. Means in each column followed by the same letter are not significant at 5%.

Table 6. Effect of fertilizer treatments on health of tomato and the incidence of disease caused by *Sclerotium rolfsii* in the spring 2001 experiment.

Fertilizer	rate[z]	Plant health[y]	Disease incidence (%)
Organic 10-2-8	0.0	3.8 a[v]	48 a
Organic 10-2-8	2.2	4.0 a	1 b
Organic 10-2-8	4.4	4.0 a	0 b
Organic 10-2-8	6.6	2.9 a	0 b

[z]Metric tons/ha.
[y]Plant health was estimated based on an index where 0 = plant dead or moribund; 1 = no growth observed since transplanting; 2 = growth observed but plant remained stunted; 3 = slight necrosis of foliage observed; and 4 = healthy plant.
[v]Mean separation by Duncan's new multiple range test, 5% level of significance.

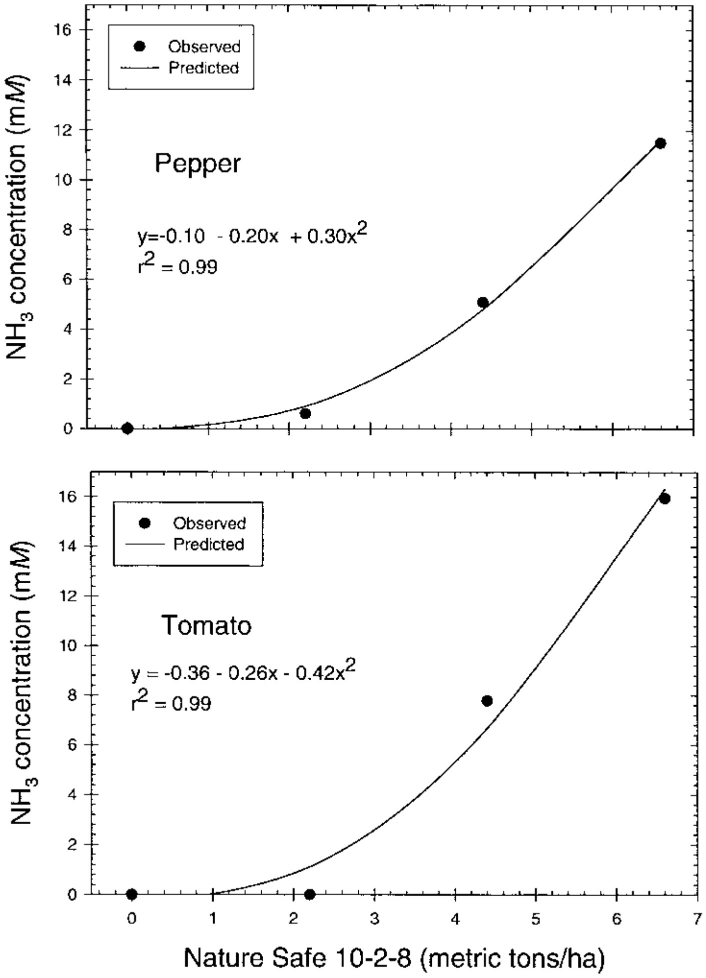

Fig. 2. Relationship between application rates of an organic fertilizer (Nature Safe 10-2-8) and ammonia (NH_3) measured 20 d after application.

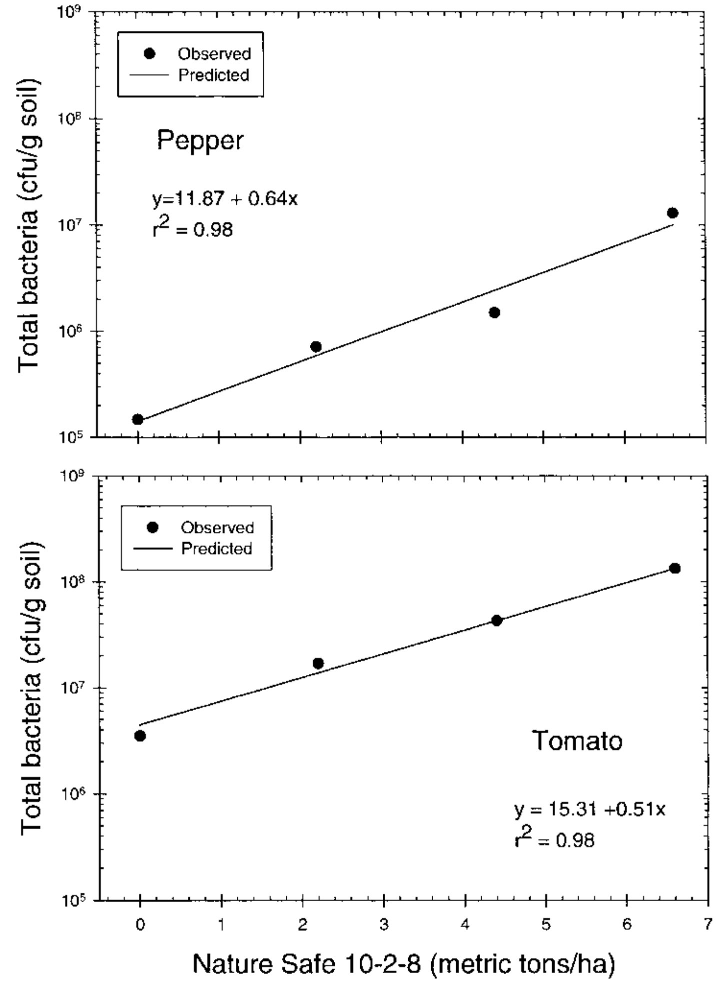

Fig. 3. Relationship between application rates of an organic fertilizer (Nature Safe 10-2-8) and total bacteria in soil measured 20 d after application.

not affected the emergence of yellow or purple nutsedge (Table 7). The incidence of nutsedge was not measured in the tomato experiment.

A quadratic effect was used to describe the relationship between application rates and marketable yield with coefficient of determination (r^2) values ranging from 0.98 for tomato to 0.83 for pepper (Fig. 5). Using the regression coefficients derived from the analysis, maximum yields on tomato were projected to occur at an application rate of 1.8 ton/ha (400 N, 36 P, 266 K $kg \cdot ha^{-1}$). Maximum yields for pepper were projected to occur at an application rate of 1.4 ton/ha (310 N, 27 P, 206 K $kg \cdot ha^{-1}$).

Table 7. Effect of fertilizer treatments on growth of pepper, emergence of nutsedge and the incidence of disease caused by Sclerotium rolfsii.in the spring 2001 experiment.

Fertilizer	rate[z]	Plant health[y]	Disease incidence (%)	Nutsedge[v] 52 d
Organic 10-2-8	0.0	3.9 a[u]	9 a	5.3 a
Organic 10-2-8	2.2	3.8 a	4 ab	3.7 a
Organic 10-2-8	4.4	2.6 b	0 b	6.6 a
Organic 10-2-8	6.6	1.7 b	0 b	4.0 a

[z]Metric tons/ha.
[y]Plant health was estimated based on an index where 0 = plant dead or moribund; 1 = no growth observed since transplanting; 2 = growth observed but plant remained stunted; 3 = slight necrosis of foliage observed; and 4 = healthy plant.
[v]Number per m^2 of row, days = days after treatment application.
[u]Mean separation by Duncan's new multiple range test, 5% level of significance.

Summary. Differences in initial soil quality and fertility existed between the location where tomatoes where grown conventionally and the location where vegetables were cultivated under certified organic production guidelines, with more favorable parameters present in the organic site (Table 1). Despite the moderate residual levels of organic matter, N, P, and K present at the organic site, a N application rate of 110 $kg \cdot ha^{-1}$ of the fertilizer derived from feather, meat, bone, and blood meal significantly increased the marketable yield of the first harvest. The supply of quality organic fertilizers has been a limiting factor for Florida organic vegetable growers (Monaghan et al., 1994). This study demonstrated that supplemental use of organic fertilizers can significantly impact marketable yields in a certified organic production farm.

Soil pH, NH_3, and counts of total fungi were increased at a N application rate of 560 $kg \cdot ha^{-1}$. Similar changes in soil chemistry and biology are associated with conditions leading to the control of soilborne pests following applications of high nitrogen-containing organic materials (Lazarovits et al., 2000). However, this application rate was phytotoxic to pep-

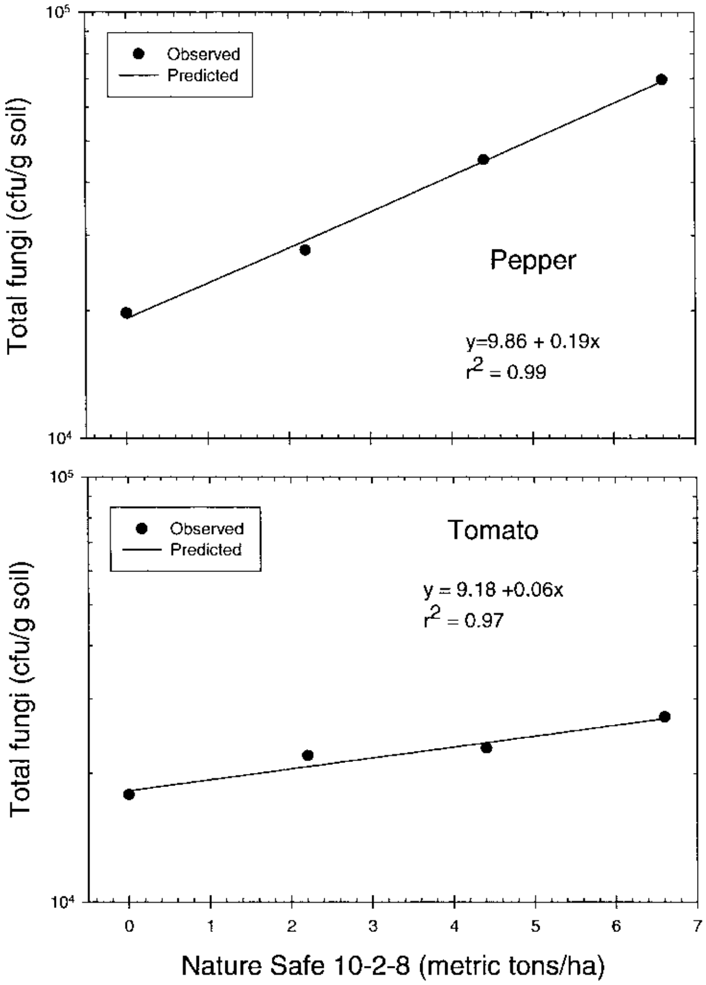

Fig. 4. Relationship between application rates of an organic fertilizer (Nature Safe 10-2-8) and total fungi in soil measured 20 d after application.

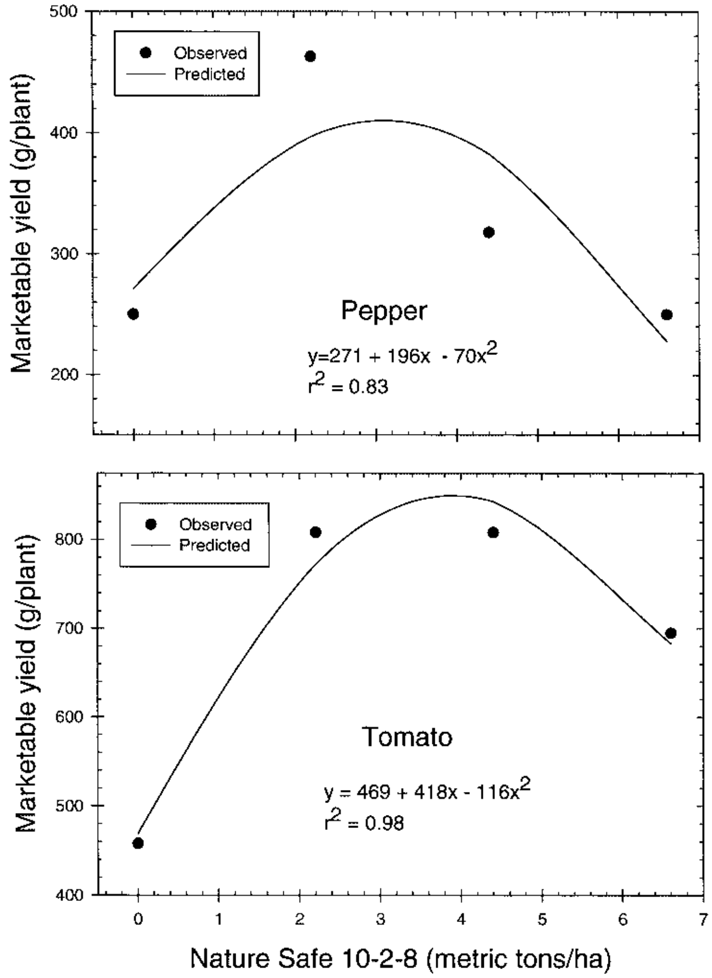

Fig. 5. Relationship between application rates of an organic fertilizer (Nature Safe 10-2-8) and marketable yield of tomato and pepper.

per, resulting in stunting and mortality of plants. Furthermore, yield reductions occurred at N application rates greater than 310 and 400 $kg \cdot ha^{-1}$for pepper and tomato, respectively. Phytotoxicity and negative effects on yield could be avoided by delaying the planting date.

Southern blight, caused by *Sclerotium rolfsii*, is a major soilborne disease of tomato and pepper. Control of southern blight was achieved at application rates below those phytotoxic to the crop and detrimental to yield. Nitrogen containing soil amendments have been used to control southern blight on sugar beets and peanuts (Watkins, 1961). With the exception of ammonia, inhibition of *Sclerotium rolfsii* by N containing amendments was not from the direct affects of N containing compounds but rather from the stimulation of antibiotic organisms associated with the sclerotia (Henis and Chet, 1968). In this study, organic fertilizers stimulated microbial activity in the soil by increasing counts of fungi and bacteria. It is possible that the control of southern blight observed in the 2001 tomato and pepper experiments was due to a biological as well as a chemical effect of the organic fertilizer.

This study demonstrated that organic fertilizers can provide benefits to Florida vegetable crop production that extend beyond soil fertility. In the search for alternatives to methyl bromide, studies have indicated that no single chemical or nonchemical tactic is available that will provide the same consistent level of broad-spectrum pest control as methyl bromide (Chellemi, 2001; Locascio et al., 1997) and it has been argued that an integrated approach to pest management is needed in the development of alternatives to methyl bromide. By providing multiple horticultural and pest control benefits, organic fertilizers are well suited for use in integrated pest management programs for soilborne pests of fresh market vegetables.

Literature Cited

Blatt, C. R. 1991. Comparison of several organic amendments with a chemical fertilizer for vegetable production. Sci. Hort. 47:177-191.

Chellemi, D. O. 2001. Field validation of methyl bromide alternatives in Florida fresh market vegetable production systems. U.N. FAO Plant Production and Protection Paper 166. p. 25-27.

Chellemi, D. O. 2002. Nonchemical management of soilborne pests in fresh market vegetable production systems. Phytopathology (92:1367-1372).

Cook, R. J. and K. F. Baker, 1983. The nature and practice of biological control of plant pathogens. APS Press, St. Paul, Minn., 539 p.

Federal Register, November 8, 2000. Protection of Stratospheric Ozone: Incorporation of Clean Air Act Amendments for Reductions in Class I, Group VI Controlled Substances. Vol. 65, No. 229, p. 70795-70804.

Geraldson, C. M. 1962. Growing tomatoes and cucumbers with high analysis fertilizers and plastic mulch. Proc. Fla. State Hort. Soc. 75:253-260.

Geraldson, C. M., A. J. Overman, and J. P. Jones. 1965. Combination of high analysis fertilizers, plastic mulch and fumigation for tomato production on old agricultural land. Soil Crop Sci. Fla. Proc. 25:18-24.

Henis, Y. and I. Chet. 1968. The effect of nitrogenous amendments on the germinability of sclerotia of *Sclerotium rolfsii* and on their accompanying microflora. Phytopathol. 58:209-211.

Jenkinson, D. S. and D. S. Powlson. 1976. The effects of biocidal treatments on metabolism in soil – V. A method for measuring soil biomass. Soil Biol. Biochem 8:209-213.

Lazarovits, G., K. L. Conn, and J. Potter. 1999. Reduction of potato scab, verticillium wilt, and nematodes by soymeal and meat and bone meal in two Ontario potato fields. Can. J. Plant Pathol. 21:345-353.

Lazarovits, G., M. Tenuta, and K. L. Conn. 2000. Utilization of high nitrogen and swine manure amendments for control of soilborne diseases: efficacy and mode of action. Acta Hort. 532:59-64.

Locascio, S. J., J. P. Gilreath, D. W. Dickson, T. A. Kucharek, J. P. Jones, and J. W. Noling. 1997. Fumigant alternatives to methyl bromide for polyethylene mulched tomato. HortScience 32:1208:1211.

Lumsden, R. D., J. A. Lewis, and G. C. Papavizas. 1983. Effect of organic amendments on soilborne plant diseases and pathogen antagonists. p. 51-70. In W. Loceretz (ed). Environmentally Sound Agriculture. Praeger, New York.

Maynard, D. N. and S. M. Olson. 2001. Vegetable production guide for Florida. University of Florida Extension, Citrus & Vegetable Magazine.

Monaghan, P. F., G. H. Brinen, and S. R. Kostewicz. 1994. Organic vegetable production in Florida. Proc. Fla. State Hort. Soc. 107:377-380.

Rodriquez-Kabana, R. 1986. Organic and inorganic nitrogen amendments to soil as nematode suppressants. J. Nematol. 18:129-135.

Spreen, T. H., J. J. VanSickle, A. E. Moseley, M. S. Deepak, and L. Mathers. 1995. Use of methyl bromide and the economic impact of its proposed ban on the Florida fresh fruit and vegetable industry. University of Florida, Bulletin 898 (Tech.).

Tenuta, M. and G. Lazarovits. 2002. Ammonia and nitrous acid from nitrogenous amendments kill the microsclerotia of *Verticillium dahliae*. Phytopathology 92:255-264.

Tsao, P. H. and J. J. Oster. 1981. Relation of ammonia and nitrous acid to suppression of *Phytophthora* in soils amended with nitrogenous organic substances. Phytopathology 71:53-59.

U.S. EPA. 2002. Methyl bromide phase out web site. http://www.epa.gov.spdpublc/mbr/.

Watkins, G.M. 1961. Physiology of *Sclerotium rolfsii* with emphasis on parasitism. Phytopathology 51:110-113.

World Meteorological Organization. 1998. Scientific Assessment of Ozone Depletion: 1998. Executive Summary. Global Ozone Research and Monitoring Project – Report No. 44.