to provide a release of nutrients and or an increase in exchange capacity for use in retention of added nutrients in the profile.

The main effect of CYW rate on soil analysis data are listed in Table 3. The K, Ca, Mg, Zn, Mn and organic matter content increased linearly with increased rates of CYW application. The soil Cu linearly decreased with increased rate of CYW application indicating that the Cu was tied up by organic matter. Although the Mn and Zn concentration *increased, these value* appear to be in a safe range. These types of compost do not in general contain excessively high concentrations of heavy metals and probably should be of little concern. Soil pH and P levels were not affected by rate of CYW applicaion.

The use of as high as 100 tons/acre of CYW appears to be useful and reasonable for pole bean production as long as adequate fertilizer to grow the crop is present. Immature CYW can result in N tie-up and reduce yield if not accounted for in the fertility program as evidenced by the 1993 application. Application of CYW appears to have a residual benefical effect since yield increased with increasing rate of residual CYW. It is unclear, however, whether that effect is due to retention of added fertilizer or release of nutrients from breakdown of the CYW.

Table 3. Main effects of CYW rate on soil chemical analysis. July 1993.

Rate of CYW (ton/acre)	pH	Mineral concn. (ppm) P	K	Ca	Mg	Cu	Zn	Mn	OM (%)
0	6.96	225	26	1045	47	1.4	4.6	10	0.9
25	6.95	216	30	1125	54	1.2	4.6	11	1.2
50	6.94	215	38	1224	62	1.0	5.1	12	1.2
100	6.91	218	52	1420	76	1.0	5.7	13	1.6
F test	ns[z]	ns	L**	L**	L**	–L**	L**	L**	L**

[z]Regression analysis indicated responses were not significant (ns) or (L) linear at the (**) 1% level.

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Municipal Solid Waste (MSW) Soil Amendments: Influence on Growth and Yield of Snap Beans

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Abstract. **The effects of compost derived from Municipal Solid Waste (MSW) on crop growth has only been recently investigated due to current availability of these materials in large quantities. The purpose of this study was to determine the effects of MSW (Reuter compost) on plant stands, growth, and yields of snap beans (*Phaseolus vulgaris* L). MSW was incorporated into calcareous limestone soil at 0, 90, 134 t·ha⁻¹ in the fall of 1992. Plant stands and bean yields were not different among treatments. However, fresh shoot weight increased quadratically as rates of compost increased. In a second Experiment, fertilizer applications at planting were compared with a control (no fertilizer). No additional compost was applied in Experiment 2. Plant stands were the highest when no fertilizer and 90 t·ha⁻¹ of MSW were used. Total snap bean yields were higher with fertilizer at planting than with no fertilizer. Total snap bean yields increased quadratically as rates of compost increased.**

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Municipal solid waste (MSW) includes paper, cardboard, glass, metals, plastics, rubber, leather, textiles, wood, food waste, and yard waste. The Environmental Protection Agency (EPA) has estimated that approximately 65 percent of the MSW produced in the U.S. is reusable organic material. MSW has recently become of greater interest in the United States, since landfills across the country are near capacity, and few additional facilities have been approved for construction (Rathje, 1991). In 1992, there were 19 operating MSW composting facilities in the United States with 7 under construction and over 150 in various stages of planning (Hyatt et al., 1992). Nationally, the number of private and MSW composting ventures has more than doubled since 1989 (Gillis, 1992). The largest potential user of MSW compost is the agricultural industry (Parr and Hornick, 1992). Vegetable crops are grown on about 21,000 ha in southern Florida with the majority located near a large and growing urban population, so it presents an important potential market for compost (Ozores-Hampton, 1993).

Most benefits from MSW compost applications to soil have been attributed to improved physical properties of the soil due to increased organic matter content rather than their value as a nutrient source (Gallardo-Lora and Nogales, 1987; Hernando et al., 1986). Soils with MSW amendment has increased yields of tomatoes (*Lycopersicon esculentum* Mill.) (Maynard, 1993), tomatoes and squash (*Cucurbita maxima* Duch. Ex Lam.) (Ozores-Hampton, 1993), papaya, beans (*Phaseolus vulgaris* L), okra (*Abelmoschus esculentus* L) (Bryan, 1990), and blackeye peas (*Pisum sativum* L) (Bryan and Lance, 1991). The soil in southern Dade County, Florida is classified as loamy-skeletal, mixed (Calhoun et al., 1974) and is low in fertility (Bryan and Lance, 1990). Addition of organic matter to the soil can improve structure, aeration, nutrient content and water holding capacity (Brady, 1974).

The purpose of this study was to determine the effects of MSW compost on plant stands, growth, and yields of snap beans growing in calcareous soils of southern Dade County, Florida.

Material and Methods

Snap beans 'Triump' and 'Pod Squad' were planted at Homestead, Florida in 1992 and 1993. MSW compost processed from urban solid waste in aerated windrow (Reuter Recycling of Florida, Inc.) was applied on the soil surface and disced into the 12.5 cm of calcareous limestone soil at 0.90 and 134 t·ha⁻¹ three weeks prior to seeding. Elemental analyses of the Reuter compost (Table 1) was determined. The experiment was a completely randomized design with treatments replicated six times. Plot size and harvested area consisted of a single 3 m long row with border row planted 53 cm apart. Beans were direct seeded at 5 cm between seeds and 53 cm between rows or equivalent to (381,000 plants/ha). Beans were sprayed according to local standard agricultural pesticides practices.

Beans were planted on 10 Oct. 1992 and harvested 3 Dec. 1992 (Experiment one). All treatment received 40-35.5-55.5 (kg N-P-K·ha^{-1}) at planting and foliar application of 72-0-60 (kg N-P-K·ha^{-1}) and 75.6-0-0 (kg N-K-P·ha^{-1}) of granular fertilizer 15 and 30 days after seeding, respectively.

Beans were grown on 19 Jan. 1993 and harvested 17 Mar. 1993 (Experiment two). Two fertility levels were superimposed on the previously applied compost treatments. These consisted of: Fertilizer at planting (all rates were the same as described in experiment 1) and a control with no fertilizer at planting, plus a foliar and granular fertilizer application at the same rates as Experiment 1. No additional compost was applied.

Plant stands, fresh shoot weight and total bean yield (included culls) was measured at the time of harvest. Since commercial bush beans are harvested only once by mechanical harvesters, plots were manually harvested once. Data were subjected to regression analyses (linear and quadratic) for the Experiment 1 and analysis of variance and regression analyses for Experiment 2.

Table 1. Nutritional analyses of municipal solid waste (MSW) material (Reuter compost).

Element	Dry weight (%)	Element	Dry weight (mg/kg)
N	1.22	Fe	9.9[z]
P	0.09	Mn	17.3[z]
K	0.24	Cd	2.4
Ca	0.26[z]	Cu	122
Mg	0.02[z]	Ni	19.2
		Pb	305
		Zn	480

[z]Immediately available.

Table 2. Main effect of municipal solid waste (MSW) rates on plant stands and total beans yield (Experiment 1).

MSW (t·ha^{-1})	No. of plants (no./m of row)	Total fruit yield (t·ha^{-1})	Top fresh weight (g/plant)
0	11.0	8.4	50.9
90	14.8	8.4	57.9
134	13.8	9.8	49.3
Regression[z]	NS	NS	*

[z]Not significant (NS) or significant (*) at $P<0.05$.

Results and Discussion

Experiment 1: Plant stands and total snap bean yields (Table 2) were not influenced by the rate of MSW applied. Shoot fresh weights of plants increased quadratically as compost rates increased (Table 2). Fitzpatrick et al., (1993) reported different blends of sludge-yard trash compost when compared with the control resulted in larger bush bean plants and had a greater biomass than the control medium. Although plant stands were not different among compost treatments, fresh shoot weight had a quadratic response to increase compost rates, possibly affecting yields adversely in the 90 t·ha^{-1} and 134 t·ha^{-1} rates due to the higher competition for nutrients, light and water.

Experiment 2: A significant interaction occurred between fertilizer at planting and MSW rate effects on plant stands. Plant stands were not different as MSW rate increased when fertilizer was applied. However, when no fertilizer was applied at planting, plant stands increased quadratically with an increase in MSW rate; with the highest stands at 90 t·ha^{-1}. Plant stands (Table 3) were higher with no fertilizer at planting and 90 t·ha^{-1} of MSW. Sikora et al. (1993) reported higher wheat (*Triticum aestivum* L.) yields when 50% compost and a 50% fertilizer combination were equal to or higher than with 100% complete fertilizer. The synergistic response from the compost-fertilizer treatment may have been the result together with other ingredients in the compost such as micronutrients or organic matter.

No significant interaction between fertilizer at planting and MSW rate occurred for total bean yields. Plants grown with fertilzier at planting (Table 4) produced higher yields than plants with no fertilizer at planting. Total snap bean yield increased quadratically with an increase rate of compost, even though the compost application occurred in the beginning of the previous crop (Table 4). Using corn (*Zea maize*) as a test crop, Shiralipour (1993) obtained an increase in yield of 10 to 135 percent when rates of compost

Table 3. Main effect of municipal solid waste (MSW) rates on plant stands (Experiment 2).

MSW (t·ha^{-1})	Fertilizer: At planting[z]	Fertilizer: Not at planting	
	Plants (no./m of row)		
0	15.1	14.3	NS
90	15.6	20.8	*
134	16.5	17.1	NS
Regression[y]	NS	*	

[z]40-35.5-55.5 (kg N-P-K·ha^{-1}).
[y]Not significant (NS) or significant (*) at $P<0.05$.

Table 4. Main effect of fertilizer at planting and municipal solid waste (MSW) rates on snap beans yield (Experiment 2).

Treatment	Bean yield ($t \cdot ha^{-1}$)
Fertilizer	
At planting[y]	12.9
Not at planting	10.7
F test[z]	*
MSW	
($t \cdot ha^{-1}$)	
0	10.8
90	13.2
134	11.1
Regression[z]	Q*

[z]Significant at P<0.05 and regression was quadratic (Q).
[y]40-35.5-55.5 (kg N-P-K·ha⁻¹).

were increased from 10 to 448 $t \cdot ha^{-1}$. The addition of MSW compost to the soil provides N almost completely in organic forms, therefore availability occurs only over an extended period of time. However, incorporation of inorganic fertilizer which is mainly water-soluble and is almost immediately available to the crops. For Experiment one, shoot fresh weight was higher when 90 $t \cdot ha^{-1}$ of MSW was incorporated as a soil amendment. For Experiment 2, the greatest effects of compost in plant population were seen in those treatments where no fertilizer was applied at planting and 90 $t \cdot ha^{-1}$ of MSW was used. Snap bean yield was higher when fertilizer was used at planting than no fertilizer at planting. The application of compost increased bean yield, with the highest yield at the rate of 90 $t \cdot ha^{-1}$ of MSW.

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SURFACE VS. SUBSURFACE DRIP IRRIGATION OF TOMATOES ON A SANDY SOIL

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Abstract. **Tomatoes (*Lycopersicon esculentum* Mill.) were produced using drip irrigation during the spring 1993 season on an EauGallie fine sand to evaluate the effects of drip irrigation tubing placement on yield. Tubes were placed on the soil surface and at a depth of 12 inches in the bed center. Daily irrigation application amounts were based on crop growth and estimations of ETo from a nearby weather station. Fertilizer rates of 192-122-183 and 279-122-279 lb/acre of N-P-K were also evaluated. Tomato plant growth and fruit production were not affected by the two fertilizer rates. However, plant size and fruit yield were lower with the drip tube placed at 12 inches than with the tube placed on the soil surface.**

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The need for conservative irrigation methods and management practices is increasing for all Florida commodities. In southwest Florida, commercial vegetable producers are one of the larger target groups that are affected by current and impending reductions in water allocations. The Southwest Florida Water Management District is encouraging growers to adopt and convert ditch conveyance subirrigation systems to either fully enclosed subirrigation systems (Clark and Stanley, 1992) or to drip irrigation (Clark et al., 1993).

One substantial benefit of drip irrigation for tomato production in Florida is the reduced water and fertilizer requirements as compared to other irrigation methods