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INFLUENCE OF IMMATURE COMPOST ON GROWTH AND YIELD OF TOMATO

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ABSTRACT

Economics often encourage utilization of compost without a curing period. Tomato (*Lycopersicon esculentum*, Mill.) transplants were set into field plots 4, 11, 19, 35, and 70 days after incorporation of uncured biosolids/yard trimming compost at 135 $t\,ha^{-1}$, Dry weights of plants in control (no-compost) plots from the first transplant date and fresh weights of plants from the last transplant date were greater than from compost plots. Fruit yields of control and compost plots were similar. In greenhouse flats, mean days to emergence were similar between treatments, and total emergence percentages in compost were lower than in a sandy field soil, but similar to a commercial peat-lite germination mix, Seedling shoot weights were similar between treatments, but root weight was lower in the peat-lite mix than in compost or soil. In general, utilization of the uncured compost was not detrimental to tomato plant growth or fruit yields.

INTRODUCTION

Florida's Solid Waste Act of 1988 (Chapter 88-130, Laws of Florida) mandated a 30% reduction in landfilling by Dec. 1994 and prohibited disposal of yard trimmings in landfills after 1 Jan., 1992, resulting in availability of substantial quantities of organic matter for commercial agricultural uses. A large portion of this material is being composted.

Compost maturity is important to its successful use in agriculture. Immature compost with a high C/N ratio can "rob" soil N (He et al., 1992; Poincelot 1975); high N (low C/N) may result in ammonia toxicity (He et al., 1992); lower oxygen caused by microbial activity in the root zone can damage plants (Chen and Inbar, 1993); and the curing period will permit beneficial fungi and actinomycetes to re-invade compost (Anid, 1986). Katayama et al. (1987) report that sewage sludge compost is stabilized when most of the ammonia produced during the composting process is nitrified.

In 1991 the Solid Waste Authority of Palm Beach County began a pilot program to compost biosolids (sewage sludge) and woody yard trimmings utilizing an agitated bed system. Carbon dioxide respiration tests have indicated that the compost is so stable that a curing period is not required (Byers, 1994). The objective of these experiments was to identify any detrimental effects of this uncured compost on tomato plants.

MATERIALS AND METHODS

Field expt. The first experiment was conducted on a commercial vegetable farm in Boynton Beach, FL. Soil type was a Myakka sand (sandy, siliceous, hyperthermic Aeric Haplaquod). Compost, obtained from the Palm Beach County Solid Waste Authority, West Palm Beach, Fla., was equal parts (by weight) of biosolids and yard trimmings which were composted in a bin about 14 days, and turned daily. The finished compost was 50% moisture and contained 1.50% N, 0.83% P, 0.37% K, 2.57% Ca, 0.22% Mg, 11300 ppm Fe, 337 ppm Zn, 190 ppm Cu, 78 ppm Mn, and 2245 ppm Na. Compost was manually applied to the field on 20 Aug., 1993, approximately 3 days after removal from the composting bin, and spread on 4 separate areas 8.75 m (the width of 5 beds and the 6 alleys beside them) by 4.6 m long. Treatments were compost at 135 t ha^{-1} (fresh weight) or no compost. All plots were rototilled and beds (20 cm high, 92 cm wide, and 1.7 m, center to center) were constructed. One drip line (Netafim, Orlando, FL) was laid 2-5 cm deep in the center of each bed. Emitters were spaced at 45 cm with each delivering 18 ml min^{-1}. Irrigation was applied twice daily, with each supplying about 9340 liter ha^{-1}. Nutrients at 1.1N and 0.9K (kg ha^{-1}/day) were added through the irrigation with each application to all plots. Beds were covered with polyethylene mulch (0.0318 mm thick). Plots were 4.6 m long and consisted of 1 bed in each treatment. A randomized complete block experimental design was used with treatments replicated 4 times.

'Agriset' tomato transplants (4 weeks old) were set into 4 cm holes manually punched in the polyethylene mulch in one bed for each treatment on 24 August, 1994 (first planting). Plants were spaced 30 cm apart in two rows spaced 45 cm apart. 'Agriset' tomatoes were similarly planted into another bed in each treatment on 31 August (second planting), and 'Solar Set' tomato transplants were set into the other 3 beds on 8 and 24 September and 29 October (third, fourth, and fifth plantings, respectively). Plant population was equivalent to 39,124 plants/ha. Plants counts were taken 4-5 times and plant height (ground level to terminal bud) and stem diameter (above cotyledonary node) were measured 2-3times for each planting. About 30 days after transplanting, every other plant in each plot was excised at ground level. fresh shoot weights were measured, shoots were dried at 70C for 4 days, and dry weights were recorded.

Fruit from remaining plants was harvested and categorized into large (5 x 6 and larger), medium (6 x 6 and 6 x 7), small (7 x 7), and culls,(Hochmuth, G.J., ed., 1988), counted, and weighed. Harvest dates were as follows (1993 and 1994):

First planting: 8 Nov., 13 Dec., 30 Dec., 7 Jan., and 20 Jan.
Second planting: 16 Nov., 23 Nov., 6 Dec., 15 Dec., 1 Jan., 8 Jan., and 20 Jan.
Third planting: 17 Nov., 24 Nov., 7 Dec., 17 Dec., 4 Jan., and 17 Jan.
Fourth planting: 31 Dec. and 17 Jan.

Cooler weather slowed ripening of the last planting so that normal farming operations at the end of the season resulted in removal of the crop before it could be harvested.

Analysis of variance by transplanting dates on all measured variables was performed using the Statistical Analysis System (SAS). Treatment means were separated by Duncan's multiple range test at P 0.05.

Greenhouse experiment

Compost from the same batch used in the Field expt. was screened through a 1.25 cm screen. Treatments consisted of screened compost, a commercial peat-lite growing mix, and an Oldsmar fine sand (sandy, siliceous, hyperthermic Alfic Arenic Haplquod). Media were placed in a polystyrene tray containing 100 5 X 5 cm cells, 1 cm deep. 'Solar Set' tomato seeds were seeded, 1 per cell on 1 Nov., 1993. Flats were placed on benches in a greenhouse where mean daily low and high temperatures were 64 and 89C. A randomized complete block was used with treatments replicated 4 times. The number of seedlings emerged was counted every 24 hours, beginning 120 hours after seeding. Mean days to emergence (MDE) were calculated according to Gerson and Honma (1978):Emergence index=Sum(days to emergence)(number emerged)/total number emerged. Eleven days after seeding, 10 plants per plot were removed from trays and excised at soil level. Roots and shoots were dried at 68C for 4 days, and weighed.

RESULTS AND DISCUSSION

Field experiment

Plant heights and stem diameters were similar between treatments at each measurement date (Table 1). Fresh weight per plant was higher in the no-compost plots as compared with compost pots, and dry weights per plant were higher in the no-compost plots in the second planting.

Marketable fruit yields were lower than normal commercial production in south Florida because tomato plants were not staked and pest control was minimal. All yield and fruit size variables were similar between treatments for each planting date (Table 2). There were no growth or yield advantages to the use of the compost, probably because water and nutrients were supplied to the plants in nearly optimum amounts through the drip irrigation. Roe and Kostewicz (1990) reported that low rates of compost did not affect broccoli yields, but yields were higher with higher fertilizer rates.

Greenhouse experiment

MDE were similar between treatments, but total emergence was highest in sand and lowest in compost (Table 3). Roe and Kostewicz (1992) reported lower germination percentages of tomatoes in composts with poultry manure (another compost with a high N feedstock) than in yard trimming composts or a commercial mix.

Seedling shoot dry weights in the three media were similar, but root weights were lower in peat-lite mix (Table 3). Shoot:root ratios, which tend to be higher in plants well supplied with water and nutrients, were highest in the mix and lowest in sand.

Although immature compost has been reported to inhibit growth of cress (*Lepidium sativum* L.) (Anid, 1986), tomatoes (Hadar et al., 1985), bell peppers (*Capsicum annuum* L.) (Bryan and Lance, 1991; Roe and Kostewicz, 1992), and dill (*Anethum graveolens* L.) and radish (*Raphanus sativus* L.) (Roe and Kostewicz, 1992) there was no conclusive evidence that the elimination of the curing period for this compost resulted in any deleterious effects on tomato plant growth or yield.

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Table 1. Plant height, stem diameter, and fresh and dry weights of tomato plants grown in soil with or without 135 t/ha compost. Field experiment.

Measured trait	Transplant date				
	24 Aug.	31 Aug.	8 Sept.	24 Sept.	29 Oct.
Plant height (cm)					
Compost	24.7	30.0	65.3	32.1	37.2
No compost	22.9	24.8	65.5	31.2	37.8
	NS	NS	NS	NS	NS
Stem diameter					
Compost	6.6	5.8	11.6	6.1	6.5
No compost	6.4	5.4	11.6	5.8	6.9
	NS	NS	NS	NS	NS
Plant fresh weight (g/plant)					
Compost	390	240	515	284	231
No compost	258	304	505	238	265
	NS	NS	NS	NS	*
Plant dry weight (g/plant)					
Compost	21.2	19.8	39.8	26.5	11.5
No compost	17.4	27.3	42.6	24.3	14.5
	NS	*	NS	NS	NS

NS, * Non-significant or significant at P=0.05.

Table 2. Yields of tomato plants grown in soil with or without 135 t ha^{-1} compost. Field experiment.

Measured trait	Transplant date			
	24 Aug.	31 Aug.	8 Sept.	24 Sept.
Total weight (t ha^{-1})				
Compost	16.4	13.0	16.9	9.4
No compost	17.7	17.1	20.8	8.7
	NS	NS	NS	NS
Fruit weight (g/plant)				
Compost	1163	686	844	472
No compost	1128	1033	1154	444
	NS	NS	NS	NS
Fruit size (g/fruit)				
Compost	146	142	148	140
No compost	149	146	148	138
	NS	NS	NS	NS

$^{NS, *}$ Non-significant or significant at P=0.05.

Table 3. Mean days to emergence (MDE), total emergence percentages, shoot and root dry weights, and shoot:root ratios of tomato seedlings in greenhouse. Greenhouse experiment.

Medium	MDE	Total % emergence	Shoot wt (mg)	Root wt (mg)	Shoot:root ratio
Compost	12.8	67.5	7.3	3.0 a^z	2.65 b
Potting mix	11.6	87.5	7.4	1.7 b	4.47 a
Sandy soil	11.7	93.2	5.0	3.4 a	1.48 c

^{z}Mean separation in columns by Duncan's multiple range test, 5% level.