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Greenhouse Use of Organic Fertilizers and Composts - 3 Floriculture Research Report 17-04

Organic Fertilizers and Composts For Vegetable Transplant Production

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Introduction

Interest in organic production methods for vegetables continues to increase. Production practices for organic field production of vegetables have a long history, but practices to grow organic vegetable transplants in a spring greenhouse are poorly known. Organic fertilizers and composts are available but the efficacy and rates for use have not been evaluated. Experiments in the summer of 2003 were completed to learn more about the use of two organic fertilizers (fish emulsion 5-1-1 and Omega 6-6-6) and three composts (derived from horse manure, cow manure and worm castings) for the production of vegetable transplants.

Materials and Methods

Tomato ('Better Boy') and pepper ('California Wonder') seed were sown into MetroMix 360 in 200 cell plug trays. After germination, plants were watered with clear water only, until the "nutrient deficient" seedlings were transplanted two weeks later.

Seedlings were transplanted into 3" pots that contained Scott's MetroMix 560 (not an approved organic growing medium) in experiment 1. Plants were irrigated by hand, approximately four fl. oz. per plant, three times each week with fertilizer solutions of 0, ¼ tsp., ½ tsp. or 1 tsp. per gallon of water with Omega 6-6-6 (microbe digested organic fertilizer derived from blood meal, bone meal and sulfate of potash, Peaceful Valley Farm Supply, Grass Valley, CA) or Safer Fish Emulsion (derived from acidulated fish tankage, urea, phosphoric acid and potassium chloride, Woodstream Corp, Lititz PA). An inorganic fertilizer, Peter's 20-10-20 at 1/8 tsp., ¼ tsp. or ½ tsp. per gallon of water, was used as a standard and control treatment. Plants were typically watered with clear water twice each day unless fertilizer was applied. Plants were harvested after sixteen days and dry weights were determined.

Tomato and pepper transplants grown with organic fertilizers at transplant (above) and at harvest (below).

In experiment 2, seedlings were transplanted into 3" pots with a 0%, 10%, 20% or 30%, by volume, mixture of composted worm castings (derived from horse manure and peat moss, Wyatt Farms, Benton KY), commercial composted cow manure, 0.5-0.05-0.05 (derived from cow manure, peat and organic humus, Green Thumb Organics Inc, LaPorte IN) or commercial composted horse manure (Thoroughbred Compost, Inc., Lexington KY) with Scott's MetroMix 560. Plants were irrigated with clear water only. Plants were harvested and dry weights were determined after four weeks. Plants were also grown with a standard inorganic fertilizer, Peter's 20-10-20, at ½ tsp. per gallon of water (3 times per week) as a control.

Each treatment, in experiments one and two, was composed of three replications of six plants per replication. Plants were grown in a naturally ventilated double poly greenhouse in June and July 2003. Greenhouse temperatures were 65^{o} to 95^{o} F each day. Soil samples of the initial mix were collected for each experiment. At harvest, soil samples were collected from each treatment and nutrient analysis was completed at the UK Soil Testing Laboratory.

Results and Discussion

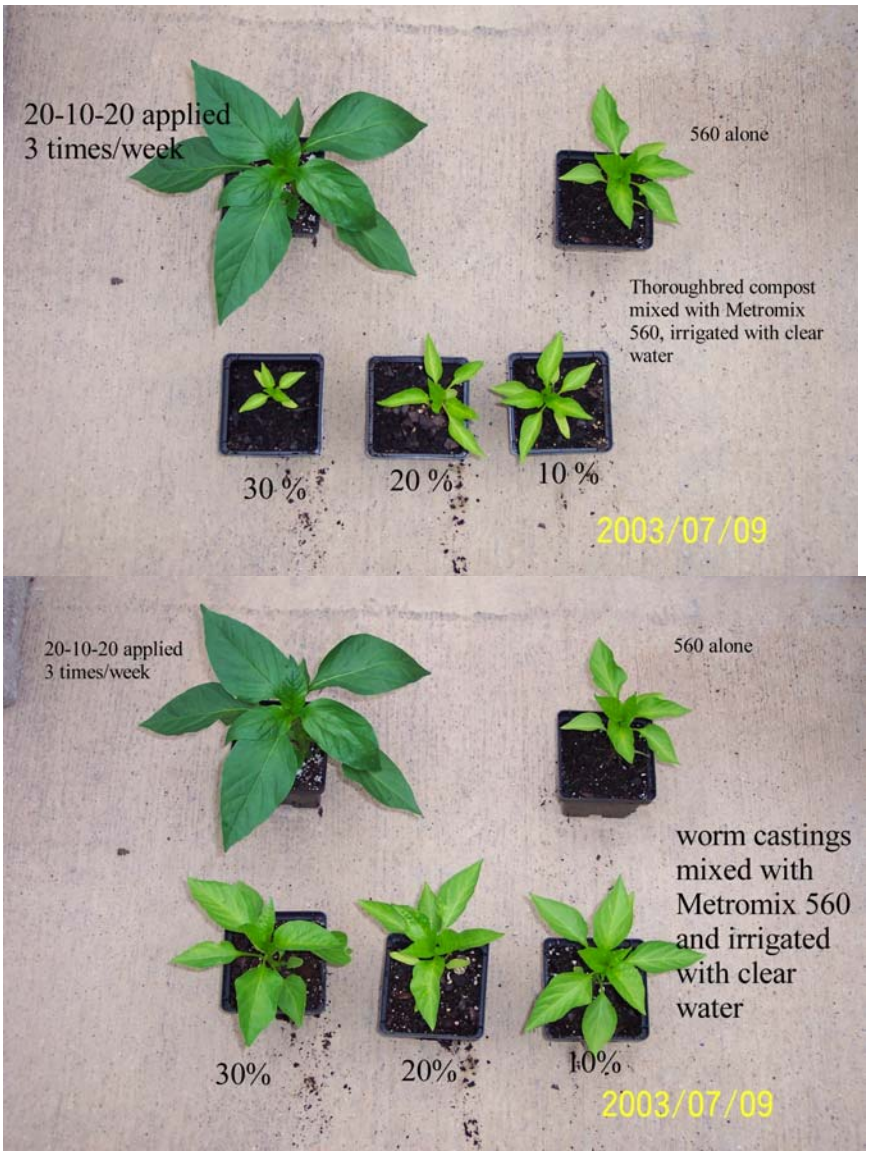
Fish emulsion and Omega organic fertilizers were effective fertilizer treatments for tomato and pepper transplants. Fish emulsion increased dry weights of transplants approximately 200% to 300% and Omega increased dry weights 200% to 500% over the unfertilized control (Table 1). The inorganic fertilizer increased plant dry weights by approximately 200% to 700%, but this fertilizer has a much higher percent of nutrients than the organic fertilizers. Plants were considered typical quality transplants, even though they were not grown in transplant trays.

Levels of plant nutrients in the growing media at the end of the experiments were reasonably good. Yet, the analyses did not reflect the differences in fertilizer rates used in the experiments (Table 2). The pH of the media remained in the appropriate range with the expected decrease in pH at the higher rates of Peter's and Omega. Electrical conductivity in all treatments was somewhat higher than optimal levels. The level of nitrate nitrogen was surprising low for all treatments. Phosphorus levels were lowest in the fish emulsion, yet no problems would be expected at these levels. Potassium was somewhat low for all treatments. The highest fertilizer rates for Peter's and Omega yielded the lowest potassium levels for an unknown reason. Most calcium and magnesium is supplied by the irrigation water, not the fertilizer. Calcium levels were fine in all treatments, magnesium levels were increased somewhat by the Omega organic fertilizer.

Mixtures of organic composts and a typical growing medium were not effective for the production of vegetable transplants (Table 3). Tomato and pepper plants grew similarly for the first seven days in Experiment 2. By day seven, the plants treated with Peter's or composted cow manure were growing normally and remained green while than the plants in the horse and worm compost mixtures and the untreated control were changing little. By day 14, plants in the no fertilizer control and horse and worm composts began to turn purple on the stems, leaves turned yellow and plants seemed to have stopped growing. At

harvest, the plants with Peter's were green and tall; the plants treated with cow manure were generally green but had been slowing down for a week and yellowing was starting to occur. The plants grown in worm and horse compost or the no fertilizer control had similar heights and appearance including purple stems, yellow leaves, and some dead leaves at the base of stem. The mean dry weight of the plants grown in worm and horse compost was less than the control plants grown in MetroMix 560 alone. This demonstrates that the worm and horse composts were probably not fully composted and they stole nutrients from the MetroMix 560 as composting continued.

Young pepper plants performed similarly to the young tomato plants grown in different types of organic composts. The pepper plants treated with Peter's appeared normal and were green at harvest. Pepper plants treated with composted cow manure were only somewhat better than the other composts. Young pepper plants grown with composted horse manure were significantly smaller, at harvest, than all other plants.



The nutritional characteristics of the organic composts were significantly different as demonstrated by the soil tests. The composted worm castings had a high pH, high levels of calcium and magnesium and very high levels of nitrate nitrogen, phosphorus and potassium that led to a very high conductivity reading (Table 4). The very high nutrient levels were satisfactorily diluted by mixing with Metromix 560 and use to grow tomato and pepper transplants. It is likely that this compost was incompletely composted thus plants were smaller than those grown without fertilizer.

The composted cow manure had a very low pH and low levels of phosphorus, a moderate level of potassium and very high levels of nitrate nitrogen, calcium and magnesium that led to a very high electrical conductivity (Table 4). When added to Metromix 560, the conductivity, magnesium and calcium readings were brought to typical use standards, but N, P and K were at very low levels and the pH was too low. However, plants grew reasonably well in the mixtures. Plants in the 20% and 30% mixtures were relatively normal transplants.

The composted horse manure had a very high pH and very high levels of phosphorus and potassium that led to very high electrical conductivity (Table 4). Nitrate nitrogen, calcium and magnesium were measured at typical use levels. Unfortunately, plants performed poorly in the three mixtures of composted horse manure, probably because this material was incompletely composted.

Conclusions

Omega and fish emulsion organic fertilizers can be used to grow vegetable transplants. Based on the experiments reported here, it seems that these fertilizers should be applied 4 to 8 times at the label rate during the life (8-9 weeks) of a crop of tomato or pepper transplants. Individual growers will have to learn the amount best for their production conditions.

A mixture, 20% to 30%, of composted cow manure may be effective for transplant production, but mixtures of composted worm castings and composted horse manure were not effective. Separate trials, not reported here, demonstrated that the composted horse manure (Thoroughbred Compost) was effective as an addition to growing media when the mixture was fertilized normally, so composting could proceed without effecting plant growth.

Table 1. The average percent increase in the dry weight, when compared to the unfertilized control, of tomato and pepper transplants grown with two organic fertilizers and a standard inorganic fertilizer.

Fertilizer rate (tsp. per gallon of water)	Fish Emulsion		Omega 6-6-6		Peter's 20-10-20	
	Tomato	Pepper	Tomato	Pepper	Tomato	Pepper
1/8					218 %	207 %
¼	190 %	173 %	216 %	247 %	413	407
½	280	173	355	447	732	687
1	332	307	502	447		

Table 2. Nutrient analyses of growing media used to grow tomato transplants with inorganic and organic fertilizers, collected at plant harvest.

Fertilizer rate (tsp. per gallon)	PH	Conductivity	Nitrate nitrogen ppm	Phosphorus ppm	Potassium ppm	Calcium ppm	Magnesium ppm
Target levels for transplants							
	5.6-6.0	0.5-0.7	30-75	5-10	50-100	60-120	30-70
Peter's 20-10-20							
1/8	5.98	0.91	2.9	3.6	70.0	83.2	23.2
¼	5.94	0.72	2.9	4.4	28.2	79.0	21.9
½	5.65	0.78	2.9	6.7	16.6	96.5	25.0
Omega 6-6-6							
¼	5.89	1.17	2.2	3.7	59.9	120.0	71.0
½	5.69	1.20	2.1	6.8	37.1	134.6	75.8
1	5.51	1.13	2.3	9.8	14.2	132.5	71.1
Fish Emulsion 5-1-1							
¼	5.90	1.0	4.0	2.2	44.2	107.2	29.7
½	5.90	0.97	2.1	2.6	36.2	102.8	28.7
1	5.78	1.08	2.0	3.0	39.9	127.9	34.9

Table 3. The average percent increase in the dry weight, when compared to the unfertilized control, of tomato and pepper transplants grown in mixtures of organic composts and a standard inorganic fertilizer.

	Composted Horse Manure		Composted Worm Castings		Composted Cow Manure		Inorganic fertilizer control	
Mixture	Tomato	Pepper	Tomato	Pepper	Tomato	Pepper	Tomato	Pepper
10%	60 %	53 %	63 %	122 %	128 %	136 %	537 %	567 %
20%	55	42	95	131	226	184		
30%	30	27	84	118	220	122		

Table 4. Nutrient analyses of mixtures of organic composts and growing media collected after preparation and at plant harvest.

Growing medium mixture	pH	Conductivity	Nitrate nitrogen ppm	Phosphorus ppm	Potassium ppm	Calcium ppm	Magnesium ppm
Composted worm castings							
Initial	6.82	5.29	295.1	90.5	1751.0	154.9	104.1
10%	6.66	0.67	4.8	10.5	71.2	62.0	25.8
20%	6.72	0.71	3.4	14.5	78.0	67.0	28.1
30%	6.73	2.22	101.1	38.5	633.5	94.6	52.7
Composted cow manure							
Initial	4.00	6.74	389.0	0.4	191.7	1521.0	309.4
10%	5.39	0.70	0.2	0.3	28.8	115.5	36.0
20%	4.84	1.18	2.6	0.7	26.7	170.4	63.8
30%	4.62	1.40	5.4	0.4	21.9	209.0	32.6
Composted horse manure							
Initial	8.21	8.54	134.9	64.8	3476.0	118.0	54.7
10%	6.61	0.71	6.7	14.1	106.8	41.1	15.8
20%	6.93	1.51	15.7	40.4	386.5	50.0	10.2
30%	7.20	1.35	11.7	41.8	411.7	38.9	14.3
MetroMix 560							
Initial	5.29	2.01	42.6	15.4	82.6	78.8	55.3
At harvest	6.08	0.84	2.6	2.3	65.1	70.3	42.3