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Project report submitted to the Organic Farming Research Foundation

Project Title:

Monitoring the ability of compost to provide sufficient nitrogen to a bell pepper crop under drip irrigation

FINAL PROJECT REPORT

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Background and Rational:

Bell peppers is an important vegetable crop in San Benito County. In 1992 there were 1,610 acres and its crop value ranked third in the county at $7.7 million dollars. It is estimated that 20% of the pepper acreage in the county is in organic production. Many of the growers that are producing organically have stated that their number one problem in producing organic bell peppers is "getting enough nitrogen to the crop". This is an interesting statement considering the many other serious problems encountered in pepper production such as soil insects, weeds, aphids and powdery mildew. Peppers are in the ground for 250+ days (February-March to October-November) and have a large demand for nitrogen in order to produce a high quality crop. The long production season and the high demand for nitrogen make it especially difficult for organic growers to provide sufficient nitrogen to give sustained yield through to the end of the production season. The end-of-the-season production is particularly important to pepper growers because this is the time when the market prices traditionally improve and growers, with good production, can make money. The other aspect that makes good yields important is the high production costs of peppers -- over $5,000 per acre. There are two strategies employed by the organic pepper growers to provide sufficient late-season nitrogen to their crops: sodium nitrate and/or feather meal. The use of sodium nitrate, while convenient and simple to use, is not desirable due to the high sodium content (20%) of the material. Unfortunately many growers begrudgingly utilize this practice because it gives good results and it is low cost. Application of feather meal is a proven practice that can provide adequate amounts of late season nitrogen, however the costs of feather meal ($485/ton) restrict the growers form using adequate amounts of the product. It is difficult for growers to build up their soils with compost and other organic matter inputs to carry the pepper crops through to the end of the season and as a result the growers are in a bind to provide the needs of the crop and to safeguard their substantial investment. The other aspect that further aggravates the nitrogen problem with peppers in San Benito County is the fact that many of the growers have switched to drip irrigation in order to conserve water. However, unfortunately drip irrigated peppers have a smaller root system and it is harder to sidedress dry fertilizer materials such as feather meal into the bed when the plants need them (i.e. at thinning). They further induce growers to utilize sodium nitrate because it is the one low-cost, soluble material that is easily injected into the drip system.

This project was designed to evaluate inputs of various rates of compost on the yield and nitrogen status of a crop of peppers. The grower-cooperator on this project makes his own compost and, for the last two years, he has applied from three to ten tons of compost (along with other nitrogen inputs such as cover crops, feather meal and sodium nitrate) to provide for the nitrogen need of his pepper crops. Unfortunately the amount of nitrogen from the compost has not been sufficient to build up his soil to the point were the crop is receiving sufficient nitrogen nutrition. It was hoped that through this project we could determine if it was possible to build up the soil nitrogen levels with compost to provide for the needs of the crop.

This project came about as the result of the concern from the growers over the long term effects of the use of sodium nitrate and in addition their concern over ways that they can improve nitrogen fertilizer practices on peppers. This research was initiated by the growers and the growers and the researcher will work together closely in carrying out this project.

Objectives

This study was designed to evaluate the effect on the nitrogen status and yield of bell peppers of various rates of compost applied to a commercial bell pepper field. We planned to accomplish the following:

1. Establish a plot where we evaluated various rates of compost applied to a pepper crop for their effectiveness in providing the nitrogen needs of the crop.

2. Monitor the soil and pepper petiole nitrogen levels over the course of the season to evaluate the sufficiency of the applied nitrogen for the crop. Yield evaluations were also conducted.

3. Upon evaluating the yield, soil and tissue evaluations we hoped to better understand the dynamics of compost in building up the soil and providing for the nitrogen needs of a long-season, high-nitrogen demanding vegetable crop, such as bell pepper.

Procedures

1. A plot was establish at the Herbert Ranch in March 29, 1994 and 0, 6, 12, and 24 tons per acre of compost were applied prior to planting the pepper crop. The plots were replicated three times.

2. The crop was monitored over the course of the season using "quick test" technology to evaluate the nitrate-nitrogen status of the pepper petioles. Soil nitrate-N and ammonium levels in the soil were monitored on a bi-weekly basis over the course of the season utilizing 2N potassium chloride extract. In addition, the soil microbial biomass was measured three times during the season.

3. Crop yields were taken by harvesting plots (September and October, 1994) within the treatment areas. Each harvest was picked and graded in the same way as commercial harvests.

Results

Table 1 indicates the nutrient content of the compost that was applied to the experimental field and it also breaks down the content of each nutrient that was applied into each of the various treatments. One important point that to notice is that the percentage of ammonium and nitrate relative to the total amount of nitrogen is very small (3.8%). This supports the contention that the nitrogen in well made compost is mostly in the complex protein and humus fractions. In theory, the nitrogen from these fractions should be slowly available to the plants over the course of the season.

We had an obstacle to over come in conducting this trial. The grower was utilizing drip irrigation and it turned out to be impossible to isolate the part of the field where the trial was being conducted from the rest of the field. In the end starting on July 7 the grower applied 88 lbs of nitrogen as soluble sodium nitrate through the drip system as weekly applications of 8 lbs of N per week. This basically disrupted our attempt to determine if compost was able to supply late season nitrogen to the crop. However, we did learn some significant information from our intensive sampling:

In figure 1 the weekly petiole levels of nitrate-nitrogen are shown. We had four sampling dates prior to the initiation of nitrate fertilization and the data from those four sampling dates indicate that there was no large release of nitrate from the compost. Figure 2 shows the soil nitrate-nitrogen levels and it also shows no clear or statistical trend that indicates a large release of nitrate-N prior to the July 7th date. After the July 7th date there is understandably no clear trend in either the petioles or the soil because of the weekly fertilization with sodium nitrate.

Figure 3 indicates the concentration of ammonium in the soil over the course of the season. These figures should not be affected by the sodium nitrate fertilization. In the 6, 12 and 24 T/A compost treatments, the June 23, July 7 and October 24 sampling dates all have statistically greater ammonium in the soil over the 0 compost per acre treatment. This data indicates that the compost does release substantial amounts of ammonium both early and late in the season.

Figure 4 indicates that amount of microbial biomass that was present in the soil on June 15, July 21 and September 3. These were 78, 114, and 157 days after application of the compost. The July and September sampling dates both had significantly greater microbial mass in the 6, 12 and 24 T/A compost treatments. This indicates a very significant increase in microbial life in the soil for a significant amount of time following the incorporation of the compost.

Tables 2 and 3 show the yield evaluations of the plots. There was no significant differences between treatments in either the first or in the total of the two harvests. The second harvest however does indicate greater yield in the 24 T/A treatment over the untreated control. This would indicate that some late season nitrogen coming from the compost did improve the yield in this treatment on that harvest date.

Summary

Given the fertilization of the plot over the season we are limited in the conclusions that we can make regarding the release of nitrogen from compost and its beneficial effect on the yield of peppers. In short however we did see the following: 1) no large release of nitrate-nitrogen from even the 24 T/A treatment of compost; 2) substantial release of ammonium both early and late in the season from all compost treatments; and 3) substantial increases in microbial biomass even 157 days after application of the compost with as little as 6 T/A of compost.

Table 1. Nutrients analysis of the compost that was applied to the site and the amounts of each nutrient that was applied at each application rate

	N	NH4-N	NO3-N	P	K	Ca	Mg	Na	Cl	B	Zn
	%	--------ppm-------		--------------------------%------------------						-----ppm----	
	1.16	160	280	0.43	1.74	5.44	0.97	0.41	0.90	60	106
	---------------------------------pounds per acre of each nutrient applied----------------------------										
0	---	---	---	---	---	---	---	---	---	---	---
6	139	1.9	3.4	51.6	208.8	653	116.4	49.2	108.0	0.72	1.27
12	278	3.8	6.8	103.2	417.6	1304	232.8	98.4	216.0	1.44	2.54
24	556	7.6	13.6	206.4	835.2	2608	465.6	196.8	432.0	2.88	5.08

Table 2. Yield of peppers on the first harvest date - September 15, 1994 - under various compost treatments

Treatment	Ex. Large	Large	Medium	No. 2	Total Yield
Tons/A	------------------Number of 30 pound boxes per acre---------------------				
0	100.2	408.1	264.3	219.3	991.9
6	90.0	472.0	188.8	261.4	1010.8
12	100.2	456.0	62.4	226.6	846.7
24	149.6	412.4	135.1	214.9	910.6
LSD(P=0.05)	85.7	62.4	132.1	152.5	342.7

Table 3. Yield of peppers on the second harvest date - October 24, 1994 - and the total of the two harvest

Treatment Tons/A	Ex. Large	Large	Medium	No. 2	Yield of 2nd Harvest	**Total of Two Harvest**
	----------------------------Number of 30 pound boxes per acre------------------------------					
0	5.8	84.2	91.5	65.3	246.9	**1,238.8**
6	13.1	111.8	111.8	94.4	329.7	**1,341.9**
12	11.6	114.7	148.1	75.5	350.0	**1,195.5**
24	16.0	119.1	178.6	120.5	434.2	**1,346.3**
LSD(P=0.05)	14.5	82.8	75.5	77.0	177.2	**425.5**

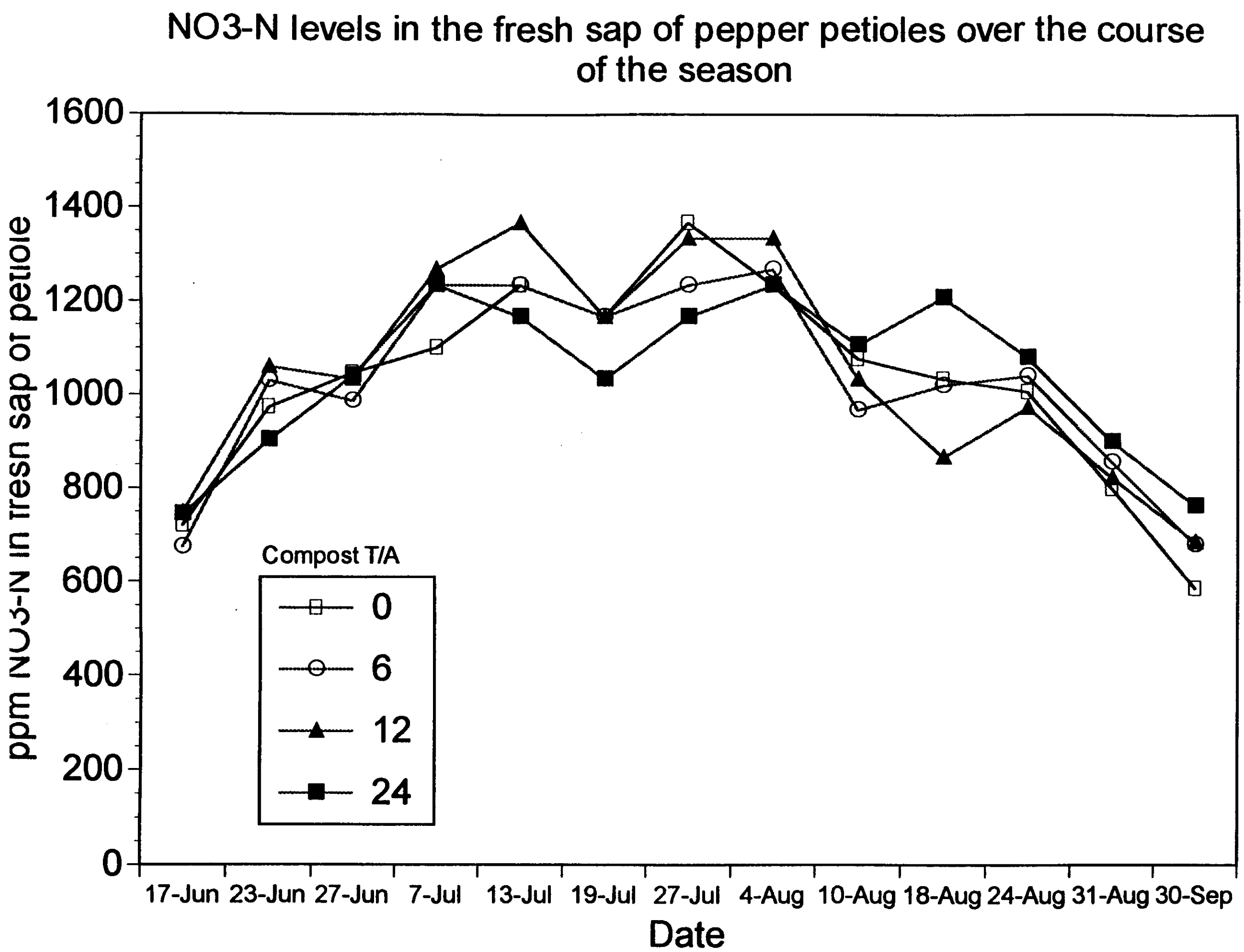
NO3-N levels in the fresh sap of pepper petioles over the course of the season
ppm NO3-N in fresh sap of petiole
1600
1400
1200
1000
800
600
400
200
0
Compost T/A
0
6
12
24
17-Jun
23-Jun
27-Jun
7-Jul
13-Jul
19-Jul
27-Jul
4-Aug
10-Aug
18-Aug
24-Aug
31-Aug
30-Sep
Date

Figure 1

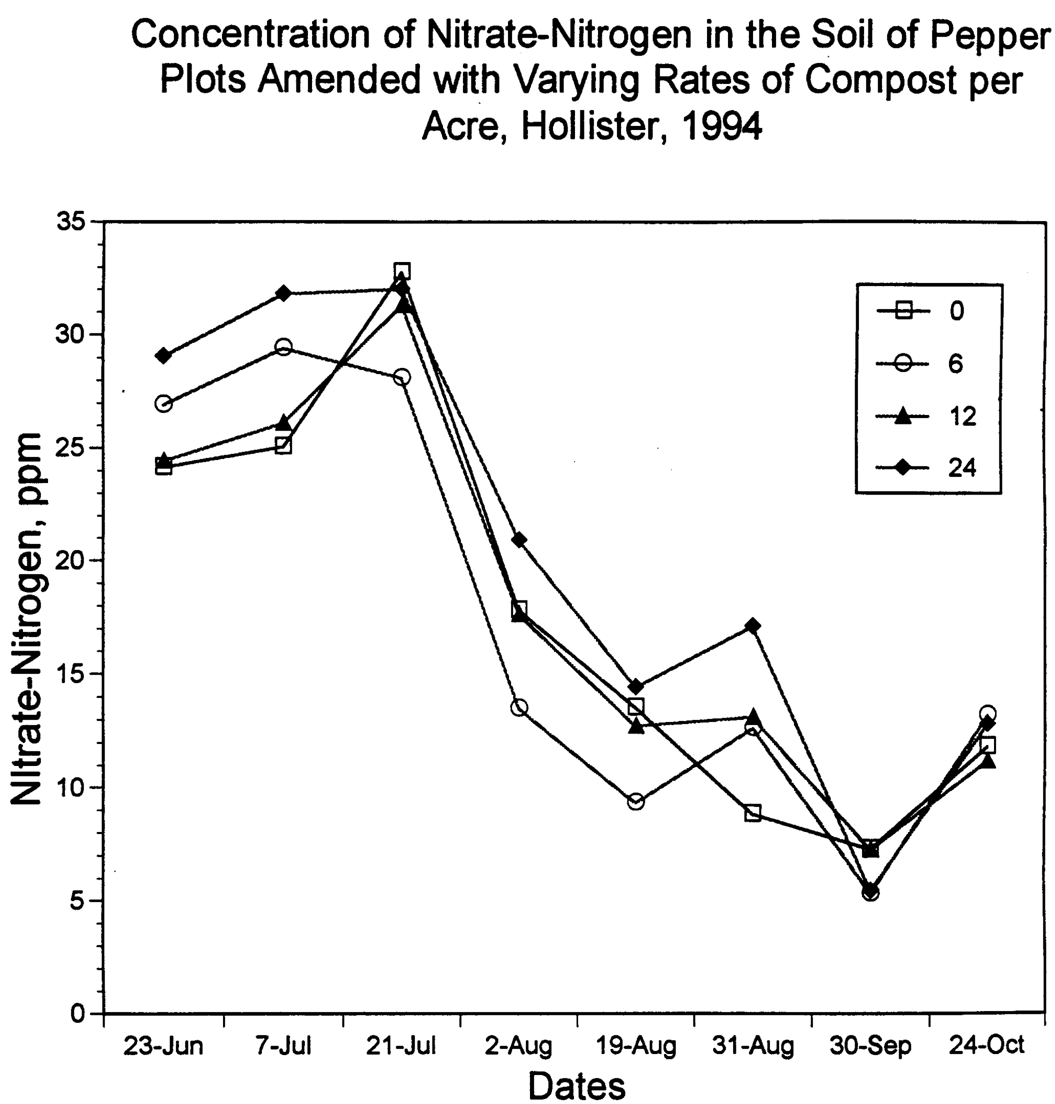
Concentration of Nitrate-Nitrogen in the Soil of Pepper Plots Amended with Varying Rates of Compost per Acre, Hollister, 1994
Nitrate-Nitrogen, ppm
0
5
10
15
20
25
30
35
23-Jun
7-Jul
21-Jul
2-Aug
19-Aug
31-Aug
30-Sep
24-Oct
Dates
0
6
12
24

Figure 2

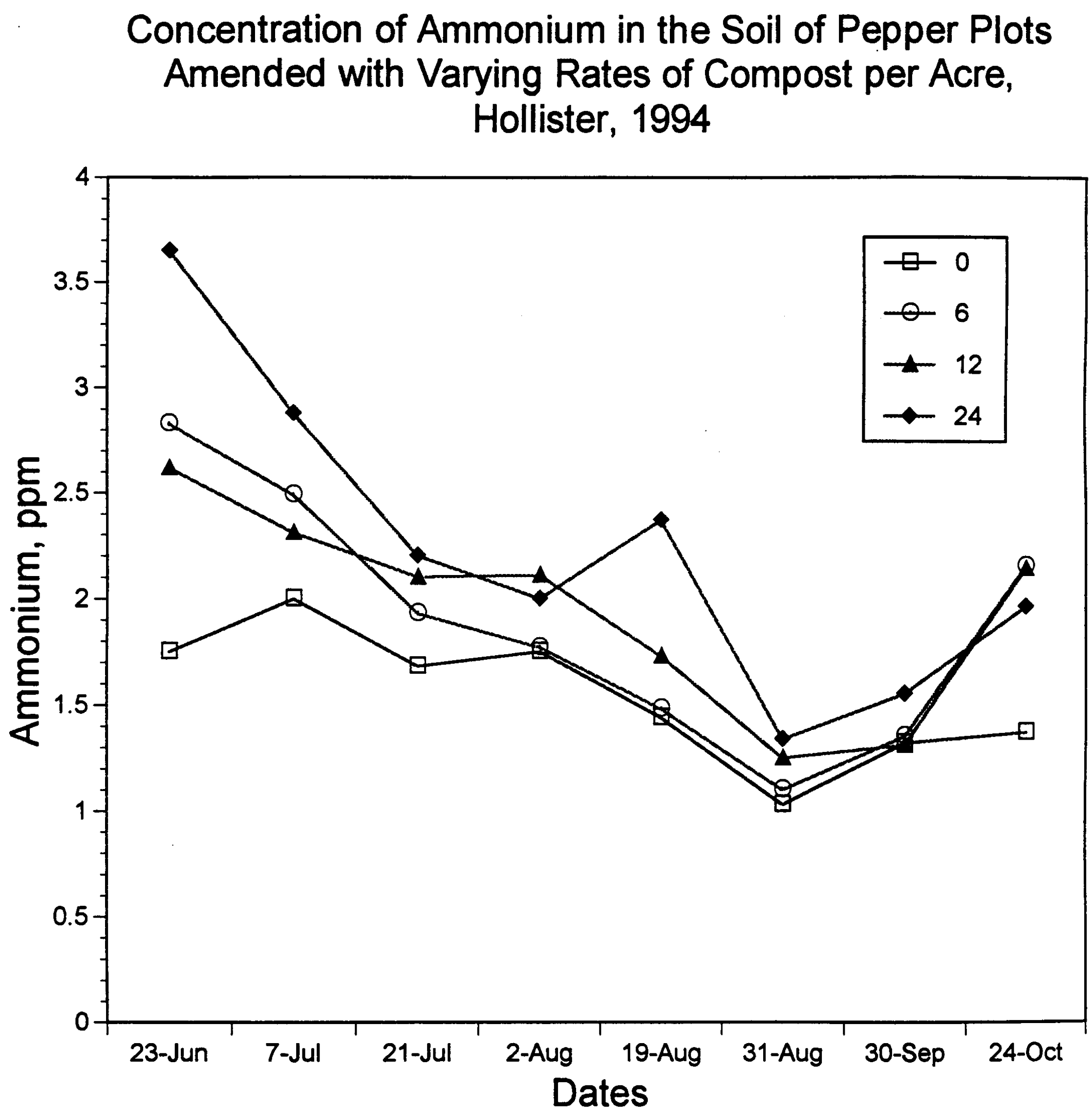
Concentration of Ammonium in the Soil of Pepper Plots
Amended with Varying Rates of Compost per Acre,
Hollister, 1994
Ammonium, ppm
4
3.5
3
2.5
2
1.5
1
0.5
0
23-Jun
7-Jul
21-Jul
2-Aug
19-Aug
31-Aug
30-Sep
24-Oct
Dates
0
6
12
24

Figure 3

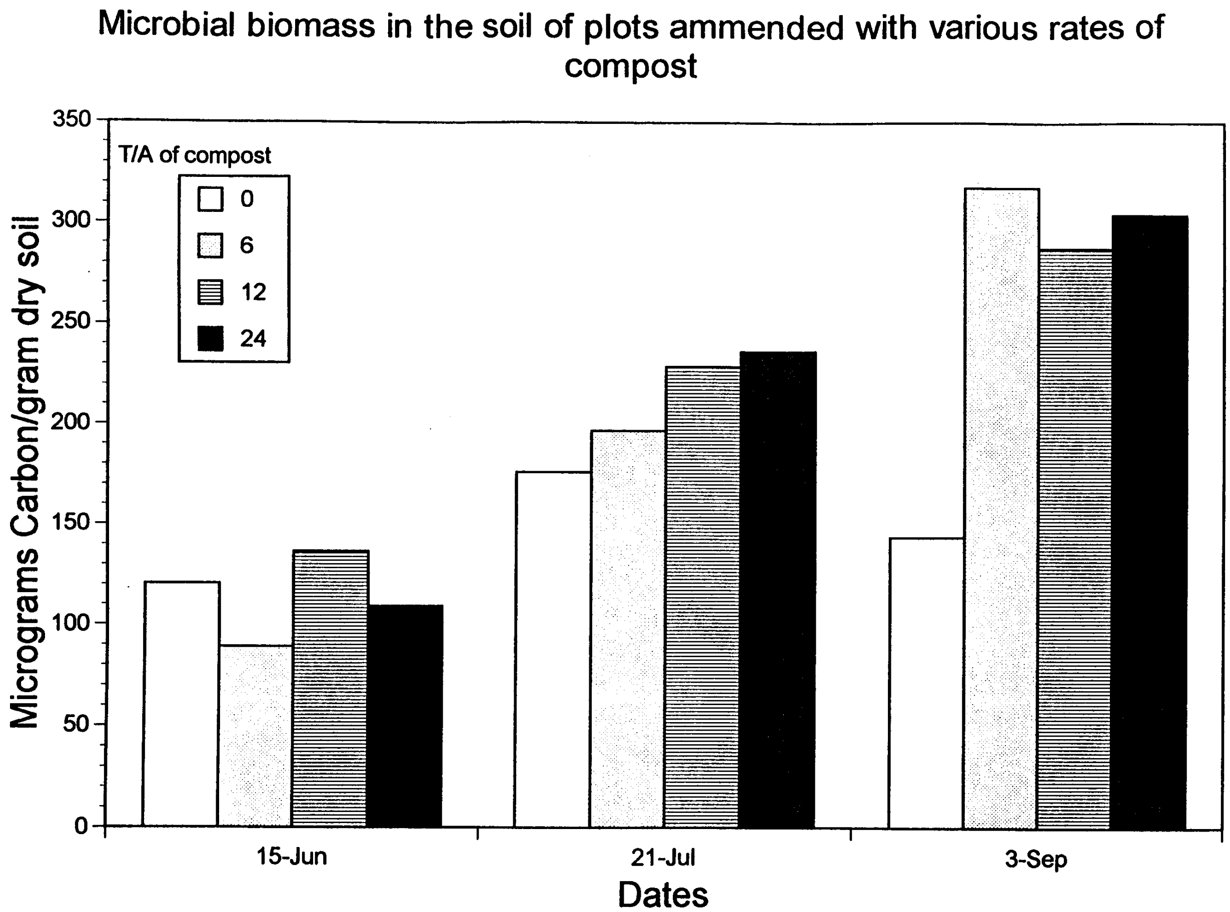
Microbial biomass in the soil of plots ammended with various rates of compost
T/A of compost
0
6
12
24
Micrograms Carbon/gram dry soil
350
300
250
200
150
100
50
0
15-Jun
21-Jul
3-Sep
Dates

Figure 4