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The use of bokashi as a soil fertility amendment in organic spinach cultivation in the Northeastern U.S.

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NORTHEAST SARE Sustainable Agriculture Research & Education

Introduction

Bokashi is a soil fertility amendment made by the fermentation of organic materials with a microbial inoculant. Originating in Japan, the use of bokashi has spread to farming communities throughout the world, being utilized in a variety of agricultural systems. Bokashi holds the promise of a faster turnover of organic wastes requiring less land and equipment than thermophilic composting methods, though there are few scientific studies that document its characteristics and capabilities as a soil amendment.

Question: How does bokashi compare to thermophilic compost and vermicompost as a soil fertility amendment in organic spinach production?

Objectives

(i) Determine chemical characteristics of bokashi made from food waste.
(ii) Compare the effects of bokashi (B), thermophilic compost (TC), vermicompost (V), and a control (C) on soil fertility over time
(iii) Compare the effects of treatments on nutrient content in spinach leaf tissue
(iv) Determine the effects of treatments on marketable yield of spinach

Experimental Design and Methods

- Field experiment at the University of Vermont Horticultural Research Farm
- Completely randomized design with four treatments B, TC, V, and C (no fertilizer) replicated three times.
- V obtained from Wormpower (Avon, New York) and TC obtained from Vermont Compost (Montpelier, VT)
- Bokashi made in the lab using wheat bran, food waste, and Effective Microorganisms® inoculant following three step process.
- Amendments applied at a rate of 100 lb N/acre.
- Spinach transplanted on May 16, harvested June 5 and June 23 for leaf tissue analysis and weighed for marketable yield
- Soils were sampled on May 17, June 5, June 23 and July 31 and analyzed for soil chemical properties
- Soil analyses: Inorganic N measured using Lachat after KCl extraction, total carbon and nitrogen measured using CN Analyzer, all other nutrients measured with ICP-AES after extraction with modified Morgan solution.
- Plant tissue analysis: N obtained using CN Analyzer, all other nutrients measured with ICP-AES after microwave-assisted nitric acid digestion

Results

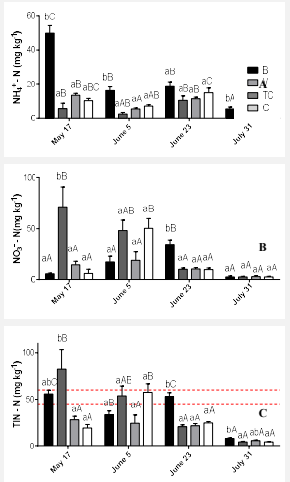


Figure 1. Concentrations of A) NH_4^+ -N, B) NO_3^--N, C) total inorganic N ($NH_4^+ + NO_3^-$) in soil over time. Different lowercase letters indicate significant differences between treatments and different capital letters signify differences over time. ($p<0.05$). The dotted red line indicates the optimum level of soil available N for spinach growth in a sandy soil.

Table 1. Comparison of nutrient profiles of V, TC, and two different batches of B. All units are mg kg^{-1} unless otherwise specified.

	TN (%)	TC (%)	C/N Ratio	NH_4^+-N	NO_3^--N	TIN*	P†	Ca†	K†	Mg†	Na†	Al†	Fe†	Mn†	Zn†	S†	pH	EC (mS cm^{-1})
V	3.4	38.1	11.2	20.8	4745.0	4765.8	2705.0	9850	22250	4225	5900	130.5	-	-	-	960.0	6.7	4.7
TC	1.2	20.4	17.6	10.2	33.6	43.8	905.0	6900	4920	1640.0	1380	14.3	3.9	65.0	5.0	230.0	7.5	2.2
B**	2.45	45.22	18.49	1055	40.2	1095.2	3645	6150	6250	1830	2390	-	14.4	42.45	22.6	414	4.5	5.09
B	3.54	46.85	13.25	1410	25.95	1435	3950	6400	8250	2695	1755	184	28.5	25.5	23.5	575	4.21	5.08

*TIN = Total inorganic nitrogen, calculated by the addition of Ammonium-N and Nitrate-N
**Bokashi used in field experiment
† Modified Morgan's extractable element

Top left: Bokashi, Top right: Vermicompost, Bottom left: Compost, Bottom right: Control

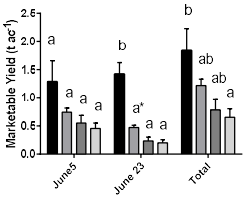
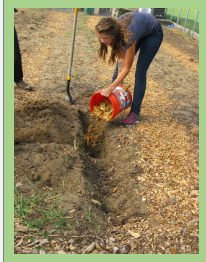


Figure 2. Comparison of marketable yield of treatments at June 5 and June 23 cuttings. Different lowercase levels indicate significant differences between treatments ($p<0.05$). An asterisk (*) indicates significant differences between cuttings of a treatment.



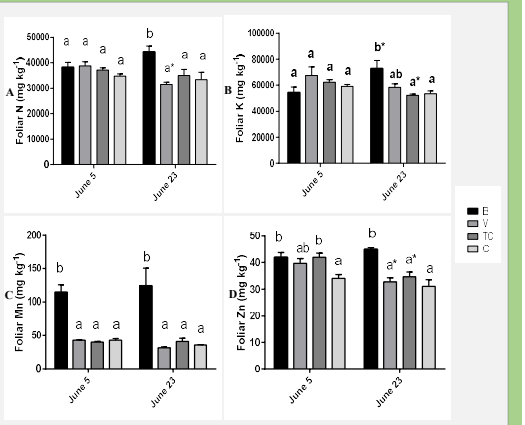


Figure 3. Concentrations of A) nitrogen, B) potassium, C) manganese, and d)zinc in spinach leaf tissue of treatments in June 5 and June 23 cuttings. Different lowercase levels indicate significant differences between treatments ($p<0.05$). An asterisk (*) indicates significant differences between cuttings of a treatment.

Conclusions

- Bokashi has a nutrient profile distinct from thermophilic compost and vermicompost regarding N speciation.
- Variability in food waste feedstock affects nutrient content and chemical characteristics of bokashi.
- Bokashi treatments had a more steady and prolonged supply of plant available nitrogen.
- Greater concentration of N in plant available form in B treatments between June 5 and June 23 soil sampling contributed to greater concentrations of foliar nutrients and marketable yield at second harvest date.
- Bokashi may be a viable alternative or supplemental soil fertility amendment in small scale vegetable production.

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