# Using bokashi to grow organic spinach

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## What is 'bokashi'?

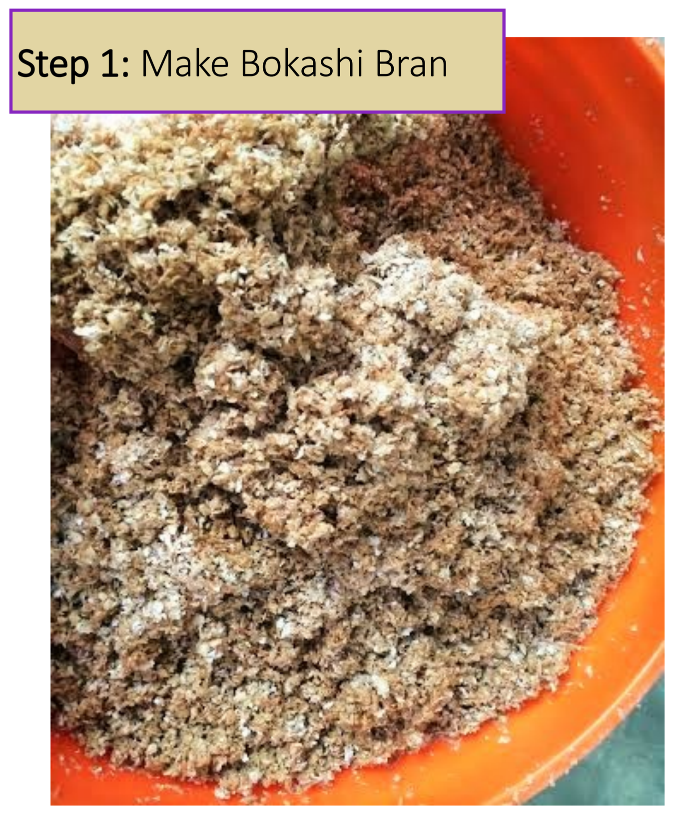
Bokashi is a soil fertility amendment made through a fermentation process. It is similar to compost, in that it is made with materials such as manures, crop residues, and other plant based materials, however the process those materials are subjected to are very different. While compost is produced through decomposition by aerobic microbes and produces heat, bokashi is produced by fermenting materials, in an oxygen-less environment by the action of anaerobic microbes. This process produces different acids, and essentially a "pickled compost". Bokashi has Japanese origins and is used by coffee farmers located in humid sub-tropical countries. Recently the buzz on bokashi has spread to the U.S. It has been claimed that producing bokashi requires less land, equipment and time than it does for compost, while providing the same soil fertility benefits, though there are very few studies that have been done to confirm this.

## How do you make bokashi?

### Ingredients

- Wheat bran
- Effective Microorganisms-1® microbial inoculant (EM-1)
- Molasses
- Water
- Food waste

**Step 1:** Make Bokashi Bran



**Step 2:** Prepare Bokashi Buckets

**Step 3:** Bury Bokashi

## Can we use bokashi to grow organic vegetables in the U.S.?

We applied four treatments: to loamy sand soils at a rate of 100 lb N/acre at the University of Vermont Research Farm:

1) Compost (TC) 3) Bokashi (B)
2) Vermicompost (V) 4) Control (C) -no amendment

- V obtained from Wormpower (Avon, New York) and TC obtained from Vermont Compost (Montpelier, VT)

Timeline:

April 30– Bokashi applied
May 12– V and TC applied
May 17– Spinach transplanted
June 5– 1st cutting spinach
June 23– 2nd cutting spinach

We measured yield and foliar nutrients of harvested spinach for each cutting. Soil was sampled May 17, June 5, June 23 and July 31 and analyzed for nutrients.

## How does the nutrient content of bokashi compare to vermicompost and compost?

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

## How does bokashi impact soil nitrogen?

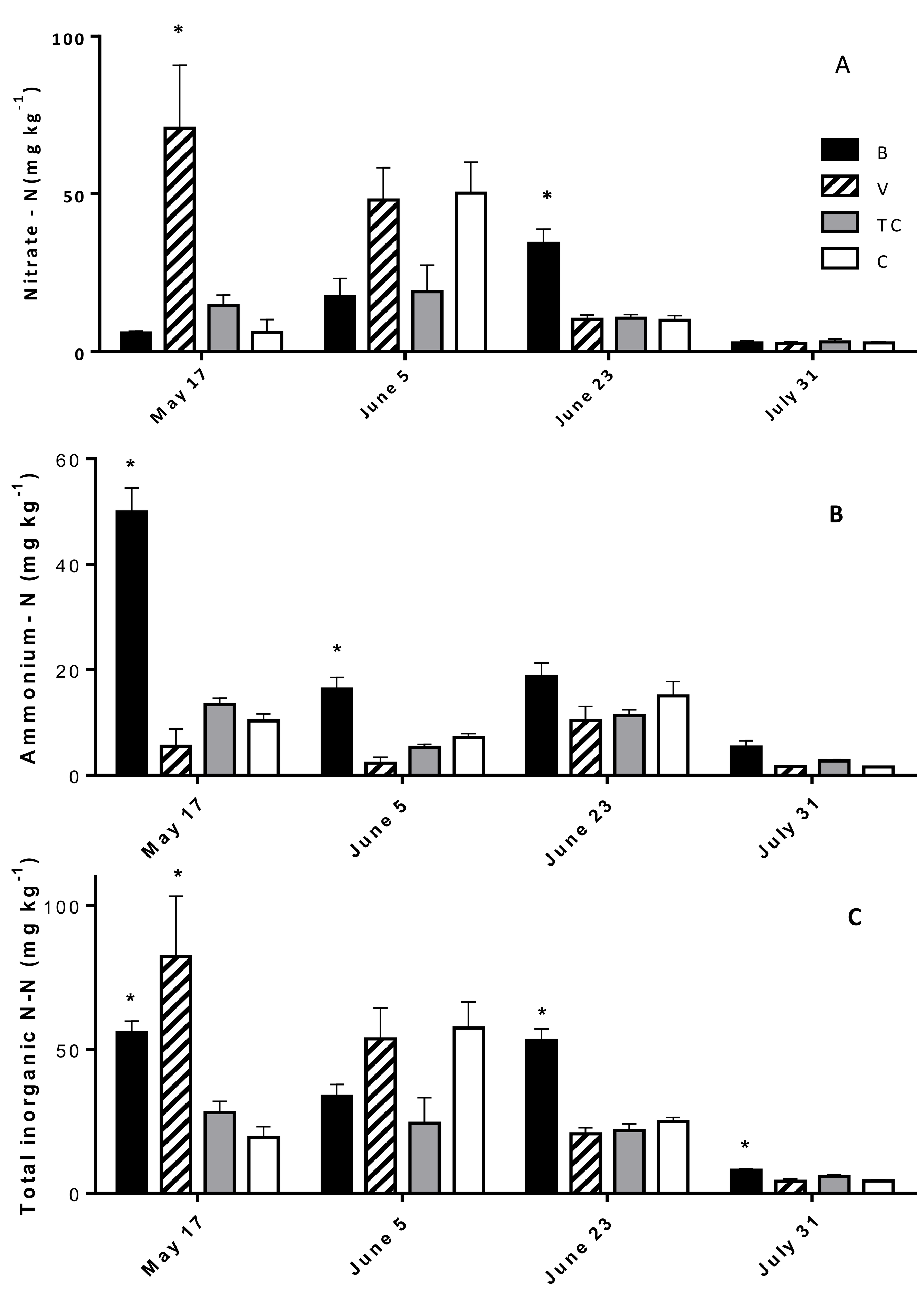



Figure 1. Concentrations of A) Nitrate-N, B) Ammonium-N, C) total inorganic N (ammonium + nitrate) in soil over time. An asterisk (*) indicates a treatment is significantly different from others ($p<0.05$).

## How does bokashi affect spinach yield and nutrients in leaves?

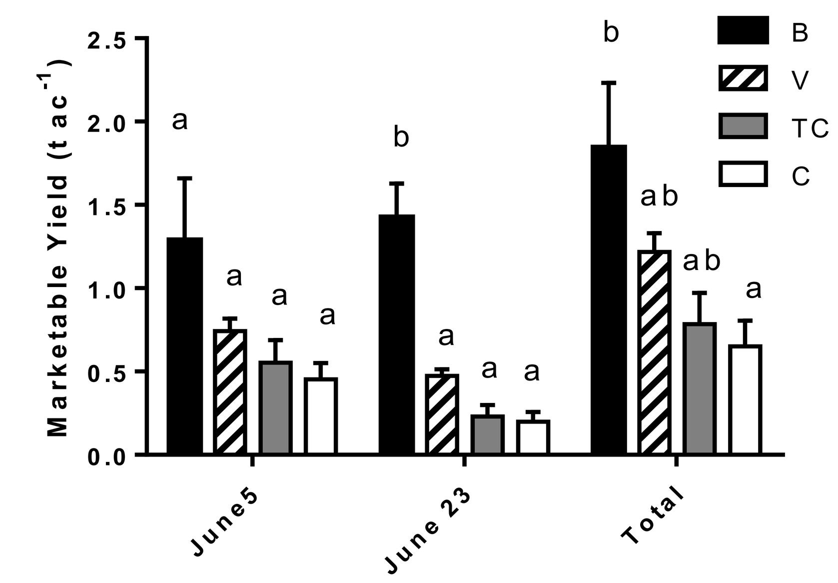



Figure 2. Comparison of marketable yield of treatments at June 5 and June 23 cuttings. Different lower-case levels indicate significant differences between treatments ($p<0.05$).

Photo: Top Left: Bokashi, Top Right: Vermicompost, Bottom Left: Compost, Bottom Right: Control. Taken before second cutting.

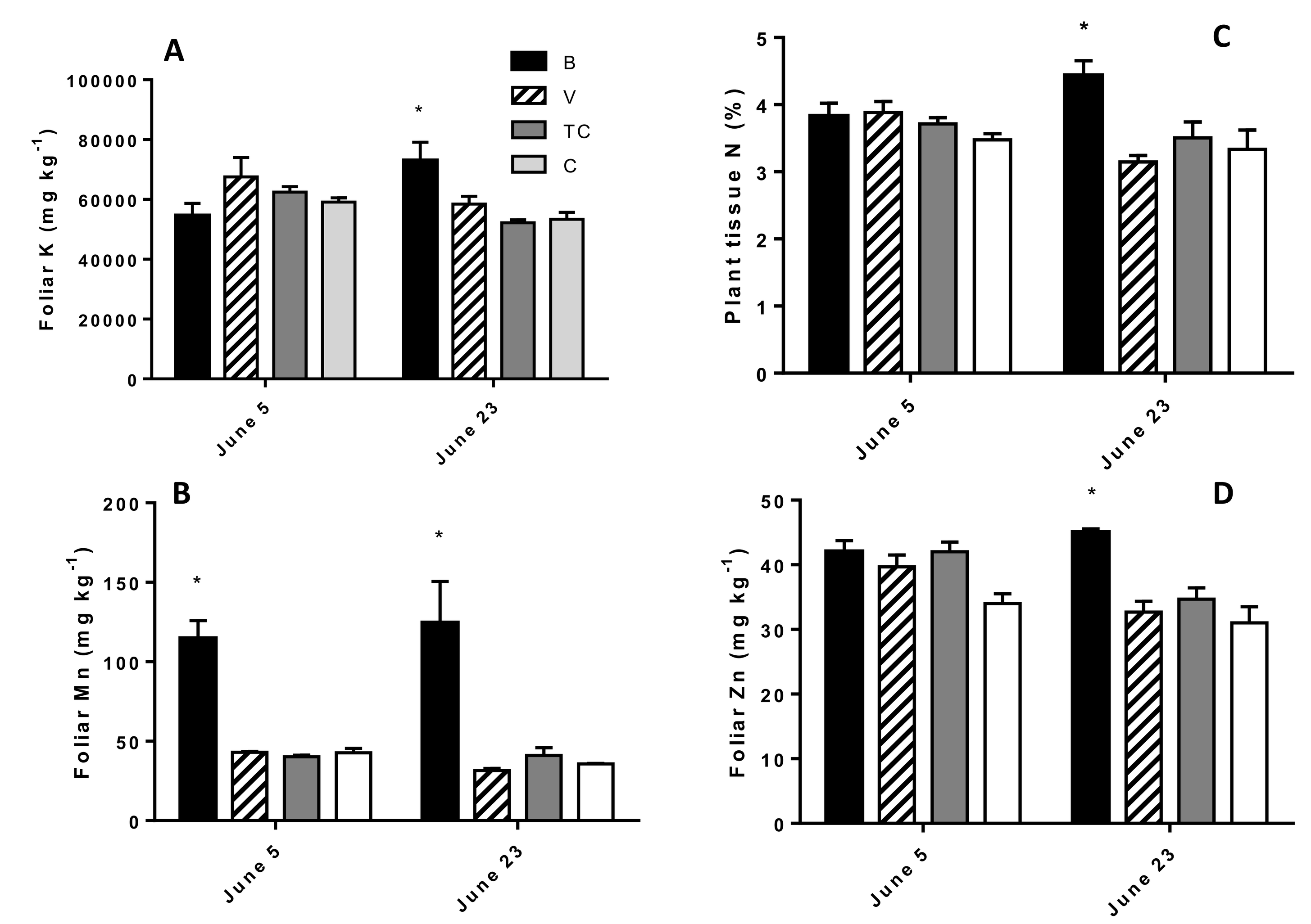



Figure 3. Concentrations of A) potassium, B) manganese, C) nitrogen, and d) zinc in spinach leaf tissue of treatments in June 5 and June 23 cuttings. An asterisk (*) indicates significant differences between treatments at that harvest ($p< 0.05$).

### Conclusions

- Bokashi has more ammonium-N than nitrate-N due to fermentation process.
- Once bokashi was buried in soil ammonium-N was converted to nitrate-N by soil microbes.
- Bokashi treatments had a more steady and prolonged supply of plant available nitrogen in this study.
- Greater concentration of N in plant available form in bokashi treatments between June 5 and June 23 soil sampling contributed to greater concentrations of foliar nutrients and marketable yield at second harvest date.
- Variability in food waste feedstock affects nutrient content and chemical characteristics of bokashi.
- Bokashi may be a viable alternative or supplemental soil fertility amendment in small scale vegetable production.
- Future studies should be replicated over multiple seasons and look into microbial characteristics of bokashi and their effects on the soil microbial community.

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