

Hawaii's Locally Produced Composts

Nitrogen release and effects on pak choi (*Brassica rapa* var. *chinensis*) growth

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INTRODUCTION

Efforts are underway to increase local food production in order to reduce the State's reliance on imports. Increasing the net productivity of the available agricultural lands in Hawai'i requires intensive fertilization. Unfortunately, the cost of imported fertilizers increased from \$300 to \$1000 per ton between 2006 and 2008, and is expected to increase in the future. Locally produced organic fertilizers are needed in order to increase Hawaiian and Pacific Island sustainability and keep local farmers competitive with imports. The results from lab incubation and greenhouse experiments that screened locally produced organic fertilizers for their nitrogen release and effects on Pak Choi growth in Mollisols and Oxisols are reported in this article.



Figure 1: Pak Choi (Chinese cabbage) plants grown under different compost amendments in greenhouse.

MATERIALS AND METHODS

Lab incubation and greenhouse experiments were conducted from January to September, 2012 to investigate twelve different organic fertilizers (see Table 1). The fertilizers were applied at the rate of 0, 5, and 10 t/ha in the lab incubation and 0, 10, and 30 t/ha in the greenhouse trials, assuming 1 ha = 1 million kg for Hawaiian soils. Some of the fertilizers are commercially available and some were produced from local products. A Complete Randomized Design (CRD) with three replicates was used for each experiment.

Table 1: Organic fertilizers used in lab and greenhouse experiments.

Compost	N%	C%	C/N Ratio	Compost	N%	C%	C/N Ratio
Vermicompost CB	1.13	16.9	15	Tankage (MBM) ²	8.43	48.61	6
Vermicompost FB	1.82	20.2	11	HEP-pile	0.87	21.3	24
Vermicompost MB	1.08	15.3	14	HEP+Tankage	0.98	20.6	21
Thermophilic-Egg	2.14	17.7	8	HEP-packed	0.81	23.5	29
Thermophilic (EKO)	1.83	21.2	12	Leuceana	2.93	43.3	15
Tankage (MBM) ¹	3.25	42.78	14	SOFT-garden waste	0.80	25.8	32

*Vermicompost CB = chicken based, FB= food based, MB = mixed bsed. 1= Tankage used for lab incubation experiment. 2 = Tankage used for greenhouse experiment. Red colored composts were used in the greenhouse trials.

Lab Incubation

This experiment was conducted for two months from January to March, 2012. Soils and composts were mixed thoroughly and maintained at a constant field moisture capacity of about 25% of soil weight throughout the experiment. Sub-samples were taken at 0, 1, 2, 4, 6, and 8 weeks and analyzed. Soil pH, electrical conductivity (EC), and nitrate (NO₃-N) concentrations were evaluated and only the nitrate-N analysis is presented here.

Greenhouse experiment

This experiment involved three plantings of Pak Choi (*Brassica rapa* var. 'Bonzai', Chinensis group) over a four month period, and seven composts that exhibited poor, medium, and high nitrogen release that were chosen from the lab incubation experiment. Limited greenhouse space made this reduction in the number of composts necessary and the representative composts used in the greenhouse experiment are in red (see Table 1).

The amendments were applied prior to the first planting. The second and third plantings, with no additional compost being applied, were conducted to evaluate the residual effect of the amendment. For each planting, seedlings were transplanted two weeks after sowing, and the plants were harvested a month later. Only the three best performing composts were used in the third and last planting. Performance was evaluated using fresh and dry weights, and leaf chlorophyll content, as measured by a SPAD meter. The performance analysis across all three planting is presented here. Tissue nitrogen and carbon content were also evaluated, although the data are not presented here.

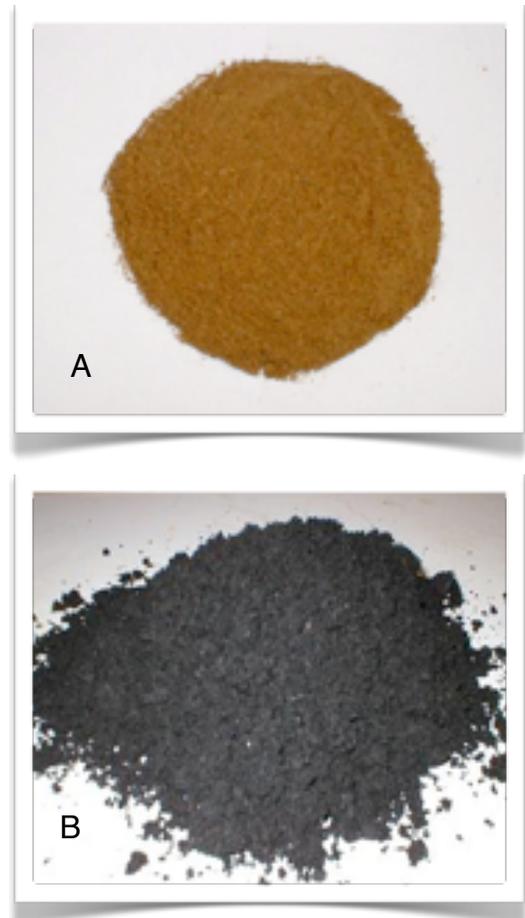


Figure 2: A-Tankage (meat and bone meal), and B-vermicompost are examples of locally produced organic fertilizers.

RESULTS AND DISCUSSION

Lab Incubation: Soil and compost type, and rate of application were found to have significant effects on EC, and nitrate-N concentration. A significantly positive correlation ($R = 0.78$) exists between the EC of the soil solution and the nitrate-N concentration. For soils amended with 10 tons of compost/ha, the nitrate-N release was 15% higher for Mollisols as compared to Oxisols (see Figure 3). Because mollisols have a higher hummus or organic matter content than oxi-

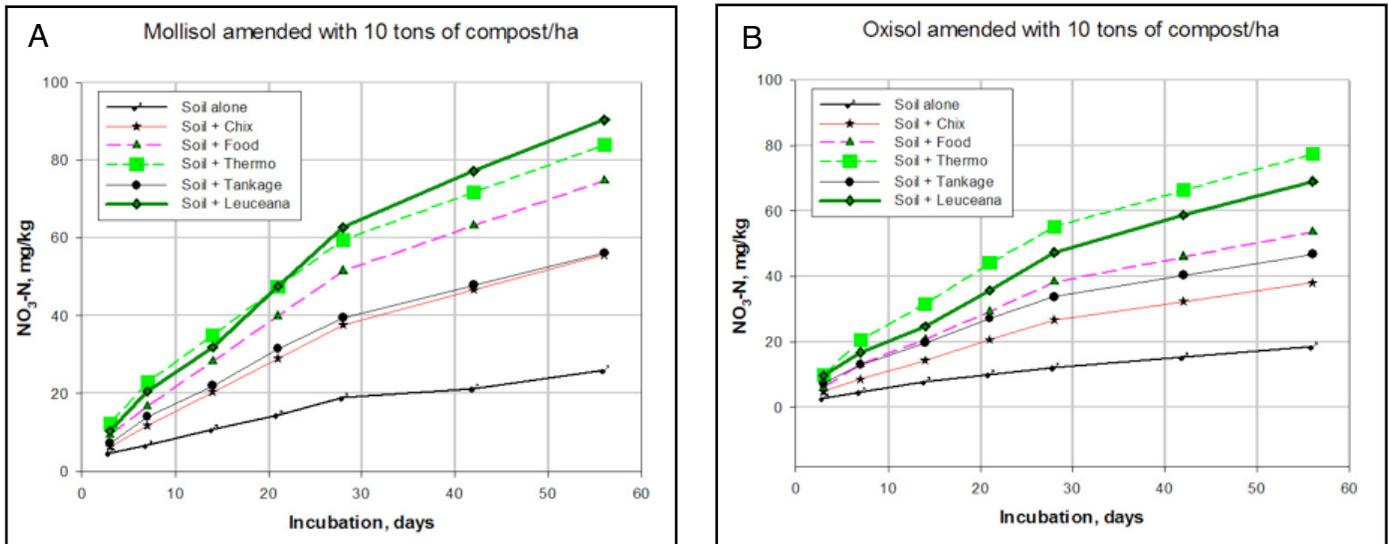


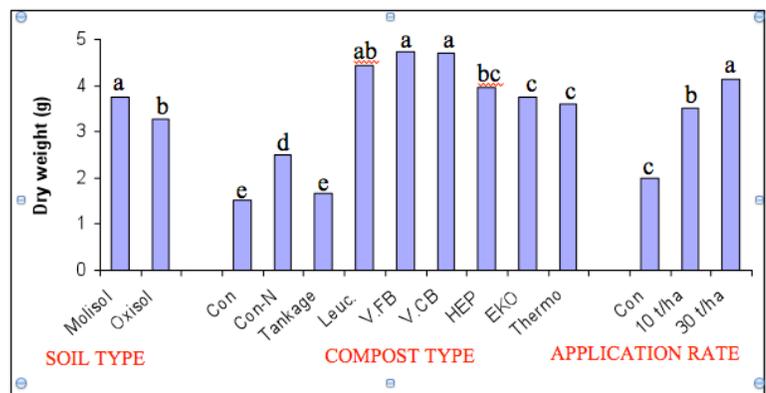
Figure 3: Nitrate-N (ppm) release as function of incubation time for composts applied at 10 t/ha on (A) Mollisol and (B) Oxisol.

sols, they have higher nutrient retention capacity, which may help explain this result. Also, clear differences were found in the nitrate-N release across the composts. The largest N release was from the thermophilic composts and Leucaena green manure, probably because of their high initial N content (see Table 1). Mineralization varied from 50 to 70% of total N across the composts. A similar pattern was found for the 5 t/ha application rate.

Greenhouse experiment: Soil and compost type, and rate of application had significant effects on Pak Choi growth. The vermicomposts, leucaena, and thermophilic composts produced the highest dry weights in the first planting, but only leucaena, EKO, and thermophilic composts continued to produce more dry matter in the second planting. This may be due to the variability in N content, or the nitrate-N release pattern (see Figure 3).

The dry weight of Pak Choi was significantly higher for Mollisols as compared to Oxisols (see Figure 4). The compost type and rate of application have a significant effect on Pak Choi dry weight. Significant differences also exist between soil and compost type, and rate of application on Pak Choi leaf chlorophyll content, which reflects differences in N release with different soil types and application rates (see Figure 3).

At the end of the second planting,



*Bars with different letters (for each factor) are significantly different at 5% probability.

Figure 4: Effect of soil type, composts, and rate of application on Pak Choi dry weight (g/pot) in the first planting.

Tankage, and leucaena, at both application rates, and thermophilic compost, at 10 t/ha, produced the largest dry weights and leaf chlorophyll content. The third planting produced only about 25% dry weight of the first planting. The likely cause of this decrease was the depletion of the nutrient supply over the three plantings.

CONCLUSION

Based on the results presented here, the following conclusions can be drawn:

- ▶ Amendments with highest N release or mineralization rates had lowest the C:N ratio and the highest total N content.
- ▶ Knowledge about the nutrient content and release pattern of organic soil amendments is needed in order to ensure that the nutrient requirements of the crop are met.
- ▶ The residual effects of organic amendments can be significant in some cases.
- ▶ Composts that are locally produced and available show promise as substitutes for imported fertilizers.



Figure 5: Variability among Pak Choi growth at the end of the 2nd planting.



Figure 6: Burning of Pak Choi leaves at Tankage high application rate (30 t/ha).

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