Predicting food production potential of urban vacant lots through soil quality

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ABSTRACT

Post-industrial cities such as Cleveland have accumulated substantial number of vacant lots due to home foreclosures and urban sprawl over the past two decades. Interest in this land has escalated recently due to increased demand for food security in disadvantaged urban neighborhoods. We measured soil physical, chemical, and biological parameters in vacant lots in the Hough neighborhood in Cleveland to assess their suitability for food production. Each lot was divided into three approximately equal sections and nine soil cores were collected from each section. The results revealed huge spatial variability in soil properties within vacant lots. Soil pH ranged from 6.24-7.46 and moisture from 1.5-20.5%. Soil clay content ranged from 4-33%, sand 40-92%, and silt 0-50%. Soil NH_4-N ranged from 1.7-21.0 ppm, NO_3-N from 2.3-35.3 ppm, microbial biomass from 40.2-245.7 ppm (N), soil organic matter from 2.0-7.0%, and soil active carbon from 413.3-694.8 mg/kg. Thirty-four nematode genera were identified, and nematode abundance ranged from 34 to 988 per sample. Soil active carbon, a rapid soil quality indicator, significantly correlated with other measures of ecosystem condition including NH_4-N, microbial biomass, soil organic matter, nematode abundance, maturity index, and combined maturity index. Principle Component Analysis revealed that vacant lots had less structured soil food webs than turfgrass lawns, but not from community gardens and vegetable farms. There were also no differences in nematode abundance, genus diversity, and enrichment index among vacant lots, turfgrass lawns, community gardens and vegetable farms. Our results indicate high potential for food production in urban vacant lots.

INTRODUCTION & HYPOTHESIS

- Healthy food access is a problem in urban disadvantaged neighborhoods.
- Home foreclosure and urban sprawl have resulted in the accumulation of vacant lots in cities across the US. (Over 16,000 vacant lots in Cleveland).
- Vacant lots undergo tremendous disturbances during house demolition, which may result in deterioration in soil quality. Therefore, the potential use of vacant lots for food production is often questioned.
- Active carbon and nematode community have been used as indicators of soil quality in agricultural ecosystems (Ferris et al., 2001; Weil et al., 2003).
- Specific objectives: 1) measure active carbon levels, nematode community indices, and other soil physical and chemical parameters in urban vacant lots, and determine their relationships; 2) compare soil quality in urban vacant lots to other land use types; and 3) compare lettuce growth in vacant lots of low, medium, and high soil quality.
- Our overall **hypothesis** was that food production capacity of urban vacant lots could be predicted from soil quality assessment.

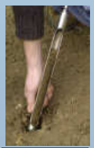
MATERIALS & METHODS

Site Selection:

- A relatively disadvantaged neighborhood: Hough neighborhood in Cleveland, OH.
- 28 city-owned vacant lots: 4 around each of seven K-12 schools.
- Each lot divided into 3 equal sections; 9 soil cores per section.
- Lettuce production study was conducted on 12 selected vacant lots based on soil active carbon level: 4 lots in each of high, medium, low levels.

A typical vacant lot showing scattered turfgrass and weed coverage.

A vacant lot with lettuce planted.



Soil sampling.

Soil and Nematode Community Analysis:

- Active carbon: Spectrophoto meter method (Weil et al. 2003)
- Organic matter: Storer, 1984.
- Soil pH & texture analysis: Gee and Bauder, 1986
- Mineral nitrogen analysis: modified indophenol blue technique (Sims et al., 1995).
- Microbial biomass: chloroform fumigation method (Brookes et al., 1985).
- Nematode extraction, identification, and calculation of nematode community indices (Ferris et al., 2001; Cheng et al., 2008).

Lettuce Production:

- Nine seedlings planted in each of the three sections per lot with a total of 27 plants per lot. The number of leaves, level of greenness, necrosis, chlorosis and anthocyanin present were recorded. At the end of four weeks the plants were cut and taken back to the lab for dry weight measurements.

Statistical Analysis:

- Coefficient of variation.
- Correlation analysis between total nematode population, nematode genus diversity, nematode community indices, and soil properties.
- Principle Component Analysis (PCA): to compare biological and chemical parameters in vacant lots in this study to those under two other urban land uses, turfgrass lawns, and community gardens, where the data were obtained from our previous studies (Cheng et al. 2008; Grewal et al., 2010).
- Relationship between soil active carbon and lettuce growth.

RESULTS

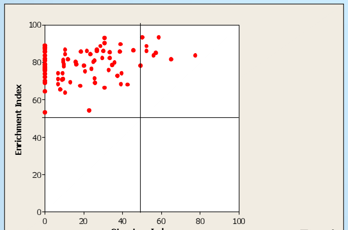


Fig. A

Fig. A: Nematode faunal profile shows that nematode food webs were highly enriched but low to moderately structured in urban vacant lots.

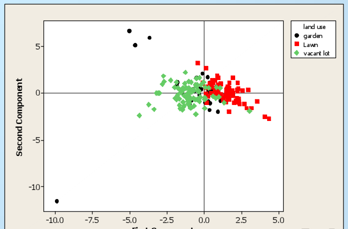


Fig. B

Fig. B: Principle Component Analysis reveals that vacant lots have less structured soil food webs than turfgrass lawns (PC1); There were no differences in nematode abundance, genus diversity, and enrichment index among vacant lots, and other 2 land use types (PC2).

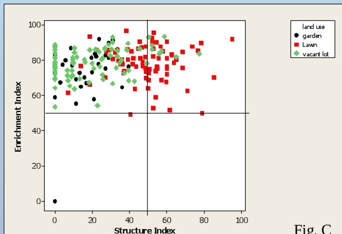


Fig. C

Fig. C: Nematode faunal profile shows that nematode food webs were highly enriched but low to moderately structured in three urban land use types.

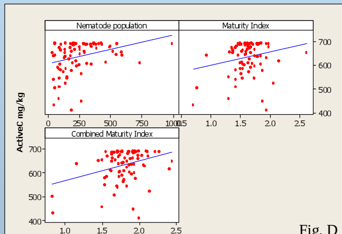


Fig. D

Fig. D: Soil active C was positively correlated with soil nematode abundance, nematode community Maturity Index, and Combined Maturity Index.

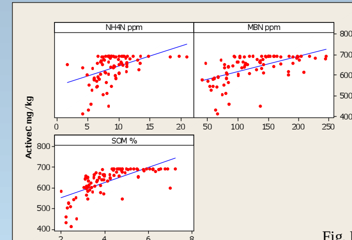


Fig. E

Fig. E: Soil active C was positively correlated with soil NH_4-N, microbial biomass, and soil organic matter.

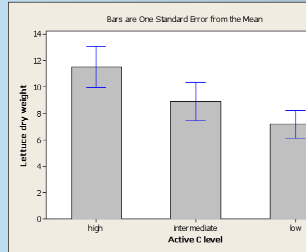


Fig. F

Fig. F: Lettuce has higher growth when soil active C is higher. Similar pattern was also found between soil active C and lettuce greenness.

DISCUSSION & CONCLUSIONS

- This study revealed tremendous variability in soil physical, chemical, and biological properties within urban vacant lots.
- Vacant lots had less structured soil food webs than turfgrass lawns, but not from community gardens.
- There were no differences in nematode enrichment index among vacant lots, turfgrass lawns, and community gardens, indicating the abundance of available nitrogen in the urban landscape.
- Nematode enrichment and diversity indices in urban vacant lots were similar to those in field crops (Briar et al., 2007) and vegetable crops (Hoy et al., 2008).
- Soil active carbon positively correlated with other measures of ecosystem health including nematode abundance, maturity index, combined maturity index, NH_4-N, microbial biomass, and soil organic matter, indicating the utility of active carbon as an effective soil quality/health indicator.
- Higher lettuce growth and quality were associated with higher soil active carbon content.
- We conclude that the potential for food production in urban vacant lots can be predicted from soil quality assessment particularly active carbon and nematode community.

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