Mykl Nelson and Gail Langellotto | Department of Horticulture

HOW SHOULD WE MANAGE URBAN GARDENS

This question ranked among the top 25 priority research questions for soil science in the 21st century.[1]

parameter	All beds (n=33) Mean (+/- s.d.)	All beds (n=33) sites w/i range	Raised beds (n=21) Mean (+/- s.d.)	Raised beds (n=21) sites w/i range	In-ground beds (n=12) Mean (+/- s.d.)	In-ground beds (n=12) sites w/i range	recommended range from OSU Extension publication EC 1478
pH	6.4 (0.3)	97%	6.3 (0.3)	95%	6.5 (0.2)	100%	6-7.5
C (% in soil)	6.4 (3.2)		7.2 (3.5)		4.8 (1.9)		
N (% in soil)	0.45 (0.2)	70%	0.49 (0.2)	59%	0.38 (0.1)	83%	0.1-0.5*
S (% in soil)	0.07 (0.02)	0%	0.08 (0.02)	0%	0.06 (0.02)	0%	0.0002-.001
P (ppm in soil)	278 (104)	0%	274 (104)	0%	262 (99)	0%	20-100
K (ppm in soil)	671 (824)	73%	792 (1028)	59%	448 (230)	92%	150-800
Ca (ppm in soil)	4344 (1354)	0%	4547 (1077)	0%	3510 (1128)	0%	1000-2000
Mg (ppm in soil)	633 (275)	0%	655 (264)	0%	545 (283)	0%	60-180
Mn (ppm in soil)	37 (14)	100%	38 (15)	100%	35 (14)	100%	>1.5
Cu (ppm in soil)	13 (7)	100%	12 (7)	100%	15 (5)	100%	>0.6
Zn (ppm in soil)	36 (16)	100%	37 (18)	100%	31 (9)	100%	>1
B (ppm in soil)	0.7 (0.7)	61%	0.8 (0.8)	52%	0.5 (0.2)	75%	0.5-2
ammonia (ppm)	1.1 (0.7)	15%	1.3 (0.8)	19%	0.8 (0.5)	8%	2-10*
nitrate (ppm)	5.6 (6.4)	6%	6.5 (7.7)	10%	4.0 (2.5)	0%	10-30

*=typical range

Table 1: Descriptive statistics of response means (+/- standard deviation) of sampled sites. The 'Sites w/i range' represents the percent of sites within the recommended range for that soil parameter, according to OSU Extension Publication EC 1478.[2]

THE STATE OF URBAN GARDEN SOILS

Urban food production has the potential to positively contribute to the sustainability and resilience of local food systems and to transform urban spaces.[5,6] In fact, studies indicate that 90% of a city's food crops could be grown within 100 miles of each urban area in the United States.[3,8] Localizing food production in or near city centers would make more efficient use of energy inputs, relative to rural-based food production.[4,7] Key to realizing the efficiency of urban agriculture is to better understand and manage urban soils as an important natural resource.

Currently, we know surprisingly little about the status and health of urban soils. We thus sampled the soils of 33 vegetable garden sites across Corvallis, OR and Portland, OR. All gardens were managed by OSU-trained Extension Master Gardener volunteers, who have received at least 6 hours of training on garden soils.

	pH	C	N	S	P	K
pH	1.00					
C	-0.11	1.00				
N	0.14	0.90	1.00			
S	0.08	0.91	0.88	1.00		
P	0.43	0.07	0.27	0.22	1.00	
K	0.31	0.54	0.75	0.58	0.38	1.00
Ca	0.20	0.69	0.70	0.78	0.29	0.41
Mg	0.00	0.73	0.71	0.72	-0.11	0.47
Mn	0.14	0.18	0.29	0.29	-0.12	0.40
Zn	0.31	0.40	0.51	0.41	0.55	0.41
B	0.26	0.67	0.86	0.69	0.28	0.95

Table 2: Pearson's correlation coefficients between multiple variables. We checked an initial chart between 21 variables across 34 sites for significant correlations (α=+0.05, -0.01).[9] We highlighted the five significant correlations in red.

STUDY METHODS

Soil samples were collected in August 2017, from raised beds and in-ground beds were vegetables were being grown. Raised-beds (RB) were defined as those with a constructed border around the entire production area. In-ground (IG) beds were defined as styles of production that work directly with the native soil without a delineating barrier. Soil was sampled using a 1m soil probe.Each site's samples were homogenized by passing the media through a 2mm sieve. Especially sticky samples were passed through an 8mm sieve and left to air dry at ~30°C for one day, then rejoined the intake process. The material which didn't pass through were examined for identifiable rock and organic matter which were set aside in separate ontainers. The remaining material was subjected to mild crushing by ceramic mortar and pestle. This material was once again passed through the 2mm sieve. After the final sieving, total matter >2mm were weighed, recorded as organic matter or rock fragments, and discarded. Sub-samples of the dried, screened, and homogenized soils were then portioned out for various chemical, physical, and biological tests.

KEY FINDINGS

- A majority of sites exceeded the recommended range for most nutrients.
- Urban garden soils seem to differ by bed-type. Urban agriculture should be advised based upon what bed management style is chosen. A strong definition would help this work proceed.
- Garden soils may be better tested by using alternate methods, particularly for tests with errors dependent upon organic matter content.

OUTCOMES OF THIS STUDY

Our results suggest that the ubiquity of compost as a soil amendment leads to unbalanced garden soils. Because these gardens are managed by Oregon State University Extension Master Gardeners, who have received at least three hours of training in soil health, the results further suggest that we must modify the message we deliver to Master Gardener trainees and volunteers. Compost easily addresses common production constraints of gardens upon establishment, but fertilization in the following years should take into account, and be adjusted for, current soil nutrient levels.

Additionally, soil labs should offer alternative testing procedures for garden soil samples, that typically have high levels of organic matter (OM). For example, preparing for texture analysis typically involves using hydrogen peroxide to oxidize organic matter out of the soil solution. The organic matter of our samples averaged 8%: double the OM in typical agricultural soil. This means a hydrogen peroxide treatment would be introduces much more variance than normal. Instead, samples could be prepared in a muffle furnace. This route is normally avoided as it can bond minerals and affect textural outcomes. But the simple guarantee it gives of removing organic matter provides a net reduction of variability.

QUESTIONS TO EXPLORE

- Nutrient pollution:
  - Do raised-beds experience excessive leaching?
  - Do raised beds experience nutrient toxicity?
- "More is better" fertility paradigm:
  - At what point is organic matter no longer needed?
  - How can a gardener tell that organic matter is limiting soil productivity?

Oregon State University

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