A PILOT STUDY ON THE DETECTION OF LEAD IN RESIDENTIAL GARDEN SOIL IN TRI-STATE MINING AREA

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INTRODUCTION

Sources of lead contamination

Anthropogenic sources: Chipping of lead paint (Traunfeld, 2020), Smelting of ores, mining (Singh et al, 2019)

Health risks:

- Permanent CNS damage
  - Intellectual/ learning disabilities (Verity, 1995).
- Lead contaminated dirt gets on their clothes, their hands, mouths (ERG, 2001).
- In adults, lead can leach from bones, in instances such as remodeling bone and during pregnancy (Richards, 2008).
- Serious reproductive affects (Taquia-Arashiro, 2018).
  - Miscarriage, premature birth, low birth weight
  - Reduction in sperm count

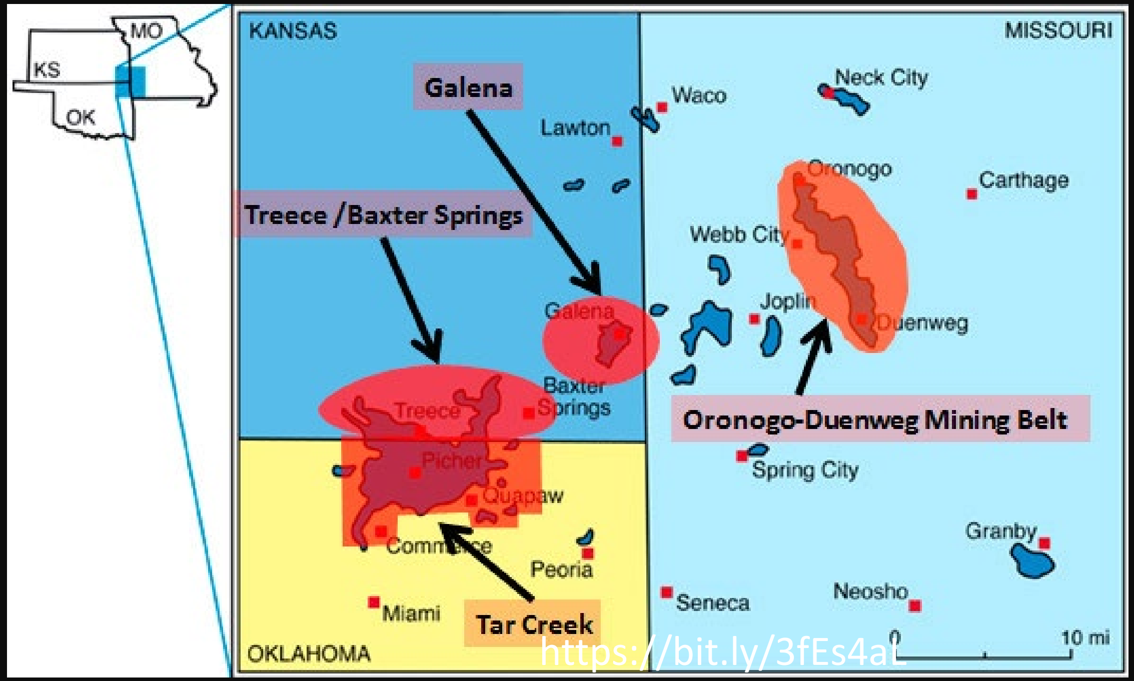
Lead persistence

- Decrease in 16S microbial diversity including long-term metal-mediated changes in soil enzyme activities (Sobolev et al, 2008)
- Some plants (e.g. water hyacinth) can uptake heavy metal and transform them into less toxic forms (Aktar et al, 2013)

Tri-state mining and lead contamination

- Rainwater over lead in mining causes acidic water to contaminate the underground aquifer (Vasquez et al, 2006).

- Tar Creek Superfund Site
  - 60 years of mining (EPA, 1994)
  - 50 square miles (Hu et al, 2007)
  - Positive control for lead contaminated soil was collected from Tar Creek chat piles



Research objectives:

i) To collect soil samples from residential garden areas of Alba, MO, and Pittsburg, KS

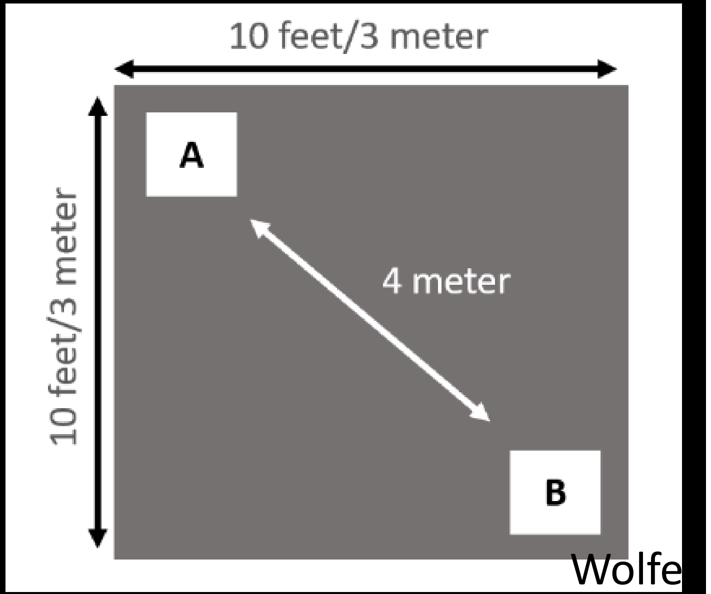
ii) To qualitatively analyze the NPK levels as well as soil pH

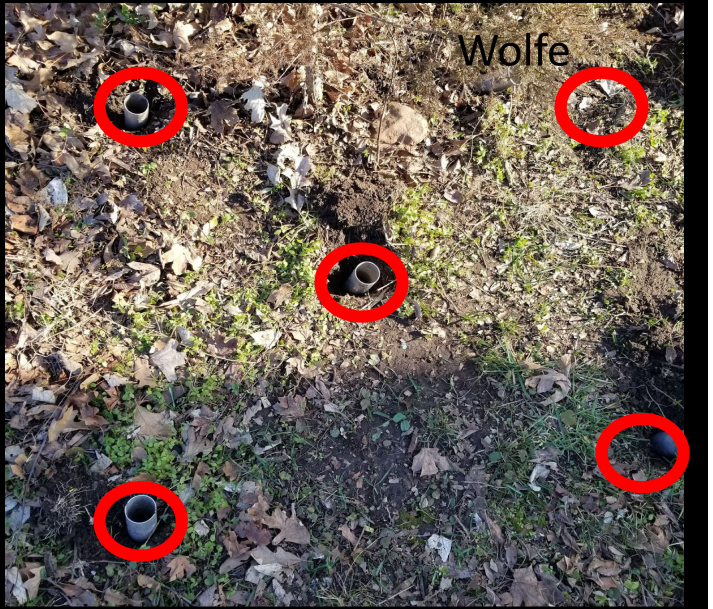
iii) To quantitatively analyze lead level in the collected soil
   - i) EPA soil lead hazard guideline of 400 ppm
   - ii) Garden soil threshold is suggested to be 100 ppm (Umass, 2020).

iv) To interpret survey questionnaire with respect to data obtained

METHODS

- ✓ Soil samples were collected four cm depth from the A horizon or A and O horizon using augur
- ✓ Air-dried, homogenized
- ✓ NPK, Lead, and pH tested



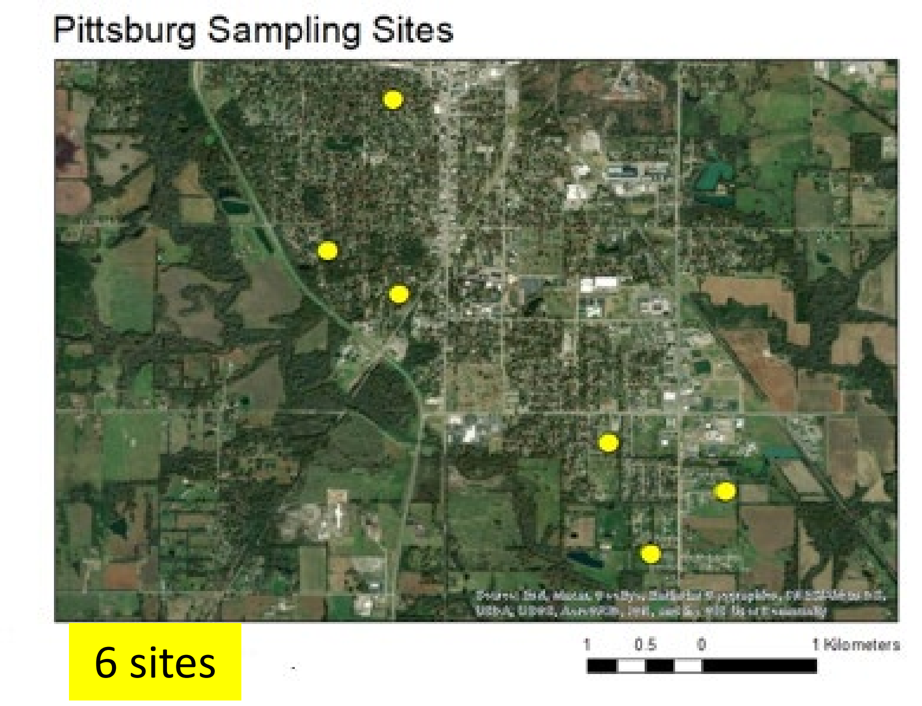


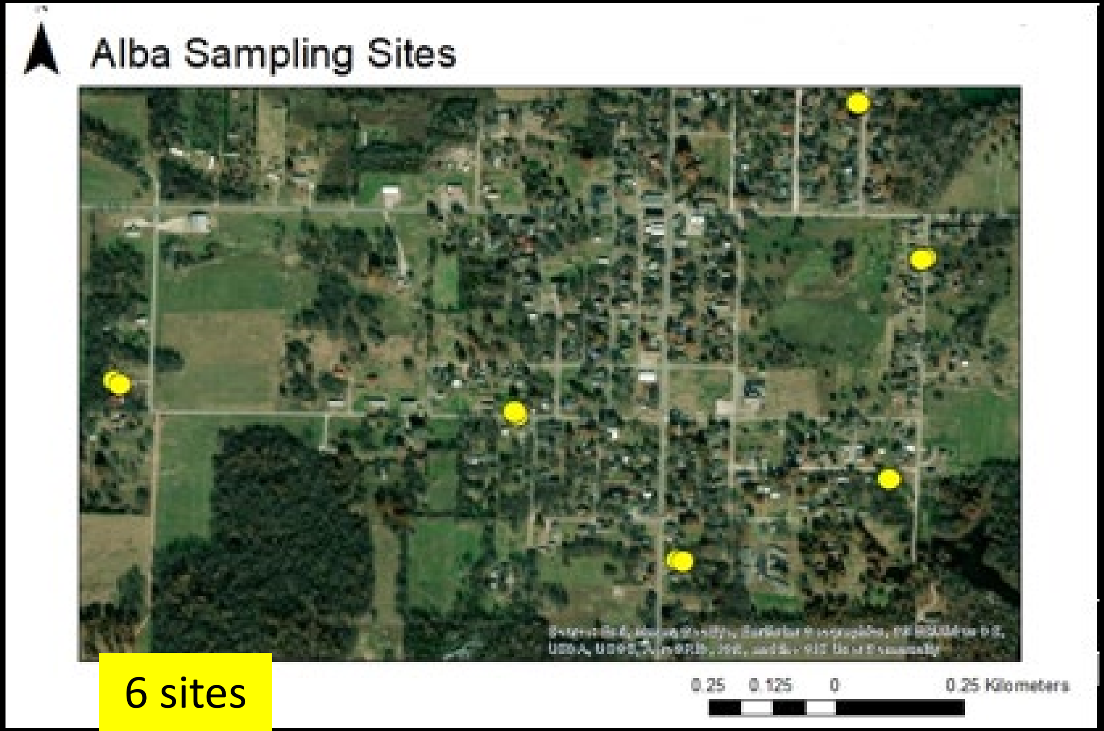
Sampling Site A

Lawn (Please indicate type of grasses in the lawn)			
☐ Native grass	☐ Planted/seeded grass	☐ Don't know	
Specify name if known			
Shrub or small tree			
☐ Shrub/ Flowering plant	Ex: Rose of Sharon, sedges, lilac, hydrangeas, etc.		
☐ Tree (Deciduous or evergreen)	Ex: Oak, maple, pine, cypress, pear tree, etc.		
☐ Don't know			
Specify any other type			
Crops			
☐ Annual vegetable garden	Ex: Greens, roots, shoots, legumes, etc.		
☐ Perennial vegetable garden	Ex: Asparagus, rhubarb, horseradish		
Specify any other type			
Fruit			
☐ Strawberry	☐ Blueberry	☐ Grape	☐Bramble (blackberry, raspberry)
Specify any other type			
Collection site topography			
Is the ground	☐ Level?	☐ Sloping?	☐ Terrace?
Irrigation/watering	☐ Seldom	☐ Occasionally	☐ Frequently
Light Intensity	☐ Full shade	☐ Partial sun	☐ Full sun

Wolfe

Maps showing soil collection sites of Alba and Pittsburg





- Environmental parameters during collection:
  - Temperature range (3-19°C/37-66°F)
  - Humidity range (30%-80%)
  - Date range (12/10/2020-1/13/2021)
  - Parson's silt loam soil type

Homeowners were given a short survey questionnaire consisting of 4 questions

RESULTS

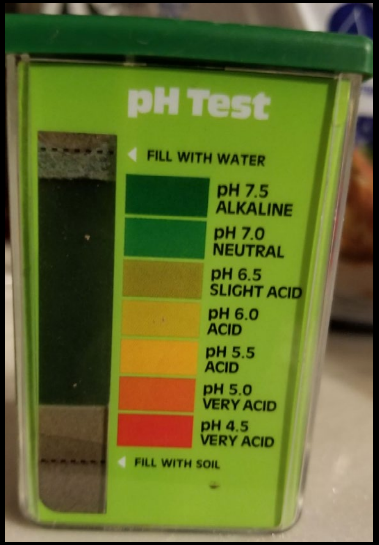
Homeowner Questionnaire Responses

N=12

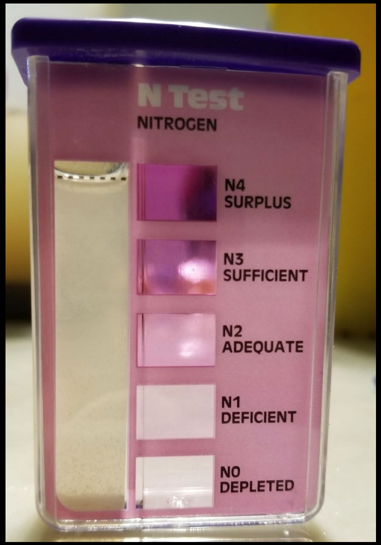
Homeowner questionnaire	Response rate	
Have you ever performed any lead test for your household paint (interior/ exterior), water or yard soil?	75% No	25% Yes
Is this household built before 1978?	58% No	42% Yes
Do you eat fresh produce from your yard? **Does this concern you?**	25% No 100% No	75% Yes 0% Yes
Do you have children/pets play in the yard? **Does this concern you?**	17% No 100% No	83% Yes 0% Yes

RESULTS

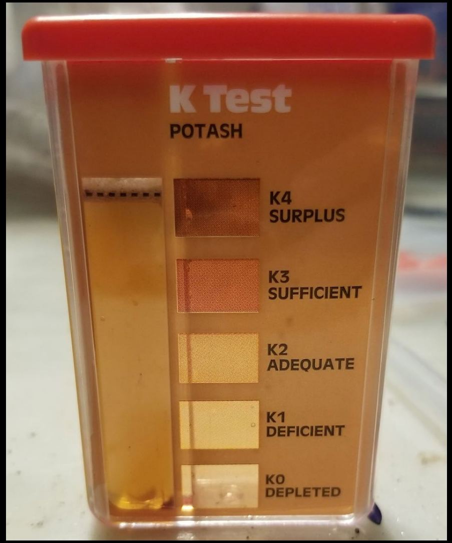
Representative photos of NPK and pH test results



Alkaline reading



Depleted reading



Adequate reading

Deficient reading

NPK- Three key nutrients (Fertilizer Institute, 2016):

Nitrogen- form proteins

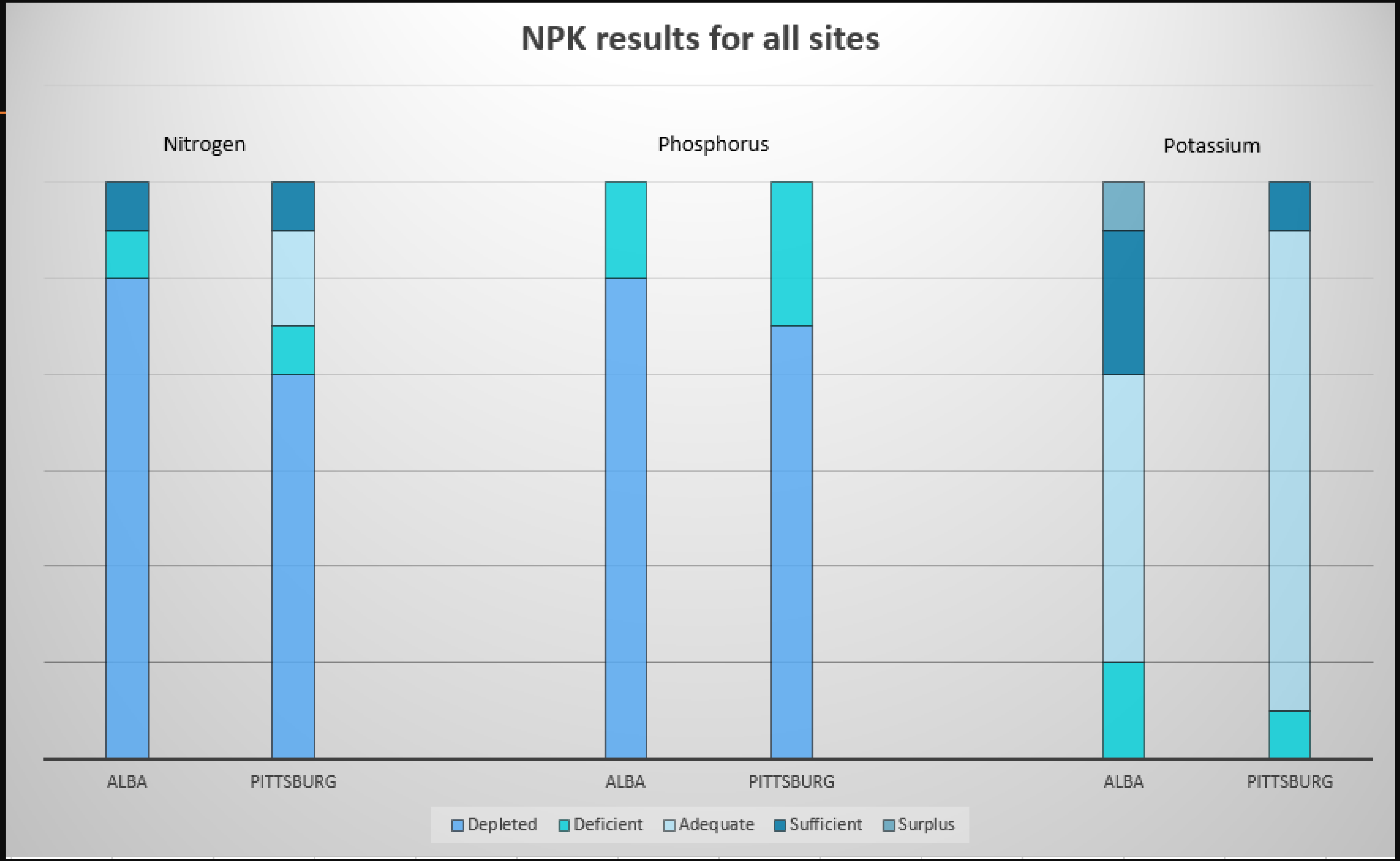
Phosphorus- growth and development

Potassium- crop yield and the ability to resist disease

Excessive use of NPK fertilizers decreases level of microbial population dehydrogenase activity (Duarah et al, 2011) –soil infertility

RESULTS

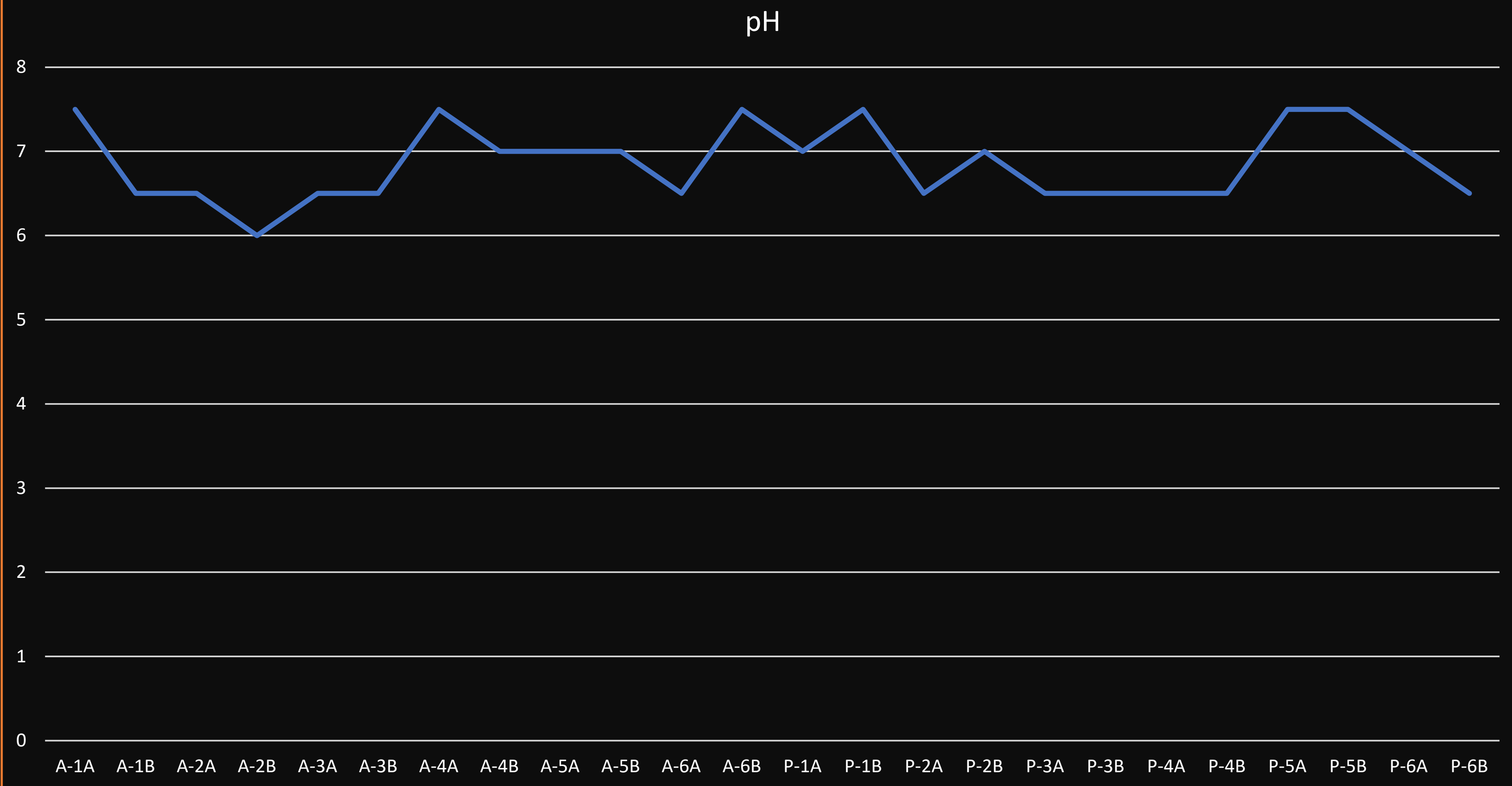
Determination of NPK and pH levels – all subsites



- N=12 sites, 24 subsites.
- Similar NPK between cities
- Mostly depleted of nitrogen
- Mostly adequate potassium
- Mostly depleted of phosphorus
  - Good because less phosphorus makes lead immobile and bound to particles

RESULTS

Determination of NPK and pH levels – all subsites



- N=12 sites, 24 subsites
- pH- Fairly neutral, ranges 6.0-7.5
  - Good since acidic pH makes lead available
  - Less leaching

Quantitation of lead using inductively coupled plasma atomic emission spectroscopy (ICP-AES)

Lead testing kit provided false positive results; data not shown

Subsites	Lead (PPM)	Lead rerun (PPM) (if applicable)
P-1A	38.9	N/A
P-1B	30.9	N/A
P-2A	17.3	N/A
P-2B	15.4	N/A
P-3A	12.2	11.6
P-3B	15.1	N/A
P-4A	40.7	N/A
P-4B	55	N/A
P-5A	987.4	933.3
P-5B	1,025.90	965.8
P-6A	39.2	N/A
P-6B	78.8	N/A

Subsites	Lead (PPM)	Lead rerun (PPM) (if applicable)
A-1A	106	N/A
A-1B	145.1	N/A
A-2A	44.6	N/A
A-2B	31.4	N/A
A-3A	28.2	N/A
A-3B	40	N/A
A-4A	61.7	58.0
A-4B	747.6	723.4
A-5A	131	124.2
A-5B	30.9	29.3
A-6A	56.5	N/A
A-6B	226.6	N/A

Data obtained from K-State soil testing lab

Subsite	Lead	Lead Reading (PPM)
T-1A	+	10,809.2
T-1B	+	7622.4

DISCUSSION

- Samplings were carried out in winter and over a short period of time
  - Avoided lawn treatments
- Detection of lead:
  - 88% of subsites were below 400 ppm.

- In Alba, a low subsite A reading (61.7 ppm) while subsite B had a reading 10x higher. Home was built over 100 years ago. The homeowner has found and removed embedded metal in the soil while gardening.
- One site in Pittsburg, had a high levels (>900 ppm) at both subsites. The home was built in 1920. The previous homeowner had painted over and sealed the interior. The elevated lead level is probably due to exterior house paint leaching into the soil.

Conclusions and Future Research

- Due to tristate mining background and use of lead-based paint, it is useful to check lead concentration of residential soil
- Bioremediation-Characterizing bacterial strains from garden soils with elevated lead-level
- Phytoremediation- Planting specific trees or shrubs that may reduce lead levels

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