Distribution of Cadmium in Rice Paddy Soil Affected By Long-Term Application of Phosphate Fertilizer and Compost for 50 years

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Research Background

Application of fertilizers are required to supply adequate nutrients for crop growth. However, phosphate (P) fertilizers may contain hazardous elements such as cadmium (Cd) and lead. Continuous application of phosphate fertilizer may result in accumulation of Cd in arable soil.

Organic matter (OM), also, is often used to improve the soil properties in arable soil. Long-term application of compost could change the Cd behavior in soils due to increase in dissolved organic carbon (DOC) resulting in the soluble DOC-Cd complexes.

Research Objective

The objective of this study was to evaluate the effect of long-term application of P fertilizer and compost on Cd phytoavailability in rice paddy soil.

Materials & methods

Field experiment

- Location : experimental farm of division of Southern Area Crop Science in Korea
- Studied years : from 1967 to 2016 (for 50 years)
- Treatments : control, NK, NPK, and NPK + compost
- Application rate
  Chemical fertilizer : N-P_2O_5-K_2O = 120-80-80 kg ha^{-1} (during 1967-1972)
  N-P_2O_5-K_2O = 150-100-100 kg ha^{-1} (since 1973)
  Compost (straw mix with cow manure) : 10 Mg ha^{-1} before flooding

Chemical analysis

Soil samples were collected from the Ap horizon (0-15cm depth) after every harvest.

- Soil pH (1:5 with H_2O)
- Dissolved Organic Carbon (DOC)
- Cation Exchange Capacity (CEC)
- Total P concentration
- Total Cd concentration : aqua regia (HNO_3 : HCl = 1 : 3) digestion
- Plant available Cd concentration : 1M NH_4OAc (pH 7.0) solution extraction measured by inductively coupled plasma-mass spectroscopy (ICP-MS)

Results

Figure 1. Changes of 1M NH_4OAc extractable Cd concentration in soils affected by the long-term application of chemical fertilizers and compost from 1976 to 2016

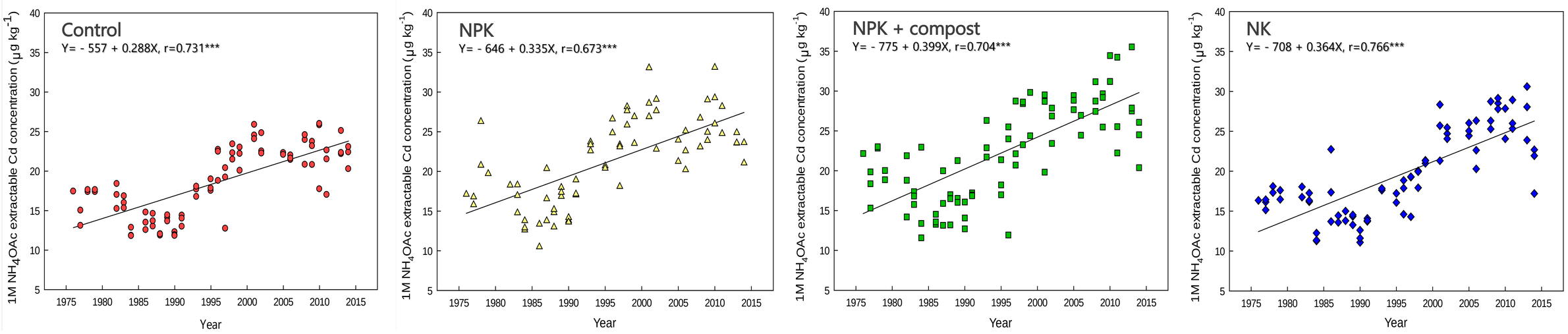


Figure 2. Changes of soil pH in soils affected by the long-term application of chemical fertilizers and compost from 1976 to 2016

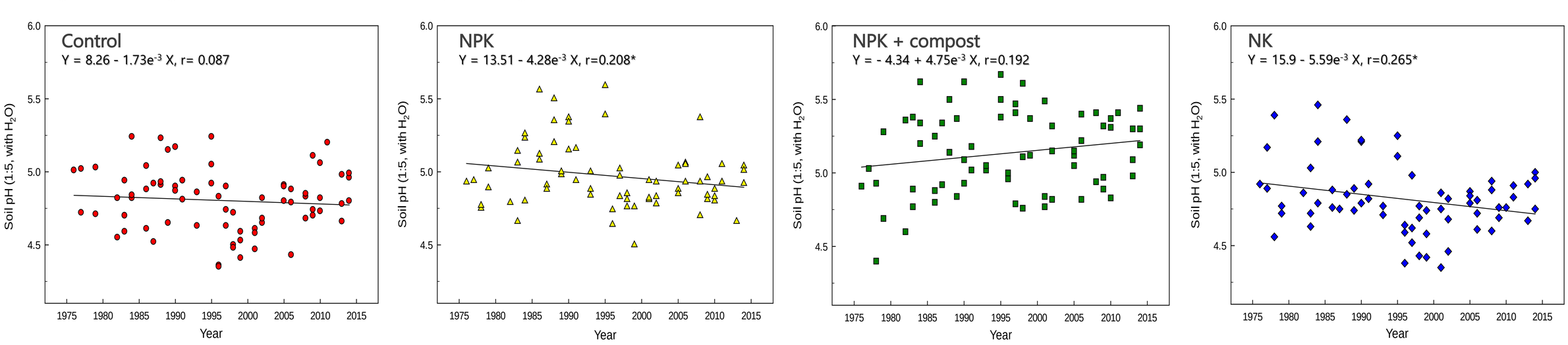


Table1. The relationship between 1M NH_4OAc extractable Cd concentration and soil pH in paddy soil

Treatment	Control	NPK	NPK + compost	NK
Regression equation	pH = 5.14 – 0.018×Ex.Cd conc.	pH = 5.49 – 0.023×Ex.Cd conc.	pH = 5.20 – 3.39e^{-3}×Ex.Cd conc.	pH = 5.12 – 0.015×Ex.Cd conc.
r value	0.374***	0.561***	0.081	0.356***

Conclusion

Plant available Cd (1M NH_4OAc extractable Cd) concentration in soil amended with NK and NPK fertilizer was negatively related with soil pH. However, there was no relationship between plant available Cd concentration and soil pH in soil with application of NPK + compost. From the above results, plant available Cd concentration in soil amended with NPK + compost gradually increased with year despite of the fact soil pH slightly increased. This might be attributed to formation of soluble DOC-Cd complex in soil amended with NPK + compost. In other words, long-term application of phosphate fertilizer and compost may increase extractability of Cd and its uptake to rice plant.