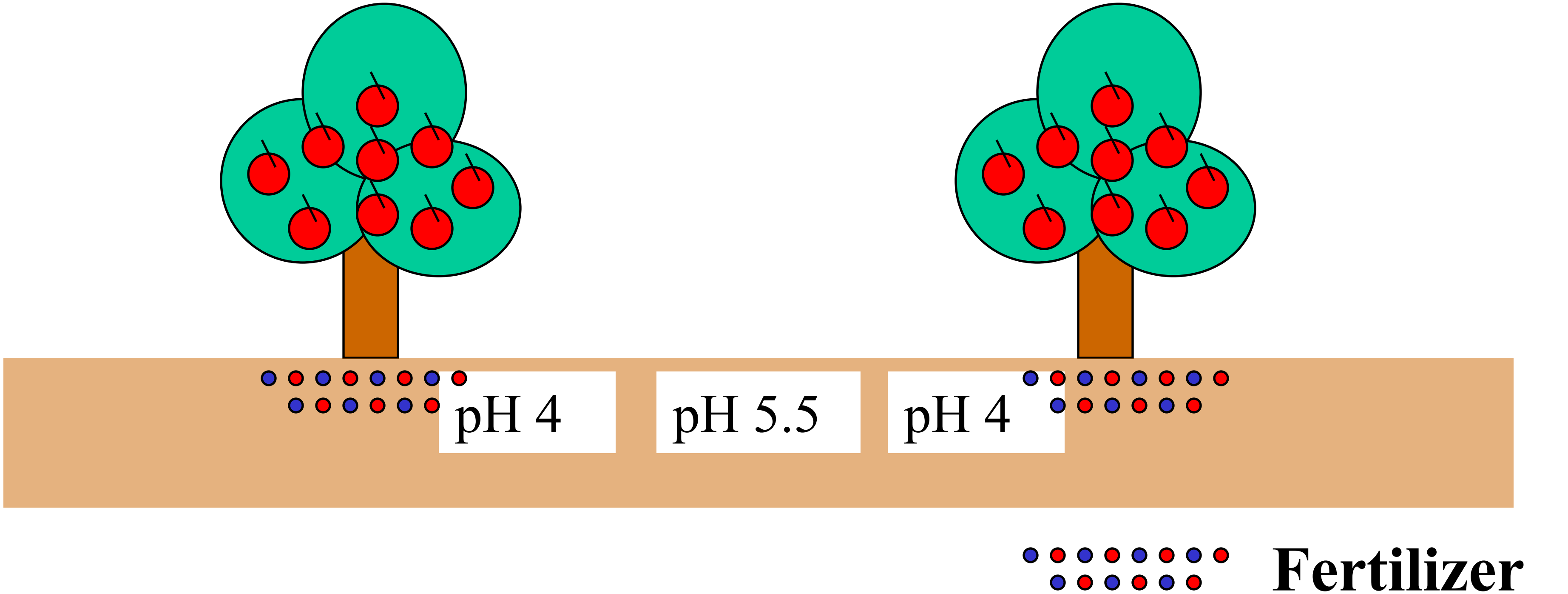
Acidification by fertilizer application



$(NH_4)_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

NH_4^+ is absorbed by crops, and

H^+ is supplied from soil colloids, root exudates, and

Physiologically acidic fertilizers

- Ammonium sulfate $(NH_4)_2SO_4$
- Ammonium cloride NH_4Cl
- Potassium sulfate K_2SO_4
- Potassium cloride KCl

NH_4^+ and K^+ are absorbed, but SO_4^{2-} and Cl^- remain in soil, unabsorbed.

Physiologically neutral fertilizers

- Urea $(NH_2)_2CO$
- Ammonium nitrate NH_4NO_3
- Ammonium phosphate $(NH_4)_2HPO_4$
- **Same for compost.**

All the constituents are absorbed or decomposed.

Acid rain

- $SO_2 + H_2O \rightarrow H_2SO_3$
- $H_2SO_3 + (1/2)\ O_2 \rightarrow 2H^+ + SO_4^{2-}$

- N_2O, NO, NO_2

  $+ m\ H_2O + (n/2)\ O_2 \rightarrow H^+ + NO_3^-$

Acid sulfate soil

- Iron sulfide (pyrite) is accumulated stably under anaerobic condition in the lake and sea sediments.
- When pyrite is oxidized in air after the reclamation, sulfuric acid is formed.
- $FeS_2 + nO_2 + H_2O \rightarrow FeSO_4 + H_2SO_4$
- Frequent problems in reclaimed paddy soils, upland field dressed with soils, and reclaimed wetland soils.

Damage by soil acidity : fixation of phosphate

- Al^{3+} + PO_4^{3-}

  → $Al\,PO_4$ ～ $Al(OH)_2H_2PO_4$

  variscite, (hardly soluble)

- Fe^{3+} + PO_4^{3-}

  → $Fe\,PO_4$ ～ $Fe(OH)_2H_2PO_4$

  strengite, (hardly soluble)

Exchangeable bases

- Mineral nutrients in the forms of cations in soils.
- Actually, Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}
- It is important that they exist in available form for crops in soil.
- Balance between these cations is important.
- K, Mg should be decreased if they are in excess.

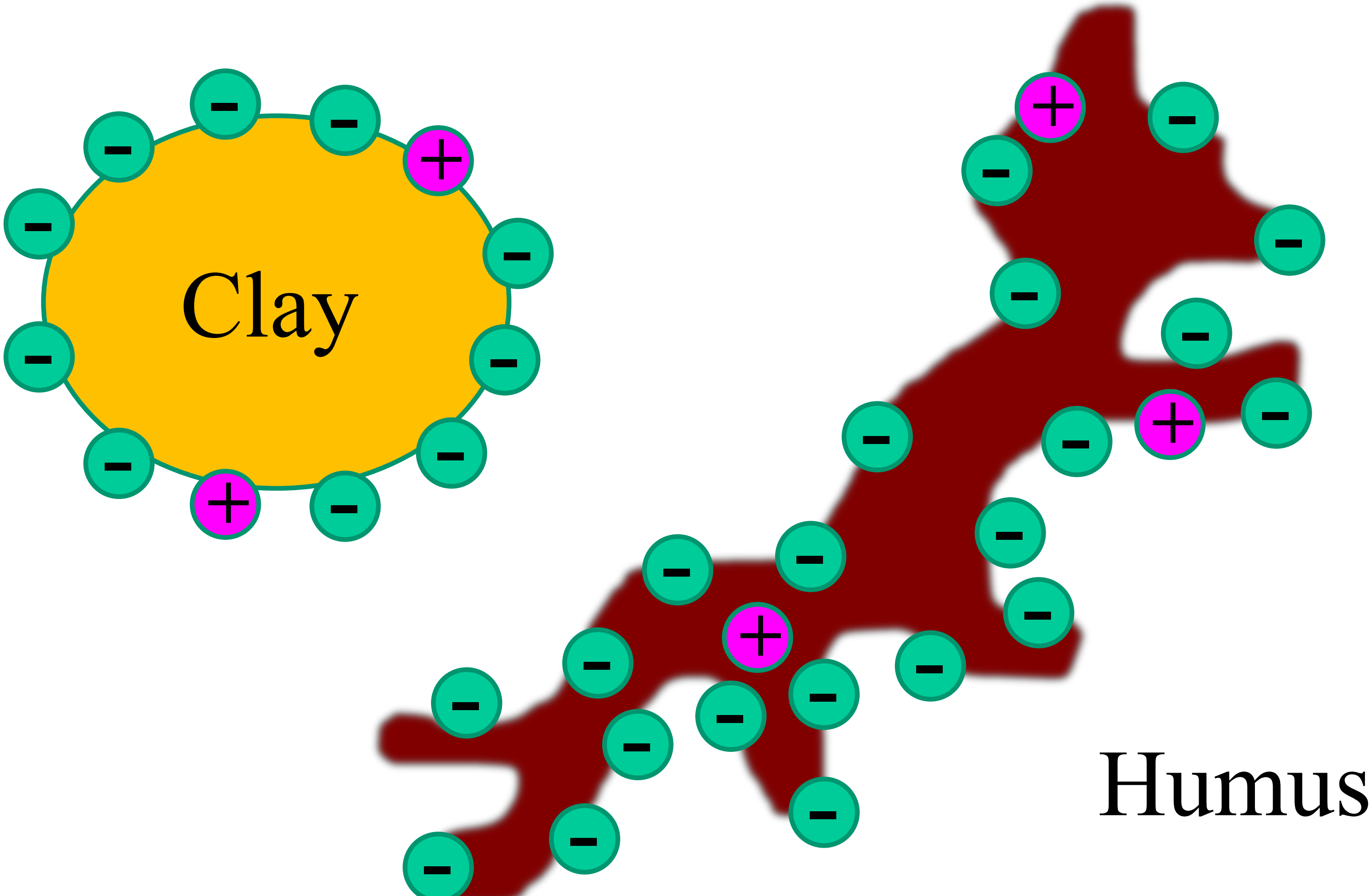
Exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+})

- Extracted with1M ammonium acetate from soil.
- Determined by the atomic absorption photometer or flame photometer.
- Essential cations existing in available forms in soil.

Exchangeable bases
(Ca^{2+}, Mg^{2+}, K^{+}, Na^{+})

- By soil acidification, Ca^{2+} and Mg^{2+} decrease.
- K^{+} reflects the applied amount of potassium fertilizers.
- Na^{+} is high in alkaline soil or in salinized soils. However, not so high in Japan.

Cation Exchange Capacity (CEC)



Cation Exchange Capacity（CEC)

- Ability of soils to hold cations electrostatically.
- It is due to the negative charges of clay minerals and humus in soil.
- Soil is first saturated with pH7 1M ammonium sulfate, then ammonium ion is eluted out with 1 M KCl. Eluted ammonium is determined by distillation and titration, or by colorimetry (indophenol method).

Soils with high CEC.

- Soils rich in humus.
- Soils rich in clay.

To increase CEC,

- Apply organic matter (compost) continuously.
- Dress soils rich in clay.

Standard values for CEC

- Used as fundamental data for planning the methods of soil improvement and fertilizer management.
- Immature sand dune soil: 3-10 $cmol_c/kg$
- Gray lowland soil, light colored ando soils: 15-25 $cmol_c/kg$
- Humic ando soils: 20-30 $cmol_c/kg$