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Nitrogen, acidification and nutrient relations

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Content

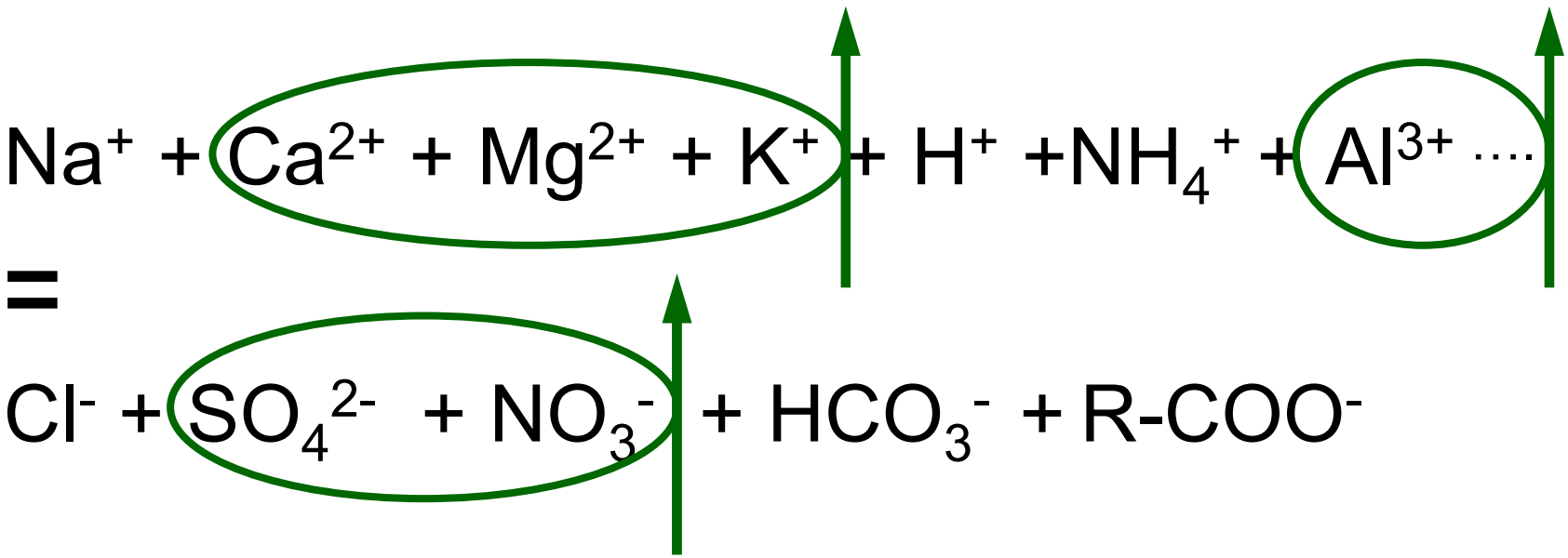
- Acidifying processes
- Proton transfer in N processes
- Potential acidification
- May be it is more complex
- Interaction on other nutrients

Acidifying processes

Dissolved CO_2	$CO_2 + H_2O \Leftrightarrow H^+ + HCO_3^-$
Organic acids	$(CH_2O)_n + O_2 \Leftrightarrow R\text{-}COO^- + H^+$
Biomass product.	$R\text{-}COOH + Me^+ \Leftrightarrow R\text{-}COOMe + H^+$
Nitrogen	$(N_2, NO_x, NH_3) + (CH_2O)_n \Leftrightarrow R\text{-}NH_2$ $NH_3 + 2O_2 \Leftrightarrow H^+ + NO_3^- + H_2O$
Sulphur	$H_2SO_4 \Leftrightarrow 2H^+ + SO_4^{2-}$

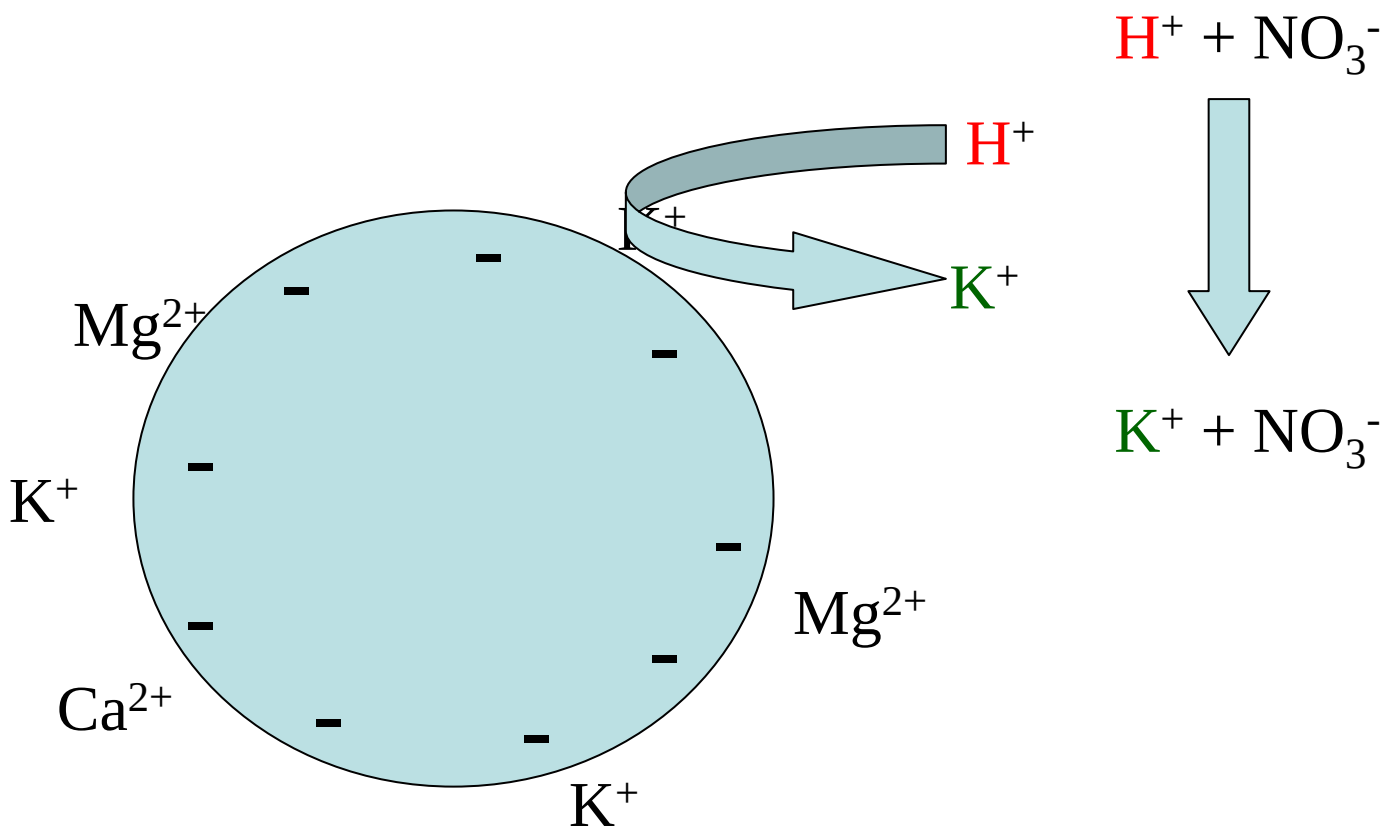
Ion balance

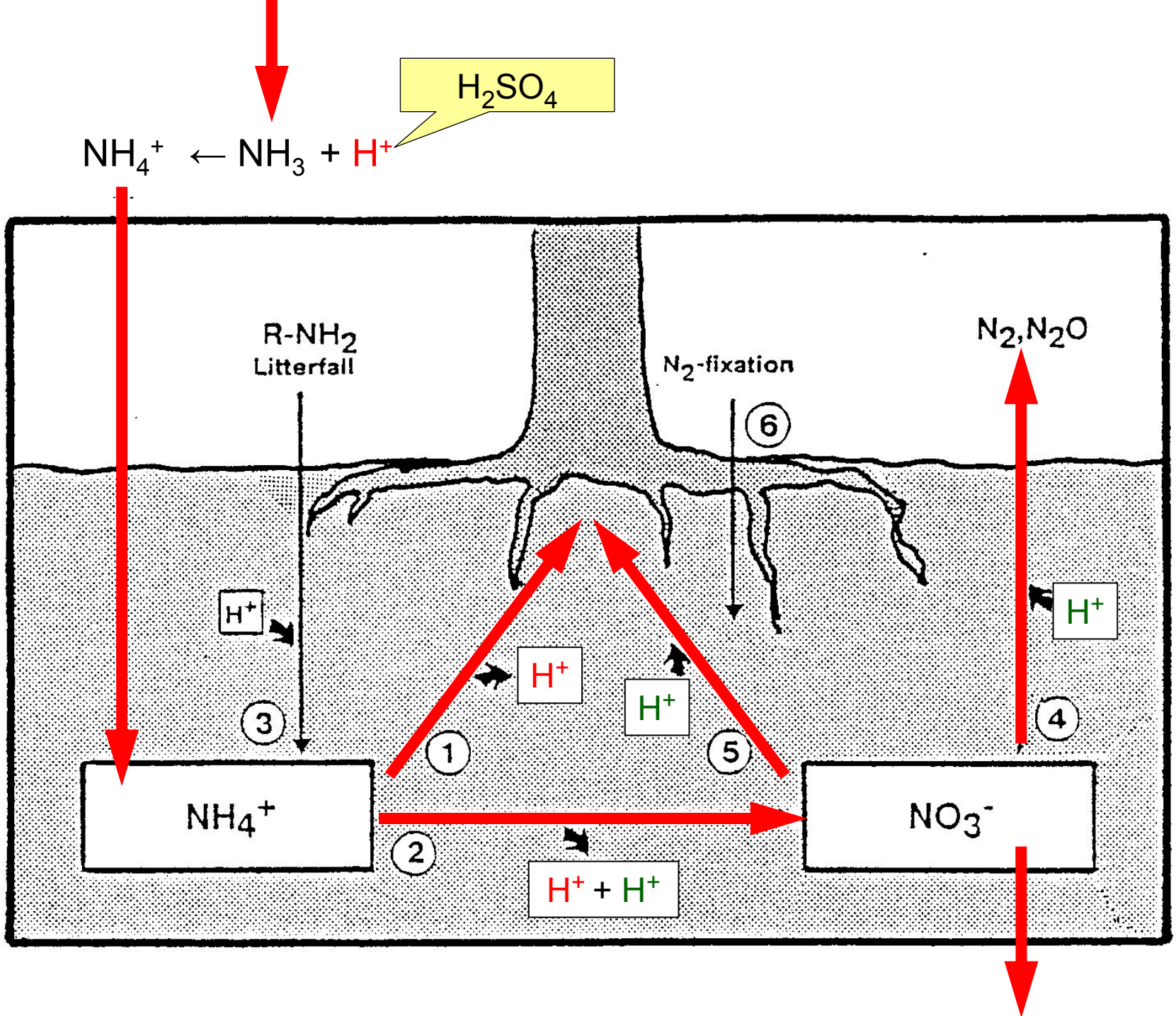
$$\Sigma Kations^{+} + \Sigma Anions^{-} = 0$$

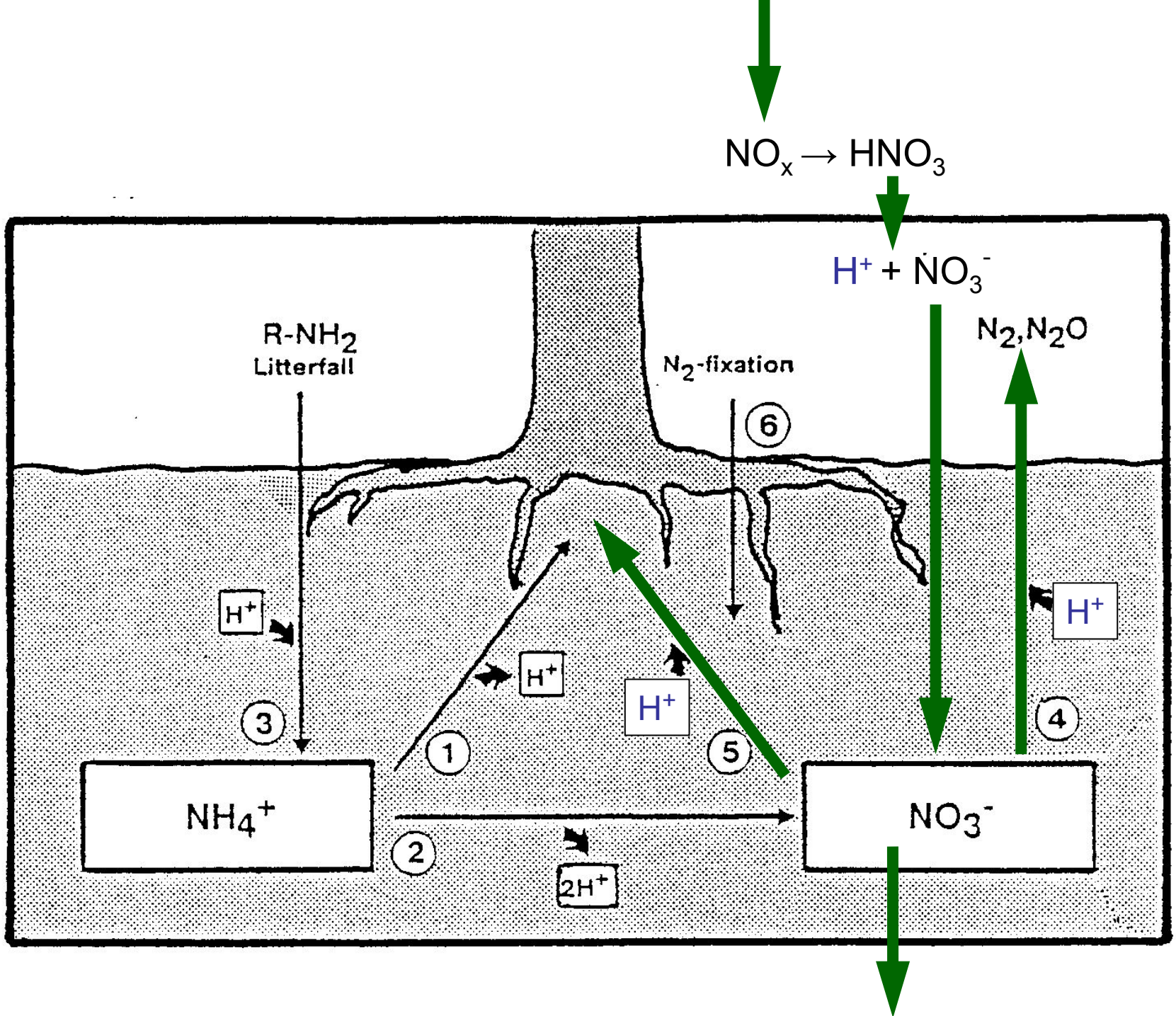


”the mobile anion concept”

Soil acidification by mobile anions




H_2SO_4
$NH_4^+ \leftarrow NH_3 + H^+$
R-NH2
Litterfall
N2-fixation
N2,N2O
H+
H+
H+
H+
H+
H+ + H+
NH4+
NO3-
1
2
3
4
5
6

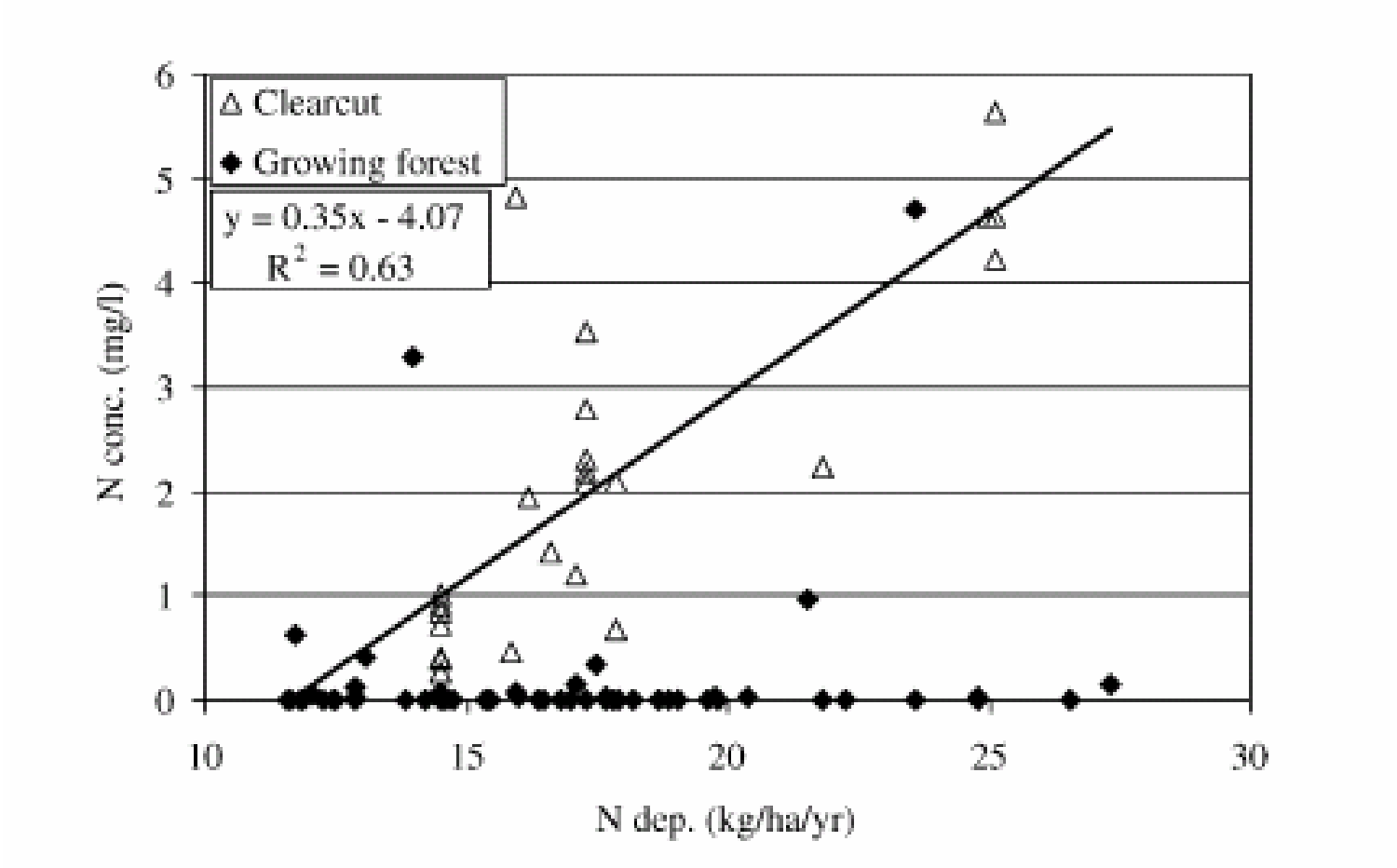

$NO_x \rightarrow HNO_3$
$H^+ + NO_3^-$
N_2, N_2O
R-NH_2
Litterfall
N_2-fixation
6
H^+
H^+
H^+
H^+
3
1
5
4
NH_4^+
NO_3^-
2
$2H^+$

N emissions are acidifying soils when nitrate is leached

Thus N is non-acidifying as long as it accumulates in the system?

- Yes there is no actual acidification,
- but there is a build up of potential acidification

Release of accumulated N at disturbance



Akselsson et al. 2004

Is an N induced growth response acidifying?

- Yes, it could

  Biomass production: $R\text{-}COOH + Me^+ \Leftrightarrow R\text{-}COOMe + H^+$

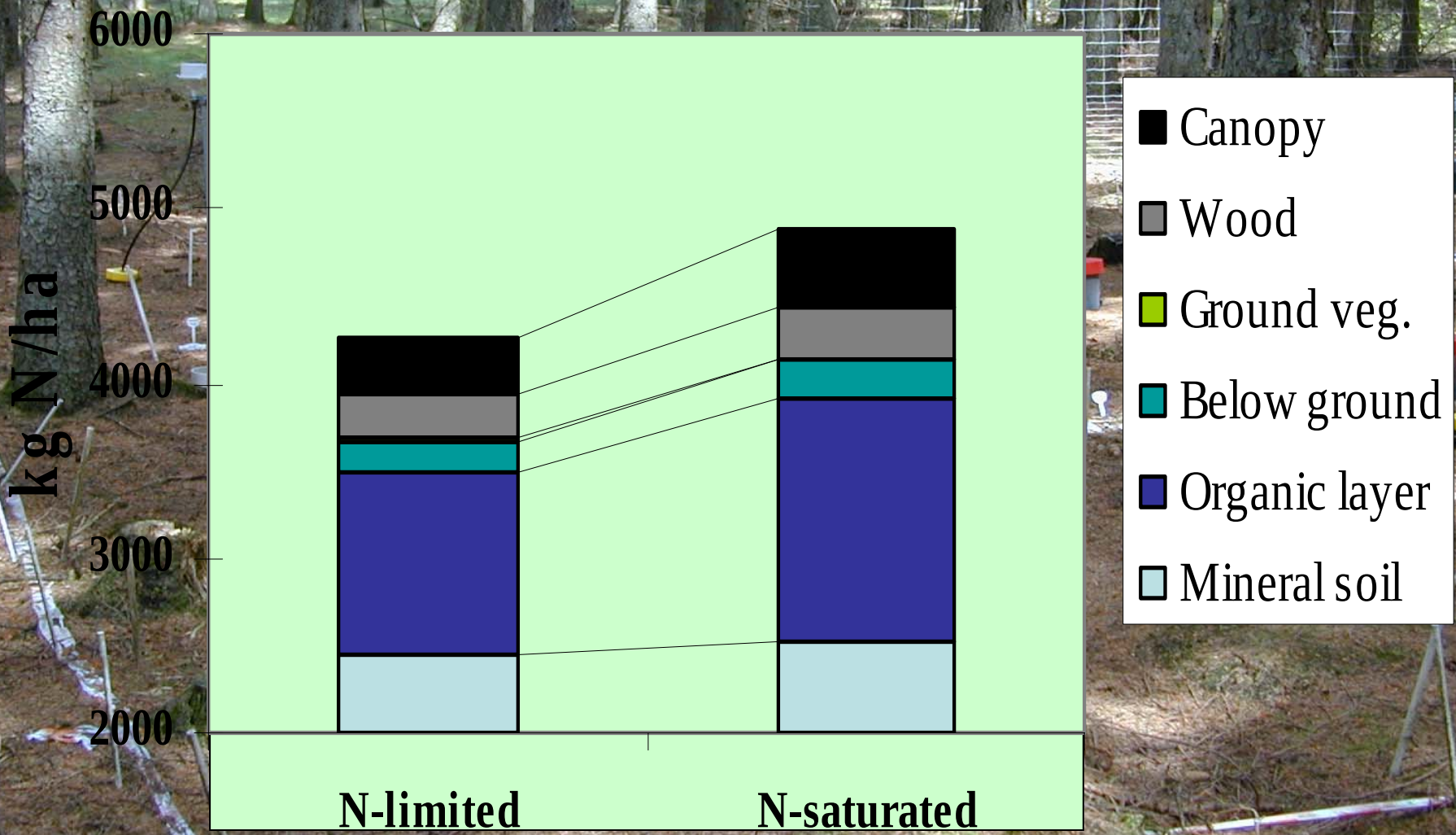
- But only if the extra biomass is actually removed from the system by harvest
- I case of decomposition and fire, nutrients and alcalinity is retured to the system

Do we know enough about how much N can accumulated as stabel N?

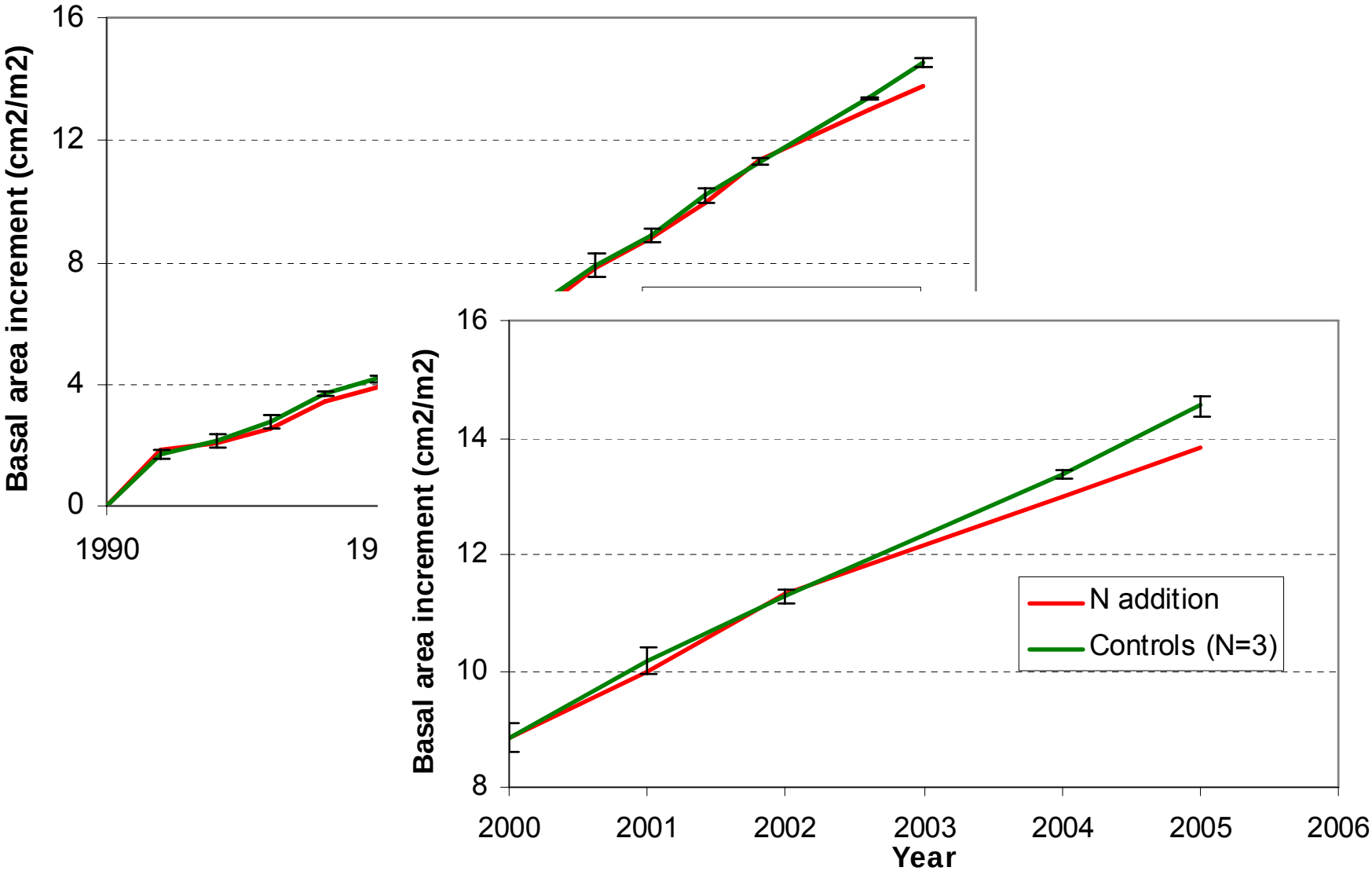
- Are we safe at C/N ratio >25?

- No
- We need to evaluate the N addition experiments now approaching long-term (15-20 yrs), example Klosterhede

N storage at Klosterhede



Tree growth with added N



Impact of N addition at Klosterhede

- Predicted N sink: 700 kgN/ha
- Observed adverse effects after adding c. 400 kgN/ha (12yr)
  - Reduced tree growth
  - Significant reduced nutrients in foliage (Ca, P, Mg, K)
  - Increasing N leaching
  - And other things not yet measured

Effect of N on other nutrients

- Increased growth → increased nutrient demand
- Acidification → increased nutrient loss
- Increased shoot/root ratio → reduced nutrient uptake
- Decreased mycorrhiza → reduced nutrient uptake

First limiting nutrient

CL(N) = min [(X-deposition + X-weathering) /bX],

where

- bX = critical X:N ratio at balanced nutrition, species dependant
- X = (Ca, K, Mg, P, ...).

Gundersen 1992; used in Reynolds et al. 1998

Conclusions

- Acidification from N only occur when nitrate is leached (mobile anion)
- Accumulated soil N is potential acidifying, can be realized after disturbance
- First limiting nutrient is an alternative approach to estimate critical N load
- New research in long-term N addition experiments
  - Difference from observation?
  - Non-linearity's