Dynamics of plant nutrients and the symptom of their deficiency and excess.

Part 1: General discussion and macro elements

Kiyoshi Tsutsuki
http://timetraveler.html.xdomain.jp

Essential elements for higher plants and higher animals.

		Plants	Animals
Macro	1	C, H, O, N, P, S	C, H, O, N, P, S
	2	K, Ca, Mg	K, Ca, Mg
	3		Na, Cl
Micro	1	Fe, Mn, Cu, Zn	Fe, Mn, Cu, Zn
	2	Mo	Mo
	3	B, Cl	I, Co, Se, Cr, others

Criteria for essential nutrients

1) Plants can not complete their lif cycle in the absence of the element.

2) The element composes a part of constituent indispensable for the growth of plant, or it involves the essential physiological and biochemical process in plants.

Details of criterion 1

- The function of the element can not be substituted by other elements: non substitutable.
- The function is not indirect: directness.
- The function is not limited to special plants (universality).

Useful elements

- Elements helpful for the growth of special plants under special environment.
- Si, Na, Co, Se, etc

Useful elements

- Si：rice
- Na: sugar beet, edible chrysanthemum
- Co: legume crops
- Se: Astragalus bisulcatus (a kind of milk vetch), some chrysanthemum species

Nitrogen absorption/ nutrition

- Nitrogen is a constituent of protein which is physiologically important, contained in protoplasm.
- Nitrogen moves from old leaves to new leaves.
- Some plants like ammonia, while other plants like nitrate for the source of nitrogen.

Plants which favor ammonia

- Rice and tea
- These plants are superior in the ability of ammonia assimilation, and ammonia does not accumulate in plants.
- Inferior in the ability of nitrate reduction. Harmful nitrite accumulates in plants, and sufficient ammonium can not be supplied.
- Ammonia can be efficiently converted to amide compounds (asparagine, citrulline, theanine).

Plants which favor nitrate.

- Common upland crops like tobacco, tomato, beans, potato, radish, and spinach.
- Inferior in the ability of ammonia assimilation.
- Growth is damaged by the high concentration of ammonia around the root.

Nitrogen deficiency in tomato

1. Leaves become totally yellow.
2. Leaf vein becomes dark violet.
3. Growth is remarkably retarded.

Phosphorus absorption/ nutrition

- Contained in nucleic acid.
- Contained in phospho-lipid, a constituent of cell membrane.
- Co-enzyme NADP important in oxidation-reduction.
- ATP important in energy transformation.

Existing forms of P in young leaves.

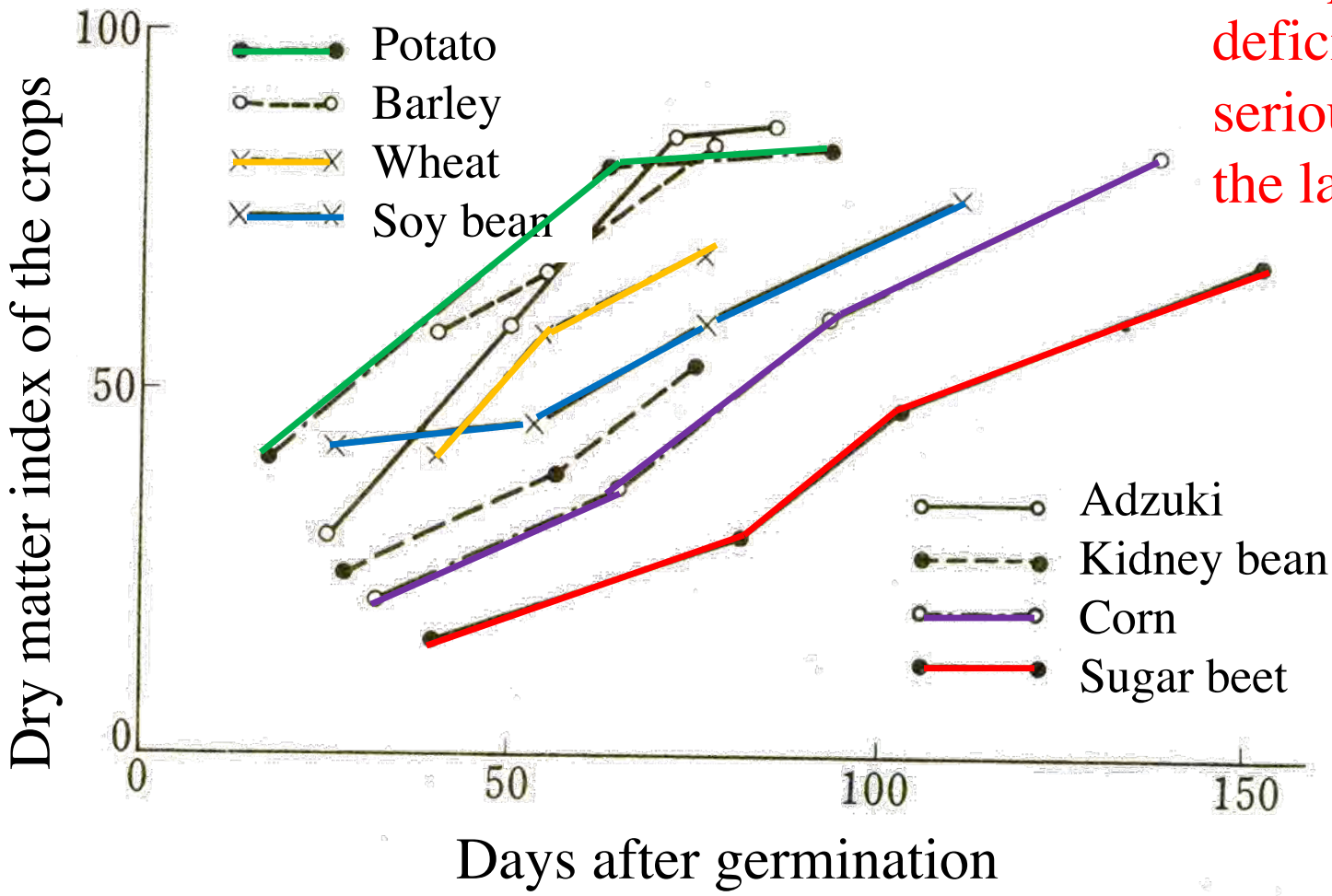
	μgP/g fresh weight
Inorganic P	310
RNA	62
DNA	4.7
Phospho-lipid	47
Phosphate-esters*	31

* sugar-phosphate, ATP, ADP

Phosphate deficiency in tomato

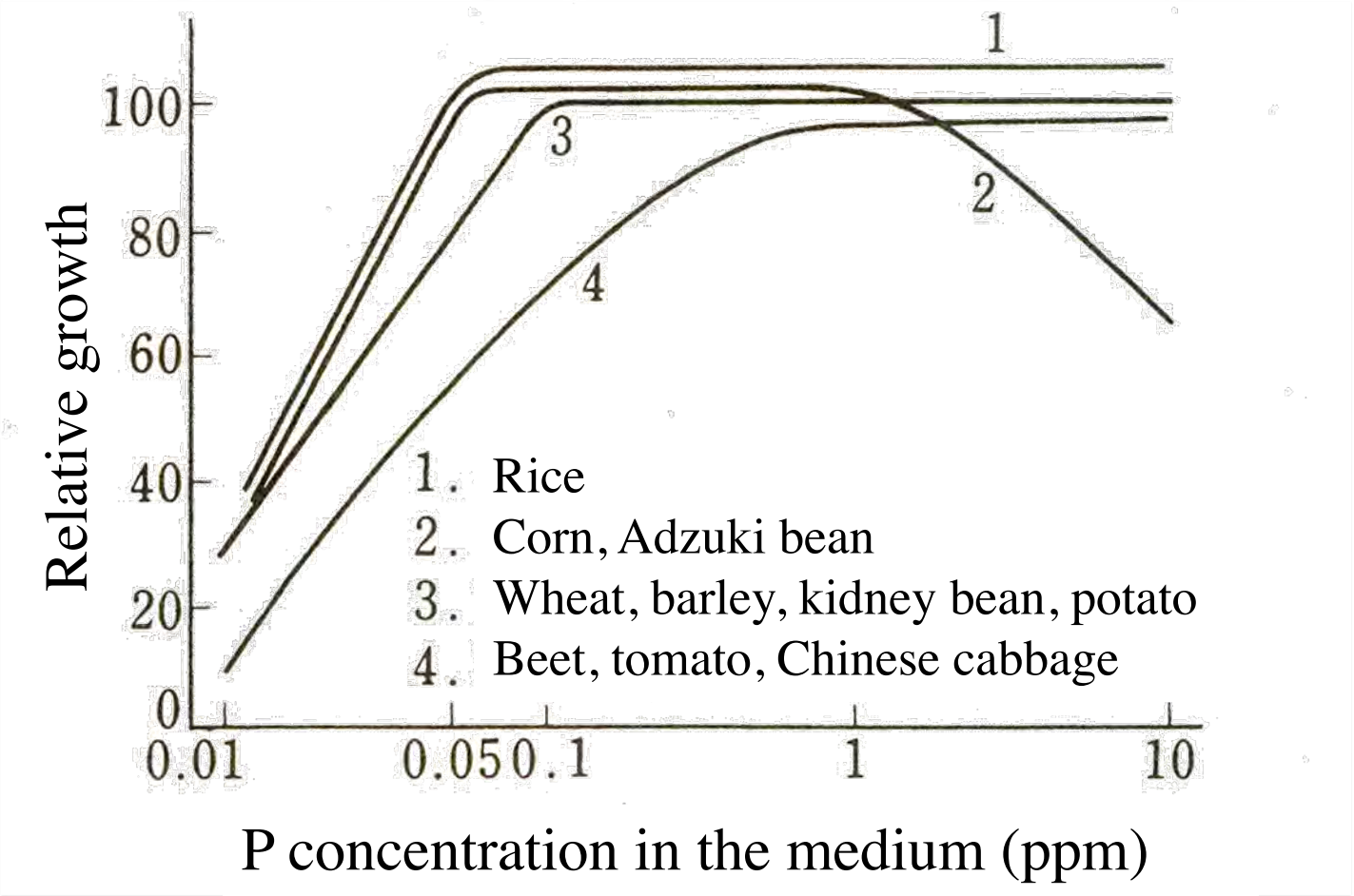
In early stage, color of lower leaves becomes dark violet – violet red from the tip point.

Dry matter index of the crops grown in –P media compared with +P treatments.



Phosphorus deficiency has a serious effect un the late growth s

Response of various crops on the phosphate concentration in the medium.



Potassium absorption/ nutrition

- Keeping the structure of protplast structures.
- Adjustment of pH and osmotic pressure.
- Contribution to the metabolism of carbohydrates and nitrogen.
- Synthesis of high molecular compounds is retarded in the K deficient plants.

Potassium deficiency in tomato

- Tip point and peripheral of the leaves are yellowed.
- Area between the leaf vine is yellowed.
- Yellowed portions become uneven.
- Decayed spots appear on leafstalk and stems.

Potassium deficiency in corn

- Tip points of leaves are withered.
- Iron deficiency accompanies.
- Yellow white stripes appear between the leaf vines.

Calcium absorption/ nutrition

- Maintenance of the structure and function of plant cell membranes.
- Maintenance of the cell structure by pectic acid Ca.
- Contents and demand differ largely by the kinds of plants.
- Deficiency symptom appears on the new leaves, because Ca hardly translocate in plant.

Calcium deficiency

- Broad leaf crops are susceptible.
- Bottom rot disease in tomato
- Core rot in Chinese cabbage, cabbage, onion.
- Bitter pit in apple.
- Suppression of root nodule growth in legumes.

Calcium deficiency in melon

Portion between leaf veins become yellow and brown due to Ca deficiency.

Bottom rot in tomato due to Ca deficiency.

Magnesium absorption/ nutrition

- Constituent of chlorophyll.
- Involved in the phosphorilation enzyme reaction.
- Involved in the protein synthesis.

Magnesium deficiency

- Often occur in acidic soil.
- Leaf becomes yellow because chlorophyll is not synthesized, but the color of leaf vein is still green.
- As Mg moves easily, lower leaves turn yellow first.

Magnesium deficiency in tomato.

- Repression of chlorophyll synthesis
- Yellowing and the formation of decay spot occur on leaves.
- Lower leaves turn yellow, then becomes violet red colored.

Magnesium deficiency in potato.

This symptom occurred in the plot applied only with organic fertilizer. This occurred on July 25, when leaves grew fully and potato was growing big in the soil.

Sulfur absorption/ nutrition

- Sulfur is absorbed in the form of sulfate, and reduced and converted into organic sulfur compounds, such as cysteine and methionine.
- Sulfur is a component of biotin which participates in CO2 fixation and decarboxylation, of Coenzyme A for lipid metabolism, and of thiamin as a vitamin.

Sulfur deficiency

- Caused by the use of fertilizers like urea and ammonium phosphate which do not contain sulfate.
- Occur in soils with low S content.
- Symptom is similar to N deficiency.
- Appear from lower leaves as it is readily translocated.

Sulfur deficiency in canola

normal

Sulfur deficient