Atoll Soil Health Management: Soil Nutrients
- what is in your Soil

SPC Online Training August 2021

Ellen Iramu and Geoff Dean

Characteristics of Low Atoll Soils

- Properties of atoll soil are dominated by calcareous nature of the parent material
- The Soil is comprised of accumulations of broken reef material deposited by storm
- Soil is alkaline and shallow
- Soil is coarse textured (sandy) and excessively well-drained

Soil Nutrients - Two groups of nutrients

- **Major nutrients** - needed in large amounts by plants: Nitrogen (N), Phosphorus (P) and Potassium (K) = Primary

  + Calcium (Ca), Magnesium (Mg) and Sulphur (S) = Secondary

- **Minor nutrients or trace elements** (TEs)

- needed in smaller amounts e.g. Boron (B), Zinc (Zn), Copper (Cu), Iron (Fe), Manganese (Mn) and Molybdenum (Mo)

If any of the essential nutrients are in short supply → poor plant growth and low yields

Status of Nutrients in Atoll Soils

Pacific Community
Communauté du Pacifique

Some essential nutrients which may be low in atoll soils:

- Phosphorus (P)
- Potassium (K)
- Manganese (Mn)
- Copper (Cu)
- Iron (Fe)

Criteria for Essentiality of Nutrients

Pacific Community
Communauté du Pacifique

A nutrient needs to meet following criteria to be essential:

- The plant cannot complete its life cycle (seed to new seed) without the nutrient
- The nutrient is directly used for the plant's growth and development
- The nutrient's function cannot be replaced by another nutrient
- If the nutrient is deficient it will show characteristic symptoms, and the symptoms can only be corrected by applying the nutrient

Diagnosis of Nutrient Deficiency Symptoms

Pacific Community
Communauté du Pacifique

It is important to understand the concept of **mobile** and **immobile** nutrients

Mobile nutrients:

- Nutrients that move freely in the plant
- When deficient they move from old leaves to young leaves
- Deficiency symptoms appear in older leaves
- Examples of mobile nutrients: N, P, K, Mg and Mo

Diagnosis of Nutrient Deficiency Symptoms

Pacific Community
Communauté du Pacifique

Immobile nutrients:

- Locked in older leaves when nutrient is limiting or deficient
- Deficiency symptoms appear in new leaves/growth
- Examples of immobile nutrients: Ca, B, S, Fe, Mn, Cu and Zn

Nutrient Deficiency Symptoms

Phosphorus (P)

- Leaves look smaller and young leaves appear dark green
- Old leaves are purple or red in colour
- Symptoms appear in older leaves

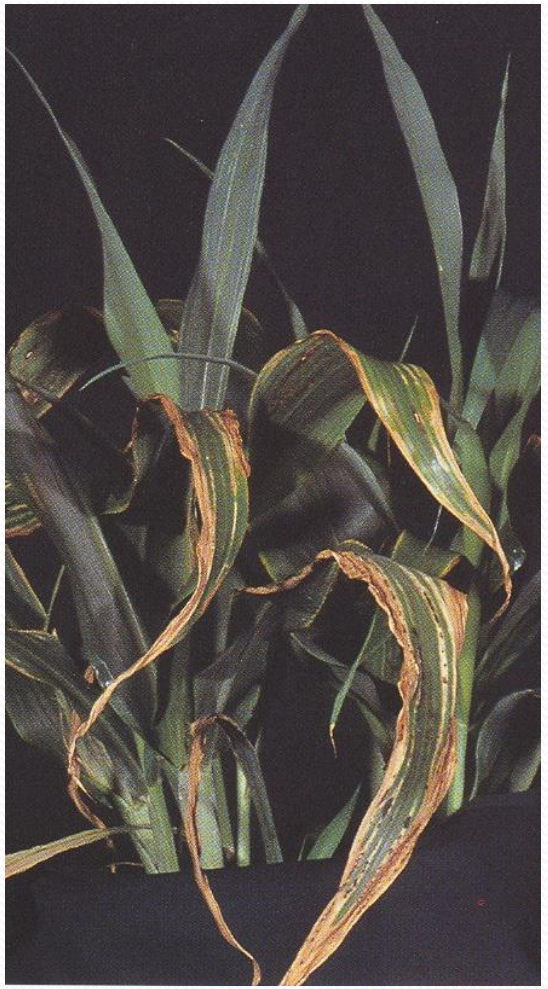
PHOSPHORUS DEFICIENCIES

Nutrient Deficiency Symptoms

Potassium (K)

- Chlorotic (yellowish) areas with burning along the leaf margin
- Observed in older leaves

POTASSIUM DEFICIENCIES



Nutrient Deficiency Symptoms

Pacific Community
Communauté du Pacifique

Manganese (Mn)

- Interveinal chlorosis (yellowing) in younger mature leaves
- Wide green veins are prominent

MANGANESE DEFICIENCIES

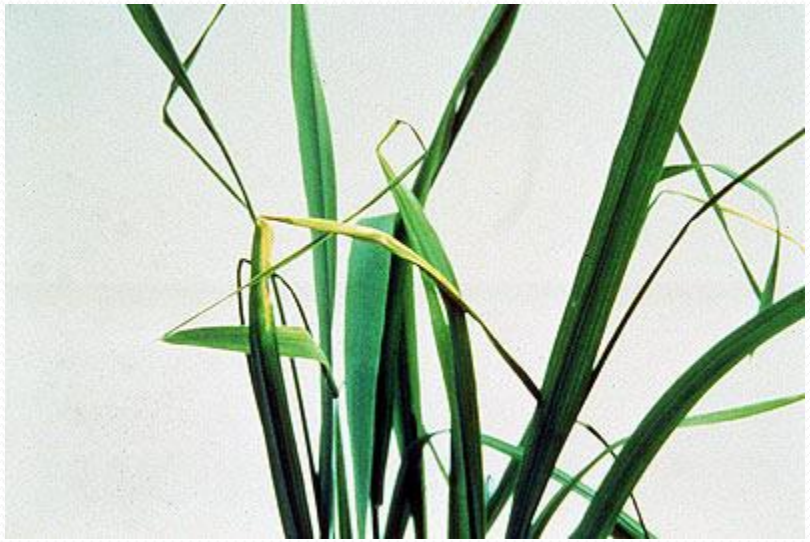
Nutrient Deficiency Symptoms

Pacific Community
Communauté du Pacifique

Copper (Cu)

- Symptoms start as cupping and slight chlorosis of whole leaf or between veins
- Within the chlorotic areas, small necrotic spots may form
- Symptoms show in young leaves

COPPER DEFICIENCIES



Nutrient Deficiency Symptoms

Iron (Fe)

- Yellowing between veins of young leaves (interveinal chlorosis)

  → **almost white**

IRON DEFICIENCIES

Sufficient Nutrient Supply – Healthy Plant Growth

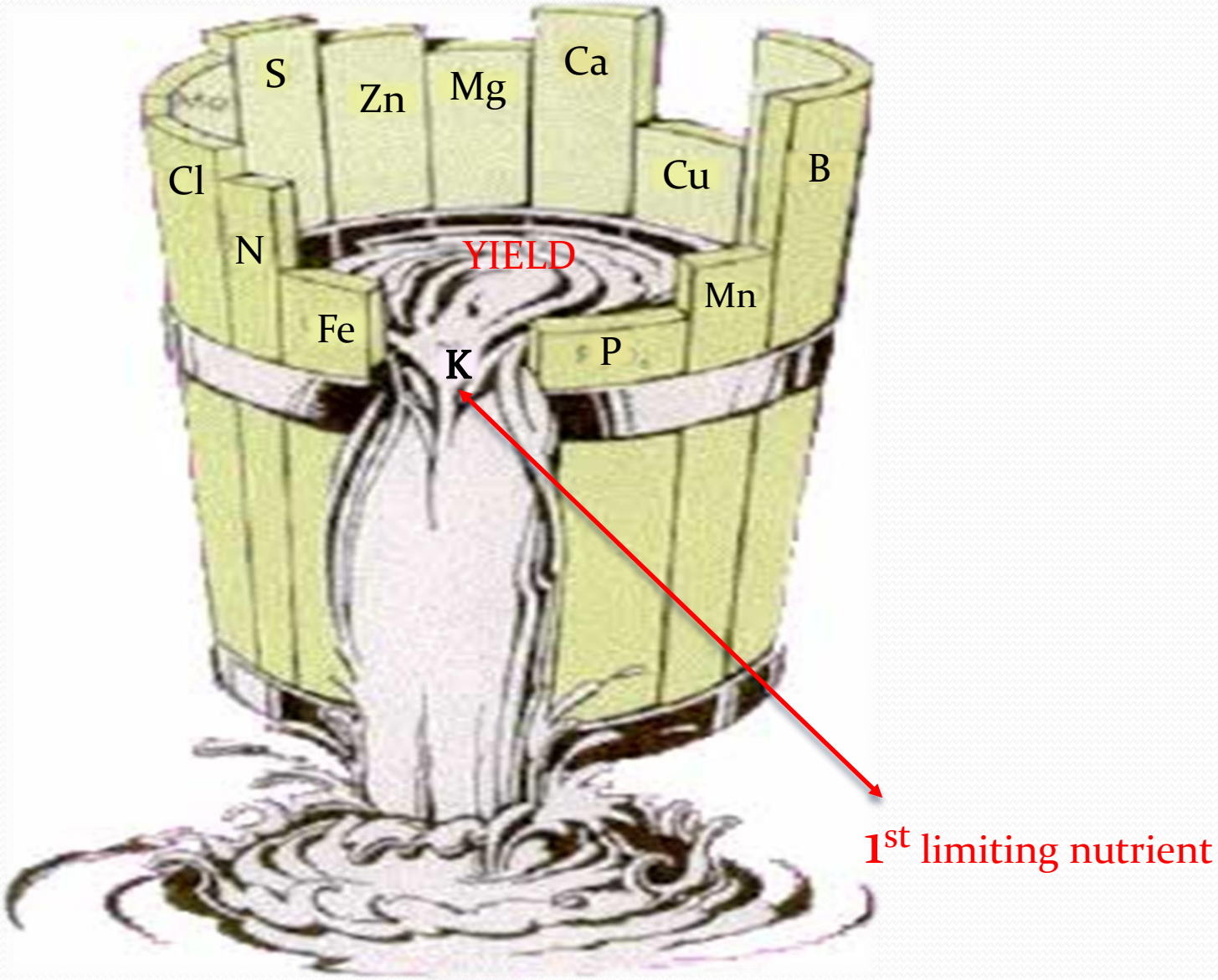
“Law of the Minimum”

- States **‘if one of the essential nutrients is deficient, plant growth will be poor** even when all other nutrients are abundant’

(Justus von Liebig)

“Law of the minimum”

➡ **where the height of water in the barrel represents crop yield**



Where do plant nutrients in the soil come from?

- **P, K, Ca, Mg, S and trace elements**

  - supplied by rocks, coral through weathering and sea-spray, rainfall

- **N - “harvested” from the air by legumes**

N fixing plants

Nutrient analyses of range of soils from Kiribati and Tuvalu (available nutrients)

	pH_w	pH_{Ca}	OC	min N	P	K	S	Cu	Zn	Mn	Fe	B	TP
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Tab N, Beru	8.5	7.7	1.8	8	69	**34**	16	0.4	9	2	8	0.4	
Abaiang	8.8	7.8	2.3	20	44	**30**	14	0.4	3	3	37	0.7	1749
Funafuti	8.4	7.8	1.7	16	81	**27**	17	2.6	32	4	12	0.8	1574
Tarawa	8.3	7.7	2.6	38	236	**35**	21	2.4	14	7	11	1.3	5304

Nutrient analysis of soil from Tuvalu (available nutrients)

	depth	pH w	OC	*min N*	P	S	K	Cu	Zn	Mn	Fe	B
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Unimproved Soil	0-15	8.5	2.1	**7**	21	30	**38**	**0.1**	0.8	6	**3**	0.8

Nutrient analyses of soils from Kiribati and Tuvalu (available nutrients)

	depth	pH w	OC	*min N*	P	S	K	Cu	Zn	Mn	Fe	B
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Unimproved Soil	0-15	8.5	2.1	**7**	21	30	**38**	**0.1**	0.8	6	**3**	0.8
"	15-30	8.6	1.0	**4**	10	65	**25**	**0.1**	**0.2**	**2**	**1**	0.5
"	30-45	**8.9**	**0.8**	**8**	10	52	**25**	**0.1**	**0.2**	**1**	**1**	0.4

Nutrient analyses of soils from Kiribati and Tuvalu (available nutrients)

	depth	pH w	OC	*min N*	P	S	K	Cu	Zn	Mn	Fe	B
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Unimproved Soil	0-15	8.5	2.1	**7**	21	30	**38**	**0.1**	0.8	6	**3**	0.8
"	15-30	8.6	1.0	**4**	10	65	**25**	**0.1**	**0.2**	**2**	**1**	0.5
Virgin Soil	30-45	8.9	0.8	8	10	52	25	0.1	0.2	1	1	0.4
Old SP row	0-15	8.3	3.4	**11**	99	33	**28**	0.3	7.2	13	24	1.2
"	15-30	8.5	2.1	**6**	34	56	**25**	**0.1**	1.7	13	7	1.4

Take Home Messages

- To improve soil health it is important to validate limiting nutrients in the soil through soil sampling and analysis

- Increasing our understanding of soil nutrients can be help us to improve our soil management practices

- Work to increase the supply of limiting nutrients in the soil by increasing soil organic matter (targeted compositing)

Pacific Community
Communauté du Pacifique

THANK YOU