Importance of Soil Testing & Interpretation of Soil Test Results

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Land Use Division

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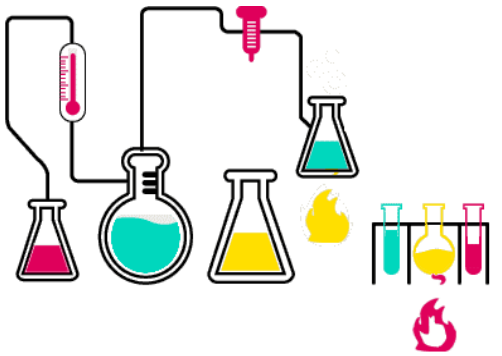


What is the importance of soil testing?

- To optimize crop production
- To understand and improve the quality of soil
- To know the nutrient requirement of soil and crop
- To save money on useless fertilizers which the soil does not need
- To protect the environment from contamination by runoff and leaching of excess fertilizer

List of soil test laboratory in the Department of Agriculture

စဉ်	တိုင်းဒေသကြီး/ပြည်နယ်	တိုင်းဒေသကြီး/ပြည်နယ်ဓာတ်ခွဲခန်း	ခရိုင်ဓာတ်ခွဲခန်း
၁။	ရန်ကုန်တိုင်းဒေသကြီး	၁	၂
၂။	မန္တလေးတိုင်းဒေသကြီး	၁	-
၃။	ကချင်ပြည်နယ်	၁	-
၄။	ကယားပြည်နယ်	၁	-
၅။	ကရင်ပြည်နယ်	၁	-
၆။	တနင်္သာရီတိုင်းဒေသကြီး	၁	-
၇။	ပဲခူးတိုင်းဒေသကြီး	၁	၃
၈။	မကွေးတိုင်းဒေသကြီး	၁	၁
၉။	ရခိုင်ပြည်နယ်	၁	-
၁၀။	ရှမ်းပြည်နယ်	၁	၂
၁၁။	ဧရာဝတီတိုင်းဒေသကြီး	၁	-

List of measurement parameters

Type of sample	Measurement parameter
Soil	Moisture, N, P_2O_5, K_2O, Ca, Mg, S, Trace Elements (Fe, Mn, Zn, Cu), Heavy Metals (Pb, Cd, Cr, Co, Ni, Hg), Na, pH, EC, OM, Texture, Soil Water Extraction, Al, H, SO_4, Cl, CEC
Water	Complete water analysis
Plant	Moisture, N, P_2O_5, K_2O, Ca, Mg, S, Trace Elements (Fe, Mn, Zn, Cu), Heavy Metals (Pb, Cd, Cr, Co, Ni, Hg), Na, OM
Fertilizer	Moisture, N, P_2O_5, K_2O, Ca, Mg, S, Trace Elements (Fe, Mn, Zn, Cu, B, Mo), Heavy Metals (Pb, Cd, Cr, Co, Ni, Hg), Si, Na, Cl, pH, EC, OM, Biuret, Microbes (*Bacillus* species, EM, E.coli, *Trichoderma*)

Soil test results: what do they mean

Lab soil analysis result report

DEPARTMENT OF AGRICULTURE (LAND USE)

SOIL ANALYTICAL DATA SHEET

ဦးဂျင်္ခန် (5.11.2020)

Division –

Township –

Sheet No. 1

Sr No. S 1-2 / 20-21

Sr No.	Sample	Moisture %	pH Soil : Water 1 : 2.5	EC Soil : Water 1 : 5 mS/cm	Texture				Organic Carbon %	Humus %	Total N %	CEC meq/100gm	Exchangeable Cations meq/100gm						Available Nutrients		Water Soluble meq/100gm
					Sand %	Silt %	Clay %	Total %					Ca^{++}	Mg^{++}	K^{+}	Na^{+}	H^{+}	Al^{+++}	P ppm	K_2O mg/100gm	$SO_4^{=}$
1	Group A Plot – 1	0.43	7.28	0.09	84.02	7.88	8.10	100.00	0.28	0.49	0.18	9.62	7.62	1.27	0.21	0.52	–	–	4.82(O)	9.64	0.37
2	Group B Plot – 1	0.19	5.70	0.07	87.02	6.88	6.10	100.00	0.08	0.14	0.14	8.03	5.07	2.53	0.10	0.33	–	–	8.22(B)	4.81	0.25

B= Bray & Kurtz Method

O= Olsen Method

Soil interpretation of results

DEPARTMENT OF AGRICULTURE (LAND USE)

SOIL INTERPREATATION OF RESULTS

ဦးကျော်နိုင် (5.11.2020)

Sheet No. 1

Division –

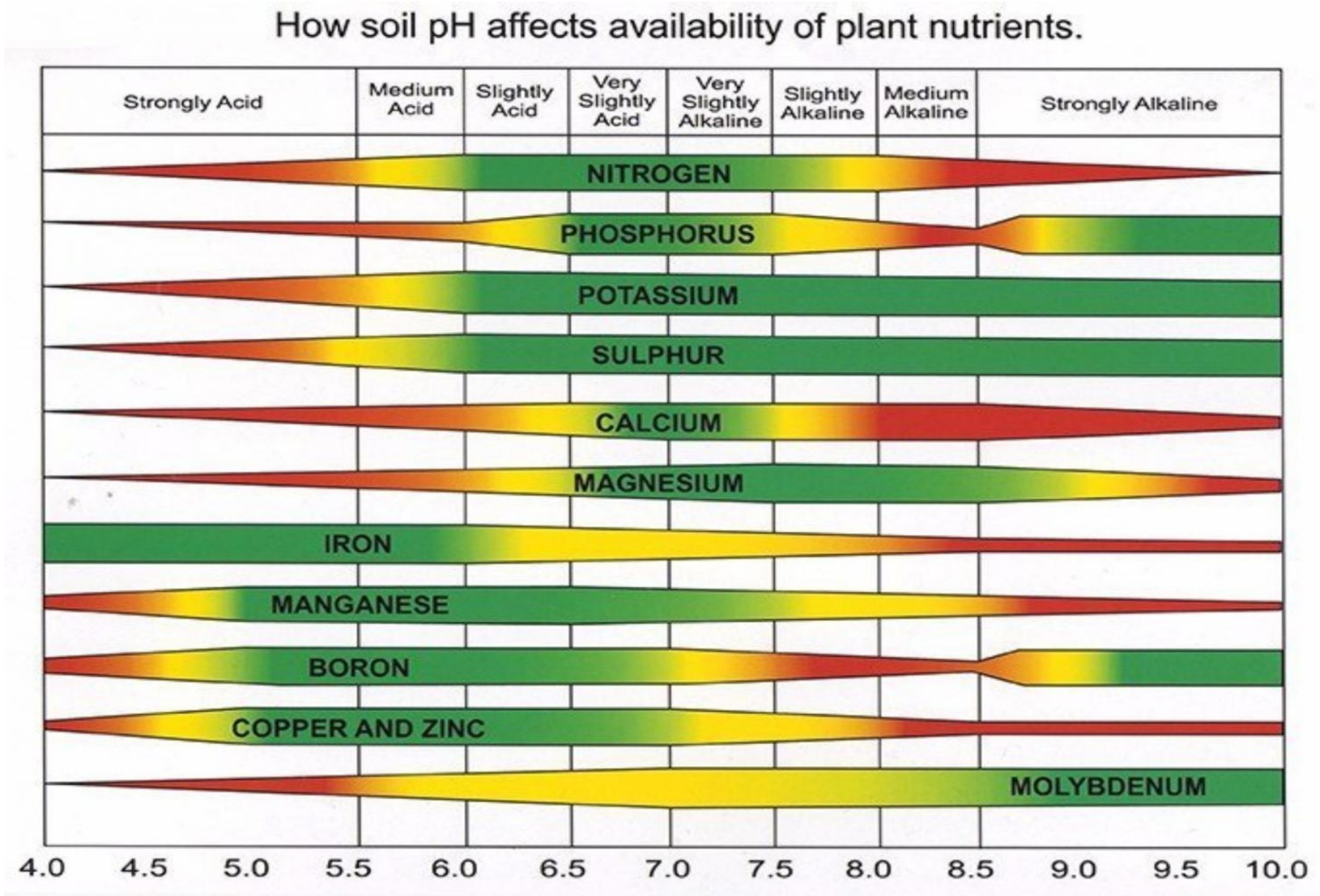
Sr No. S 1-2 / 20-21

Towship –

Sr No.	Sample	pH	EC	Texture	Organic Carbon	Total N	CEC	Available Nutrients		Water Soluble meq/100gm
								P	K_2O	$SO_4^=$
1	Group A Plot – 1	Slightly alkaline	Very low	Loamy sand	Very low	Low	Low	Low	Low	Low
2	Group B Plot – 1	Moderately acid	Very low	Sand	Very low	Low	Low	Low	Low	Low

Soil pH

pH value	Interpretation
< 4.5	Extremely acid
4.5 – 5.2	Strongly acid
5.3 – 5.9	Moderately acid
6 – 6.5	Slightly acid
6.6 – 7	Near Neutral
7.1 – 7.5	Slightly acid
7.6 – 8.3	Moderately alkaline
8.4 – 9	Strongly alkaline
> 9	Extremely alkaline



SOURCE: https://www.emporiumhydroponics.com/what-is-ph-1-to-14

Effect of soil pH on plant growth

Soil pH	Plant growth
> 8.3	Too alkaline for most plants
7.5	Iron availability becomes a problem on alkaline soils
7.2	6.8 to 7.2 near neutral 6 to 7.5 acceptable for most crops
7	
6.8	
6	
5.5	Reduced soil microbial activity
< 4.6	Too acid for most crops

Interpretation of soil pH

Soil pH	Implication	Management
< 4.6	Aluminum or Iron toxicity Deficiencies of Mo, Ca, Mg, & K Reduced microbial activity	Apply liming materials Grow acid tolerant crops
4.6 – 5.5	Aluminum or Iron toxicity is probable Deficiencies of Mo, Ca, Mg, & K Reduced microbial activity	Apply liming materials Grow acid tolerant crops
5.6-6.5	Mn toxicity still limit yield in water logging soil	Acid tolerant crops growing with liming materials

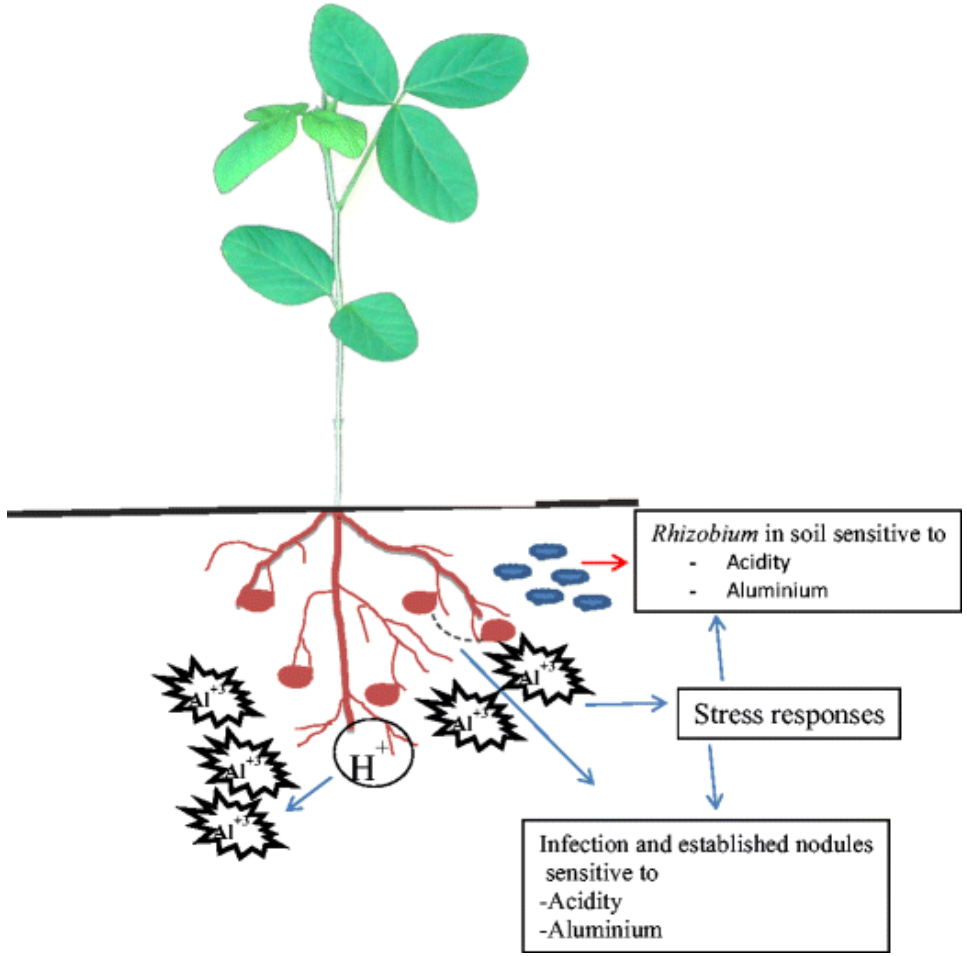
Interpretation of soil pH…

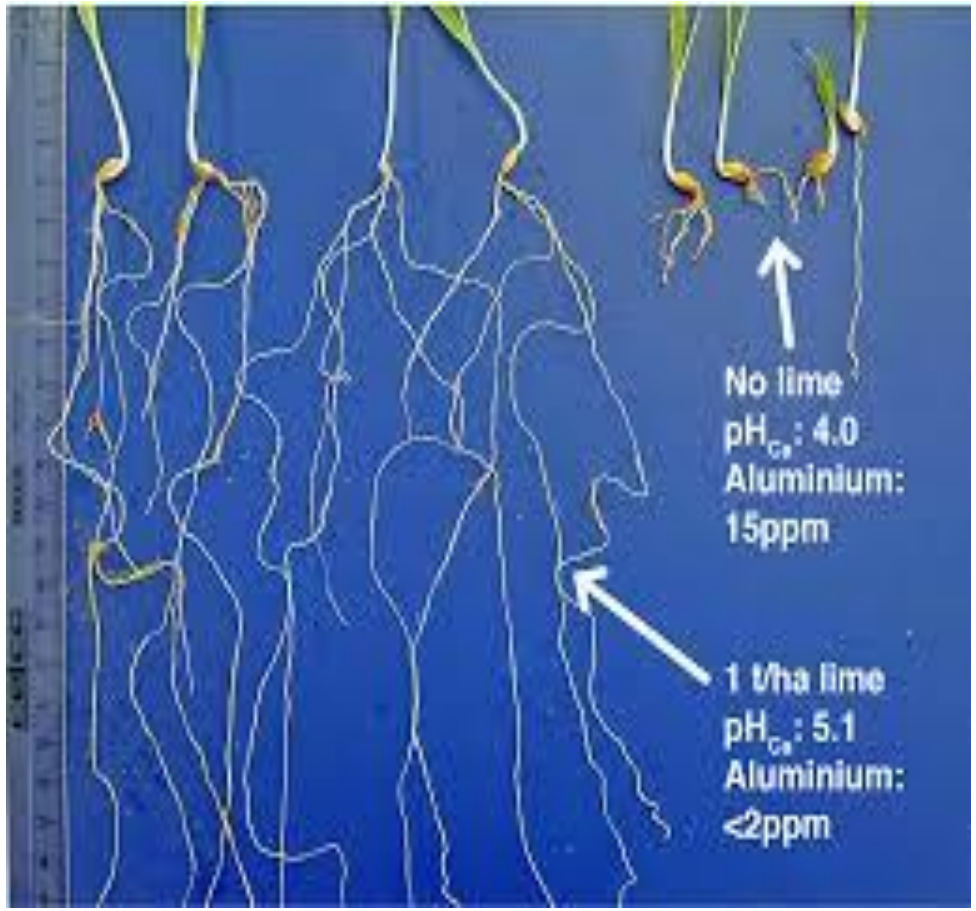
Soil pH	Implication	Management
6.6 - 7.5	Optimum for the growth of most crops Mn toxicity may limit yield in water logging soil	Soils are likely to be productive
7.6 – 8.5	Zn, Fe, Mn less available, Mo more available	Micro nutrient deficiencies may present, where acid soils have been over limed
> 8.6	Soils are strongly alkaline Micro nutrients (Cu, Zn, Fe, Mn), P or K deficiencies B toxicity exits Soils have a very poor nutritional and structural status	Only alkaline resistant crops will survive and micro nutrients may require

List of crops based on soil pH

pH 4 – 6	pH 5 – 6.5	pH 6 – 7.5	pH 5 – 7.5	pH 6 - 8
Potato	Apple Berry Mango Melon Pineapple Watermelon Peanut Sweet Potato Peanut Rice Soybean	Grape fruit Lemon Lychee Broccoli Chinese cabbage Lettuce Mushroom Radish Spinach Onion	Banana Strawberry Carrot Cucumber Garlic Sweet corn Cauliflower Pumpkin Tomato Pepper	Avocado Asparagus Ginger Mint Paprika Watercress

Aluminum Toxicity





Iron toxicity

Sulfide toxicity

Lime Requirement

Lime requirement (ton/ha) $=[(Al^{3+} + H^{+}) – (CEC * 0.01)] * 2 = X$

Lime Requirement (ton/ac) = X / 2.471

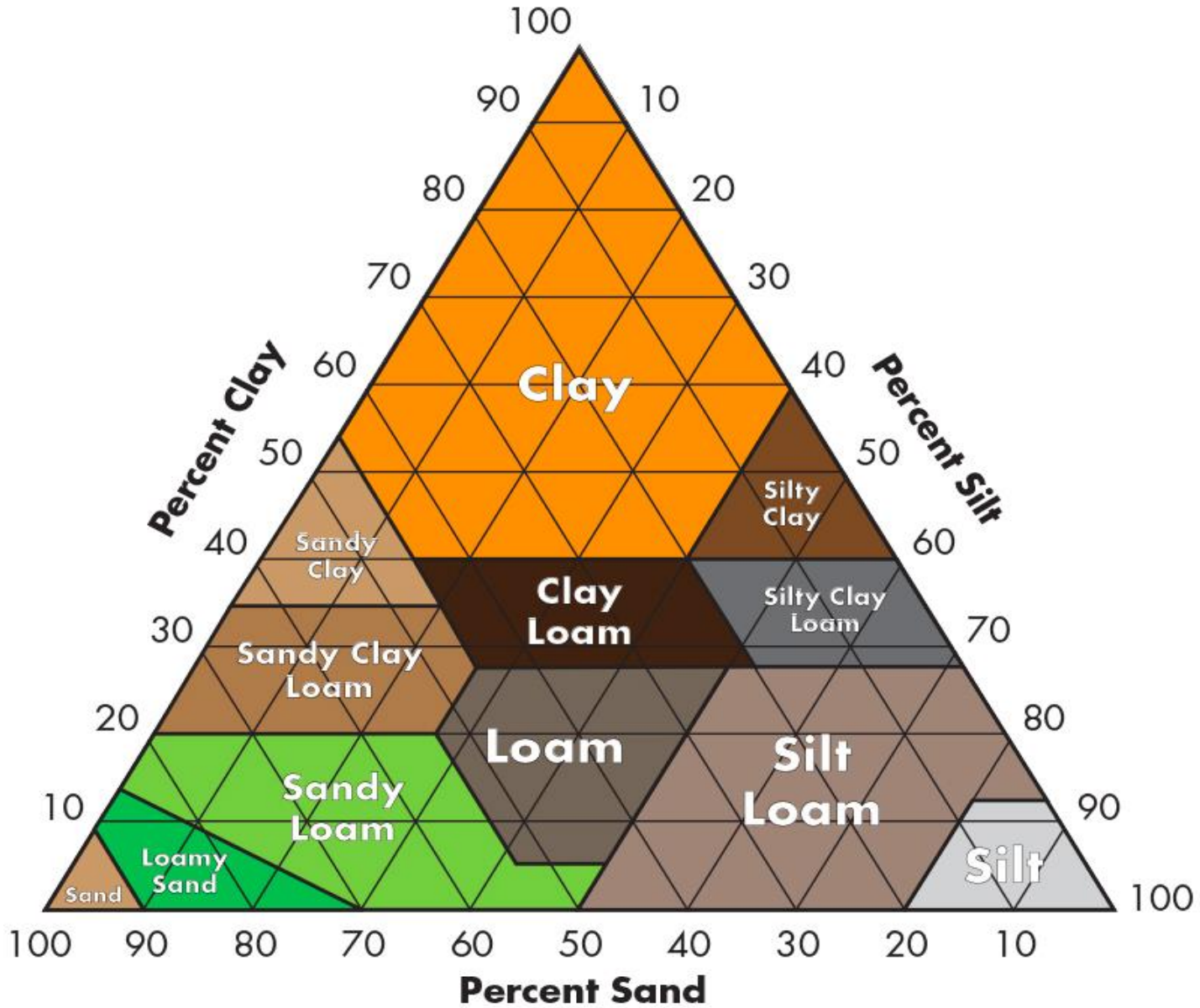
(1 ha = 2.471 ac)

Lime requirement based on soil texture

Soil texture	From pH 4.5 to 5.5 (ton/ac)	From pH 5.5 to 6.5 (ton/ac)
Sandy & Loamy sand	0.5	0.6
Sandy loam	0.8	1.3
Loam	1.2	1.7
Silt loam	1.5	2
Clay loam	1.9	2.3

Checking the results of nutrient content…

Soil texture



Types of soil & suitable crops

Types of soil	Suitable crops
Sandy soil	▪ Not good for plants ▪ However, melon and coconut grow in sandy soil. ▪ If water is available for irrigation, crops such as maize, millets, barley can be grown.
Clayey soil	▪ Not good for many plants. ▪ It is only good for crops like paddy, which require a lot of water.
Loamy soil	▪ Ideal for growing crops such as wheat, sugarcane, cotton, jute, pulses, and oilseeds. ▪ Vegetables also grow well.
Black soil	▪ Suitable for growing groundnuts, pulses, millet, cotton and tobacco.
Red soil	▪ Ideal for growing crops such as cotton, sugarcane, tobacco, wheat, millets, and oilseeds.

Normal Range of CEC Values for Common Color/Texture

Soil groups	CEC (meq/100g)
Light colored sands	3-5
Dark colored sands	10-20
Light colored loams and silt loams	10-20
Dark colored loams and silt loams	15-25
Dark colored silty clay loams and silty clays	30-40
Organic soils	50-100

Estimated soil texture based on CEC

CEC Range (meq/100g)	Soil texture class
1 to 10	Sand
10 to 20	Coarse Loams
20 to 30	Fine Loams
> 30	Clays/ Clay Loams

Interpretation of soil organic carbon, nitrogen, phosphorus & potassium

Level	Organic carbon %	Total N %	P ppm		K_2O meq/100gm
			Bray	Olsen	
Very low	< 1	< 0.1	-	-	-
Low	1 – 2	0.1 – 0.2	< 15	< 8	< 10
Medium	2 – 4	0.2 – 0.5	15 – 50	8 – 12	10 -20
High	> 4	0.5 – 1.0	> 50	12 – 20	> 20
Very high		> 1.0	-	>20	-

Synergism

Optimum supply	Optimum uptake
N	P, Mg
Cu, B	N
Mo	N utilization, P
S	Mn, Zn
Mn	Cu

Antagonism

Excessive amount of supply	Reduce uptake
N	Zn, P, K, Fe, Ca, Mg, Mn, Cu
P	Fe, Mn, Zn, Cu
Cu	Fe
Fe	Zn
Zn	Mn

Fertilizer recommendation for corn

Target yield (bsk/ac)	Fertilizer	Low (kg/ac)	Medium (kg/ac)	High (kg/ac)
80	Urea	72	77	82
	TSP	11	40	56
	Potash	19	44	52

Micronutrients

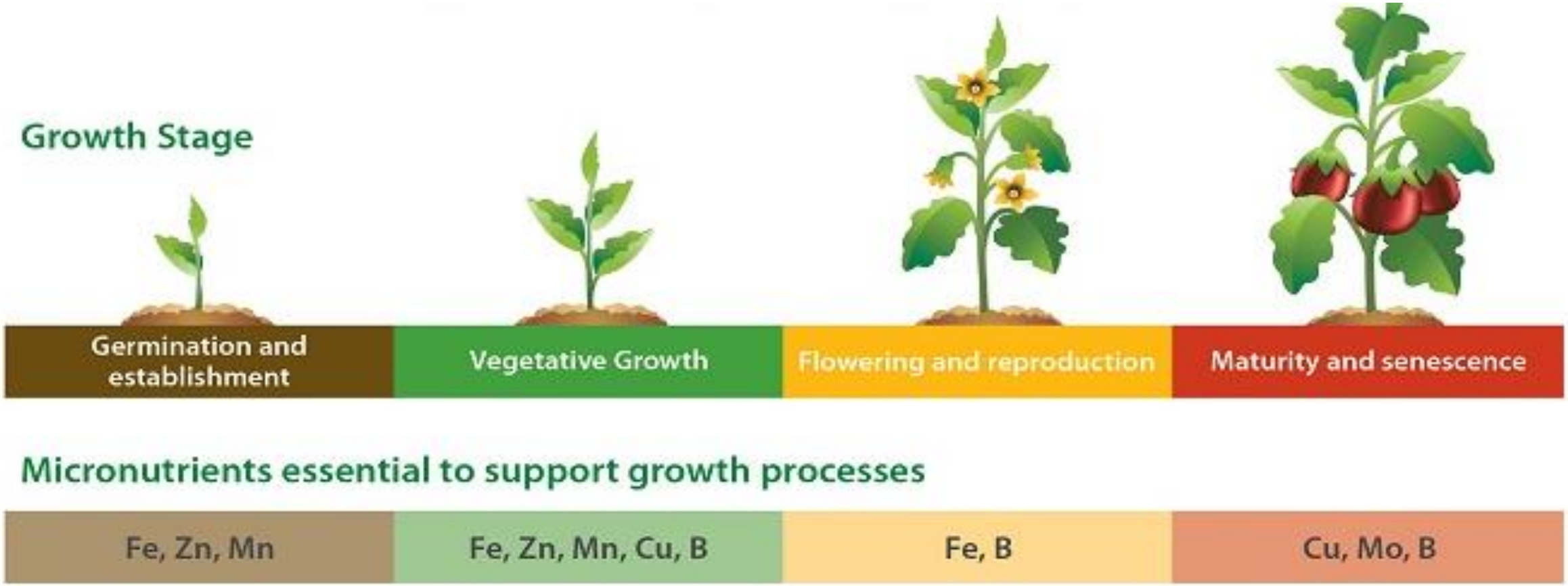
- Although many of the micronutrients are reported on soil test reports, their levels do not currently affect fertilizer recommendations.
- Many soils are adequately supplied with available form.
- Deficiencies are most commonly found in peat and muck soils, sandy soils, calcareous soils, alkaline soils above pH 8 and acid soils below pH 5.

Micronutrients…

- If deficiencies are known to exist, or are discovered through soil or tissue testing, it is advisable to apply no more than recommended rates. here
- There are distinct interactions among all macro and micronutrients.

Micronutrients…

Micronutrients are required throughout the growth cycle.



Deficiency symptoms of micronutrients

Mn deficiency

Zn deficiency

Fe deficiency

Cu deficiency

Recommendation rates for micronutrients

Micronutrients	Soil test (ppm)	Fertilizer rate (kg/ac) 6 inches
Boron	0-1.5	0.91
	0.5-1	0.45
	> 1	0
Copper	0-0.5	0.91
	> 0.5	0
Manganese	0-0.5	9.09
	0.5-1	4.55
	> 1	0
Zinc	0-0.25	4.55
	0.25-0.5	2.27
	> 0.5	0

Source; Jacobsen et al. 2005

List of heavy metals commonly found in contaminated soils

- **Lead (Pb)**
- **Chromium (Cr)**
- **Arsenic (As)**
- **Cadmium (Cd)**
- **Copper (Cu)**
- **Mercury (Hg)**
- **Nickel (Ni)**

Interpretation of heavy metals in soil

Heavy metals	Concentration (mg/kg or ppm)
As	20
Cd	2
Cu	100
Pb	70
Zn	300
Cr	200
Hg	5
Ni	120
Co	100
Fe	1000

Reference: ASEAN Nutrient Management Guidelines (2017)

Measurement parameters of Soil Water Extraction

- pH
- EC
- Total Dissolved Solids (TDS)
- Sodium Adsorption Ratio (SAR)
- Residual Sodium Carbonate (RSC)
- Exchangeable s
- Na
- Cl
- HCO_3
- CO_3
- SO_4

Lab soil water extraction analysis result report

DEPARTMENT OF AGRICULTURE (LAND USE)

SOIL WATER EXTRACTION ANALYTICAL DATA

ဆလိုင်းအုပ်နှန်ဘွေ (27.8.2020)

Division – ချင်းပြည်နယ်

Towship – နတ်မတောင်

Sheet No. 1

Lab No. S- 1 / 19-20

Sr No.	Sample plot	ANIONS meq/100gm				CATIONS meq/100gm				pH Soil : Water 1 : 2.5	EC Soil : Water 1 : 5 mS/cm	TDS %	SAR	RSC meq/100gm
		$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$	Ca^{++}	Mg^{++}	K^{+}	Na^{+}					
1	မြေနမူနာ	Not detected	0.2	0.65	0.18	2.51	0.42	1.07	0.69	5.88	1.05	0.37	0.57	Not detected

Lab soil water extraction analysis result report…

DEPARTMENT OF AGRICULTURE (LAND USE)

SOIL WATER EXTRACTION INTERPRETATION OF RESULTS

ဆလိုင်းအုပ်နှန်ဘွေ (27.8.2020)

Division – ချင်းပြည်နယ်

Towship – နတ်မတောင်

Sheet No. 1

Lab No. S- 1/ 19-20

Sr No.	Sample plot	pH	EC	TDS	SAR	RSC	Dorminant Salts
1	မြေနမူနာ	Moderately acid	High	High	Low	Not detected	$CaCl_2$

Interpretation of soil water extraction

Level	EC	TDS	SAR	RSC	ESP	Cl	SO_4
	mS/ms					me%	me%
Very Low	< 0.15						
Low	0.15 – 0.4	< 0.045	< 10	< 1.25	< 2		
Medium	0.4 – 0.8	0.045 - 0.2	10 – 18	1.25 – 2.5	2 – 8	0 – 1.41	0 – 2.1
High	0.8 – 2	> 0.2	18 - 26	> 2.5	8 – 15	1.41 – 2.82	2.1 – 6.25
Very High	> 2				15 - 27	> 2.82	> 6.25
Extremely High					> 27		

Saline soil

- Color –**White**

- Physical Characteristics

  (i) Soil Structure – Good

  (ii) Infiltration rate – High

  (iii) Soil Aeration – Good

Saline soil…

- Physicochemical Characteristics

  (i) EC of the saturation soil extract is more than 4 dSm^{-1} (> 4)

  (ii) pH of the soil is less than 8.5 (< 8.5)

  (iii) ESP is less than 15 (< 15)

  (iv) SAR is less than 13 (< 13)

Dominated by Ca^{2+} and Mg^{2+}

Sodic soil (Black-Alkali Soil)

(a) Color –black

(b) Physical Characteristics

(i) Soil Structure – Very poor

(ii) Infiltration rate – Very poor

(iii) Soil Aeration – Very poor

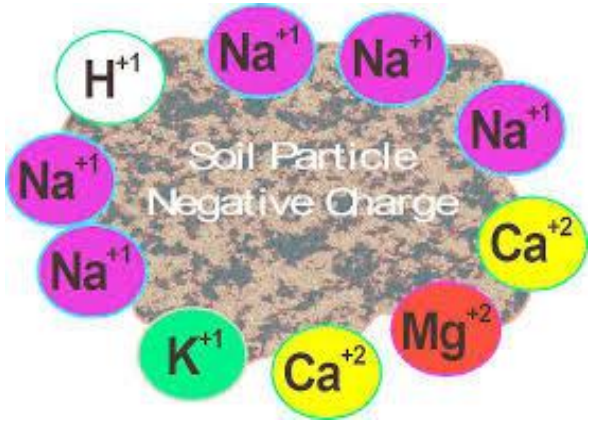
(c) Physicochemical Characteristics

(i) EC of the saturation soil extract is less than 4 dSm^{-1} (<4)

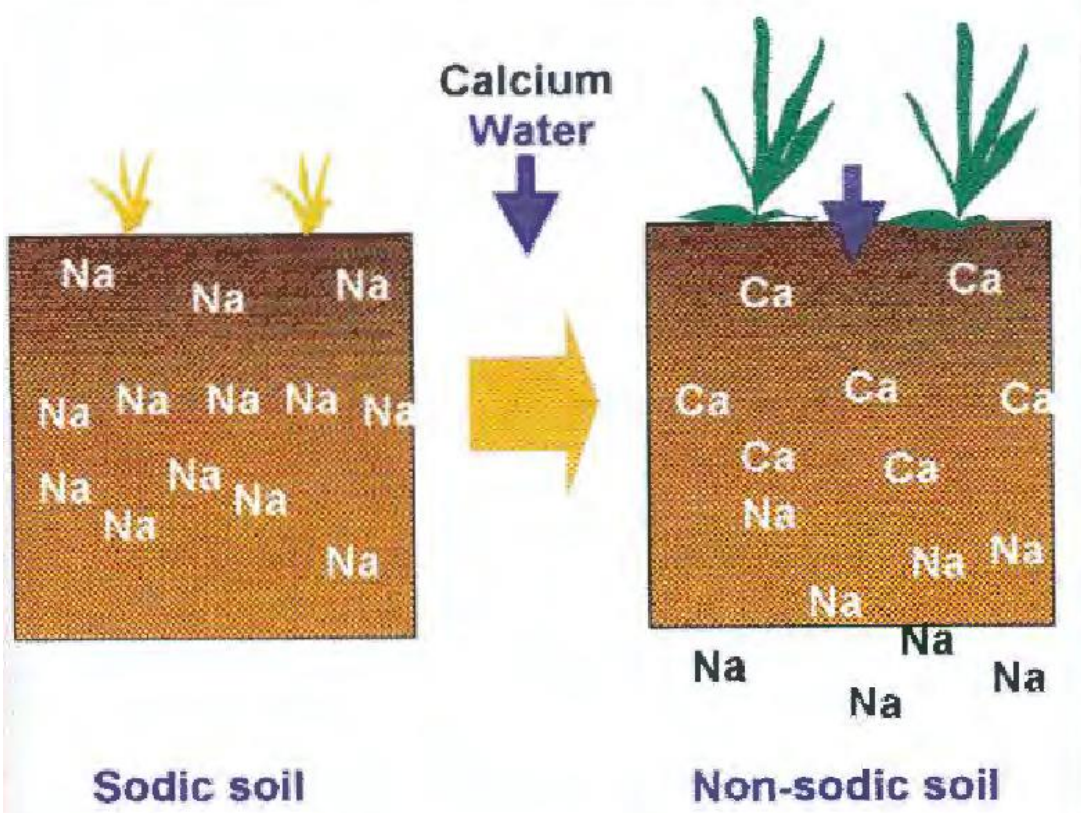
(ii) pH of the soil is more than 8.5 (>8.5)

(iii) ESP is higher than 15 (>15)

(iv) SAR is greater than 13 (>13)



High in exchangeable Na+ compared to by Ca^{2+} and Mg^{2+}



Saline-Sodic Soil

(a) Color – Usually white

(b) Physical Characteristics

(i) Soil Structure – Good

(ii) Infiltration rate – Good

(iii) Soil Aeration – Good

Saline-Sodic Soil…

(c) Physicochemical Characteristics

(i) EC of the saturation soil extract is higher than 4 dSm^{-1} (>4)

(ii) pH of the soil is lower than 8.5 (<8.5)

(iii) ESP is higher than 15 (>15)

(iv) SAR is greater than 13 (>13)

Water analysis result

DEPARTMENT OF AGRICULTURE (LAND USE)

WATER ANALYTICAL DATA

မစောမွန်ငွေး (17.1.2022)

Division – ရန်ကုန်တိုင်း

Township – သန်လျင်မြို့နယ်

Sheet No. 1

Sr No. W 1/2022

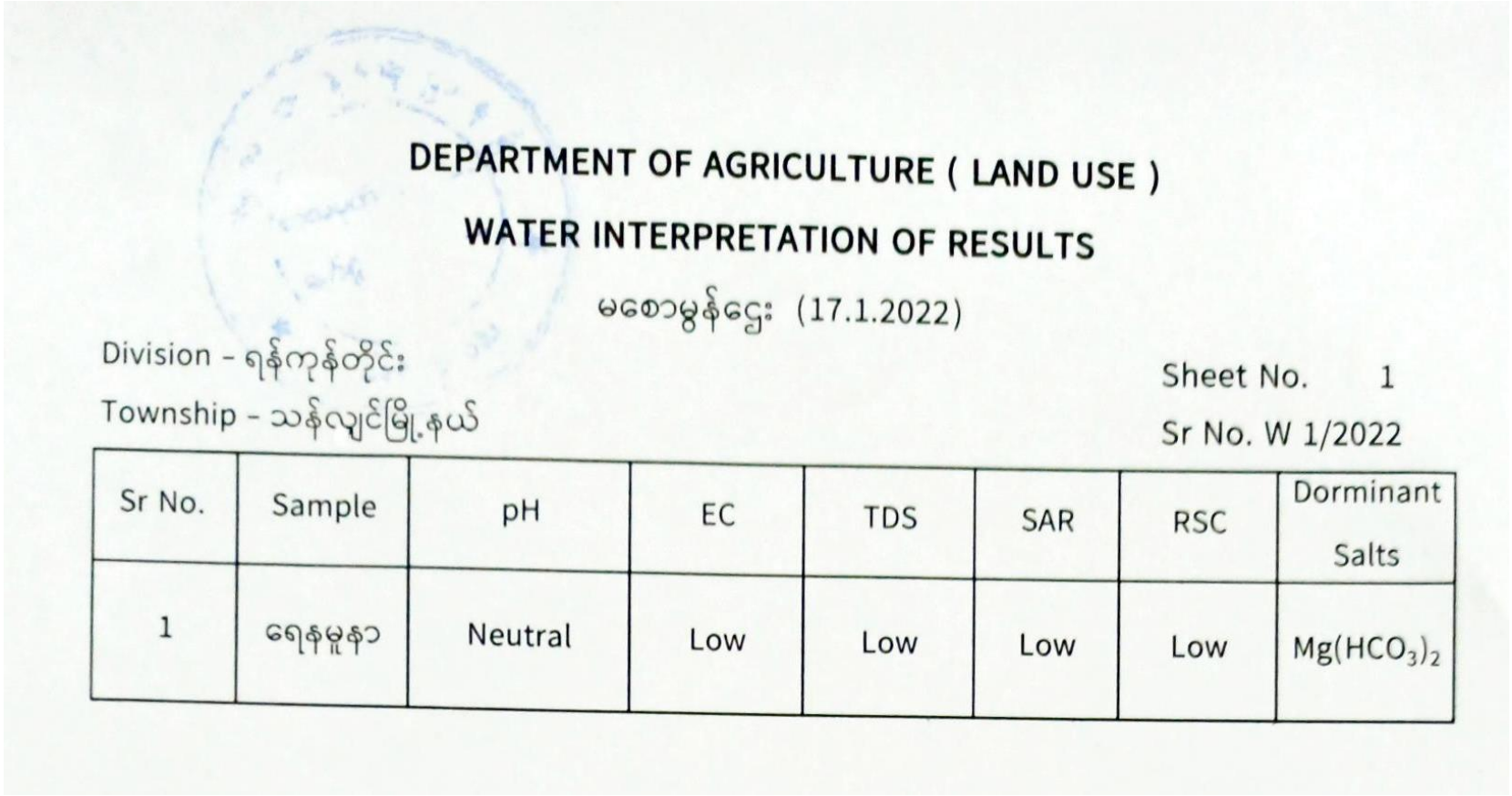
Sr No.	Sample	ANIONS				CATIONS				pH	EC mS/cm	TDS ppm	SAR	RSC me/l
		$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	K^+	Na^+					
1	ရေနုပူနာ	Nil	0.56	0.48	0.16	0.24	0.64	0.002	0.17	6.62	0.05	32	0.256	-0.32

TDS = Total Dissolved Solids

SAR = Sodium Adsorption Ratio

RSC = Residual Sodium Carbonate

Interpretation of water analysis results



DEPARTMENT OF AGRICULTURE (LAND USE)

WATER INTERPRETATION OF RESULTS

မစောမွန်ငွေး (17.1.2022)

Division - ရန်ကုန်တိုင်း

Township - သန်လျင်မြို့နယ်

Sheet No. 1

Sr No. W 1/2022

Sr No.	Sample	pH	EC	TDS	SAR	RSC	Dorminant Salts
1	ရေနမူနာ	Neutral	Low	Low	Low	Low	$Mg(HCO_3)_2$

Interpretation of irrigation water quality…

Level	EC	TDS	SAR	RSC	Na	Cl	HCO_3	NO_3
	mS/ms				me/L	me/L	me/L	me/L
Low	< 0.7	< 450	< 10	< 1.25	< 3	< 4	< 1.5	< 5
Medium	0.7 – 3	450 – 2000	10 – 18	1.25 – 2.5	3 – 9	4 – 10	1.5 – 8.5	5 – 30
High	> 3	> 2000	18 - 26	> 2.5	> 9	> 10	> 8.5	> 30

Interpretation of water pH

- pH 7 = Alkaline
- pH 7 = Neutral
- pH < 7 = Acidic

Problems

- Plant and soil management problems
- Damaged irrigation equipment
- Reduced pesticide efficacy

Interpretation of water salinity

- Lab - Total dissolved salts (TDS)
- Field- EC

Problems

- Reduces seed germination, rooting, growth, establishment, and fruiting of plants
- Lowers the osmotic potential of the soil solution, reducing plant available water

Suitable water for irrigation based on TDS

Very low	Low	Medium	High	Very high
0 – 300 ppm	301 – 600 ppm	601– 1000 ppm	1001 – 1500 ppm	> 1500 ppm
Suitable for all crops	Suitable for all except extremely Sensitive crops	Suitable for moderately tolerant crops and moderately susceptible crops if special precautions are taken	Suitable for moderately tolerant and highly tolerant crops	Suitable for highly tolerant crops only with special precautions

Relatively tolerance of crops to salts

Highly tolerant	Moderately tolerant	Moderately sensitive	Highly sensitive
Cotton Wheatgrass Bermuda grass	Wheat Soybean Sorghum Broccoli Cucumber Tomato Soybean	Cowpea Lettuce Apple Grape Pears Blackberries	Field beans Carrot Onion Strawberries

Bicarbonates

- Produced by dissolving CO_2 in water
- Unit: ppm, meq/L
- High level of bicarbonates in water cause a problem

Problems

- **Cause unsightly foliar deposits on leaf tissue**
- **Precipitate salts**
- **Clog drip emitters and soil pores**
- **Form complexes with Mg and Ca – reducing Ca and Mg for plant uptake and colloidal dispersion**
- **Increase soil pH if the buffering capacity of the soil (resistance to pH change) is low**

Residual Sodium Carbonates

- **Indicates the alkalinity of soil**
- **Determines if excess Ca and Mg in irrigation water after Ca and Mg ions precipitate with carbonates**

Useful when determining

- **Irrigation water management**
- **Soil amendment needs**

Other irrigation water test parameters

- **Sodium**
- **Potassium**
- **Calcium, Magnesium**
- **Nitrate**
- **Sulfate**
- **Chloride**
- **Carbonate, Bicarbonate**
- **Boron (> 1 ppm)**

Thank you for your kind attention!