Unit 3

Soil Chemicals and Plant Nutrition

According to their chemical reactions, soils are characterized as acid, neutral or alkaline. The acidity of the soil can be measured with the use of the pH meter although this is not the only method of testing the soil reaction. High pH readings, above 7.0, indicate plenty of lime and the soil is classed as alkaline. Readings from 6.6 to 7.3 indicate that the soil is neutral, and low pH, 6.5 or less, show an acid soil.

Some plants grow well in soils that are highly acid while others can grow in soils with pH readings above 7.3. Such plants, called plant indicators, show with their presence the relative acid content of the soil.

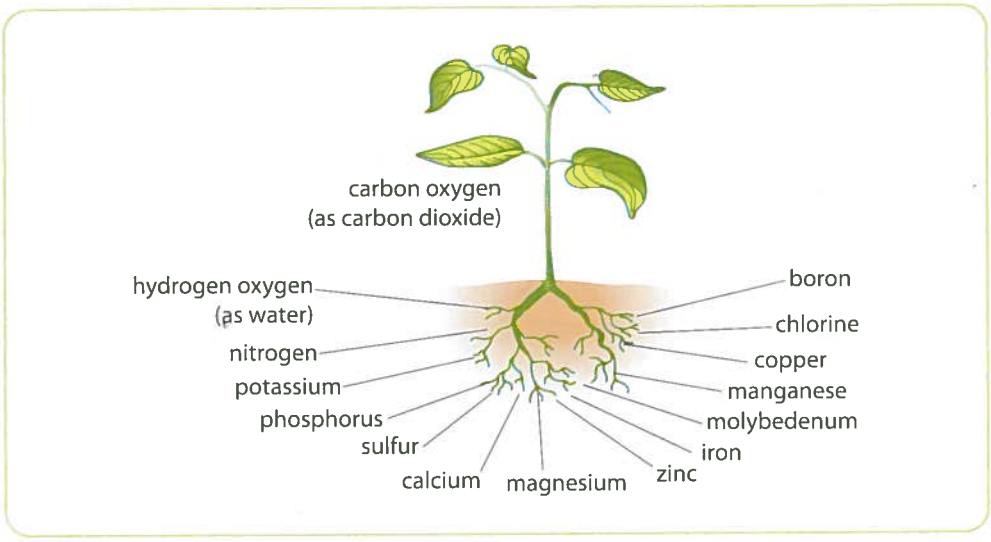
Plants, like all living creatures, need nutrients to live and grow. Plants use nutrients from the air, water, and soil to make their own food through the process of photosynthesis. More than 60 elements are found in plants, but only 18 are considered essential elements. Scientists categorize the essential elements as macronutrients, which plants need in relatively large amounts, and micronutrients, which plants need in small amounts. Calcium, carbon, hydrogen, magnesium, nitrogen, oxygen, phosphorus, potassium, and sulfur are plant macronutrients. Plants take up carbon, hydrogen, and oxygen from air and water. All the other macro- and micronutrients come from weathered minerals or decomposing organic matter dissolved in the water in soil.

Photosynthesis, the process by which plants make sugar from air and water in the presence of light and chlorophyll, takes place only when nitrogen is present. Too little nitrogen causes stunted and weak plants with yellow looking leaves. Too much nitrogen causes tall and weak plants.

Phosphorus is important for the root system of a plant. It is found in the growing parts of the plant, the flower and the seed.

Potassium is found in the soil and enables the plant to produce good fruit because it helps the plant to form sugar and starches. It also makes it possible for these nutrients to move from one part of the plant to another.

Apart from the three main plant foods mentioned above, calcium is very important too because it holds plant cells together and enables the plant to take the other foods from the soil.



Soil Chemicals

Watch the video titled 'Soil Nutrients From the Ground Up' https://www.youtube. com/watch?v=gBrhZKuG-HY to revise how nitrogen, phosphorus and potassium affect the development of plants.

Periodic Table of Elements

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
		*	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
		**	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Special Terms

Acid soil	a soil giving an acid reaction (precisely, below pH 7.0; practically below pH 6.6).
Alkaline	containing alkali; having a pH greater than 7.
Macronutrients	chemical elements of which large quantities are essential to the growth of plant.
Magnesium	the chemical element Mg.
Neutral soil	a soil with a pH between 6.6 and 7.3.
Nutrient	an element in a soil which is essential for the growth of a plant.
Plant indicators	an individual species of a plant, or a community, which by its presence indicates a condition of soil, depth of moisture, climate or other characteristics of the site.
Potassium	the chemical element K.
Sulphur-Sulfur	a yellow mineral substance, insoluble in water, easily fusible and inflammable; the chemical element S.
Trace elements	any of certain chemical elements necessary in very small quantities for growth and development of plants.

Practice Tasks

Task 1 *True or False?*

1. If the soil contains plenty of lime then it is neutral. [___]
2. Most of the chemical elements required for a plant's healthy growth can be obtained from the soil. [___]
3. Trace elements are found in large quantities in the plants. [___]
4. Photosynthesis takes place only if nitrogen is absent. [___]
5. Phosphorus is only useful for the root system of the plant. [___]
6. Potassium is not helpful for the fruit production of a plant. [___]

7. Calcium and magnesium are macronutrients. [ ]
8. Sulfur and potassium are micronutrients. [ ]
9. Nitrogen is not needed for plant's cell division. [ ]
10. Neutral soils are characterized by readings of acidity which are higher than 7.3pH. [ ]
11. Plants grow well in acid soils. [ ]
12. All elements needed for a healthy growth of plants can be acquired from the soil. [ ]
13. Magnesium is a trace element. [ ]
14. Abundance of nitrogen causes stunted plants. [ ]
15. Phosphorus is essential for the flowers and seeds of a plant. [ ]
16. Sugar and starches move to the various parts of plants with the help of potassium. [ ]
17. Calcium takes other plant foods from the soil. [ ]

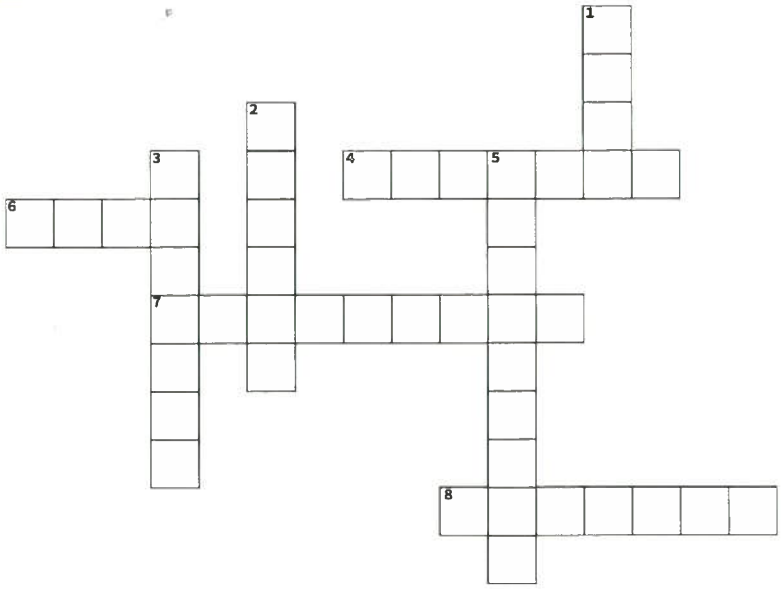
Stunted Tomato Plants

Task 2 *Write the terms for the following symbols*

Mg _____ Ca _____ K _____

N _____ P _____ S _____

Task 3 *Use the clues to fill in the crossword puzzle*



Across

4 It can be measured with pH meter.
6 A mineral that consists mainly of calcium carbonate.
7 To break something, into smaller parts or to decay.
8 A chemical substance is neither an acid nor an alkali, it is…

Down

1 The part of a plant that grows down into the earth to get water and food.
2 A white substance that exists in large amounts in potatoes and particular grains such as rice.
3 The number that a piece of measuring equipment shows.
5 A synonym for diluted.

Task 4 *Complete the sentences by choosing the appropriate part from the right column*

1. Too much nitrogen causes [__] a) the transfer of nutrients from one part of a plant to another.

2. Too little nitrogen causes [__] b) acid.

3.	Phosphorus	[__]	c) are also called micronutrients.
4.	Photosynthesis requires	[__]	d) helps the root system of the plants.
5.	Chemical elements required for plant growth	[__]	e) classified as alkaline.
6.	Potassium enables	[__]	f) are called macronutrients.
7.	Calcium	[__]	g) tall and weak plants.
8.	Trace elements	[__]	h) the presence of light.
9.	Elements found in large quantities in the plants	[__]	i) holds plant cells together.
10.	Soils with pH above 7.3 are	[__]	j) are found in the soil.
11.	Soils with pH 6.5 or lower are	[__]	k) plants with yellow looking leaves.

Excerpt 1: Micronutrient Soil Deficiencies

Micronutrients occur in in relatively small quantities. Soil conditions such as pH level and weather conditions such as drought affect their availability. Selected micronutrients and visual cues to diagnose a deficiency of them are below. Visual diagnosis — difficult for both macro- and micronutrients — is more art than science. The following guidelines may help.

- Boron deficiency appears first on younger or upper leaves that appear pale green and twisted at the base. The buds die.
- Calcium deficiency appears first on younger or upper leaves. Buds and young leaves die back.
- Copper appears first on younger or upper leaves that are pale and wilted with brown tips.
- Iron deficiency appears first on younger or upper leaves as interveinal chlorosis. Growth is stunted.
- Manganese deficiency appears first on younger or upper leaves as interveinal chlorosis with brown spots scattered through the leaf.
- Molybdenum deficiency appears first on younger or upper leaves as interveinal chlorosis. Growth is stunted.
- Sulfur deficiency appears first on younger or upper leaves that appear light green overall. Growth is stunted.
- Zinc deficiency appears first on older or lower leaves as interveinal chlorosis. Leaves thicken, and growth is stunted.

Excerpt 1 Task 1 *Read the excerpt and record the impact nutrient deficiencies have on plants*

Nutrient	*Nutrient deficiency impact*

Excerpt 2 *Nutrition Facts for Plants and People*

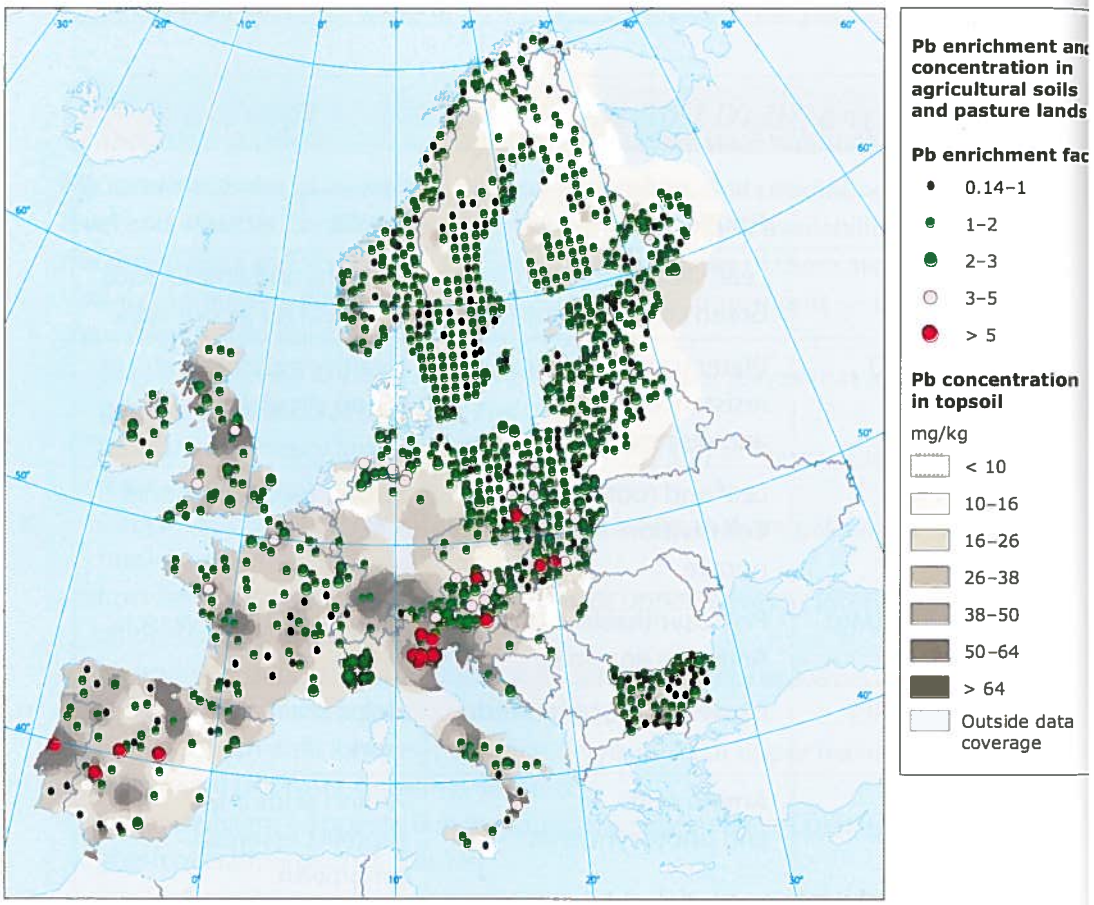
Nutrient	*For Plants*	*For Us*
Nitrogen (N)	Leaf, stem, and root growth. Green color (chlorophyll).	Proteins and amino acids essential for all our cells.
Potassium (K)	Water uptake. Improves resistance to pests and disease.	Healthy muscles and blood circulation.
Calcium (Ca)	Leaf and root growth. Cell division. Nutrient uptake.	Strong teeth and bones.
Magnesium (Mg)	Photosynthesis. Activates enzymes.	Heart and blood vessels.
Phosphorus (P)	Flowers, fruits, and seeds.	Helps brain and nerves work.
Sulfur (S)	Amino acids and photosynthesis.	Amino acids and proteins essential for growth.

[Source: Agronomy: Grow with it! Ateh et al., 2016, p.73].

Delve Deeper Into...

Soil Contamination

Soil contamination is the occurrence of pollutants in soil above a certain level causing a deterioration or loss of one or more soil functions. Also, soil contamination can be considered as the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage tanks, application of pesticides, percolation of contaminated surface water to subsurface strata, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. The occurrence of this phenomenon is correlated with the degree of industrialization and intensity of chemical usage.



Soil Contamination by Heavy Metals