

# Plants Need Nutrients

Fertilizer's role in  
soil management  
(Grades 6-8)

UCCE Master Gardener Program of  
Riverside County



# Master Gardeners

The University of California Cooperative Extension (UCCE) Master Gardener Program (MGP) is an educational program designed to teach and effectively extend information to address home gardening and non-commercial horticulture needs in California.

UCCE is the outreach arm of UC's division of Agriculture and Natural Resources (ANR). Master Gardener volunteers (MG volunteers) promote the application of basic environmentally appropriate horticultural practices through UCCE-organized educational programs that transfer research-based knowledge and information.



University of California

Agriculture and Natural Resources

UCCE Master Gardener Program

# Why is This Important?

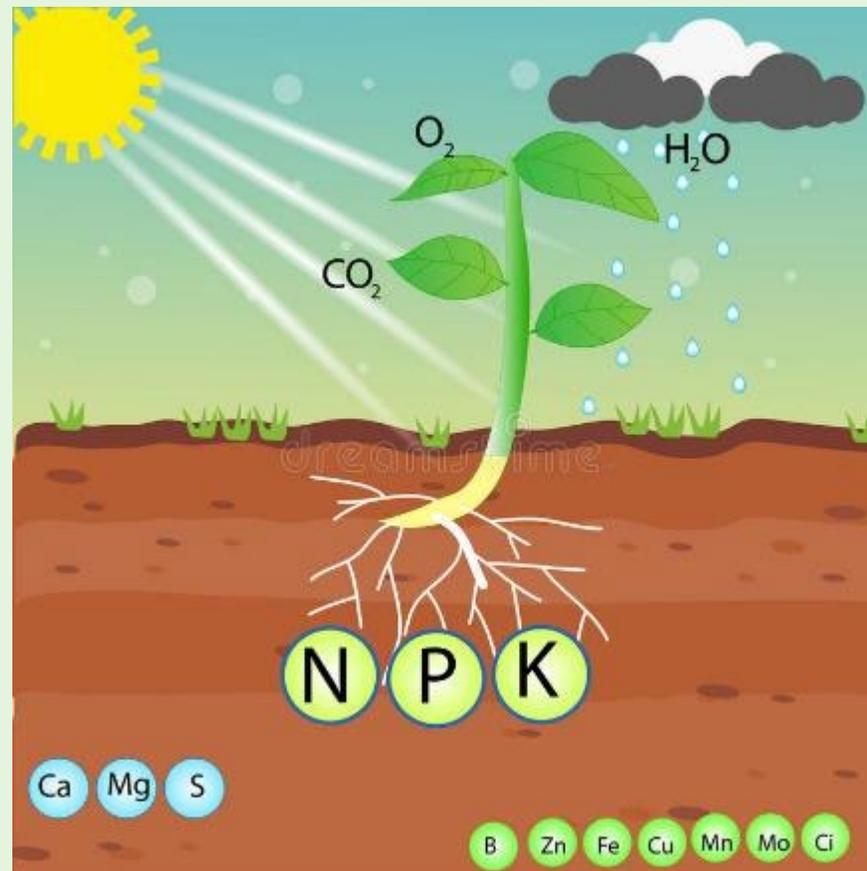
Fertile soil contains nutrient elements in amounts favorable for optimal growth of crop plants and in a plant available form that crop roots can absorb.

**Learning Goal:** Students will learn that plant nutrition is a plant's need for and use of 17 chemical elements for growth and development, and that factors can enhance plant use of these nutrients.



# Plant Nutrients

- Plant nutrients are chemical elements and compounds necessary for plant growth and reproduction.
- Healthy soil contains the 17 elements plants need
  - 3 from air and water
    - Oxygen (O), Hydrogen (H), and Carbon (C)
  - 14 from minerals in soil
- People can add nutrients to plants *if needed*



# What You Need to Know:

## Definitions – Element

**Element:** A substance in its simplest form that cannot be broken down further (such as carbon, oxygen or nitrogen).

**Periodic Table of the Elements**

1 1A 11A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
1 H Hydrogen 1.0079																		2 He Helium 4.00260
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0064	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.1797	
11 Na Sodium 22.989768	12 Mg Magnesium 24.305											13 Al Aluminum 26.981539	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.06	17 Cl Chlorine 35.4527	18 Ar Argon 39.948	
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.95591	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.90	
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9062	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29	
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon 222.0176	
87 Fr Francium [223]	88 Ra Radium [226]	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [285]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Uut Ununtrium [288]	114 Uuq Ununquadium [289]	115 Uup Ununpentium [288]	116 Uuh Ununhexium [289]	117 Uus Ununseptium [289]	118 Uuo Ununoctium [289]	
		57 La Lanthanum 138.9055	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.9654	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967		
		89 Ac Actinium [227]	90 Th Thorium 232.0377	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium 237.04817	94 Pu Plutonium 244.0642	95 Am Americium 243.06136	96 Cm Curium 247.07645	97 Bk Berkelium 247.07125	98 Cf Californium 251.07958	99 Es Einsteinium [252]	100 Fm Fermium 257.1035	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [260]		
		Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetals	Nonmetals	Halogens	Noble Gas	Lanthanides	Actinides							

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# What You Need to Know:

## Definitions –Compound

**Compound:** A substance formed when two or more chemical **elements** are chemically bonded together (such as water, made up of hydrogen and oxygen, H<sub>2</sub>O).



# 17 Essential Plant Elements

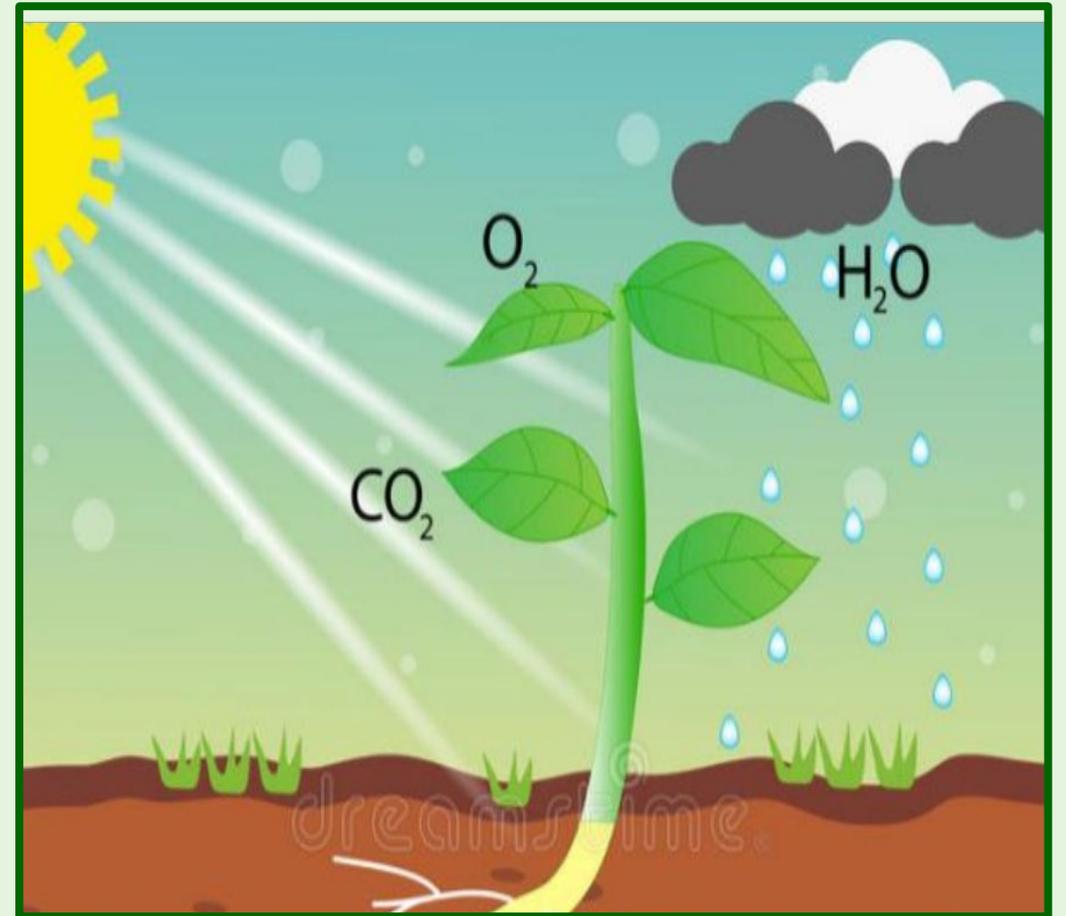
The 17 plant nutrients are divided up into mineral and non-mineral elements.

- *Mineral* nutrients enter plants primarily through the soil.
- *Non-mineral* nutrients may enter either through the soil or atmosphere.

7 <b>N</b> Nitrogen	15 <b>P</b> Phosphorus	19 <b>K</b> Potassium	12 <b>Mg</b> Magnesium	16 <b>S</b> Sulfur	20 <b>Ca</b> Calcium	
Macronutrients			Secondary Nutrients			
5 <b>B</b> Boron	17 <b>Cl</b> Chlorine	25 <b>Mn</b> Manganese	26 <b>Fe</b> Iron			
28 <b>Ni</b> Nickel	29 <b>Cu</b> Copper	30 <b>Zn</b> Zinc	42 <b>Mo</b> Molybdenum	1 <b>H</b> Hydrogen	6 <b>C</b> Carbon	8 <b>O</b> Oxygen
Micronutrients				Non-fertilizer Elements		

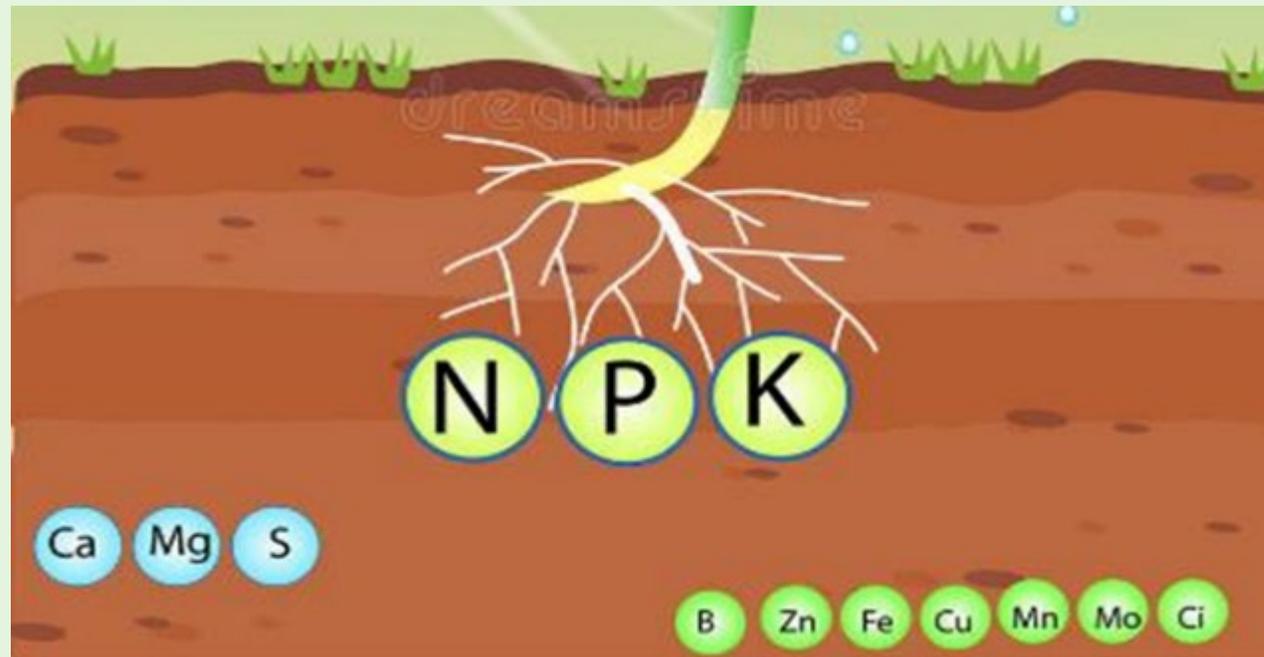
# Non-Mineral Nutrients

Non-mineral nutrients are in the ***compounds*** required for photosynthesis. Water, supplied via irrigation or rainfall provides the hydrogen (and electrons) required to convert solar energy (light) into chemical energy (sugars.)



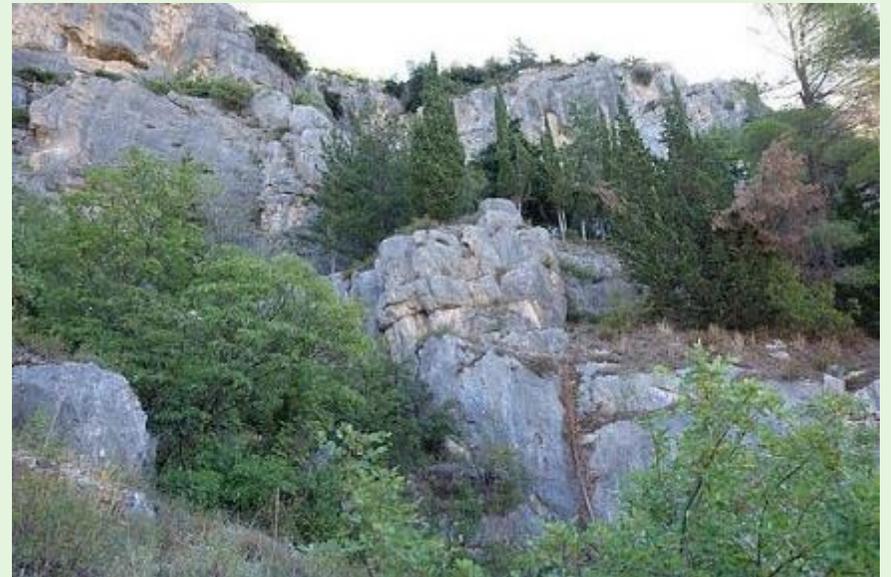
# Mineral Nutrients

All other essential elements are mineral nutrients. These are dissolved in water and most commonly enter the plant when absorbed by plant roots.



# Minerals in Soil

- **Minerals:** A solid material formed by natural events
  - Not from plants or animals
- Minerals in soil come from erosion or weathering of rocks
- **Minerals support plant growth:** They provide nutrition, or food for the plant



# What You Need to Know

## Definitions - Nutrients

There are 14 mineral elements that are needed by plants, but the required amount varies.

- **Macronutrient**

- Plant-essential elements required in relatively large amounts by plants.

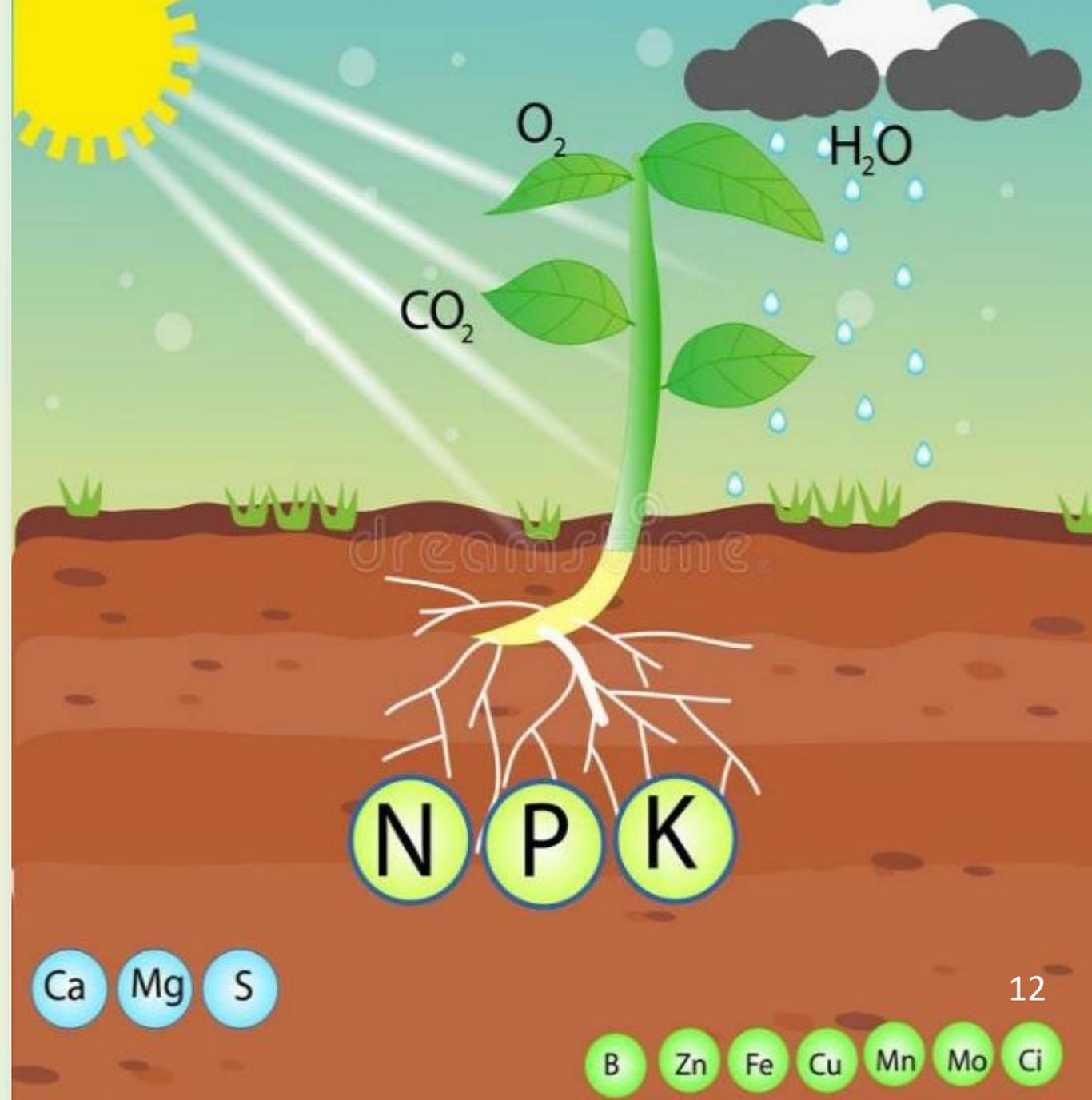
- **Micronutrient**

- Plant-essential element required by plants in very small amounts.



## NPK

- Three **primary** mineral macronutrients for plants:
  - **N** Nitrogen
    - Greening of plant
  - **P** Phosphorus
    - Health and vigor
  - **K** Potassium
    - Movement of water and nutrients



# Plants Need for NPK Varies

- Some plants need different levels of the three primary macronutrients, so fertilizers, or plant food products, list three values (percentages) for nitrogen, phosphorus and potassium.
- Numbers on products provide the % for each chemical element

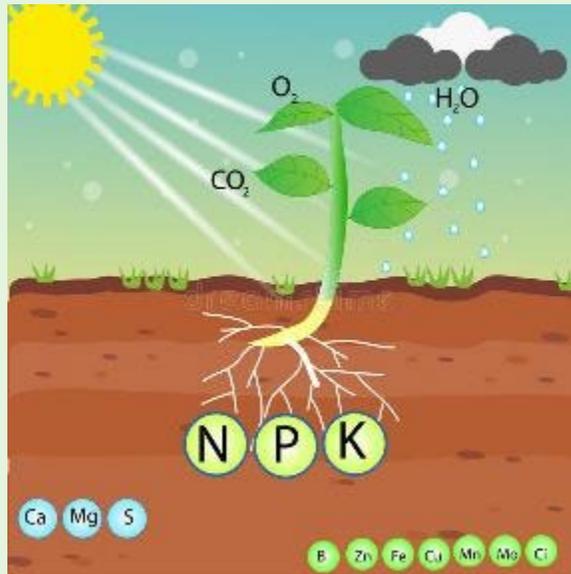
 <p><b>NITROGEN</b> Helps with leaf development and makes your lawn green</p>	 <p><b>PHOSPHOROUS</b> Aids in root growth</p>
 <p><b>POTASSIUM</b> Vital for disease resistance and root development</p>	<p>Numbers on the bag are percentages. For example, 16-4-8 is 16% nitrogen, 4% phosphorous, and 8% potassium.</p>

# Additional Mineral Nutrients

In addition to Nitrogen, Phosphorous and Potassium, plants need other minerals from the soil

- Other *secondary macronutrients*

- Calcium
- Magnesium
- Sulfur

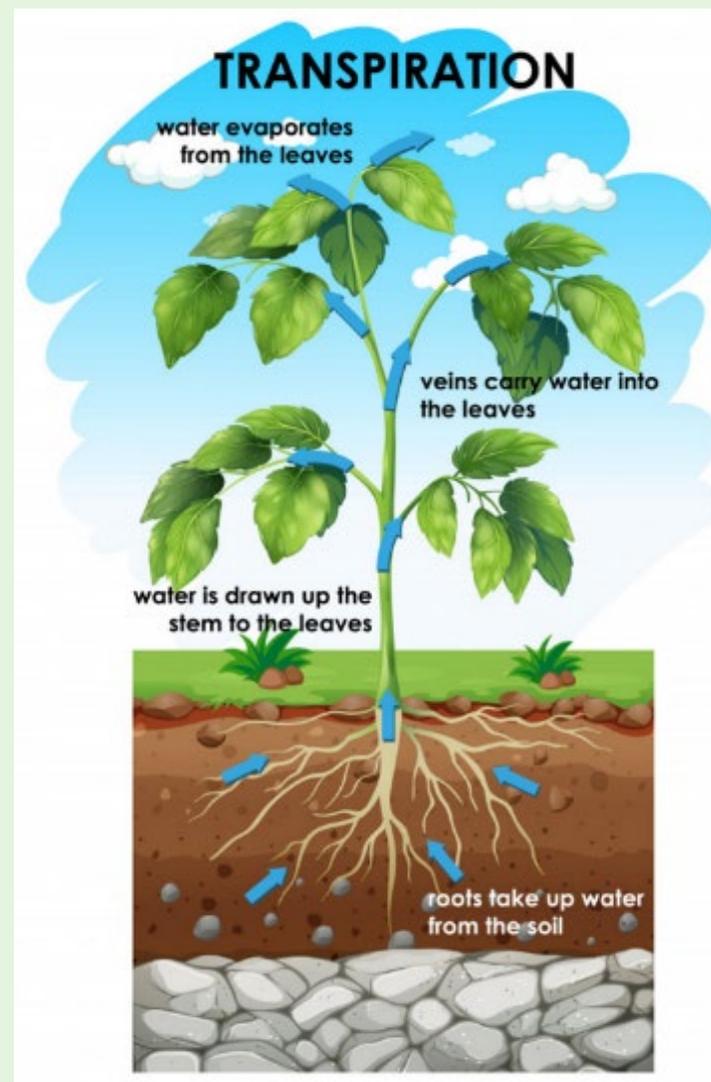


- Eight *micronutrients*

- Boron
- Chlorine
- Copper
- Iron
- Manganese
- Molybdenum
- Nickel (not included in this diagram)
- Zinc

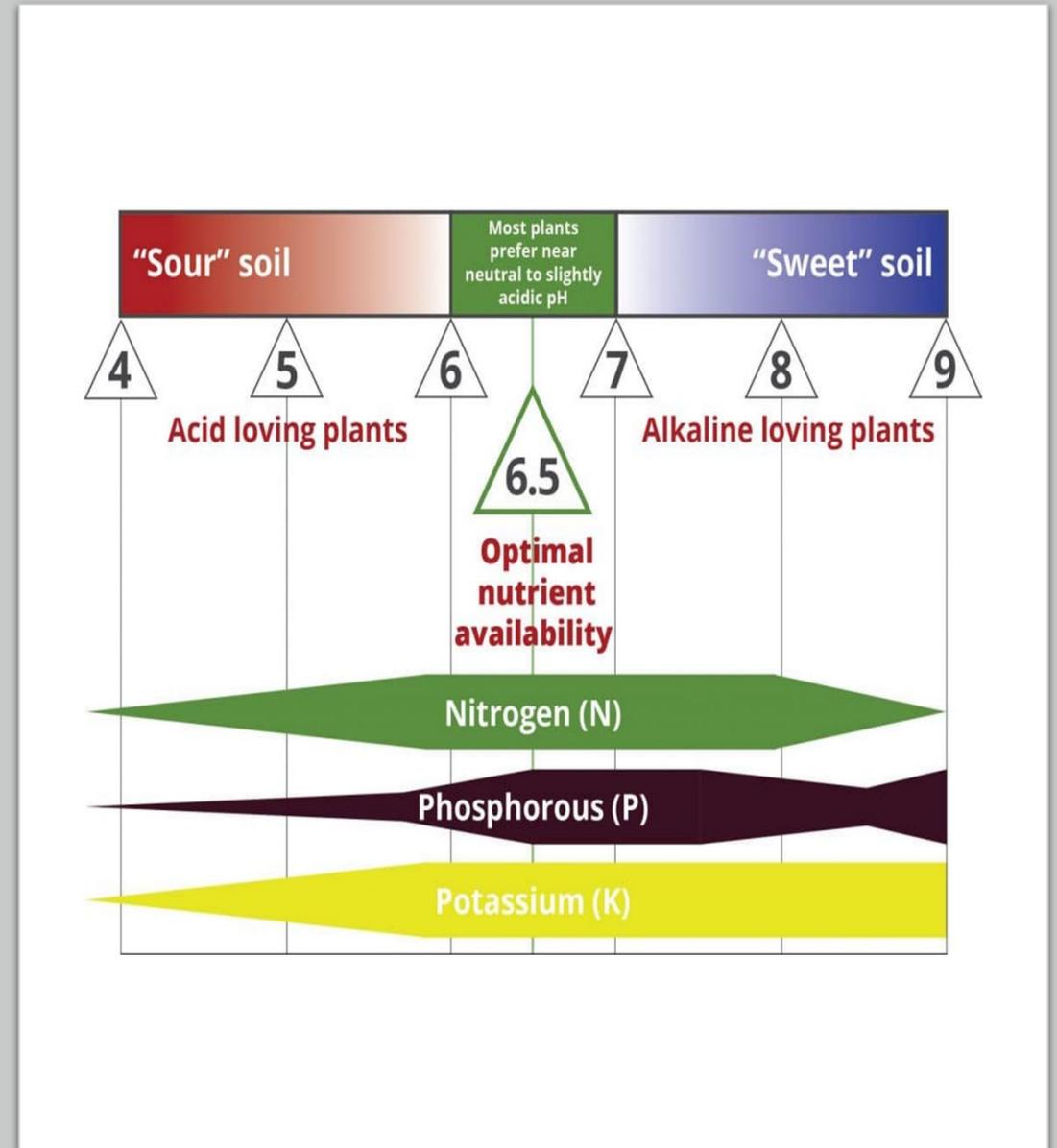
# Uptake of Nutrients

- Before a nutrient can be used by plants it must be dissolved in a soil and water solution
- Nutrients are carried up through the plant with water absorbed through the roots
- Most minerals and nutrients are more available in acid soils than in neutral or slightly alkaline soils



# pH Level in Soil

- The pH level measures the acidity and alkalinity of soil
- The scale ranges from 4.0 to 9.0
- pH Level affects the availability of nutrients to support plants
  - Nutrients can be absorbed at a pH level from 5.5 to 7.5
  - Many plants do well at a pH range of about 6 to 7



# Nutrient Balance

- Although plants need much higher amounts of macronutrients than micronutrients, all 17 essential elements must be present for a plant to be healthy.
- A common problem in California is related to a plant's need for nitrogen, phosphorus, potassium, zinc and iron, as well as symptoms caused by excesses in boron, chloride and sodium.

Source: California Master Gardener Handbook Second Edition, Pettinger, 2015

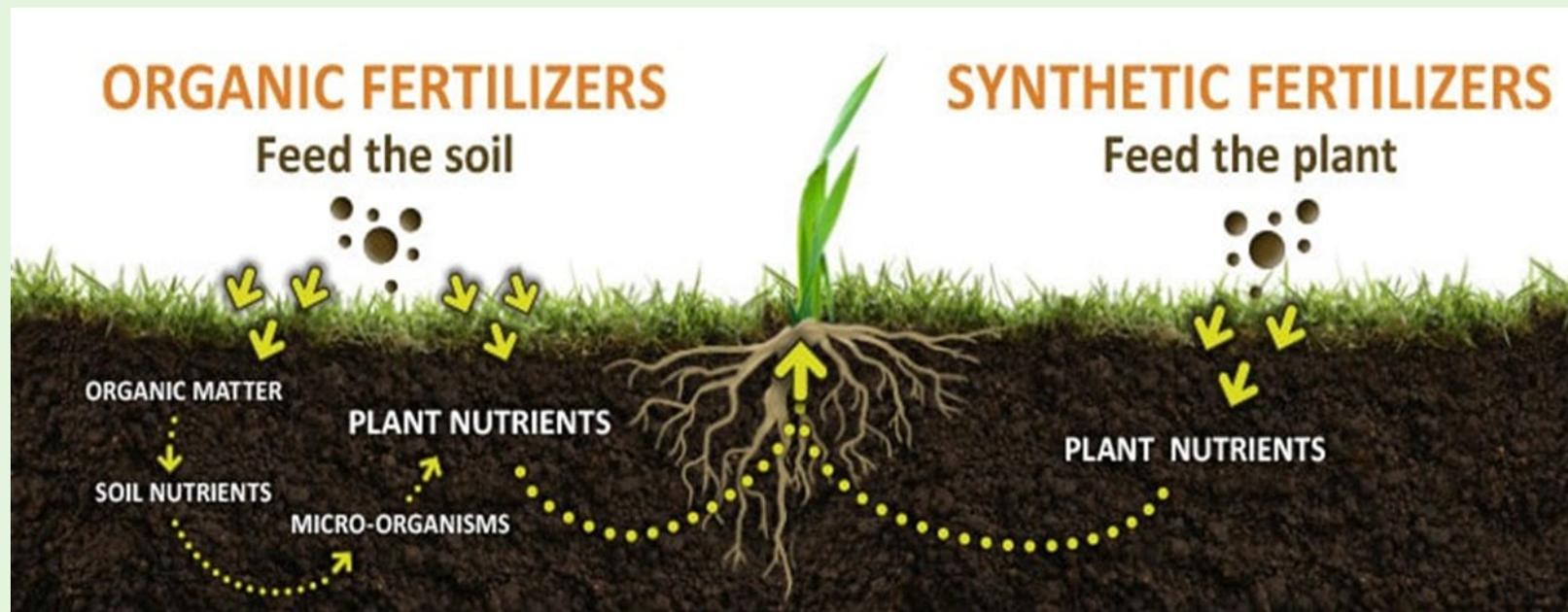
# Hunger Signs in Plants

- Plant Distress
  - Under or overwatering- Yellowing or wilting of leaves
  - Disease-Fungus, virus, bacteria
- Deficiency or imbalance of nutrients



# Correcting Nutrition Deficiencies

Nutrient deficiencies can be corrected by the addition of inorganic or organic fertilizer, along with soil and water management.



# Types of Fertilizers

- **Inorganic (chemical)**
- Generally contains 3 primary nutrients:
  - NPK
- Fast acting
  - Reduces deficiencies in NPK
  - Promotes plant growth
- **Organic (from plants and animals)**
  - Animal excrement (manure)
  - Plant remains (compost)
- Slow acting
- Improves plant health
- Enriches soil with organic matter to improve the health of the soil

**Many successful gardeners use a combination of inorganic and organic fertilizers.**

# Video: Determining Nutrient Level in The Soil

To learn whether you need to add nutrients, have your garden soil tested. You can begin by using a soil testing kit sold at most garden centers and nurseries.



Note: Ideally, **distilled** water should be used when administering a soil test.

# Check For Understanding

- What is the definition of nutrition for plants?
- What elements come from air and water?
- Name the three primary mineral elements for plant nutrition.
- How does pH level affect a plant's use of nutrients?
- What are three signs of a plant in distress?
- What are the two types of fertilizers?



# Apply Your Understanding

Research the best options for fertilizing your vegetable garden with inorganic and/or organic plant nutrients. Refer to pages 14-15 in [Vegetable Gardening Handbook for Beginners](#) .

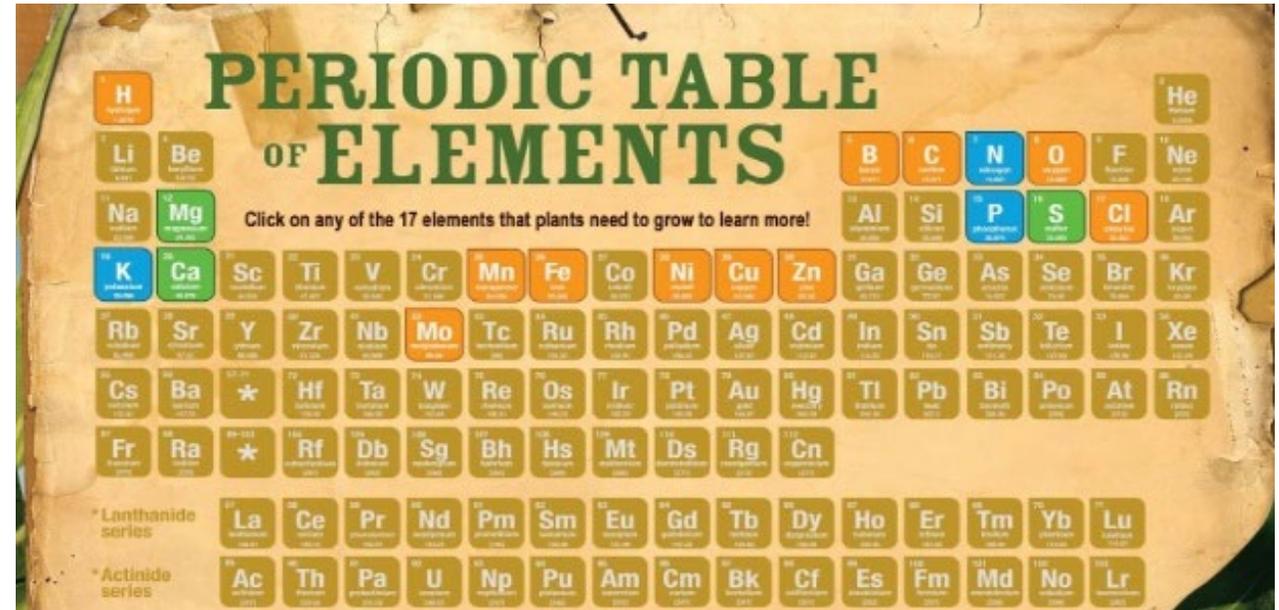
## Handbook for Beginners



UC Master Gardener Program of Contra Costa County  
*Advice to Grow By*

# Extend Your Understanding

Explore the [interactive periodic table](#) to learn more about how each chemical element is important to plant nutrition.



# Next Generation Science Standards

## **PS1.A: Structure and Properties of Matter**

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3)

## **LS1.C: Organization for Matter and Energy Flow in Organisms**

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1- 6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

# Career Technical Education

## Agriscience Pathway Standards

### **C10.0 Explain soil science principles.**

- C10.2 Summarize how soil texture, structure, pH, and salinity affect plant growth.
- C10.4 Differentiate among the types, uses, and applications of amendments and fertilizers.

### **C11.0 Analyze plant growth and development.**

- C11.2 Identify plant growth requirements.

# Resources

- California Master Gardener Handbook, Second Edition, Dennis R. Pittenger, Editor, 2015
- Suny College of Environmental Science and Forestry, <https://www.esf.edu/pubprog/brochure/soilph/soilph.htm>
- [Essential Plant Nutrients - November 27, 2002](#), Jeff Schalau, County Director, Agent, Agriculture & Natural Resources, Arizona Cooperative Extension, Yavapai County
- [Nutrients For Life Foundation](#)

# Resources Continued

- Images [www.kiddle.co](http://www.kiddle.co) [www.Britannica.com](http://www.Britannica.com) [www.lowes.com](http://www.lowes.com)  
[www.cepolina.com](http://www.cepolina.com) [www.dreamstime.com](http://www.dreamstime.com) [www.worldatlas.com](http://www.worldatlas.com)  
[www.extension.imn.edu](http://www.extension.imn.edu)
- Image [https://www.fertilizer.org/Public/Media/Change Makers Drivers/2019 01 29 Plant Nutrition Pioneers.aspx](https://www.fertilizer.org/Public/Media/Change_Makers_Drivers/2019_01_29_Plant_Nutrition_Pioneers.aspx)
- Image [www.ucanr.edu](http://www.ucanr.edu)
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- Creative Commons
- Getty Images

# Gardening Questions?

- Email the UCCE Master Gardeners of Riverside County
- Email Helpline
  - [anrmgriverside@ucanr.edu](mailto:anrmgriverside@ucanr.edu)
- [Riverside Master Gardeners Website](#)



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