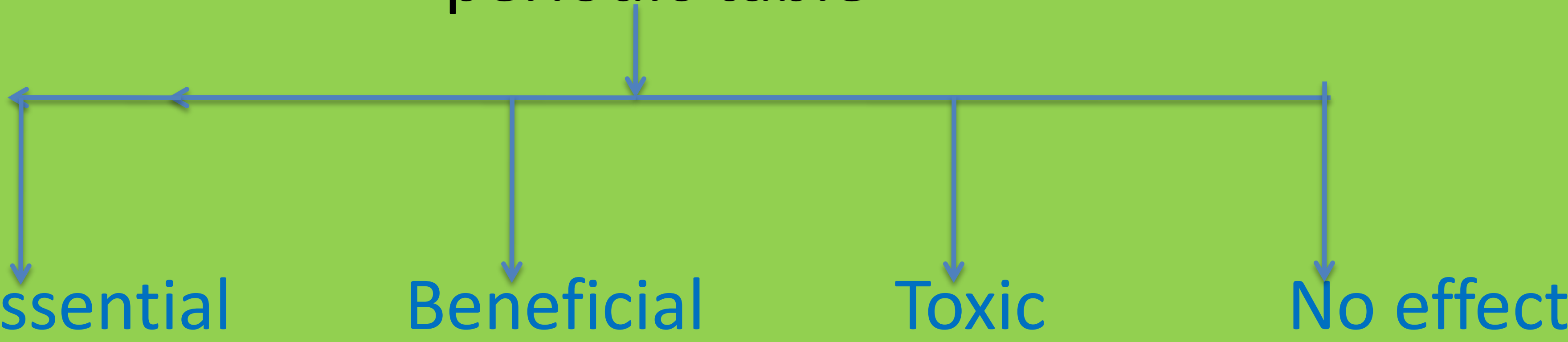
اسمدة متقدم 2

Essential elements and their roles in plants.

Nutrition : growth and metabolism

nutrients : inorganic elements used by plants.

periodic table



(hand out elements of periodic table)

For an element to be essential three criteria must be met :-

- Deficiency of the element makes it impossible for the plant to complete its life cycle . (direct effect on plant growth and reproduction).
- No other element substitutes for the element.
- All plants require the element. (?)

For beneficial element :-

elements that might enhance growth or that have function in some plants. (sparing effect)

Toxic :-

at natural level has no effect, but at high conc. It is toxic.

No effect :- present in nature at low conc.

Essential elements , their date of acceptance as essential…….

Table 1.1 in handbook of plant nutrition p.4

(next slide)

essential elements :-

conc. Has Varity effect

too high → toxic

optimum → very good

→ too low deficiency

TABLE 1.1

Listing of Essential Elements, Their Date of Acceptance as Essential, and Discoverers of Essentiality

Element	Date of Essentiality[a]	Researcher[a]
Nitrogen	1804	de Saussure[b]
	1851–1855	Boussingault[b]
Phosphorus	1839	Liebig[c]
	1861	Ville[b]
Potassium	1866	Birner & Lucanus[b]
Calcium	1862	Stohmann[b]
Magnesium	1875	Boehm[b]
Sulfur	1866	Birner & Lucanus[b]
Iron	1843	Gris[c]
Manganese	1922	McHargue[c]
Copper	1925	McHargue[c]
Boron	1926	Sommer & Lipman[c]
Zinc	1926	Sommer & Lipman[c]
Molybdenum	1939	Arnon & Stout[c]
Chlorine	1954	Broyer, Carlton, Johnson, & Stout[c]
Nickel	1987	Brown, Welch, & Cary (11)

[a]The dates and researchers that are listed are those on which published articles amassed enough information to convince other researchers that the elements were plant nutrients. Earlier work preceding the dates and other researchers may have suggested that the elements were nutrients.

[b]Cited by Reed (22).

[c]Cited by Chapman (13).

Basis for classification of essential nutrient L2

1- Quantity :- on the basis on the amount required by plants

a- macro nutrients : taken up by plant in large amount include C, H, O ,N, P, K, S, Ca , and Mg.

b- micro nutrients : taken up by plant in small amount include Zn, Mn, Fe, cu, B , Mo, Cl.

Other classification :

a- primary nutrients (N, P , and K) : taken up by crop by largest amount.

b- Secondary nutrients (Ca, Mg ,and S)

These elements are taken by plants in the next largest amount.

c- micro (minor) nutrients (the rest of essential nutrients) . Taken up in the smallest amount.

2- Mobility in plants : transfer of nutrients from one part to other.

mobile	immobile
N, K, Mg, P, Cl	Ca, S, Fe , B, and Cu
Na, Zn, and Mo	

3 – Biochemical functions in plants

1st group

C,H,O,N ,and S

2nd group

P, B , and Si

3th group

K , Na, Mg , Ca , Mn , and Cl.

4th group

Fe ,Cu , Zn , and Mo

table in Mengel and Kirkby p.13

Although the functions of essential elements are diverse, they can be grouped into four general categories.

1. Essential elements can be parts of cell structures. Carbon, hydrogen, and oxygen are part of all the biological molecules, such as carbohydrates. Similarly, nitrogen is an integral part of proteins and nucleic acids.
2. Essential elements can be parts of compounds involved in energy-related chemical reactions in a plant. Magnesium is part of chlorophyll, and phosphorus is part of ATP and nucleic acids.
3. Essential elements can activate or inhibit enzymes. Magnesium stimulates several enzymes involved in cellular respiration, whereas calcium inhibits several enzymes. In some cases, these enzymes may be those responsible for synthesizing plant hormones.
4. Essential elements can alter the osmotic potential of a cell. For example, the movement of potassium into and out of guard cells causes them to open and close stomata, the tiny openings in the epidermis of leaves.

Functions of essential elements in plants and deficiency symptoms :-

Table 2.1 in soil fertility management for sustainable agriculture p 6-8.

Table 5.2 in plant nutrition chpt. 5 p.69

Table 5.1 in plant nutrition chpt. 5 p.68

- Organic F is very common can be accumulated by plants

  tea accumulate O. F. → 70---300 ppm.

  F- acetate , F- oleric acid , F- citric acid

  ↓

  (toxic principle) .

  No evidence at all that F is essential to plants

  Na :

  - required by animals → serve in place of K
  - in plants:

    i-may be a macronutrient

    (in some halophytes)

ii- micro nutrient → certain plants

Corn ,suqarbeet and some other C_4 plants.

iii- beneficial → sugar beet

iv- sparing effect(very limited) for K (osmotic)

Selenium (SeO_4^{--}) :

- not essential for plants
- in sulfamino acid

i- cysteine

$$
\begin{array}{c}
NH_2 \\
| \\
COOH\text{-}C\text{-}CH_2 - SH \\
| \\
H
\end{array}
$$

↑ Se- seleno cystene

ii- Methionine

$$\begin{array}{c} NH_2 \\ | \\ COOH\text{- }C\text{- }CH_2\text{ –}S\text{-}CH_3 \\ | \\ H \end{array}$$

Se - selenomethionione

iii- Methyl cysteine

$$\begin{array}{c} NH_2 \\ | \\ COOH\text{-}C\text{- }CH_2\text{ - }S\text{- }CH_3 \\ | \\ H \end{array}$$

Se- methyl cysteine all above may convert to protein (inactive protein)

recently, it has been suggested to enhance plant growth .

Silicon :

diatoms → required by animals

grass → cell wall

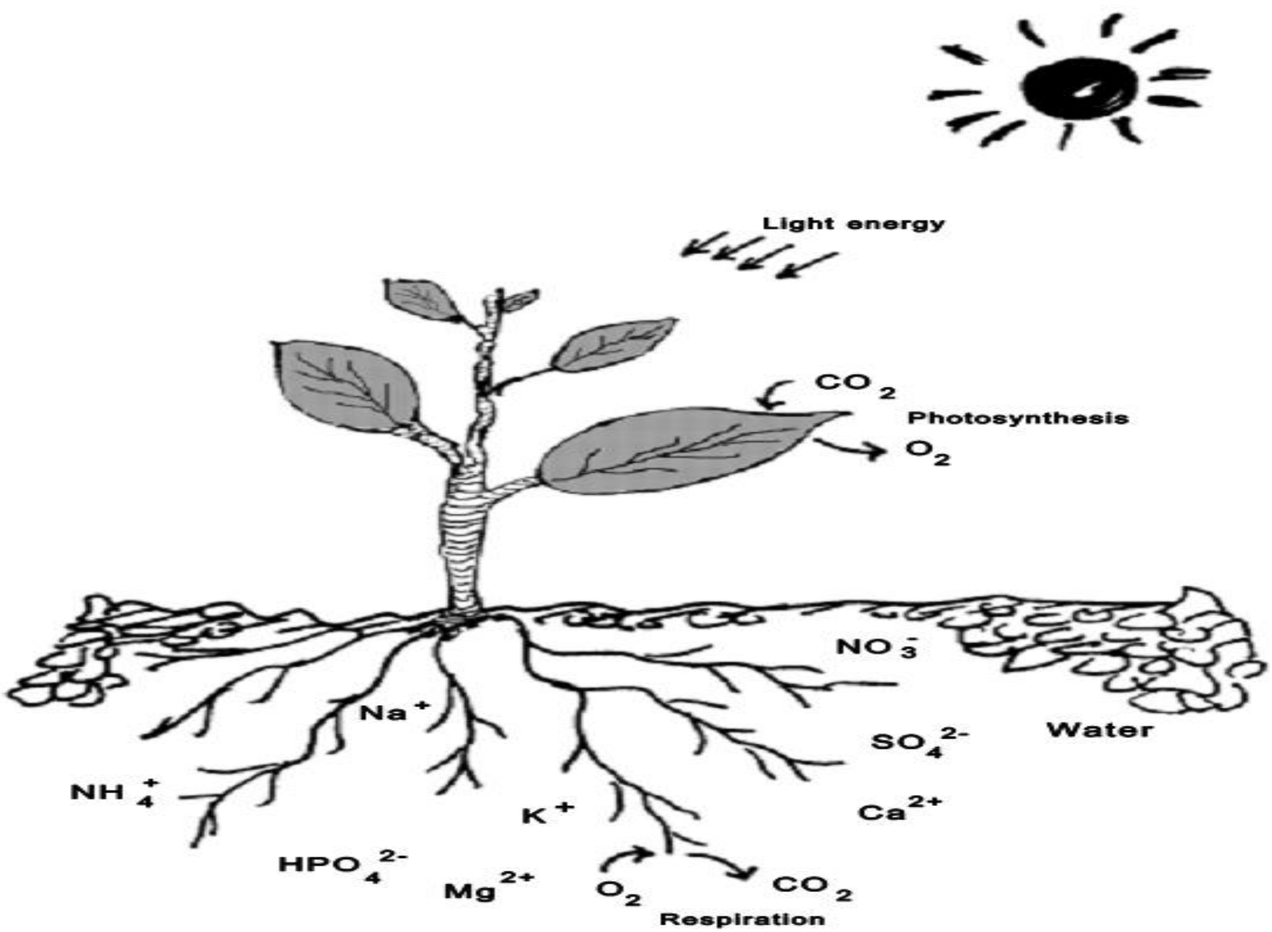
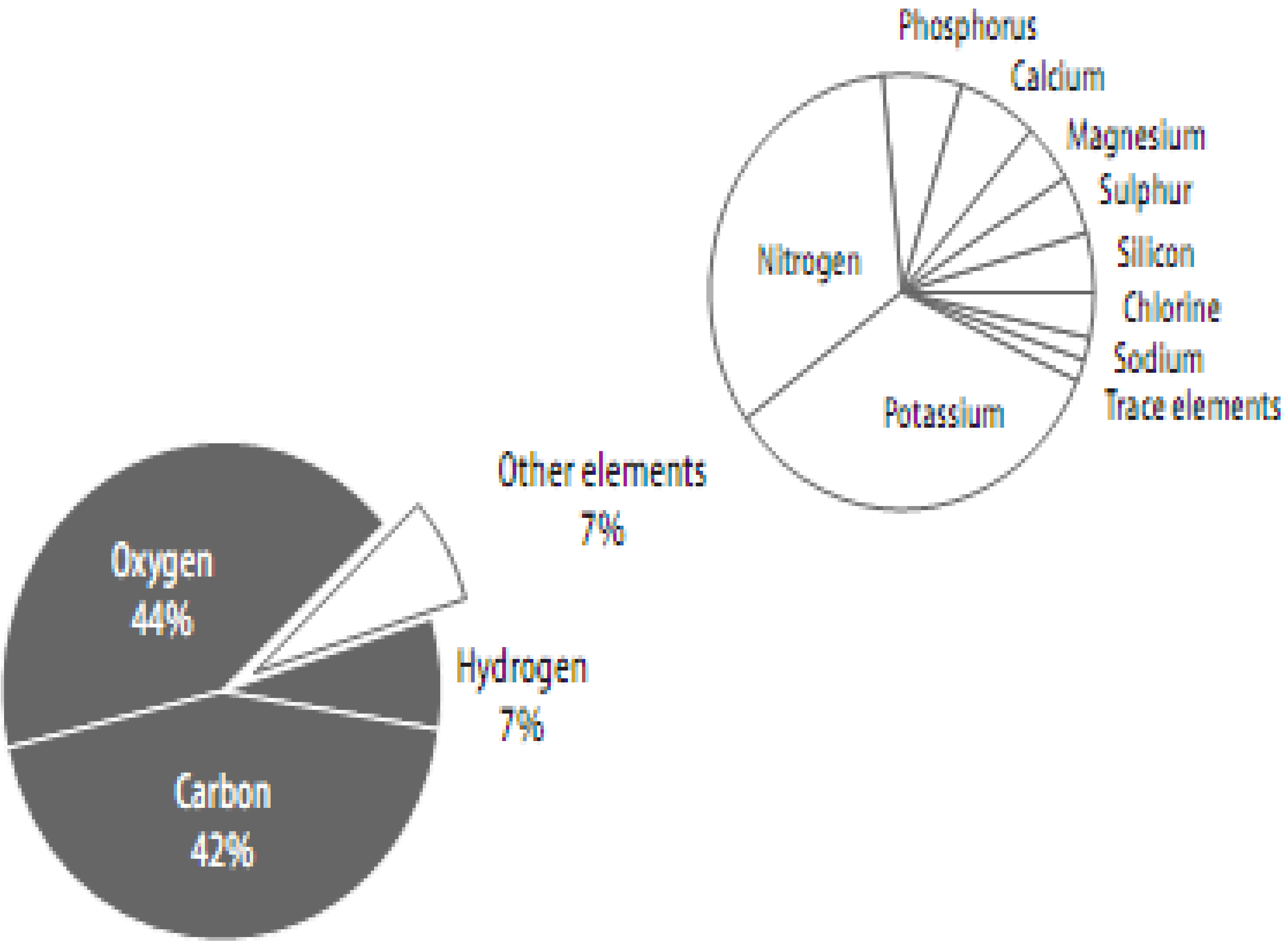


Figure 1 - The plant environment

Table 1 - Typical Plant Dry-matter Composition

Element	Amount by mass		Relative number of atoms
	%	ppm	
Hydrogen	6		60 000 000
Carbon	45		40 000 000
Oxygen	45		30 000 000
Nitrogen	1.5		1 000 000
Potassium	1.0		250 000
Calcium	0.5		125 000
Magnesium	0.2		80 000
Phosphorous	0.2		60 000
Sulfur	0.1		30 000
Chlorine	0.01	100	3 000
Iron		100	2 000
Boron		20	2 000
Manganese		50	1 000
Zinc		20	300
Copper		6	100
Molybdenum		0.1	1

Figure 3. **Average elemental composition of plants**



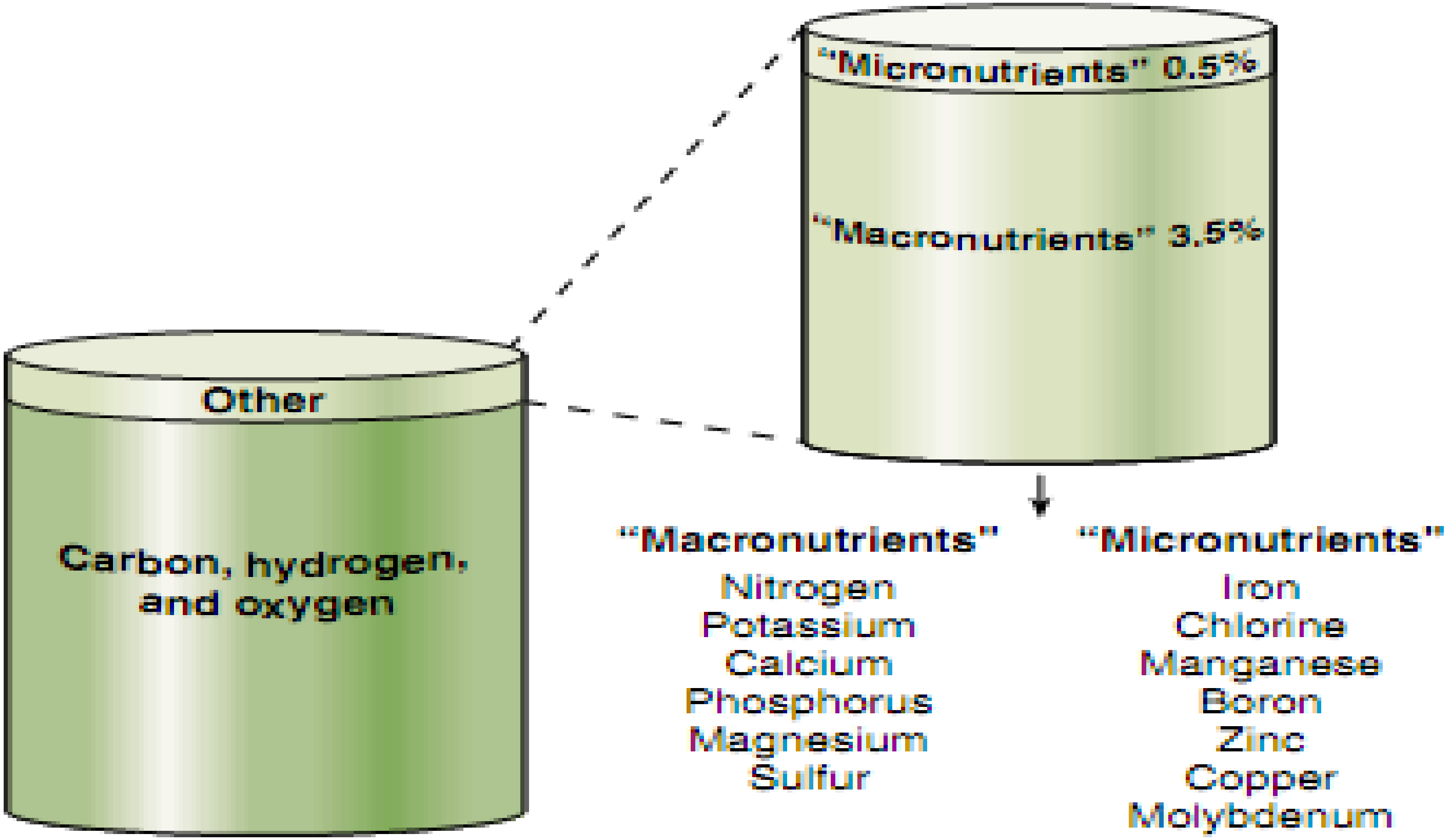


FIGURE 7.29

The proportional weights of various elements in plants. Macronutrients and micronutrients together total only 4% of the total weight of the plant, but they are essential to the plant's life and growth.

plant growth and yield in response to fertilizers application

growth : progressive development of an organisms . For plants It may be expressed in terms of dry weight , length, height , or diameter.

Crop yields(both quantity and quality) are function of four major factors:

i- the soil on which the crop is grown,

ii- the crop grown (genetic factor , the most important factor among other).

iii- the management practices (fertility, plant pop., moisture,.. etc)

iv- the climatic conditions

Soil fertility :

ability of soil to supply plants with nutrients at proper quantity , forms and times. So, soil fertility is only one factor of many others.

.

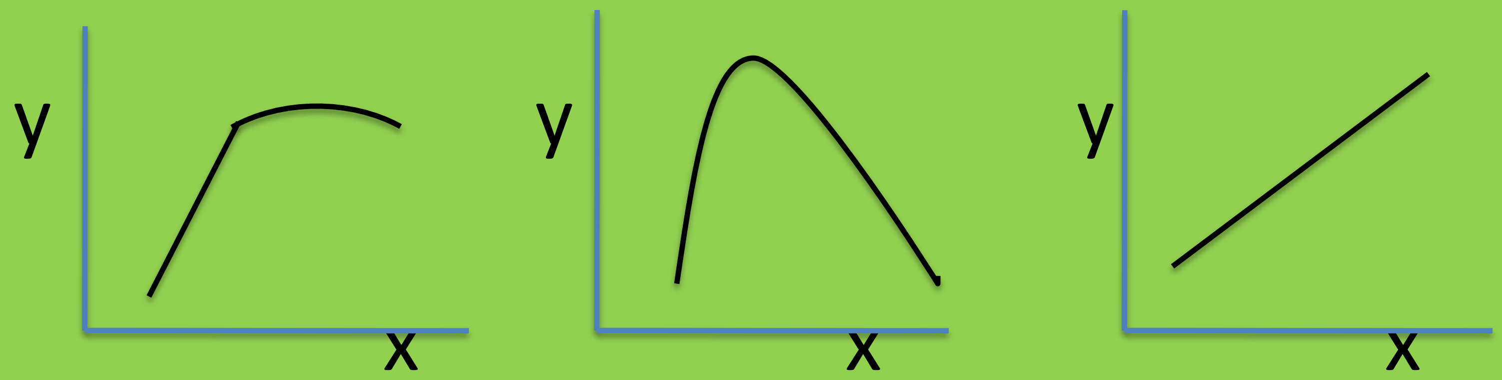
yield = f ($x_{1,}$ $x_{2,}$ x_3 .....etc) , if all variable remained constant except soil fertility then,

yield = f (soil fertility $)_{x1,x2,x3}$ ....etc

* Three general types of mathematical expression are frequently used to relate soil nutrient levels to crop growth, namely:

a- exponential b- quadratic c- linear

($y= a+bix-biix^2$) ($y= a+ bx$) ($y= a.x^b$)



* Immobile nutrients, such as P, K , Ca , and Mg are absorbed by soil and, therefore, diffuse, migrate, and move at a much slower rate than the root tips penetrate the soil, can usually be related to growth through either the exponential or quadratic expression.
* Mobile nutrients , such as nitrate and borates that are not absorbed by soil and can diffuse, migrate, and move in and with the soil water at rates much faster than the root tips advance, are more often related to plant growth through straight line function.

* Many, if not most, biological reactions are exponential in character , so many growth factors can be shown to have exponential relationship to yields. Therefore, biologically an exponential function has merit over the quadratic function in attempting to relate a growth factor mathematically to yield responses, or predicting responses from experimental data.
* Change in growth rate (due to fertility level) will not change the shape of growth rate, only the magnitude. Therefore, if growth is related to time in exponential fashion when rate is hold constant, then growth must also be related to rate in an exponential fashion when time is hold constant.