

Fertilization & Nutrition

RIGHT PRODUCT

RIGHT TIME

RIGHT REASON



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What is Fertilizer?

Any material added to the soil to provide nutrients that will increase growth, yield or nutritional value of plants

Fertilizers:

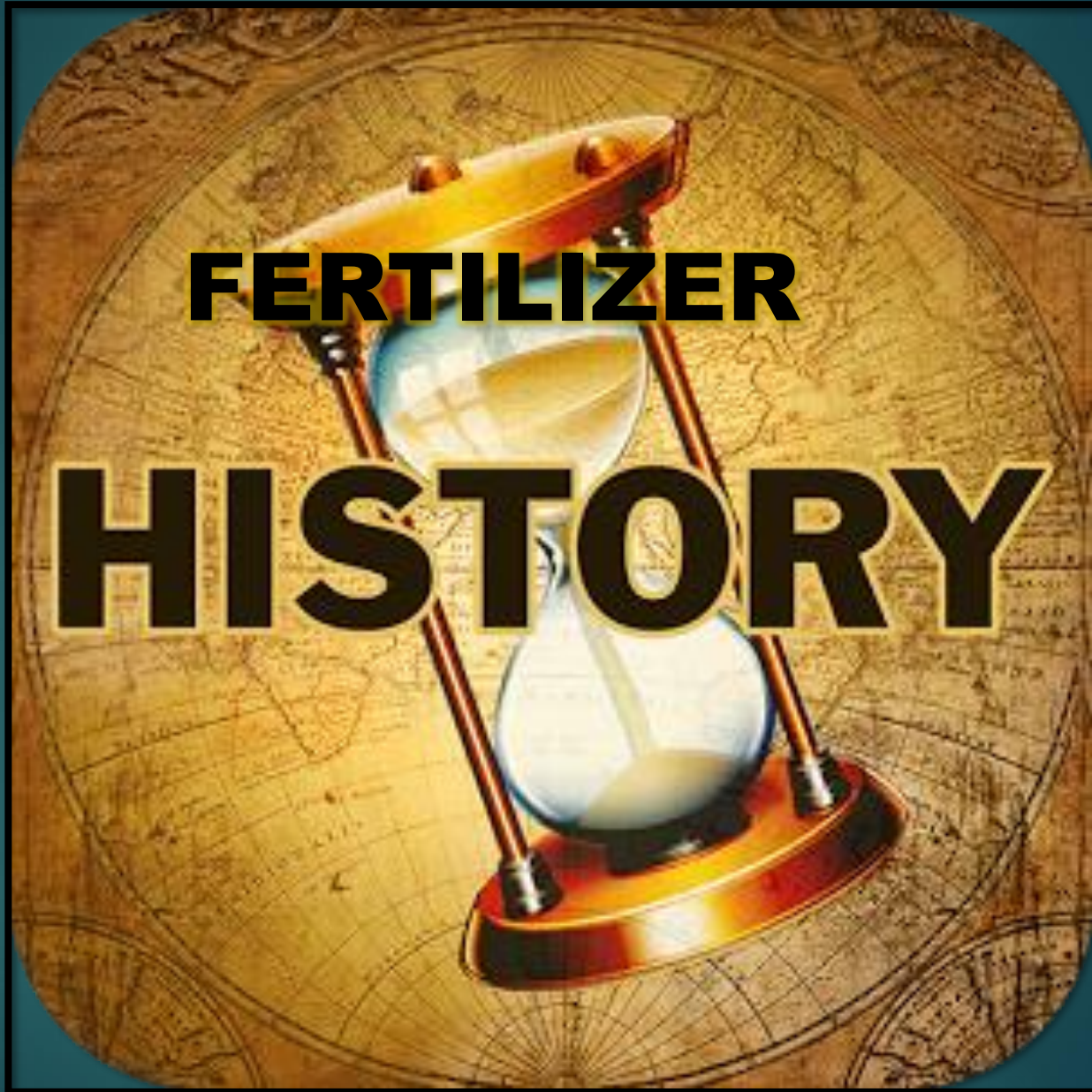
- Replace the chemical components taken from the soil by growing plants
- Improve the growing potential of the soil

Not a “one-size-fits-all” treatment.

Different plants and soil conditions dictate the type and level of fertility needed

Without commercial fertilizers 1/3rd of world’s food supply could not be produced

Results depend on using the appropriate type of nitrogen-based fertilizer

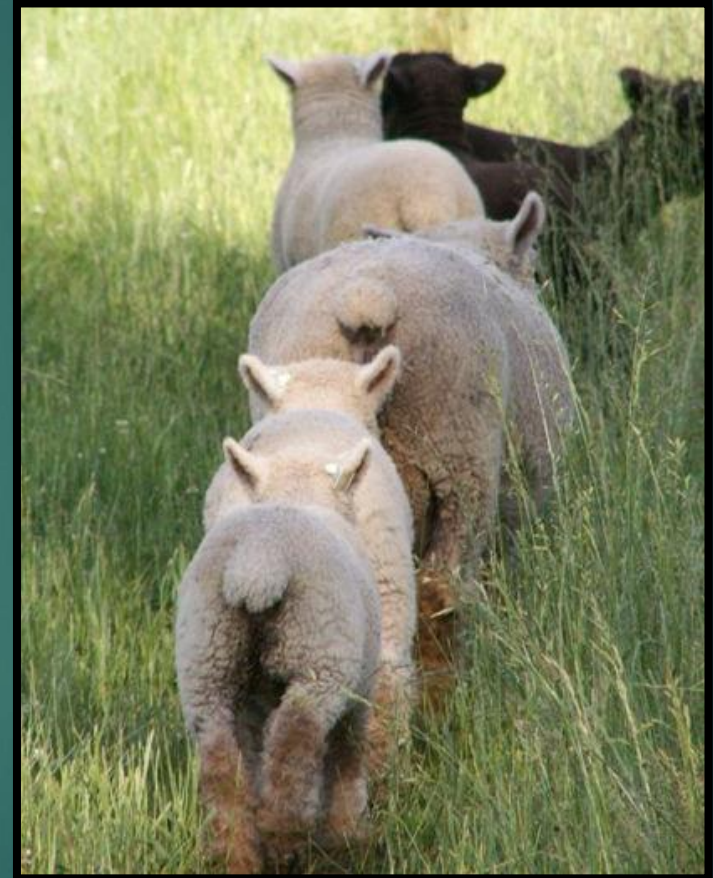


FERTILIZER

HISTORY

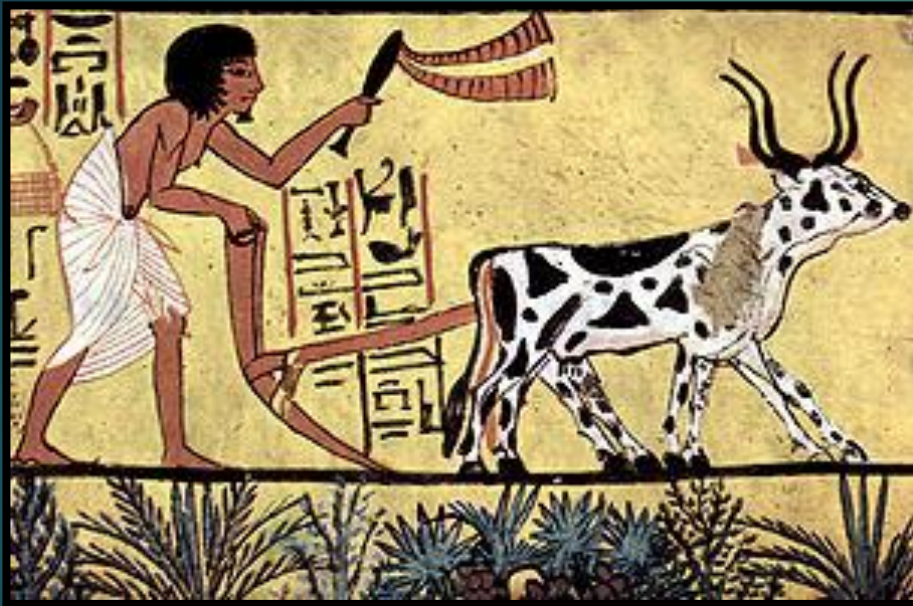
8,500 - 8,000 BCE – Farming & Herding Develop in Tandem

- ▶ In the Near East (Israel, Palestine, Syria, Jordan) farmers & herders moved planting plots to new locations as yields decreased
- ▶ They figured out that manure was a key to sustained crop yields
- ▶ The view from the rear tells the story



Shepherds noticed crops colonizing patches of super fertile ground where herd animals congregated

8,000 BCE Forward



Plowing with a yoke of horned cattle in Ancient Egypt. Painting from the burial chamber of Sennedjem, 1290 - 1279 BCE

- ▶ Farmers begin to invest in long term management of their fields
- ▶ They spread manure which breaks down slowly and increases the fertility of farmland over many years
- ▶ How do we know?

Earliest Record of Fertilization

Farming spread from the Near East to Europe about 8,500 BCE

13 archeological digs of early farming sites:

- 7,900 and 4,400 BCE
- 124 crop samples;
- 2,500 grains/seeds

Manure has higher-than-normal proportion of the rare isotope, Nitrogen-15, which is different than common nitrogen.

Almost all of the specimens tested had high levels of Nitrogen-15. This proved manures were being used to fertilize crops on a wide scale across many geographic regions



World's oldest barley grain, proved manure was being used to fertilize crops 8,000 year ago; courtesy of University of Oxford

Early Fertilization Expands

Egyptians, Romans, Babylonians and Germans also used minerals to enhance productivity

- Crushed sea shells & bones (Ca),
- Wood ash (P, K, Ca),
- Clay
- Vegetable waste (N)

Greeks and Romans used various animal dungs depending on the type of soil and plant grown



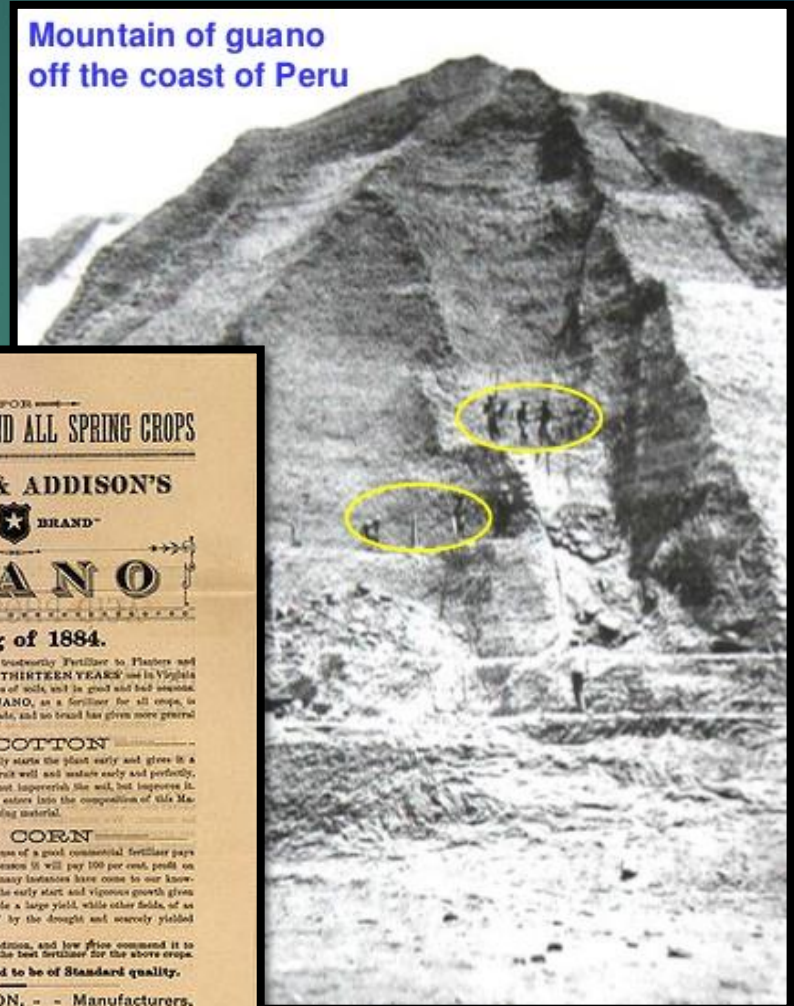
Stercutius – Roman God of Manure

Manures are a Commodity

Manures remain the fertilizer of choice for more than 9,000 years

In some countries as late as the 1800s it was considered a commodity

Mountain of guano off the coast of Peru



FOR
COTTON, CORN, AND ALL SPRING CROPS

ALLISON & ADDISON'S
"STAR BRAND"

GUANO

Spring of 1884.

We again offer this standard trustworthy Fertilizer to Planters and Farmers as having stood the test of THIRTEEN YEARS' use in Virginia and North Carolina, on all varieties of soils, and in good and bad seasons. The "STAR BRAND" GUANO, as a fertilizer for all crops, is justly ranked with the very best made, and no brand has given more general satisfaction.

FOR COTTON

When used on Cotton, it not only starts the plant early and gives it a vigorous growth, but causes it to fruit well and mature early and perfectly, making the finest lint. It does not impoverish the soil, but improves it. There is not a single article which enters into the composition of this Manure which is not a first-rate fertilizing material.

FOR CORN

There is no crop upon which the use of a good commercial fertilizer pays better than corn. In an ordinary season it will pay 100 per cent. profit on the cost—and, in case of drought, many instances have come to our knowledge in which, in consequence of the early start and vigorous growth given the crop by the fertilizer, it has made a large yield, while other fields, of as good or better land, were cut off by the drought and scarcely yielded anything.

In very high grade, fine condition, and low price commend it to those farmers who want to use the best fertilizer for the above crops.

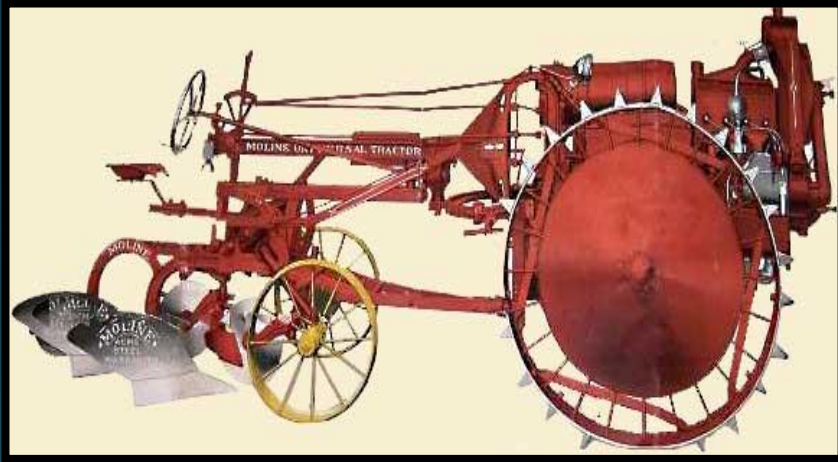
Every bag is Guaranteed to be of Standard quality.

ALLISON & ADDISON, - - Manufacturers,
RICHMOND, VA.

[1884.]

Agricultural Revolution

1750 – 1900's



1842 – 1st synthetic fertilizer created – 1st patent issued

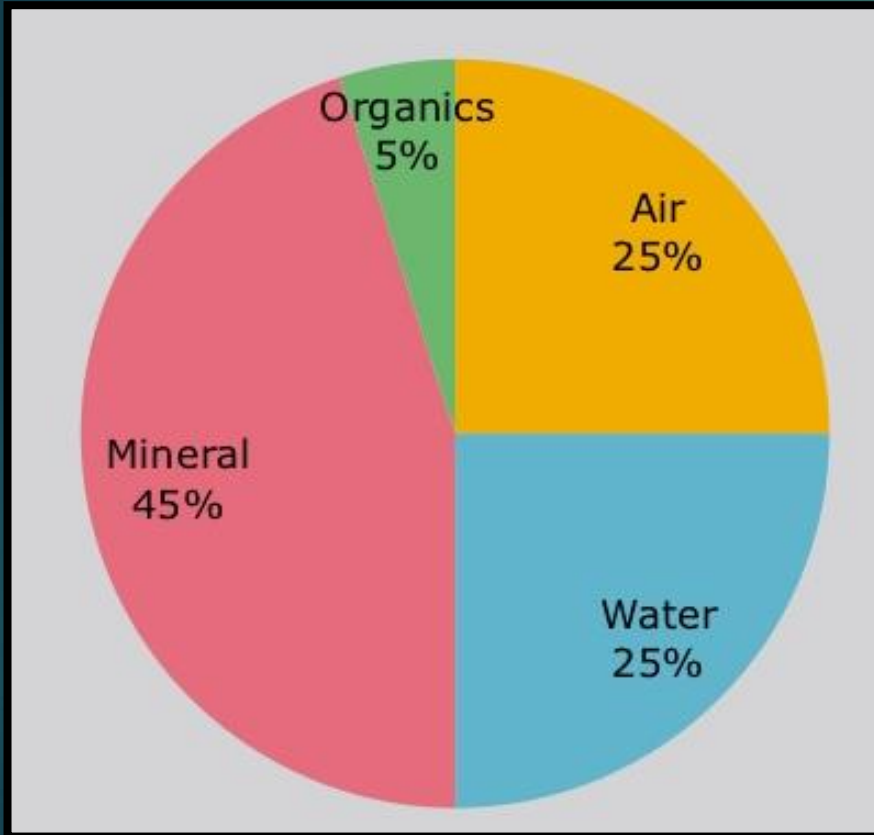
Justus von Liebig (1803-1873) created commercial organic Fertilizer – plants must have nitrogen / phosphorous to grow

1909 synthetics mass produced

- ▶ Invention of equipment that made growing plants profitable
- ▶ Organized research in plant nutrition began
- ▶ Fertilizer industry was borne (late 1700's)
- ▶ Scientists began to understand chemical needs of plants



Plant Nutrition Starts in Soil



Keepers of dirt must replenish, replace or help release nutrients that may be beyond the plants' reach

Healthy soil is made up of 4 parts

- Minerals (45%)
- Water (25%)
- Air (25%)
- Organic Matter (5%)

Within the mineral component, all nutrients essential for plant growth are present – so why fertilize?

- Some nutrients may be depleted
- Some may have leached away
- Some may not be useable
- Some may be prevented from being absorbed

Something must happen to nutrients before plants can use them

- Decay, degradation
- Dissolve

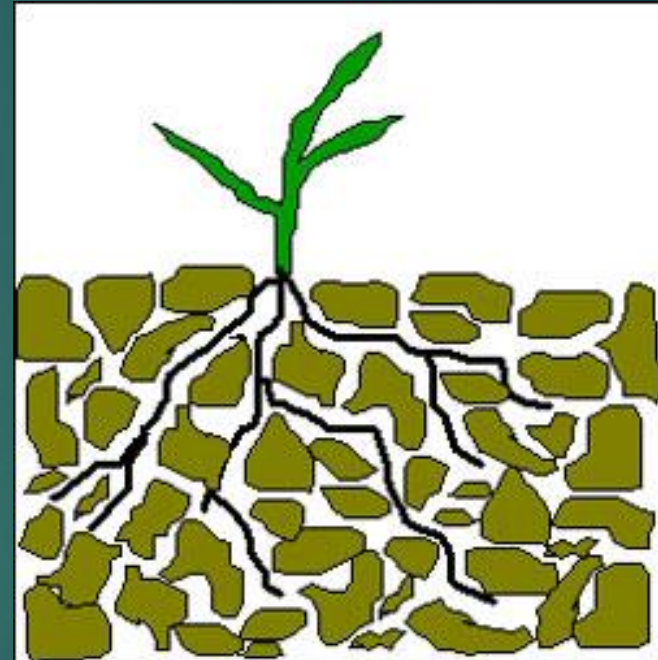
For Metabolism to Occur

- ▶ Soil must be sufficiently aerated & moist
- ▶ Soil bacteria & microbes need a certain amount of oxygen & water in order to do their job
 - ▶ Without oxygen living parts of soil cannot break down organic matter into nutrients
 - ▶ Without oxygen, plant roots lack energy to pick up nutrients and transport them through the plant



Oxygen deficiency symptoms are similar to nitrogen deficiency symptoms

- ▶ Good drainage warms soil up quickly which increases the amount of nitrogen that becomes available to plants



Soil microbes thrive and work at peak productivity when temperatures are 70° - 100°

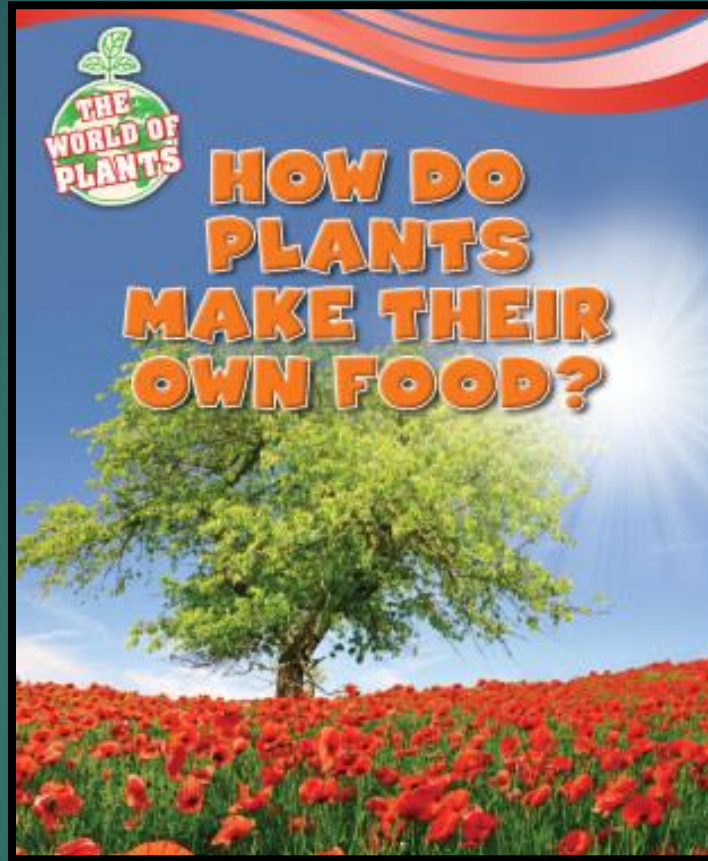
The Soil – Organic Matter



Too much of a good thing
may not be a good thing

- ▶ Manage the level of organic matter in the soil
- ▶ Level of organic matter should be around 5%
- ▶ Excess levels of organic matter (8% or above) or soil low in organic matter and within incorrect pH almost always exhibit nutrient deficiencies

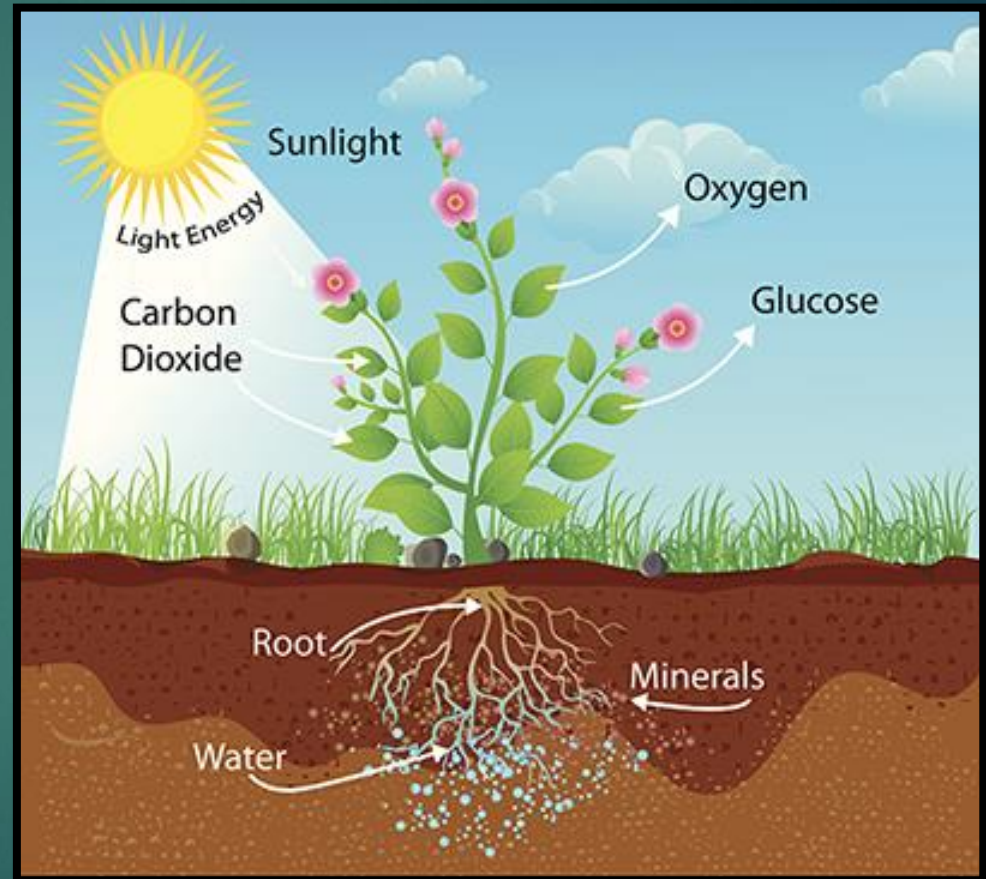
Plants–Manufacturing Marvels



Plants are “autotrophic”...
They are a class of living thing that can produce their own food

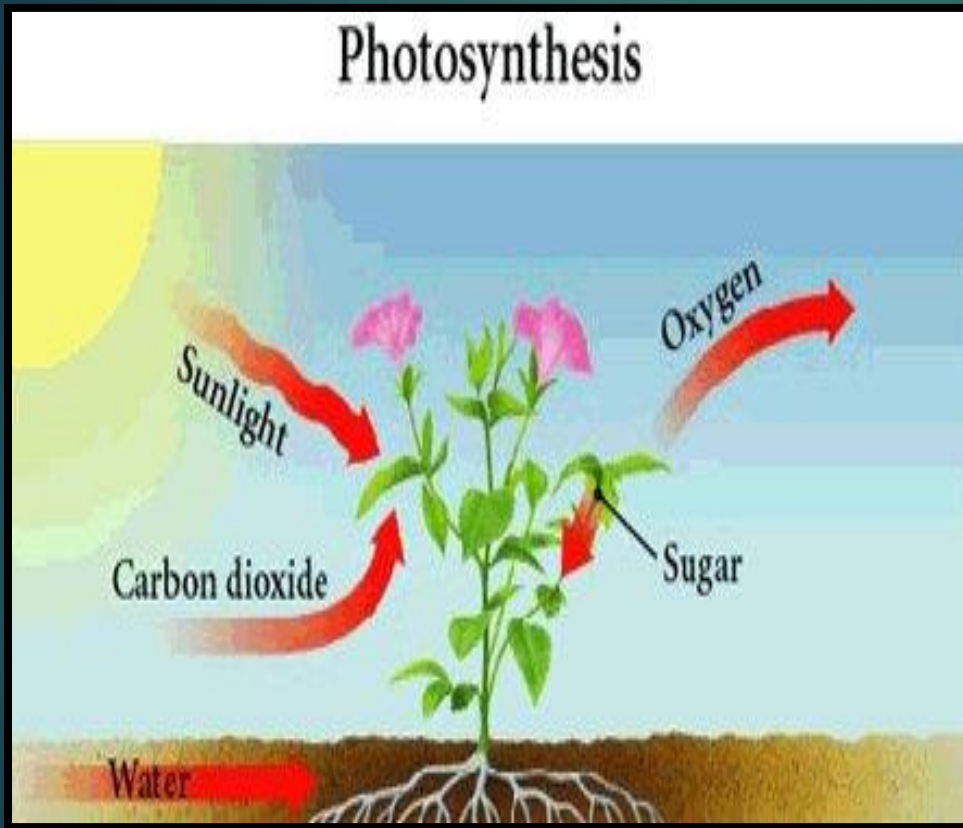
Plants – Manufacturing Marvel

- ▶ They collect the base ingredients from
 - ▶ Water
 - ▶ Minerals in soil
 - ▶ Carbon dioxide
 - ▶ Sunlight



3 D's occur in soil

Plants—Manufacturing Marvel

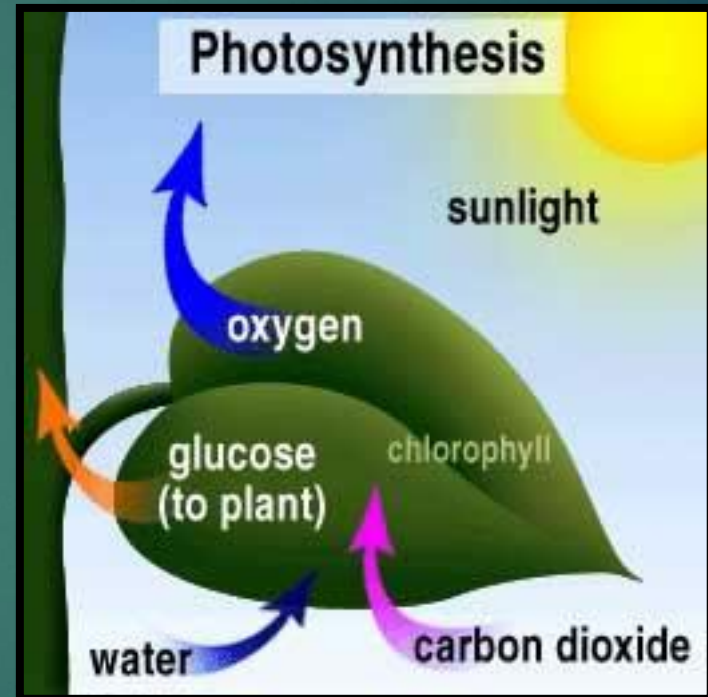


- ▶ Sunlight is required for photosynthesis
- ▶ Minerals in soil dissolve in water and are absorbed by plant through root hairs
- ▶ Roots send dissolved minerals to the leaves
- ▶ Chlorophyll in plant cells trap sunlight energy and gathers water, carbon dioxide & minerals (raw sap)

Photosynthesis only occurs in the leaves

Plants—Manufacturing Marvel

- ▶ Raw sap in the leaves mixes with water & carbon dioxide and becomes “elaborate” sap... plant food
- ▶ Elaborate sap is distributed by the leaves to all parts of the plant

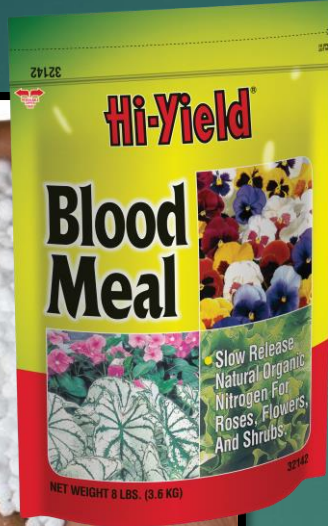


No leaves – no distribution network...no matter how much fertilizer you apply

Forms of Fertilizers



Granular



Water Soluble



Timed, Slow and Controlled Release

Granular Fertilizers

Soil Temp - 70° or above



Pros

- ▶ Covers large areas well
- ▶ Easy to apply by a hand-rotary, drop spreader or by hand
- ▶ Deliver food slowly (have to break down before plant can use)
- ▶ Do not leach out as fast as water soluble
- ▶ Easy to apply

Cons

- ▶ Can burn plant foliage if not washed or knocked off after application
- ▶ Not readily available to the plants
- ▶ Have to break down to a soluble state to be useable
- ▶ Will wash away during the rainy season or be forced deeper than the roots can reach
- ▶ Non homogenous blends are different sizes/weights and result in irregular results

Most preferred type by the gardening public – 90% of fertilizer market

Water Soluble

As a foliar feed – plants must have leaves to work
As a drench – do not apply to cold soils



Pro

- ▶ Fastest acting / immediately available
- ▶ Applied with watering can or hose attachment ("fertigation")
- ▶ Excellent for containers and vegetables
- ▶ Can be applied as foliar treatment when plants quickly need to absorb trace elements

Cons

- ▶ Must be applied more frequently
- ▶ Leach out of the soil more readily than other forms
- ▶ In fast-draining sandy soils, water soluble fertilizers can pass through the root zone faster than the plant roots can catch it

Liquid Seaweed

Liquid Fish

Miracle Grow

Houston Rose
Society Fertilizer

SuperBloom

Peters

Timed, Slow & Controlled Release

- ▶ One application every 6 – 9 months
- ▶ Contain nutrients encapsulated in a pellet, ball or tablet with a special coating which releases plant nutrients over time
 - ▶ Some regulated by soil temp
 - ▶ Some regulated by soil moisture
- ▶ Maximize efficiency and decrease the potential for environmental contamination
- ▶ Most efficient form of fertilizer
- ▶ Reduces the potential of plant “burning”
- ▶ Types with a polymer coating (tablets/spikes) are a true-time-release or staged nutrient release



Slow Release Fertilizers

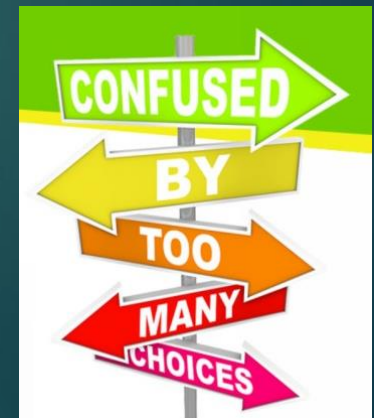
- ▶ Coated with multiple layers of resins
- ▶ When contact with water, layers swell and increase pore size
- ▶ Fertilizer dissolves and permeates through the shell into the soil
- ▶ Release rate depends on coating, thickness, temp and water content of the soil
 - ▶ Immediate release
 - ▶ Timed release (6-9 months)



With slow release – plants not likely to be subjected to burn because there is no sudden increase in the salt index

With So Many Options – How Do You Pick?

- ▶ Understand your options
- ▶ Right time / right product
- ▶ Soil type
- ▶ Apply what nutrients you need – not what you don't
- ▶ Base selection on soil test



Synthetic vs. Organic Fertilizers



- ▶ Plants DO NOT KNOW the difference whether their nutrients are synthetic or organic
- ▶ The soil DOES

Difference is the long term effect on the condition and health of the soil

Constant use of synthetic fertilizers without adding organic matter (either as fertilizer or mulch) will deteriorate the soil structure and overall health of the soil

Organic Fertilizers –once living

Can be granular or soluble



Pros

- ▶ Slow release
- ▶ Feeds soil life – keeping it healthy
- ▶ Adds humus
 - ▶ Improves soil ability to store nutrients
 - ▶ Increases water holding capacity
 - ▶ Improves soil structure

Cons

- ▶ Low in nutrient concentrations
- ▶ Does not release nutrients until the soil is warm (above 70°)
- ▶ Can have high carbon levels. If carbon to nitrogen ratio is more than 25:1 biological action will use more nitrogen than is available in the fertilizer
- ▶ Some can lead to excess levels of phosphorous in the soil

Bone Meal

Fish Meal

Alfalfa Meal

Cottonseed Meal

Blood Meal

Liquid Seaweed

Manures

Composts

Synthetic Fertilizers- man made

Short term solution for long term need



Pros

- ▶ A combination of mineral salts used by plants for growth
- ▶ High concentration of nutrients
- ▶ Small amount encourages spurt of new growth and larger fruits
- ▶ Can be granular or soluble

Cons

- ▶ Are all salts; must degrade to be useable
- ▶ Too much can harm plants and the microbes living in the soil
- ▶ Salts cause roots to dry out resulting in fertilizer "burn" on foliage
- ▶ Leach away with irrigation and rain
- ▶ Result in diminished soil fertility
- ▶ Push microbes to consume organic matter. If organic matter is not regularly added to the soil, plants have less nitrogen to harvest
- ▶ Frequency of application tends to increase

Scotts Rose & Bloom

Miracle Grow

ColorStar

Hi-Yield

Houston Rose Society

Bayer Rose & Flower

Osmocote

10-10-10

13-13-13

20-20-20

The Elements of Fertilizers

Main nutrient concentrations will be prominent on the label

N – nitrogen



P – phosphorous

K – potassium

These are the building blocks for plant nutrition

Without NPK a plant can't grow because it can't make the food it needs to survive



28% nitrogen

14% phosphorous

10% potassium
52%

48% fillers (no value)

Fillers can be
chemical salts
limestone
sawdust
biowaste
cat litter
sand

Each element of fertilizer nourishes a plant in its own way

Nitrogen

Without nitrogen there would be no life as we know it

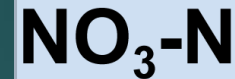


Most commonly deficient nutrient worldwide

- ▶ Not directly available to plants but can be converted to useable state by microbes, fungi, bacteria
 - ▶ Influenced by soil temperature, moisture and acidity
 - ▶ Conversion greatly decreases if soil pH drops below 5.5 or gets very high
- ▶ Nitrogen demand increases as plant size increases
- ▶ When nitrogen is adequate, plants grow rapidly with large amounts of succulent green growth

Nitrogen

Nitrate nitrogen is fast acting and most useable form of nitrogen available to plants



Nitrogen:

- Stimulates growth & production of chlorophyll
- Tall strong canes
- Nice blooms
- Dark green foliage

- Healthy plants have 3 – 4% nitrogen in their above-ground parts

- Should be applied to avoid periods of significant loss and applied when rose needs it the most (spring & fall)

- Nitrogen rates vary by crop, region, yield goal and quantity of nitrogen present in the soil.

- Leaches readily so it is not a long term form of fertilization

Nitrogen – Practice Tips

- ▶ Excess water will flush nitrate nitrogen quickly out of the soil
- ▶ Not recommended to apply during summer months as excess irrigation washes nitrate nitrogen away
- ▶ Use a quality product

“Cheap” products can end up costing a lot of money in the long run



Nitrogen – W.I.N.

WATER INSOLUBLE NITROGEN



Water Insoluble Nitrogen

- Slowly released to plants
 - Organic N
 - IBDU
 - Urea-formaldehyde, Ureaform, or nitroform
 - Coated ureas
 - Sulfur, plastic, polymer, or resin-coated
 - Release rates controlled by coating thickness, environmental conditions and diffusion rates
- Useful in hot, rainy weather

- ▶ Usually organic forms of nitrogen and/or urea
- ▶ Must be broken down by the plant to become useable
- ▶ Usually referred to as “slow release” nitrogen sources
- ▶ Recommended for summer months
- ▶ Provides long-lasting lush green foliage

Phosphorous

- ▶ Phosphorous affects plant growth:
 - ▶ Stimulates root & stem growth
 - ▶ Hastens plant maturity
 - ▶ Produces quality plants with big blooms
- ▶ Aids in winter hardiness
- ▶ Moves very slowly through the soil
- ▶ Best time to apply is at planting
- ▶ Many gardening products contain phosphorous so it is easy to end up with too much in the soil
- ▶ Excesses take years to remediate



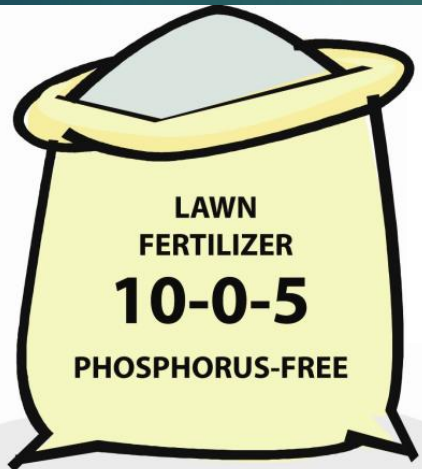
In excess, phosphorous can act like a locked door preventing the plant from being able to take in other nutrients

Regular applications of a “complete” fertilizer can result in phosphorous build-up in the soil

80% OF PLANT PROBLEMS REST WITH SOIL

Phosphorous is often the culprit in many soil problems. Phosphorous level in typical soil test of Tx. home landscape is 189 ppm. Agricultural applications are REGULATED to be NO MORE MORE THAN 200 ppm

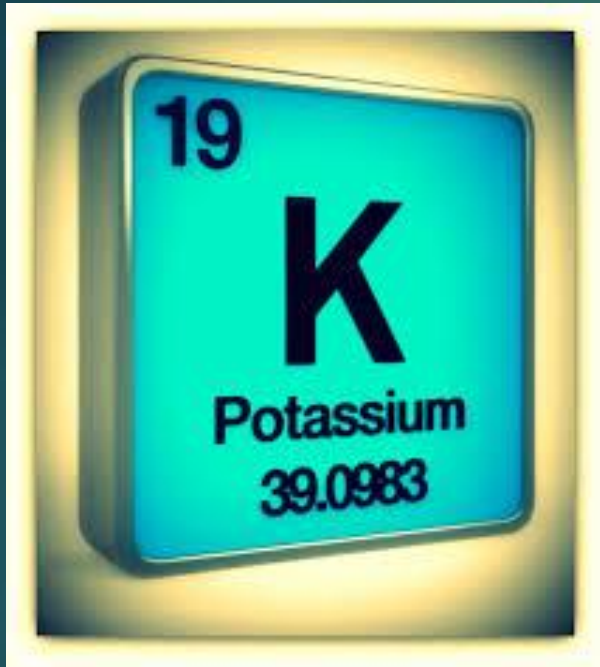
“Organics” often result in 100 times the acceptable levels of phosphorous in the landscape. All organic treatments should be tested for nutrient levels before using.



In many states it is illegal to buy, apply and sell fertilizers containing phosphorous



Potassium



- ▶ Not in a useable form and must be converted
- ▶ Promotes
 - ▶ Root growth
 - ▶ Vigor
 - ▶ Bloom color
- ▶ Essential for starch (food) formation and development of chlorophyll
- ▶ Leaches readily



Moves quickly through the soil

Nutrient Deficiencies



**NPK deficiencies
affect older leaves
FIRST**



Examples of nitrogen deficiency

Secondary Elements

Sulfur



Has become the second-most deficient element in soil

Must be converted to be useable

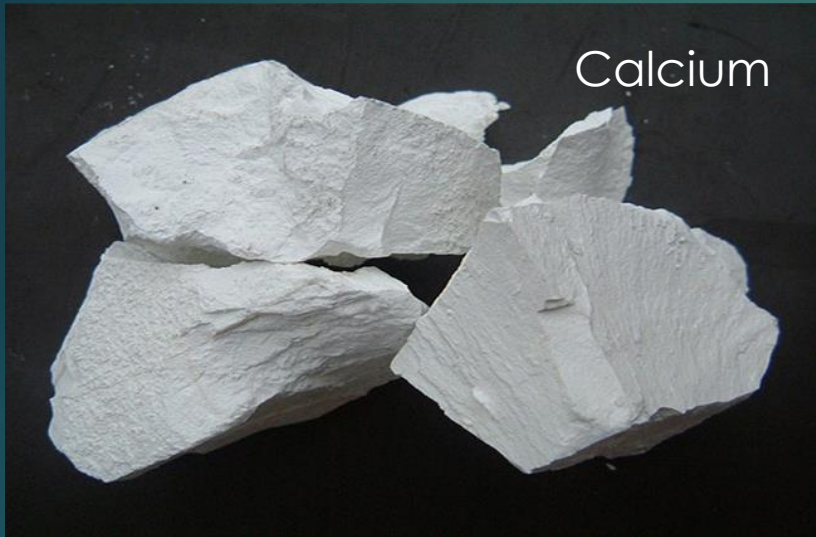
Magnesium



Promotes chlorophyll formation
Produces greener, healthy, disease resistant plants
The center molecule for chlorophyll



Secondary Elements



Neutralizes certain toxic acids that form as a by-product of metabolism

Calcium, magnesium and sulfur are only included in fertilizers in small amounts since most soils naturally contain enough of these elements

Trace (Micro)Elements

Iron, chlorine, copper, manganese, zinc, molybdenum and boron are co-factors in enzymatic reactions.

Boron is important and often taken for granted:

- Controls starch formation
- Stimulates cell division
- Stimulates flower formation



Zinc also important:

- Stimulates stem growth
- Stimulates flower formation



Roses need these elements only in small amounts



Without micro/trace elements...plants die

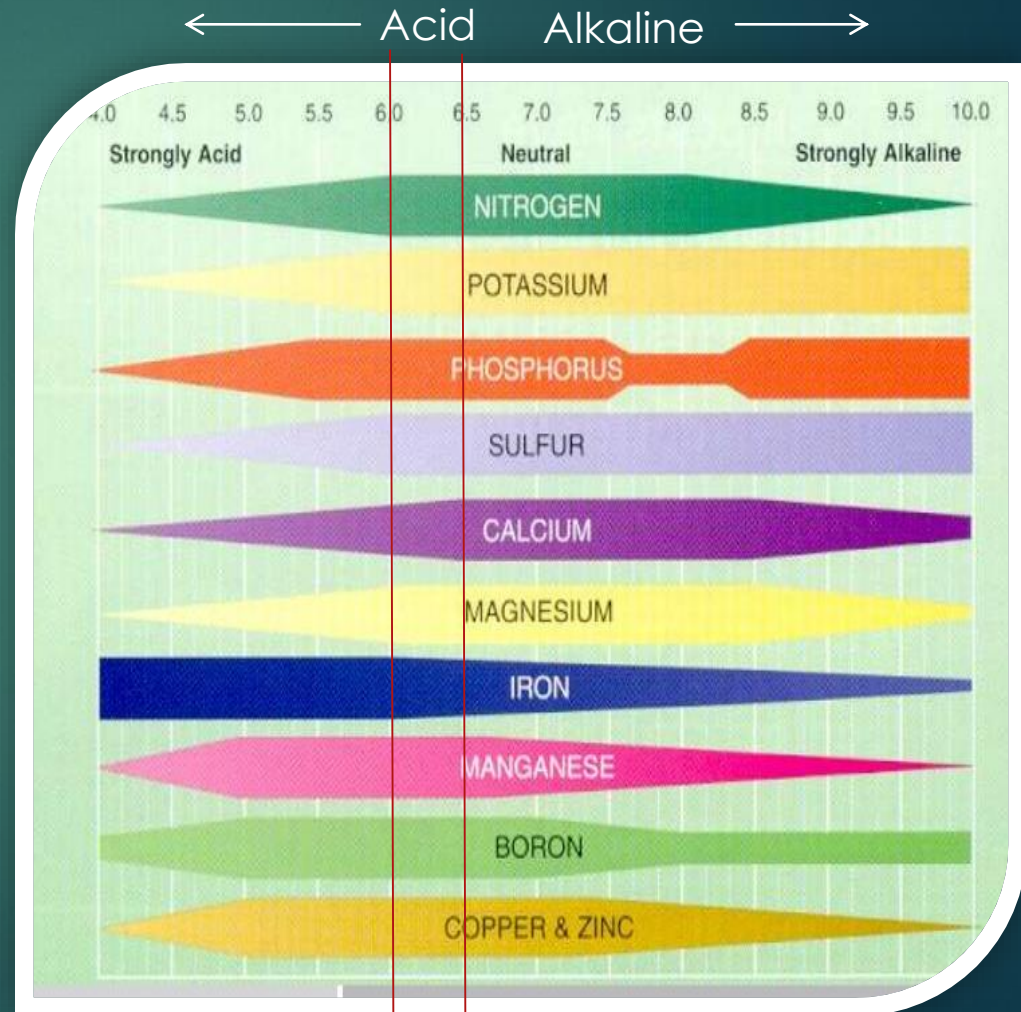
pH = Power of Hydrogen

Measurement of how acid or alkaline a soil is

- ▶ pH and Phosphorous can create a locked door
- ▶ Nutrient deficiencies are problems with availability rather than supply
- ▶ Soil may have sufficient levels of nutrients – but plant can be prevented from using it because pH is too high or low
- ▶ Some pH ranges prevent absorption of nutrients



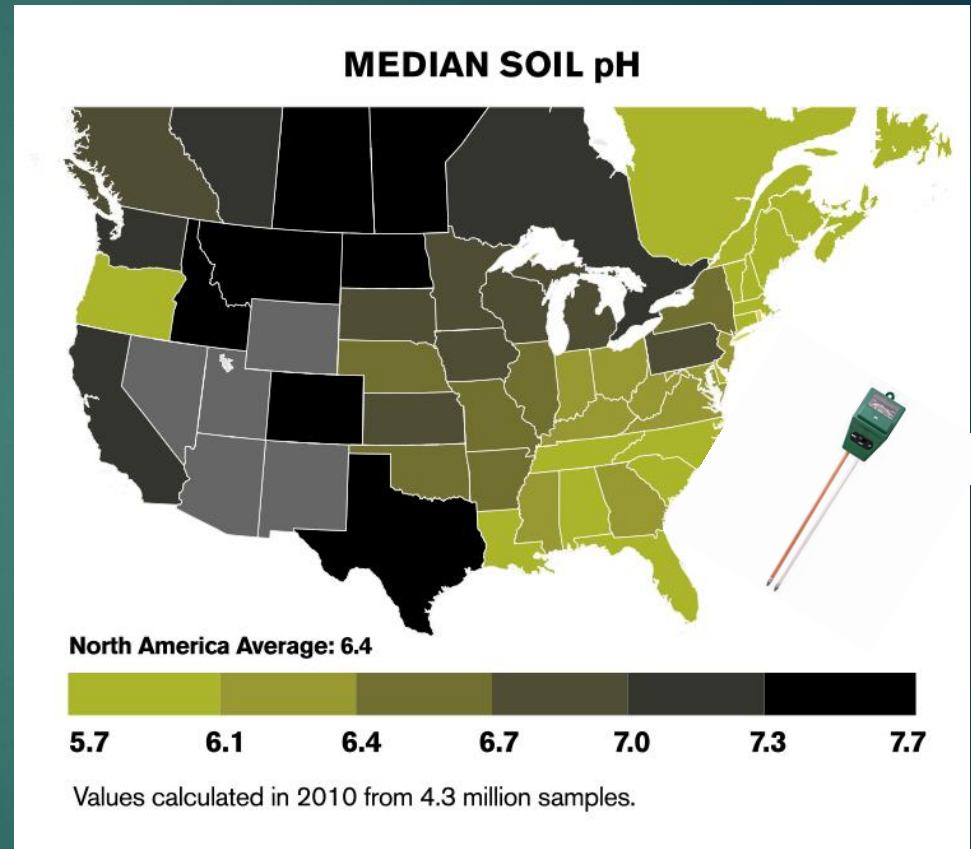
pH of 6.0 – 6,5 best for roses



Impact of pH Extremes



- ▶ Phosphorous and iron deficiencies occur
- ▶ Primary elements (NPK) become unavailable
- ▶ Systemic chemicals may be prevented from being absorbed
- ▶ High pH (above 7.0) limit the solubility of micronutrients



Maintaining correct pH is a priority in nutrition management

When Things Go Wrong



Synthetic fertilizers are made of mineral salts

- ▶ A build-up of mineral salts in soil can cause:
 - ▶ Roots to dry out & die
 - ▶ Foliage to turn yellow & die
 - ▶ Death of soil microbes
 - ▶ Retarded growth
 - ▶ Wilting
 - ▶ Lack of bloom set
- With build-up, roots may not be able to carry water to the plants

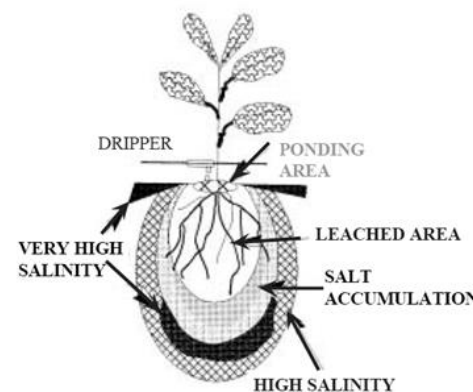
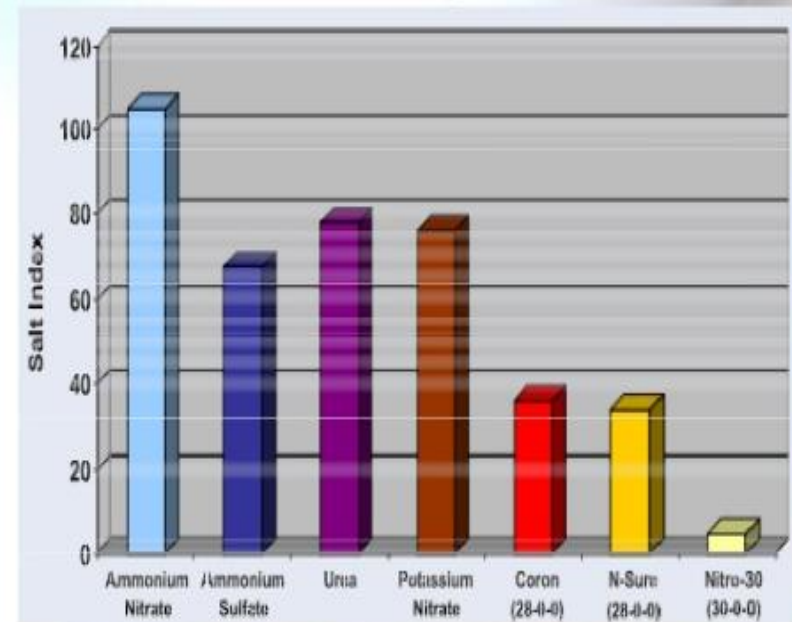


Salt accumulation in the soil interferes with water availability to plant roots. This is not uncommon in rose gardens

When Things Go Wrong

- ▶ The higher the salt level the greater the stress on the plant to obtain moisture
 - ▶ Induce a physiological drought state on the plant
 - ▶ High analysis fertilizer materials commonly used in rose food are capable of producing a high salt index
- ▶ As soil becomes dry, concentration of salts that would be safe in moist soil – become toxic
- ▶ Only takes 1 drying cycle for a rose to lose roots and leaves

Salt Index Comparison



Culprits:
Ammonium Nitrate
Ammonium Sulfide
Urea
Potassium Nitrate

Best Practices – The “Dos”



- ▶ Start with a soil test – know pH
- ▶ Water well before and after fertilizing to avoid root/foliar burn. Moist conditions are necessary for nutrient uptake
- ▶ Stop applying 45 days before first freeze to slow down the development of new growth
- ▶ Match nutrient release with the same conditions that stimulate growth (e.g. soil temp above 70°)
- ▶ Follow application rates
- ▶ Use right product for time of year and soil type

Maximum growth response will be obtained if fertilizer is available
In the root zone at or slightly before the start of spring growth

Best Practices – The Don'ts



- ▶ Don't apply on a windy day
- ▶ Don't apply on a rainy day
- ▶ Don't apply synthetic granular or soluble fertilizers before spring showers have occurred as nutrients will leach out of the plant's root zone
- ▶ Don't apply when temperatures are above 95°
- ▶ Don't apply more product than the recommended rate

Best Practices - Timing

- ▶ If fertilizer is not applied at a time when the plant can use it – there's no point in fertilizing at all
- ▶ Perennials / vegetables – spring
- ▶ Annuals – 3 or 4 times
during the growing season
- ▶ Lawns, trees, shrubs, roses –
spring & fall
- ▶ Bulbs – 1 tsp bone meal in
hole at planting



Knowing when to fertilize
Is just as important as knowing
how to fertilize

Rate of metabolism doubles for each 20° increase in soil temp.
At 40° - 50° metabolism is very slow. As temperatures increase
so does the availability of nutrients – especially nitrogen

THE KEY TO ANY SUCCESSFUL FERTILIZATION PROGRAM IS

- RIGHT PRODUCT
- RIGHT TIME
- RIGHT REASON



Sunrise Sunset (shrub)
Earth-Kind Rose Trial, Farmers Branch, TX