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KKMU- LUD, DOA

Introduction

- The groundnut (Arachis hypogaea L.) is an important **food legume of tropical and subtropical areas**.
- It is known as peanut and **rank 13th among the principal economic crops of the world**.
- It is mainly an **oilseed crop**, but also use as **snack food**, the roasted and various preparation of groundnut are used throughout the world.
- The crop is grown in different **agro-climatic regions between latitudes 40°S and 40°N** where rainfall during the growing season exceeds 500 mm.
- The production of groundnut is now being cultivated on **about 25 million hectare of land** in **more than 90 countries**, **India, China, USA, Senegal, Indonesia, Nigeria, Brazil and Argentina** are the major groundnut producing countries.
- Nutritionally, groundnut is an energy rich crop, but it is grown mainly in marginal land under energy-starved conditions of poor soil fertility and in rain fed (85 % rain fe

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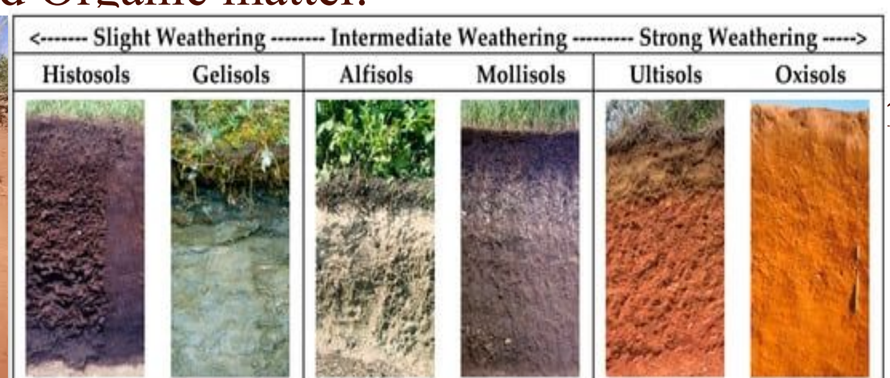
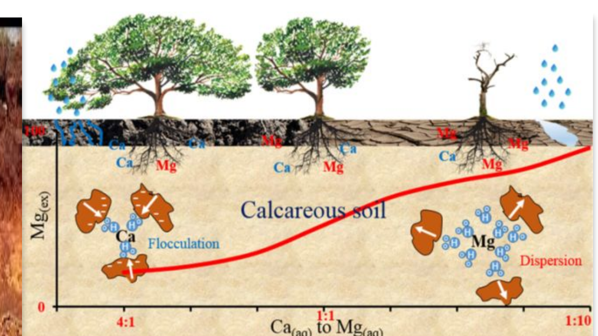
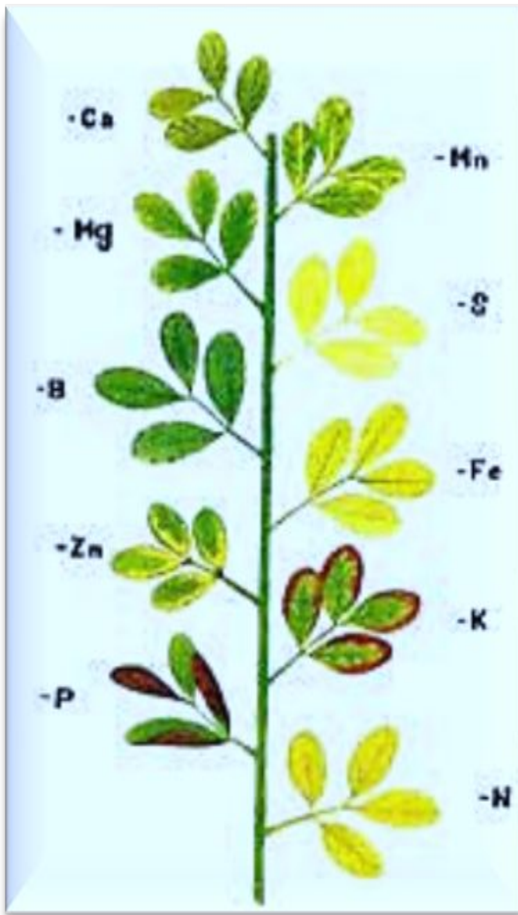
Growing Soils and Problems

- The groundnut cultivation has been extended on all soil types in tropical countries, the most predominant soils on which it is grown are **Vertisols, Inceptisols, Entisols, Mollisols, Alfisols, Oxisols and Ultisols**.
- The alluvial soils are neutral to alkaline, rich in P and K but poor in Organic carbon and N, however, the coastal alluvials are alkaline and poor in N, P and organic carbon.
- The red soils are neutral to acidic in pH, rich in Fe, Al and Mn but poor in N, P, humus, Ca and K.
- The black **calcareous soils** are generally alkaline, rich in Ca and Mg high CEC (40-60 meq/100g soil) and K but poor in N, P and Organic matter.





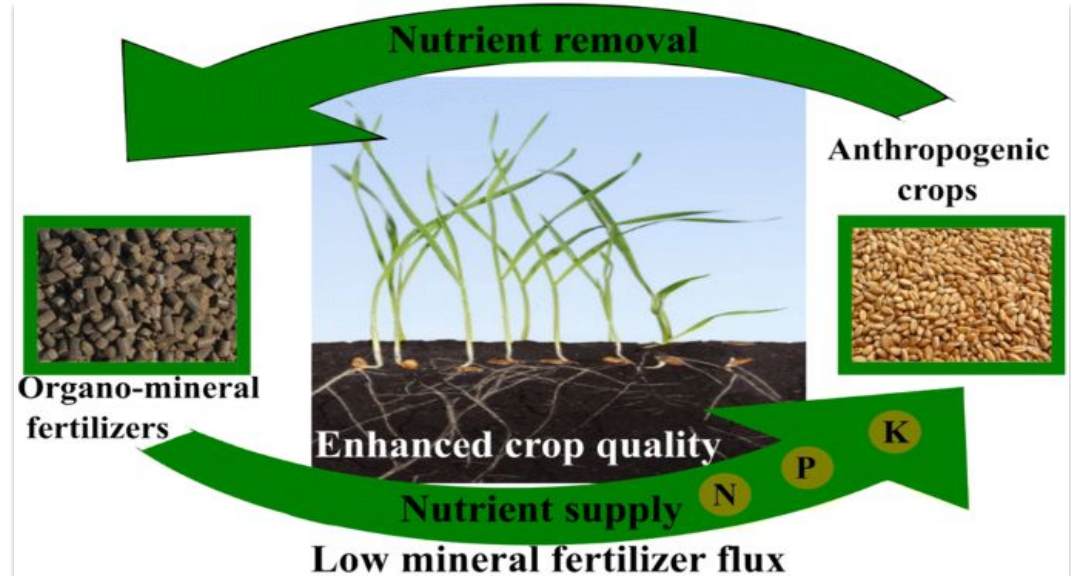
Mineral Nutrient Requirement



- The term 'plant nutrition' generally refers only to 'mineral nutrition' and like other plants; groundnut also requires all the **17 elements** for its growth and development.
- **Carbon, hydrogen and oxygen**, assumed to be plentiful and mainly required for photosynthesis, are taken up by the plant from air, air space of the soil and water and hence these are called **non-mineral nutrients.**
- The essential elements are assimilated into plant through absorption by root or other plant parts as ions from the soil and hence described as mineral nutrients and based on their requirement by plant these are classified as
  - ✔ macro-nutrient (N, P, K, Ca, S and Mg)
  - ✔ micro-nutrients (Fe, Mn, Zn, Cu, B, Mo and Cl).

Groundnut Nutrient Removal

- Groundnut is an exhaustive crop and depending upon the yield, it removes large amount of macro- and micro-nutrients.
- An average groundnut crop, with **2.0 to 2.5 t ha^{-1} of economic yield, requires,**



- 160-180 kg N   20-25 kg P
- 80- 100 kg K   60-80 kg Ca
- 15-20 kg S   30-45 kg Mg
- 3-4 kg Fe   300-400 g Mn
- 150-200 g Zn   140-180 g B
- 30-40 g Cu   8-10 g Mo

- The groundnut crop removes
  - 4-12% of the total nutrient during vegetative (0-25 days) stages
  - 42-88% of the total nutrient reproductive (25-75 DAE) stages
  - 6-53 % of the total nutrient pod development (75-105 DAE) stages

- The Peak absorption of Ca, Mg, P and K is during (25-75 DAE)

Balanced Nutrition

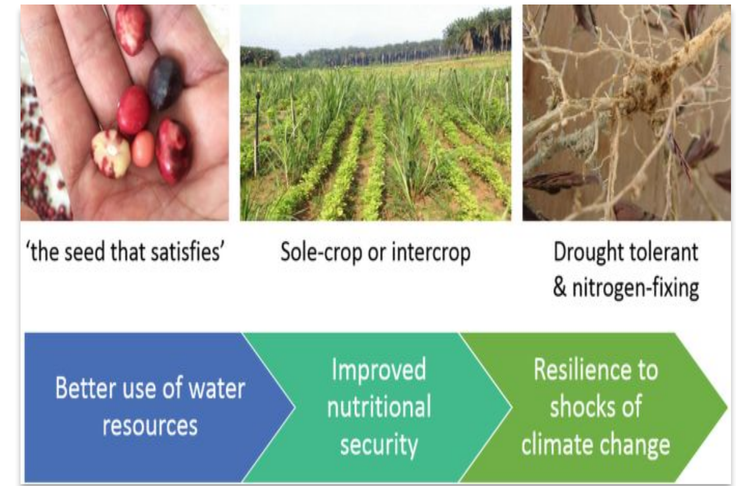
Fertilizer Management in Groundnut

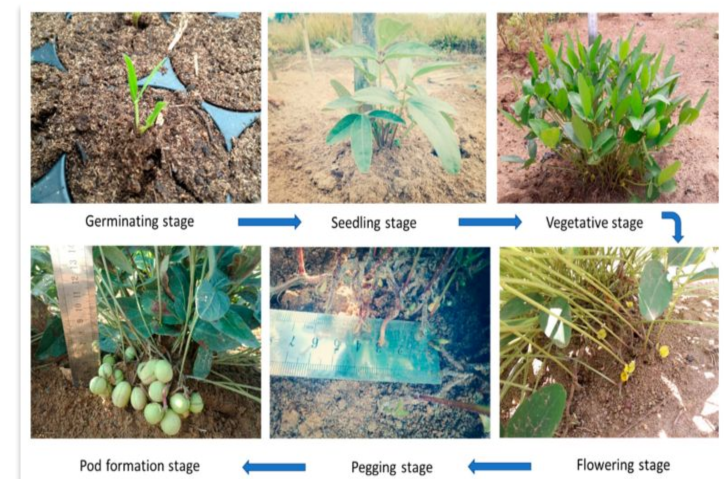
- The concentrations of macronutrients in leaves at 60 DAE and seeds at harvest were the main indicator to assess the mineral nutrient status of groundnut crop.
- Increasing the levels of any macronutrient, up to certain level in the nutrient solution, increased the concentration of particular element in the leaves, stems, seeds and shells and their uptakes by groundnut.
- N, along with N also increased P, K, Ca and Mg,

  K decreased Ca and Mg,

  Ca decreased K and Mg

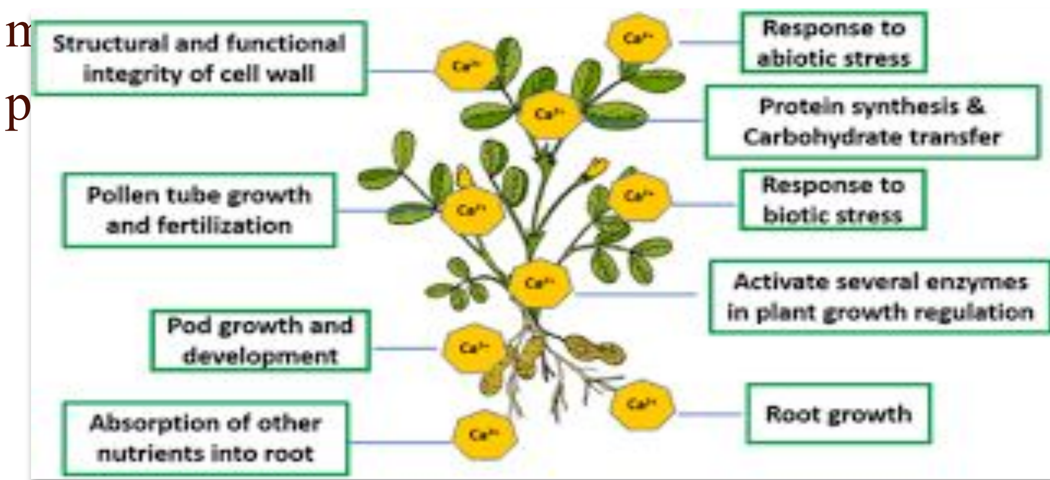
  concentrations in the plant tissues.
- The crop received balanced nutrition, and showed best growth, and fruiting at 50, 20, 50, 50, and 20 ppm levels of N, P, K, Ca and S, respectively.





Inadequate and imbalance use of nutrient

- Inadequate and imbalance use of nutrient is one of the major factors responsible for low yields in groundnut, limited efforts has been made to quantify the same and suggest the appropriate remedies.
- India is the world's second largest producer of groundnut where nutritional disorders causes 30-70% yield reductions depending upon the soil types, soil nutrient status and groundnut varieties.
- The average yield increased due to **application of calcium in the pegging zone was 24 % in USA**.
- The sulphur and iron deficiencies causes 15-29 and 14-40% yield losses, in calcareous soil.
- Groundnut plants require all the essential nutrients in balanced proportions and any deviation may result in mineral disorders which may be due to deficiency or the toxicity of a particular nutrient or m... re deficient or toxic simultaneously, the composite p... own symptoms





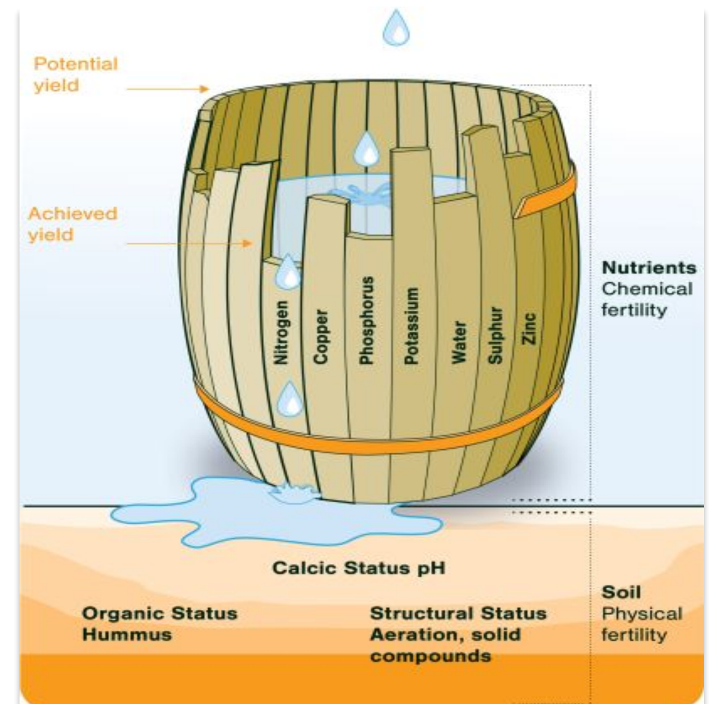
Major Causes of Mineral Disorders

Plant grows in an environment facing different climatic conditions and soil types.

There are several factors causing these nutritional deficiencies and toxicities in plants.

These factors are interrelated and interaction between them is very complex, for the absorption and utilization of nutrient by plants.

Some of these are:



- ☐ Continuous withdrawal and inadequate supply of nutrients in the soil
- ☐ Leaching, run off and nutrient fixation in the soil
- ☐ Edaphic factors (Soil, water, temperature and environmental) preventing absorption of nutrients by plants
- ☐ Changes in soil physico-chemical conditions such as pH and EC
- ☐ Imbalance use of fertilizers
- ☐ Induced deficiency
- ☐ Interaction between minerals during uptake
- ☐ Antagonism (ပဋိပက္ခ)
- ☐ Use of intensive nutrient (response) requiring crops and nutrient in-efficient crops
- ☐ Biotic (Disease and pests) factors.

****** *In phytopathology, **antagonism refers** to **the action of any organism that suppresses or interferes with the normal growth and activity of a plant pathogen**, such as the main parts of bacteria or fungi. These organisms can be used for pest control and are referred to as biological control agents.*

Problem Soils

Acid and alkali are the two major problem soils causing mineral stresses in crop. These soils occupy about two third (each one third) of the land surface area word- wide.

The saline and sodic soils, acid sulphate soils, degraded saline soils, coastal soils, and marshy soils are also the problematic soils causing nutritional stresses in plants.

(Acid soils

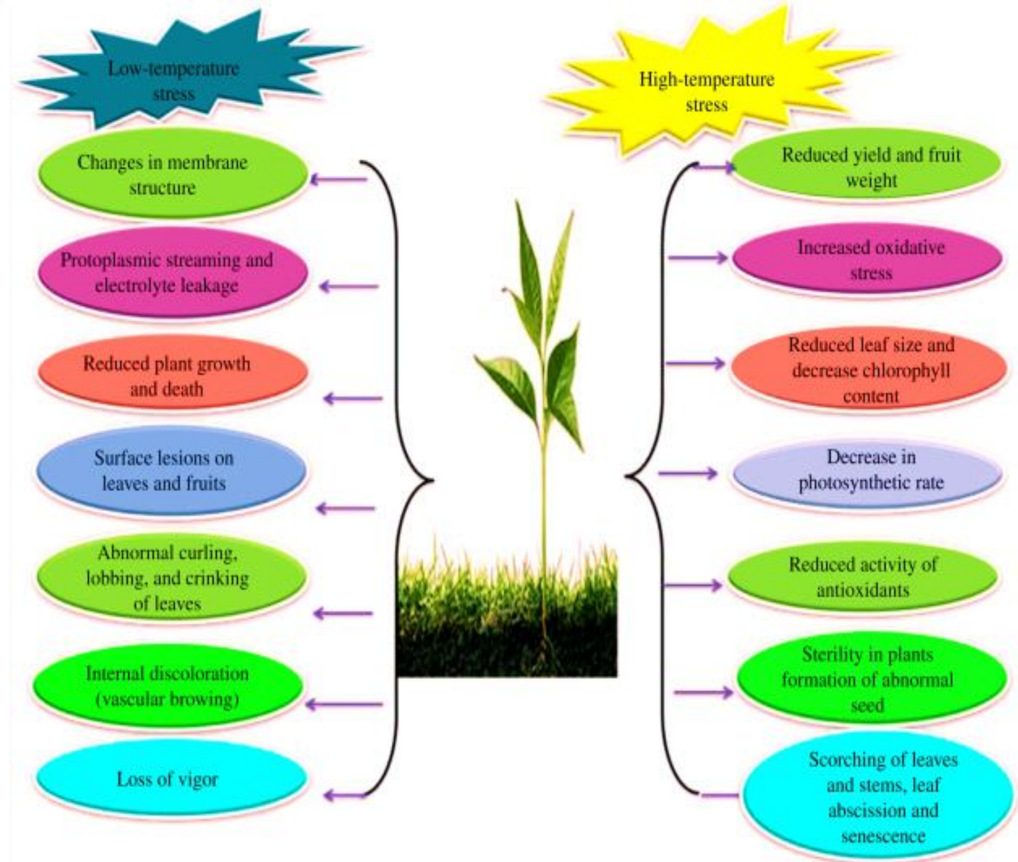
- Acid soils, with pH less than 5.5 in their surface zones, occupy approximately 30% (3950 m ha) of the world's land area and occur mainly in two continents of America and Asia where they have developed under udic or ustic moisture regimes.
- On global level about70 % of the groundnut is grown on acid soil where productivity is below 800 kg ha^{-1}. Soil acidity increases the solubility of iron, aluminum, and manganese and it reaches to toxic level in highly acidic soil.
- The acid soils are deficient in Ca, P and Mg, degree of saturation of CEC is low (25%) and have excess Al, Mn and Fe.
- The major nutritional problem of groundnut on acid soils is due usually to a **combination of toxicities of Al, Fe and Mn** and **deficiencies of P, Ca, Mg and K**.
- Besides these the acid soils have low water holding capacity, susceptible to crusting erosion and compaction making them low productive.

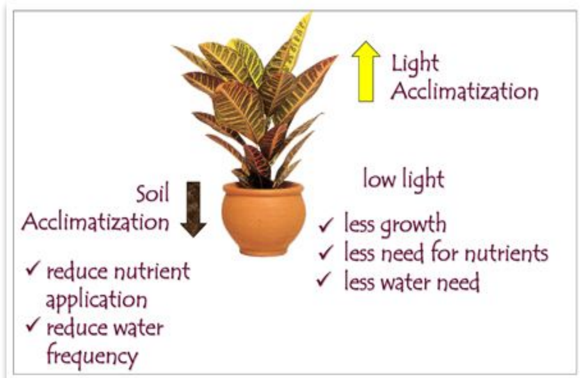
Calcareous and Alkaline Soils

- In calcareous soil high HCO_3^- is associated with increased pH or CO_2 concentration, which reduces the solubility of Fe and Mn causing their deficiencies in plant. The alkaline soils are **well supplied with Ca, Mg, and K**, but **deficiencies of S** and **toxicities of B** may occur.
- The management practices such as **deep ploughing**, which brings up carbonate of higher solubility to increase the amount in the surface layers and increases the soil pH should be avoided.
- Phosphorus availability is often low in calcareous soil and adsorption of added P depends on the number of weakly adsorbing sites. The high bicarbonate content directly affects the uptake of P. Thus utilization of P depends on plant tolerance to alkalinity.
- About one third of the soils, in the world, are calcareous where iron deficiency is most common problem The plant growing well on calcareous soils are called calcicoles.
- The medium to deep black calcareous soils and calcareous alluvial soils of are productive mainly due to high Ca and cat-ion contents and their easy accessibility. Groundnut generally grows well on these soils due to high Ca requirement.
- High availabilities of Ca and Mg in calcareous soils and their higher uptake by plant show multi-nutrient deficiencies, which are very difficult to diagnose and rectify timely.
- The chlorosis due to iron and sulpur deficiencies are major problem of calcareous and alkaline soils.
- The high free $CaCO_3^{--}$, HCO_3^-, pH in calcareous soils are main cause of chlorosis.

Light and Temperature

- The concentrations of elements are also influenced by **light intensities and duration and extreme temperature.**
- Light affects the photosynthetic produced and alter the ratio of element to dry matter due to dilution effects.
- The light, through photosynthesis, provides energy for active uptake of elements and enhancing concentration, this positive effect is overridden by the dilution effect.
- Thus increasing light exposure reduces the N, P, K, concentration, but Ca concentration may increase.
- Genotypic differences are obvious as changes are genetically controlled. While shading increases the P, K, Al, Ca, Fe, and Mn concentrations and decreases the Cu, Mg, and Zn concentrations in leaves.
- The adverse effects of excess Na and K associated with high salinity and low light have been partially corrected by high light by helping to maintain plant cat-ion concentrations.



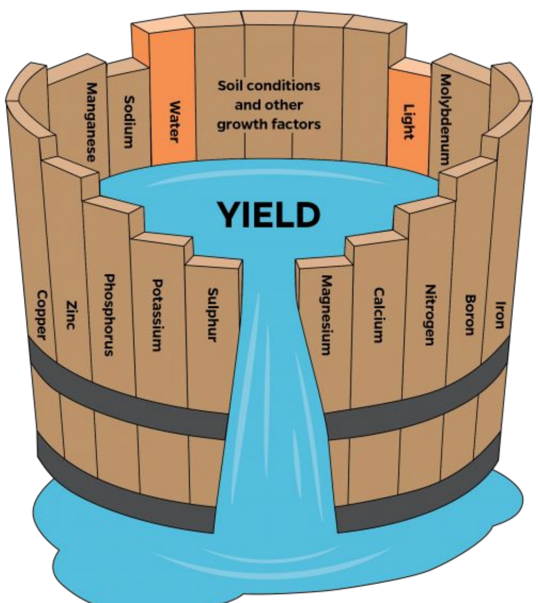


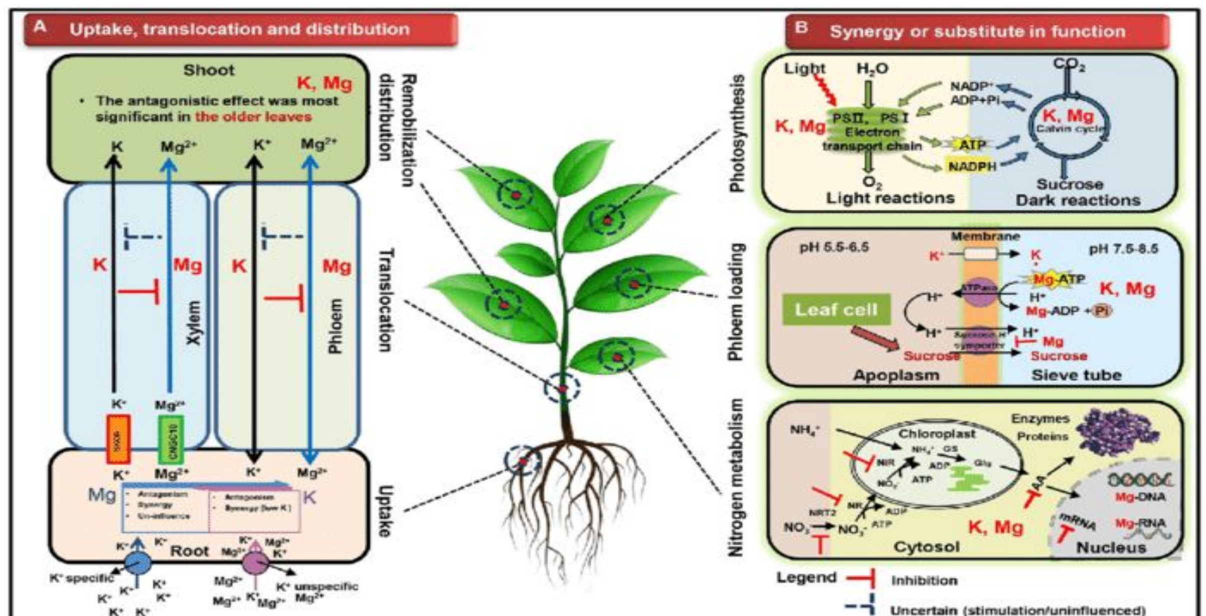
Water

- The rainfall increases soil moisture, by bringing the levels within the beneficial range between wilting and field capacity, stimulates the plant growth and hence tends to lower the elemental concentration again due to dilution effects.
- The favorable moisture condition influences the soil nutrient availability and their movement in plant, all these are overcome by fast growth and dry matter accumulation.
- The humidity influences the rate of transpiration and indirectly affects the nutrient content in plants.
- Flood irrigation aggravates problem of root aeration in groundnut resulting in abnormal respiration, inhibiting root growth and altering metabolic functions. Because of this plant becomes chlorotic due to deficiency of N caused by inability of roots to take up N and ineffectiveness of Nitrogen-fixing bacteria, deficiency of S due to leaching in course texture soil and deficiency of Fe in calcareous soil due to conversion of ferrous to ferric form.

Interaction of macronutrients

- Increasing the levels of any macronutrient, up to certain level in the nutrient solution, increases the concentration of that particular element in the leaves, stems and seeds and their uptakes by plant.
- Low or excess of any element influence the uptake of other nutrients also that may be **synergistic (beneficial) or antagonistic (detrimental) effects.**
- The P and S did not show any of such interaction with other macronutrients.
- The concentrations of Ca and Mg decreased with increasing the levels of K but were high in all the plant tissues except seeds at very low levels of K.
- Similarly, the concentrations of K and Mg in plant tissues decreased with increasing Ca levels.

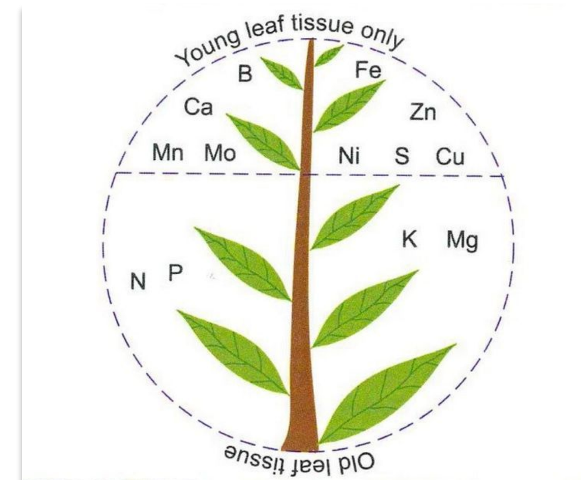


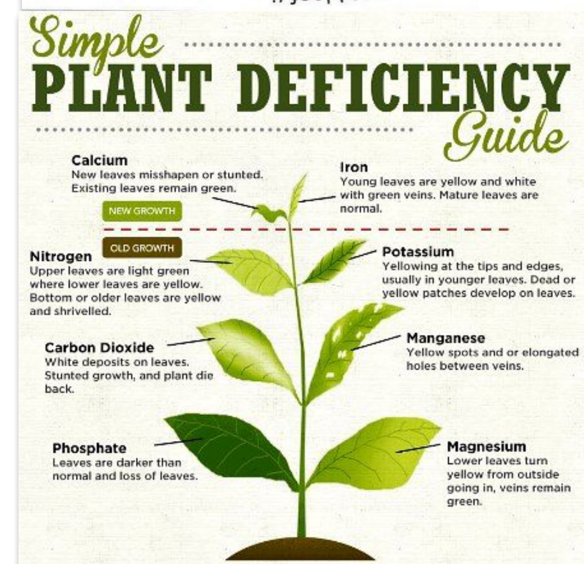


Diagnostic Methods of Mineral Disorders

Generally there are three types of symptoms in groundnut:

- ♣ In case of N, P, K and Mg deficiencies the plant tend to withdraw these elements from older leaves and redistribute them to young, actively growing plant via phloem as these are phloem-mobile. Thus their symptoms occur first on older leaves.
- ♣ The Ca, Fe, Mn and B are phloem-immobile and not redistributed under scarcity, thus their symptoms occur on young actively growing parts of the plant, including root tips. For phloem-immobile element, there should be 14 continuous supply of element for maintaining healthy groundnut crop. Fluctuations in supply of these nutrients, during the growing season commonly show the deficiency symptoms on the leaves formed during the period of deficiency with healthy leaves both above and below the affected leaves.
- ♣ The S, Zn, Mo and Cu have variable mobility in phloem and act as phloem-mobile as well as phloem-immobile depending upon the conditions and factor and their symptoms appear on young as well as old leaves depending upon the factor. In groundnut, however, mostly these deficiencies occur on young leaves first.

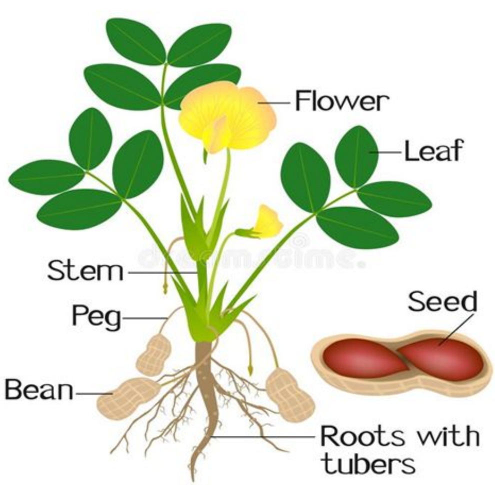


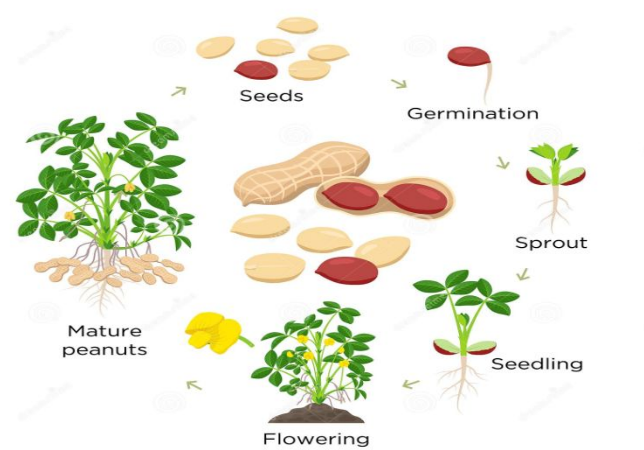


The Time of Groundnut Sampling and Tissues

For field grown groundnut, the time of sampling and tissues, which vary from element to element, has been standardized in our laboratory and being recommended below:

Elements	Plant tissues and stages of crop
N, P, K, Ca, S, Mg, Fe, Mn, Zn, Cu, Mo & B	Fully matured top 5 leaves at 40-60 days after emergence (DAE)
N and P	Fully matured top 3 leaves at 20-40 DAE
Fe, B	Youngest fully emerged leaf and seed (B)
Ca, P and Zn	Seed at 80 DAE and at harvest





Nutrient Concentrations in Groundnut at Various Stages

Nutrient	Upper part of plant prior to bloom stage (25 – 40 DAE)			Upper part of plant at early pegging (40-60 DAE)		
	Low	**Sufficient**	**High**	**Low**	**Sufficient**	**High**
	percent (%)					
N	< 3.50	3.50 - 4.50	> 4.50	< 3.5	3.50 - 4.50	> 4.50
P	0.18- 0.24	0.25 - 0.50	> 0.50	< 0.20	0.20 - 0.35	> 0.35
K	0.50 – 1.60	1.70 - 3.00	> 3.00	< 1.70	1.70 - 3.00	> 3.00
Ca	< 1.25	1.25 - 2.00	> 2.00	< 1.25	1.25 - 1.75	> 1.75
S	< 0.20	0.20 - 0.35	> 0.35	< 0.20	0.20 - 0.30	> 0.30
Mg	< 0.30	0.30 - 0.80	> 0.80	< 0.30	0.30 - 0.80	> 0.80
	ppm					
Fe	50- 59	60. - 300	> 300	< 100	100 - 250	>250
Mn	50 – 59	60 - 350	>350	< 100	100 - 350	> 350
Zn	20 – 24	25 - 60	>60	< 20	20 - 50	> 50
Cu	< 5	5 - 20	>20	< 10	10 - 50	> 50
B	20 – 24	25 - 60	>60	< 20	20 - 50	> 50
Mo	< 0.1	0.1 - 5.0	>5	< 0.1	0.1 - 5.0	> 5

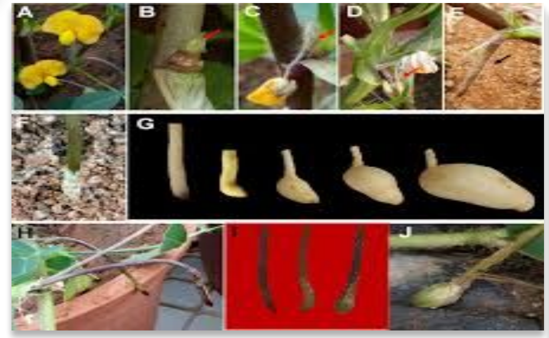
(Sources; Jones et al., 1991; Singh 1999)

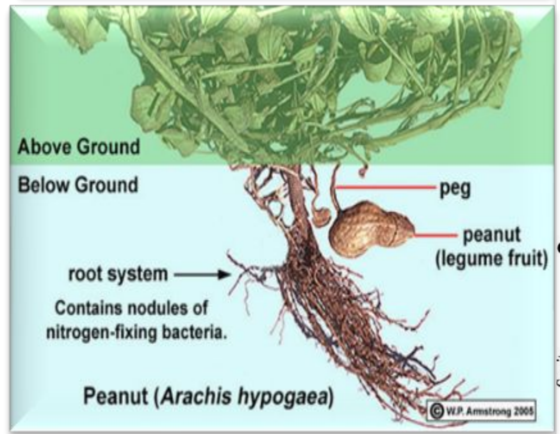
Choose of Correcting Nutrients

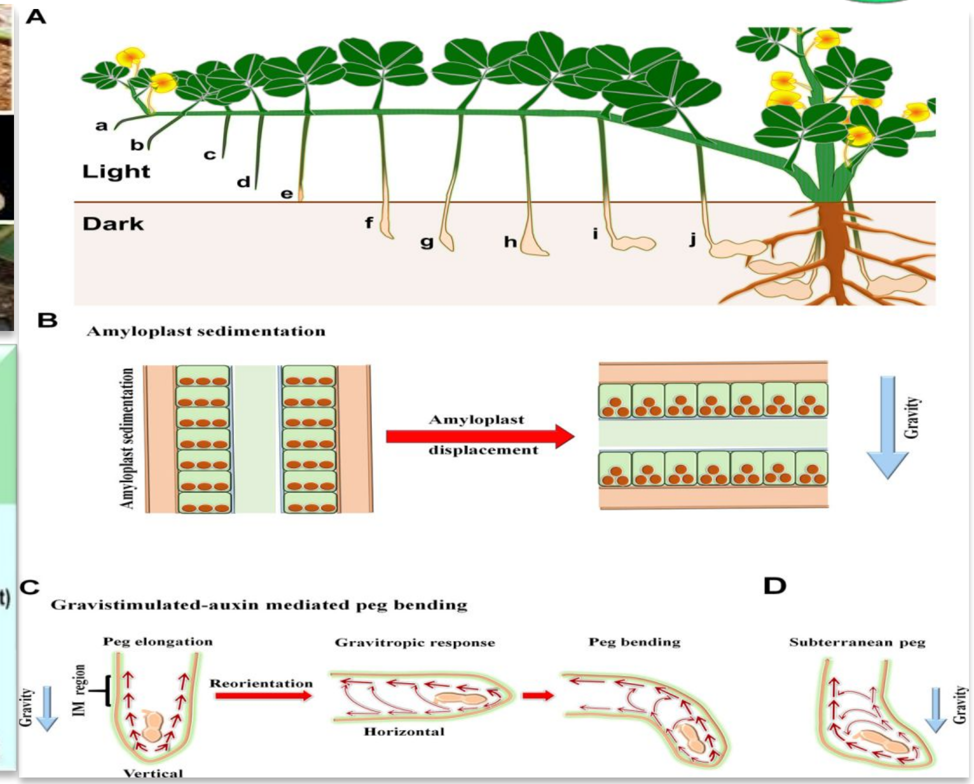
Nutrients	Corrective Measures
Nitrogen	Application of N fertilizer and organic matter to soil, use on N-efficient cultivars
Phosphorus	Application of amendments to maintain soil pH near neutral in acidic soils; application of phosphorus fertilizers, use of P-efficient cultivars
Potassium	Application of crop residue and potassium fertilizers
Calcium	Liming (addition of $CaCO_3$) of acid soils; addition of gypsum or other soluble calcium source where lime is not required
Magnesium	Soil application of dolomite; soil or foliar application of magnesium soil sulfate or magnesium nitrate solutions
Sulfur	Soil application of pyrite, ammonium sulfate; single super phosphate; gypsum or elemental sulfur.
Zinc	Addition of zinc sulfate to soil; foliar spray of 0.1-0.5% solution of zinc sulfate
Iron	Soil application of Fe EDDHA or iron sulphate, foliar spray of o.5 % iron sulfate or 0.02 - 0.05 % solution of iron chelate; use of efficient cultivars, fertigation with iron chemicals
Copper	Soil application of copper source of fertilizer or foliar spray of 0.1-0.2% solution of copper sulfate
Boron	Soil application of borax or foliar spray of 0.1-0.25% solution of borax, care not to exceed 1 ppm B in solution in irrigation
Molybdenum	Liming of acid soils; soil application of sodium ammonium molybdate; foliar spray of 0.07-0.1 % solution of ammonium molybdate
Manganese	Foliar application of 0.1% solution of manganese sulfate

Macronutrients

1. Nitrogen
2. Phosphorus
3. Sulphur
4. Potassium
5. Calcium
6. Magnesium







- Unlike other plant **the groundnut nutrition is unique** as **the pod develop under soil** and most of the seed nutrition is directly through pod rather than those transported from root, shoot and back to the seed.
- The Ca, K, P and S, among macronutrients and Fe and B among micronutrients are involved in the kernel filling and oil synthesis and hence are required in higher quantity.
- The groundnut is susceptible to nutritional disorders due to insufficient supply of minerals.

Mineral Symptoms

Nitrogen

Function

Nitrogen is an important constituent of proteins, chlorophyll, amino and nucleic acids, and is required for the vegetative and reproductive growth, nutrient absorption, photosynthesis and production of assimilates **for developing pods**. It also plays an active role **in the enzyme reactions and energy metabolism**. The nitrogen requirement of groundnut is **much higher** than cereals because of its high protein content; however, most of the soils where groundnut is grown in the world are deficient in nitrogen.

Requirement

Groundnut produces approximately 30-40 kg of biomass kg^{-1} of N assimilated, and to produce 5-6 t of an average biomass of a good groundnut crop, it needs 180-200 kg of N. This large amount of nitrogen is supplied to the groundnut plant mainly by its root nodules. Groundnut is capable of meeting its 60-80 % nitrogen requirements from symbiotic nitrogen fixation by root nodules and only 20-40 % from soil nitrogen as, depending upon the soil nitrogen status. However, the nitrogen supply to groundnut is very crucial and deficiency is observed in between 10-45 DAE and at pod formation stages (Singh, et al 1991, Singh and Joshi 1993).

Nitrogen Symptoms and Diagnosis

- The nitrogen deficient crop shows slow and stunted growth with weak and prolonged stem and pale to yellowish green coloration of the older leaves. The chlorosis starts at the leaf tips, and dry up with pale brown necrosis.
- Nitrogen is very mobile and as the older leaves dies, it is mobilized from older to younger leaves in form of amines and amides. Since there is no early senescence of leaves in groundnut, the characteristic deficiency symptom of nitrogen is the appearance of uniform yellowing of leaves including the veins due to decomposition of chloroplast, being more pronounced on older leaves.
- The nitrogen concentrations in leaves decrease with plant age and vary with cultivars making leaf N a difficult diagnostic tool for determination of need. The sufficiency levels of N in leaves at full bloom stage (45-60DAE) has been reported to be in between 3.0-4.5 % and nitrogen deficiency symptom appears when the leaf N concentration falls below 2.2 %.

  (Dwivedi, 1988; Jones et al., 1991; Singh, 1999)
- However the critical concentration of N in leaves at 45- 60 DAE is in between 2.5-3.0 % and vary with genotypes. For optimum yield, the N, P and S ratio should be around 15:1:1 in the 4th leaves from the top. Increasing the levels of N, increased the concentrations of P, K, Ca and Mg in leaves, but did not affect S and Mg . (Singh, 1999)

Phosphorus

Requirement and function

Phosphorus, is present in inorganic form as a component of ATP, RNA, DNA, certain enzymes and proteins, and involved in various energy transfer reactions and genetic information. It limits nodule development and N_2-fixation, plant growth, seed development and oil synthesis in groundnut.

On global level P is the most deficient element, and hence P deficiency is restricted to the areas that are not fertilized with. **Phosphorus enhanced root production** and is **very critical at flowering and pod formation stages of groundnut crop** and its **application increased the nodulation, N_2- fixation and N contents of the kernel and foliage** .

Symptoms, and diagnosis

In groundnut, P deficiency causes purpling of leaf margin and **stunted growth but more dark green in color**. The deficiency first occurs on older leaves and later spread to other leaves from the bottom, but it takes **minimum of 4 weeks to appear the deficiency symptoms on the plants**. The older leaves, petiole and veins with purple suffused pigmentation, without orange or brown lesions. The older leaves may also become orange yellow, then brittle and finally shed. Some older leaves also show yellow symptoms of P deficiency.

> Note ATP; Adenosine triphosphate: A substance present in all living cells that provides energy for many metabolic processes and is involved in making RNA. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are perhaps the most important molecules in cell biology, responsible for the storage and reading of genetic information that underpins all life.

Sulphur

Requirement and function

Sulphur, constitutes methionine, cysteine and cystine amino acids and inpart in **oil synthesis** in groundnut. It **improves nodulation and pod yield**, **reduce the incidence of diseases and is as important as P**. Sulphur increases, chlorophyll and decreases chlorosis in calcareous soil by increasing availabilities of micronutrient in soil. The Groundnut grown on coarse-textured sandy soils generally suffers from S deficiency due to leaching of SO_4^-S causing 10-25 % yield losses. The deficiency is mainly due to use of S free fertilizers, adoption of high yielding varieties and losses of S through leaching and erosion.

Symptoms and diagnosis

The S deficiency symptom is like nitrogen but occur on young leaves. S element is mobile, in groundnut, the symptoms appear mainly on young leaves first and extend to middle showing pale yellow colour with vein showing white. The S stored in the older leaves as sulphate is easily mobilized and transferred to growing organ to a certain extent, but not the one that has already been incorporated into organic compound. However, the S mobilized from older leaves is not sufficient to maintain the normal growth, as a result **the youngest leaves remain small and more or less yellow owing to lack of protein and chlorophyll**. The severe chlorosis is due to disturbance of protein metabolism in the chloroplast and chlorophyll synthesis. The S content of older leaves is thus some what higher than the young leaves.

Potassium

Requirement and function

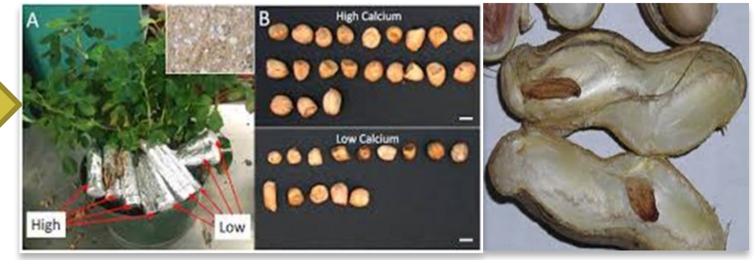
Potassium is not a constituent of any compound or structurally bound in groundnut, it is **required for translocation of assimilates and involved in maintenance of water status of plant especially the turgor pressure of cells and opening and closing of stomata, and increase the availability of metabolic energy for the synthesis of starch and proteins.** Besides It **increases peg formation, synthesis of sugar and starch and help in pod growth and filling.** The nitrate reductive, EDTA-osmotic, and productivity of groundnut under water deficit conditions were increased due to K application. **The groundnut vines, which are rich in protein and are used as fodder, remove considerable amount of K from the soil.**

Symptoms and diagnosis

The potassium deficiency in groundnut is more common on the older leaves. **The K^+ is highly mobile in both xylem and phloem which enables the plant to regulate their K budget easily.** The K deficiency symptoms first appear in the older leaves characteristically developing mottling or chlorosis. The yellowing of leaves starts from the tips or margins of leaves extending towards the center of leaf base. Drying up of leaf margin with hallow yellowed margin and necrotic symptoms and reddish coloration of tip of branches. The stem becomes red accompanied by excess storage of starch and become light green. Some times, there is interveinal chlorosis too. The groundnut roots are highly efficient in obtaining soil K and hence the optimal soil K levels for high yield and quality vary with soil types.

EDTA; **Ethylene diaminetetra-acetic acid**; a colourless crystalline slightly soluble organic compound used in inorganic chemistry and biochemistry. It is a powerful chelating agent used to stabilize bleach in detergents.

Calcium



Requirement and function

Calcium is more important for groundnut and **lack of Ca reduce the yield and quality** more than any other element. Calcium maintains the cell integrity and membrane permeability, enhance pollen germination, activates the number of enzymes for cell division and takes part in protein synthesis and carbohydrate transfer. Recently it has been implicated as a second messenger in certain **hormonal and environmental responses and regulating enzyme activities.** In its physiological effects, Ca is usually regarded as counterpart to K. Calcium influences the stability of structure of protoplast and owing to its dehydration properties, it opposes the plasma-expanding action of K. **The calcium requirement is very high especially for gynophore's development and pod filling.** Field work showed that calcium and potassium levels in the fruiting zone affected seed quality. Early ovule abortion was prevented by adequate calcium supply.

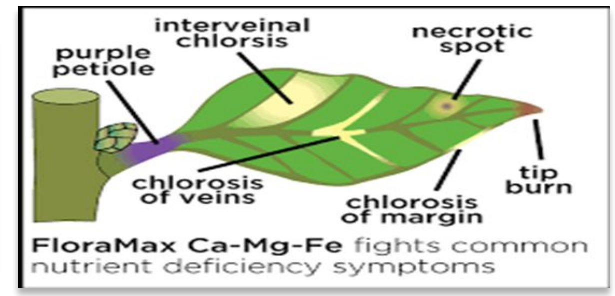
Symptoms and diagnosis

Ca is not mobilized from the older leaves, its deficiency occurs on the fresh and emerging leaves under field condition, the visual deficiency of Ca in plant is rarely observed except in **extreme condition of acidic soil having pH less than 5.5**. The Ca deficiency in leaf is characterized by development of localized pitted area on lower surface of leaves which later on converts into large necrotic spots. **Leaves becomes cupped shape, distorted and hook like near the leaf tip, the lamina dries out and tears beginning at the tips and margines, with pale to white-greener grayish-brown tints (crinkle leaf) cracking of basal stem and dieback of shoot at later stage of growth**. **Severe Ca deficiency results in the death of root tips and terminal buds.** The calcium ion (Ca^{2+}) is transported exclusively in xylem tissue upward with transpiration stream but its downward movement from the leaves through phloem is practically nil.

Magnesium

Requirement and function

Magnesium is present in chlorophyll, as a bridge between pyrophosphate structures of ATP or ADP and the enzymes molecules and it serves as a **cofactor in most of the enzymes activating phosphorylation**. **The deficiency of magnesium is a problem of sandy and strongly acid soils as under high rainfall,** the Mg is leached out more easily in these soils. **Magnesium is present as carbonate in the form of dolomite ((CaMg) CO_3) and magnetite in calcareous soils.** **Increase of pH in alkaline soils the Mg becomes non-exchangeable**. Magnesium also influences the **phyto-hormone balance and nitrate reduction**. Like K the groundnuts are very efficient in extracting Mg from the soil, it rarely shows deficiency symptoms.

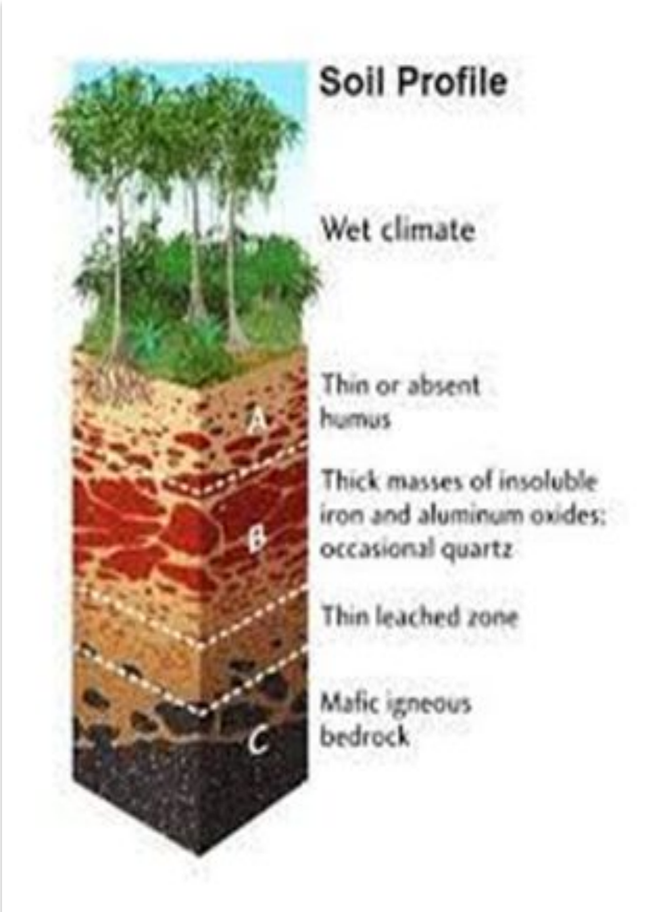


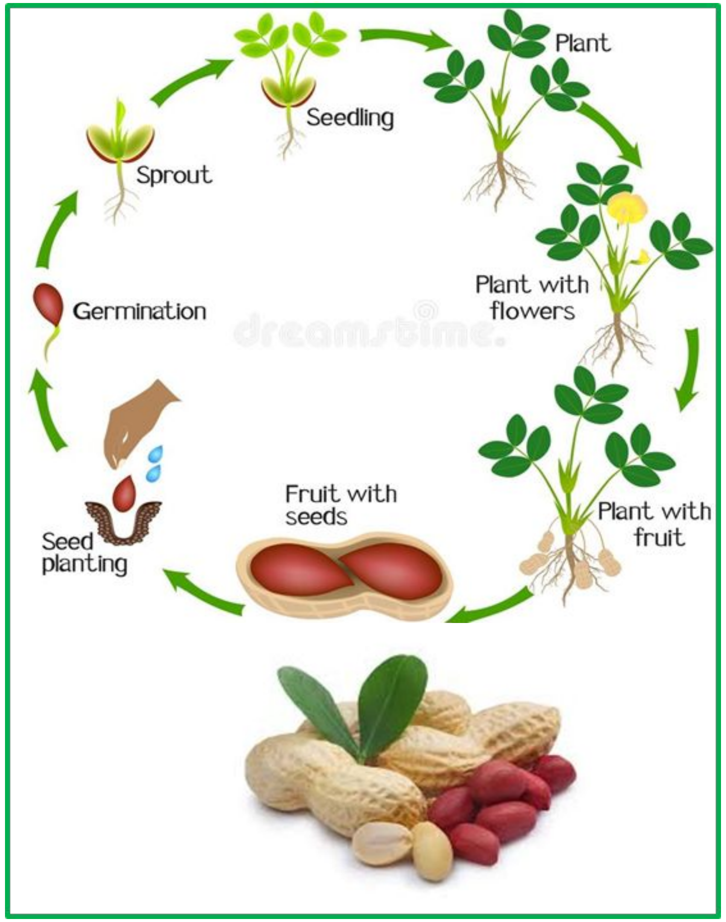
Symptoms and diagnosis

Due to breakdown of chlorophyll in the region that **lies between the veins, the interveinal chlorosis is the most pronounced symptom in Mg deficient plant.** The chloroplasts in the vein are less susceptible to Mg-deficiency and retain their chlorophyll much longer. As **Mg is mobile the basal leaves are first affected and the deficiency starts from leaf margin and advances towards midrib and under extreme stress the young leaves are also affected**. **Intercostals chlorotic lesion or blotches is the typical Mg deficiency, which are usually bright yellow, sometimes brown, orange and purple.** The critical level of Mg in top soil is 11 ppm of extractable Mg, however sufficiency level is above 15 ppm.

Micronutrients

1 . Iron
2. Manganese
3. Zinc
4. Copper
5. Boron
6. Molybdenum
7.Chlorine





Iron

Requirement and function

Among all micronutrients, iron deficiency is most commonly observed in groundnut and it is most severe on calcareous and alkaline soils. Due to its high Ca requirement by pods, the groundnut is preferably grown on calcareous soil, where it suffer from lime-induced iron-deficiency chlorosis. **In groundnut, the Fe-deficiency appear 10-15 days after emergence in the field and remains throughout the cropping season, but its maximum intensity was observed in between 30-70 DAE.**

Health support; In India, approximately 7% population is facing Fe-Deficiency; B and Zn deficiencies are also reported and groundnut being a very good source of micronutrients, has to play a major role in combating these deficiencies.

Symptoms and diagnosis

In groundnut, the Fe-deficiency first appears as **chlorosis of young rapidly expanding leaves** which is characterized by interveinal chlorosis and later under severe deficiency, the veins also become chlorotic and leaves become white papery. **These areas later become brown and necrotic**. The acute deficiency leads to dying of plant in the field and crop failure. The Fe deficient plant showed lesser peroxidase activity in their leaves, stems and roots, and the root peroxidase activity was identified as an indicator of iron deficiency. **The Fe deficiency also limits nodule development in groundnut in calcareous soil resulting in the N deficiency.** The sufficiency level of Fe in groundnut leaves is 50-300 ppm and the critical limit is 40 ppm, but Fe-deficiency in groundnut is visible when tissue concentration falls below 30 ppm in leaves.

Manganese

Requirement and function

Without Mn plant accumulates H_2O_2 causing cell damage. The Mn deficiency is a problem of high pH soil and the Mn content are inversely related to Ca and Mg levels. **In groundnut the Mn deficiency is soil pH as low as 5.8**. The calcareous soils are Mn deficient owing to immobilization as insoluble MnO_2 at high pH, majority of groundnut is grown on calcareous soil where Mn deficiency is bound to occur causing 8-17 % yield losses.

Symptoms and diagnosis

In groundnut, the Mn deficiency appears as interveinal chlorosis of younger leaves and continues on older leaves producing bold pattern of dark green major veins. Appearance of varied but characteristic necrotic spotting or lesions on the leaf margins distinguish the Mn deficiency from iron-deficiency.

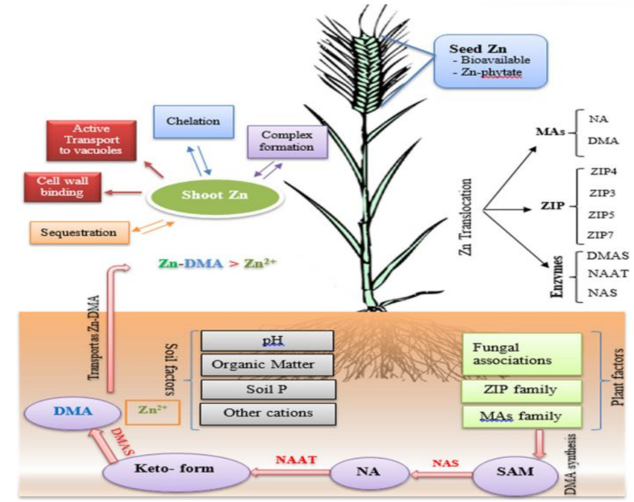
The reticulate or mosaic like interveinal and intercostal chlorosis with mottling and marbling; green margin along the main veins form a Christmas tree pattern on moderately old leaves; mottled area get necrotic with red-brown interveinal lesions.

The critical Mn concentration in soil for growth is in between 3-5 ppm. The sufficiency level of Mn in leaf is 50 to 350 ppm at 50-70 DAE and concentration below 50 ppm is considered low. However the deficiency occurs when the leaf Mn concentration dropped below 20 ppm.

Zinc

Requirement and Function

The Zinc is a much worked micronutrient. Carbonic anhydrase is a very specific enzyme activated by Zn, besides it is involved in many enzyme systems. The problem of Zn is also much more of its availability rather than abundance. The Zinc deficiencies in groundnut are found in almost all states in calcareous and alkaline soils that are low in organic carbon, high available P and bulk density and low soil temperature. In calcareous soil, the Zn deficiency causes 15-20%, yield losses.



Symptoms and diagnosis

In groundnut, the Zn deficiency occurs mainly in the upper leaves showing irregular mottling with yellow-ivory interveinal chlorosis. **Reduction in size of young leaves which are some times clustered or borne very closely**. **Young leaves with broad yellow or white bands between the margins and mid vein in lower half of leaf. Under severe deficiency, the entire leaflets become chlorotic. Faint chlorosis of the lower leaves between the vein, leaf margin and tips are also observed**. The Zn deficiency can be separated from Fe with its wider strip, which may not run entire length of the leaflets. Under high temperature, the leaf bronzing with occasional small necrotic spots are also observed.

The sufficiency range of Zn in leaf during flowering and fruiting (40-70 DAE) is 25-60 ppm and Leaf tissue less than 20 ppm showed its deficiency. The critical levels of zinc in the soil are in between 0.5-0.7 ppm DTPA extractable zinc. However, the DTPA extractable zinc below 1.2 ppm reduced groundnut yield.

Copper


Requirement and function

The copper participate in protein and carbohydrate metabolism and nitrogen fixation and is a constituent of chloroplast protein, plasto-cyanin, and part of many enzymes such as cytochrome oxidase, ascorbic acid oxidase and polyphenol oxidase. **Copper is also involved in the de-saturation and hydroxylation of fatty acids**. The copper deficiency is a major problem of organic and acid soils. In calcareous soil the **Cu deficiency causes 13-15 %, yield losses**.

Symptoms and diagnosis

In the copper deficient groundnut plant, the **young leaves are curled**. The entire leaf becomes cupped and leaflet margins turn upwards. The plant become stunted, rosettes, interveinal crinkling and marginal wilting occur due to weakness of cell wall, but not due to water stress. Irregular leaflets with marginal necrosis, mild chlorosis and small yellow-white spots on the foliage. Bronzing and necrosis of the outer edges of the leaflet occur if deficiency is prolonged. **Copper deficiency also reduces root growth more than shoot growth creating an unfavorable shoot : root ratio. The pigments in flower decreases.**

The sufficiency level of Cu in the leaf during flowering and fruiting (40-70 DAE) is 5-20 ppm and the groundnut shows deficiency when the tissue concentration falls below 5 ppm. The critical concentration of Cu in soil is 0.2 ppm. The activity of ascorbic acid oxidase was reduced in Cu-deficient plants

Boron

Requirement and function

In groundnut, boron facilitate translocation of sugar and fat synthesis and is important for RNA (uracil) synthesis, cell division, differentiation, maturation and pollen germination. The B is transported primarily in xylem and is relatively immobile in phloem. **The B deficiency is reported to occur in neutral to alkaline and highly weathered soils**. The factors influencing B deficiency are soil low B, organics in soil, low humicgley, moderate to heavy rainfall, dry weather and light intensity. **In calcareous soils, the B deficiency causes 16-26 %, yield losses** (Singh, 2001). Thailand is a hot spot for B deficiency where `**hollow heart' of groundnut** is more common.

Deficiency symptoms, and diagnosis

The B deficient groundnut plant **shows retarded growth of the apical portion**. As the B is immobile and deficiency occur on the growing points, death of the stem apex, and regeneration from the lateral bud, malformation of the leaf vein, chlorosis, necrosis of basal margins in emerging leaves are commonly observed. The B deficiencies are similar to Ca except that in B the necrotic areas are localized near leaf margins but in Ca they are distributed over the entire surface. **The internodes are shortened and margin of leaflets develop light brown colour bushy or rosette appearance of the plant**. The young leaflets some times appears as rudimentary with purple red, orange yellow or blue green tinting. **Roots become blackened and growth of root nodules is suppressed**.

Hollow-heart

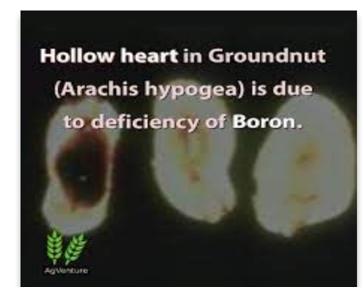
Boron (Cont.;)

The deficiency of B causes low pod filling and hollow darkening or off-colour area develop in the center of the seed known as `hollow heart' of groundnut reducing the quality of seed.

The B deficiency occurred when the hot water soluble B of the soil is less than 0.2 ppm, depending upon the soil the critical limits of B may vary from 0.2- 0.4 ppm (Singh, 1994b).

The sufficiency level of B in the leaf during flowering and fruiting (40-70 DAE) is 25-60 ppm and the critical level is 20ppm.

The groundnut kernels containing less than 17 ppm B showed the incidence of hollow-heart.



Molybdenum

Requirement and function

In groundnut, molybdenum is essential for nitrogen fixation as well as involved in several enzyme systems. **The nitrogenase and nitrate reductase are the main enzymes influenced by Mo**. Of all the micronutrients, though Mo is needed in the least amount, the Mo deficiency disrupt the nitrogen metabolism and the plant shows nitrogen deficiency because of role of Mo in Nitrogen fixation. **The factors influencing Mo deficiency are low soil Mo, acid soil high organics, high free Fe which.** Though Mo availability increases with pH, the deficiencies are quite likely to occur on soil with high pH also. **In calcareous soil the Mo deficiency causes 13-19 % yield losses**.

Symptoms and diagnosis

In groundnut, the Mo deficiency reduce chlorophyll and the leaves show bright yellow, green interveinal chlorotic mottling. The symptoms first occur in older leaves and then progress towards the younger until plant die. At later stages, leaf margin curled and leaves collapse completely. The Mo deficient plants show very few nodule and the deficiency generally occur in acid soils.

The sufficiency level of Mo in leaf during flowering and fruiting (40-70 DAE) is 0.3-5 ppm which need to be maintained to have a good crop yield. However, the critical limit of Mo was found to be 0.04 ppm in soil and 0.2 ppm in the leaves. As the nitrate reductase activity reduced in Mo deficient plant, it is a good indicator of Mo status of groundnut plant.

Chlorine

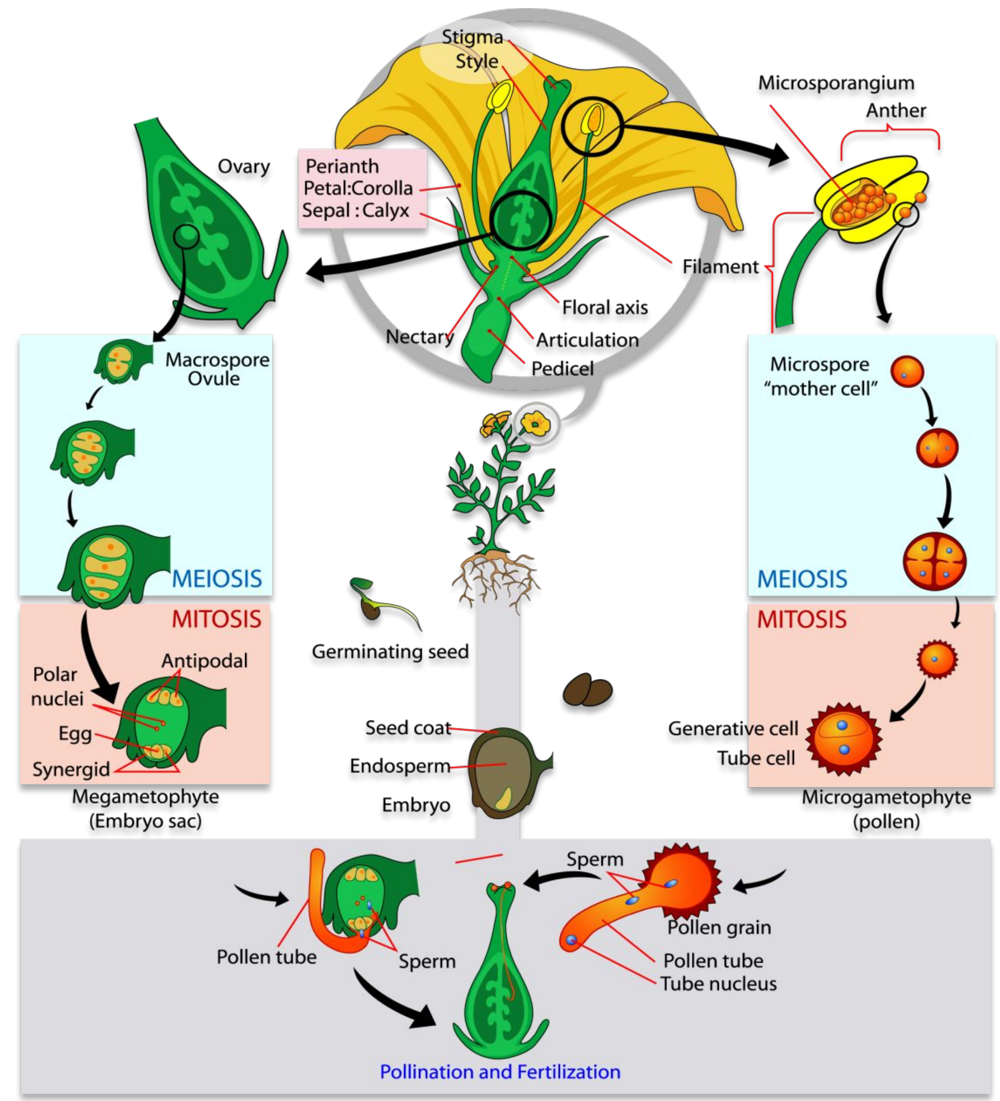
In plant chlorine is a major counter ion maintaining electrical neutrality across membranes and osmotically active solutes in the vacuole.

It is also required for **cell division in both leaves and shoots.**

Plant deprived of Cl exhibit reduced growth, the symptoms first appear on young actively growing leaves as wilting of the leaf tips and normal chlorosis, stubby roots, yellowing and bronzing.

Most soils contain sufficient Cl and receive enough of it in fertilizer especially potassium thus the deficiency is rarely observed.

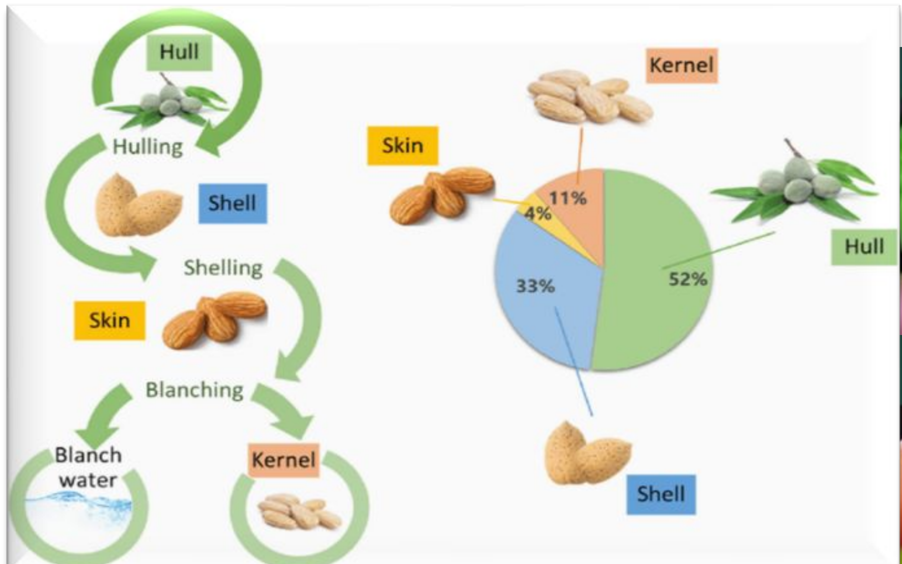
In groundnut as the deficiency of Cl- has not been reported so for, no effort was made for its diagnosis and remedial measure.



Beneficial elements

The other elements regarded as micronutrients or “beneficial elements” are

- Aluminum
- Nickel
- Cobalt
- Silicon
- Vanadium
- Fluorine
- Sodium and
- Heavy Elements

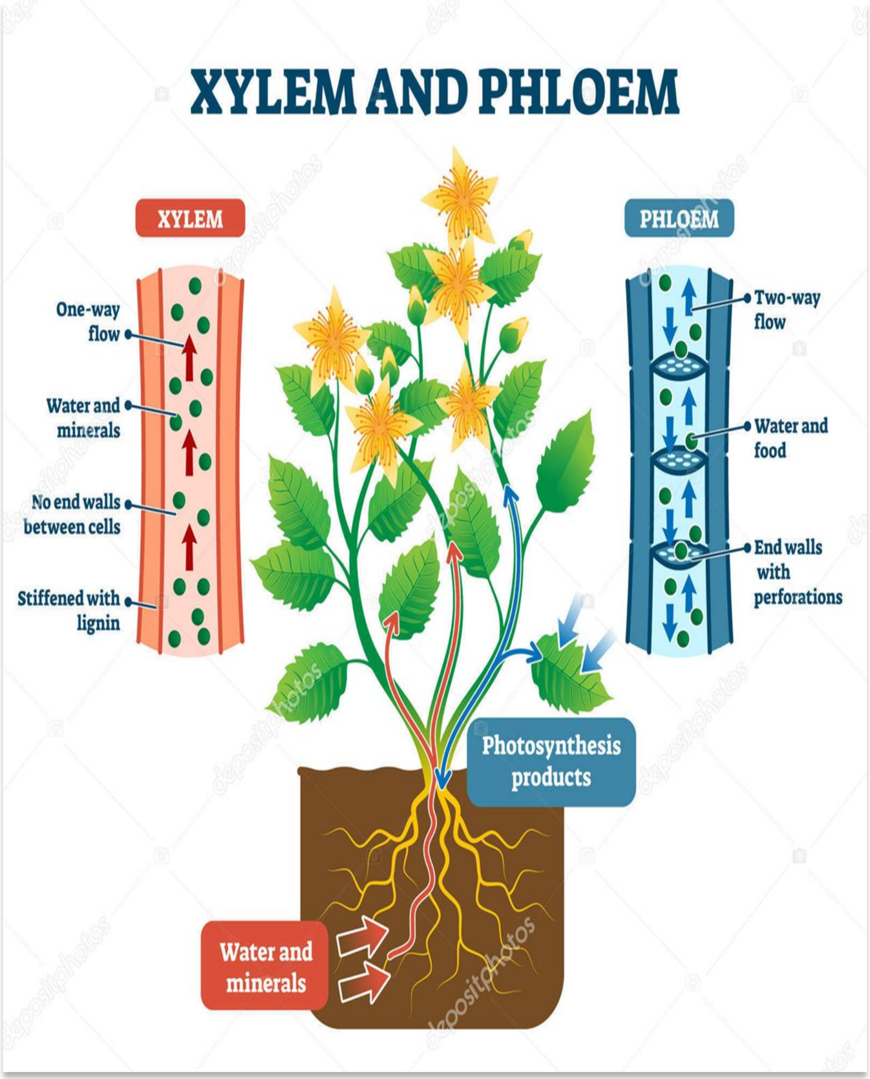


As not all these have been studied in groundnut.

Here, the description of a few beneficial elements only.

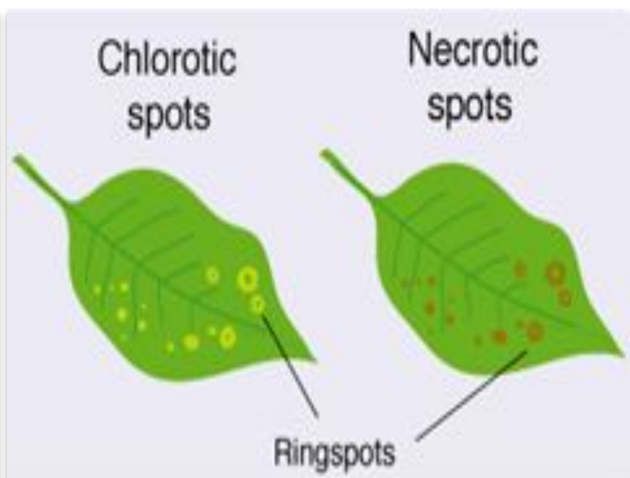
Nickel

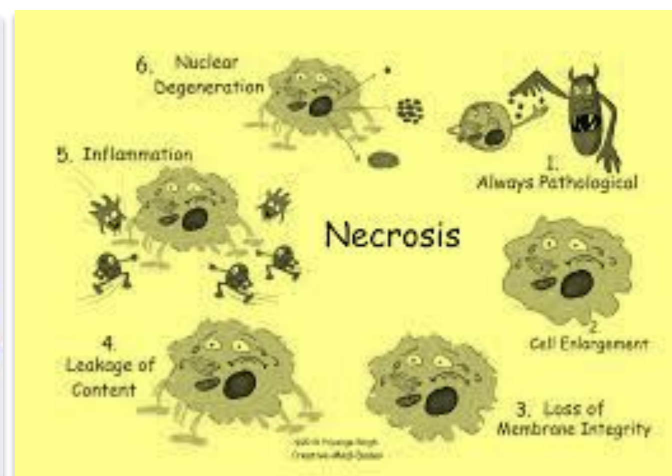
- Nickel has been recently added to the list of essential elements for plant , however its role in groundnut is being worked out. It is required in extremely small quantity.
- The Ni is known to be a component of urease and hydrogenated and needed for mobilization of nitrogen during seed germination and early seedling growth thus seeds need nickel to germinate.
- Uredines are the common form of nitrogen present in legumes which are formed in root nodules during nitrogen fixation and transported via xylem throughout the host plant and finally transported to developing seeds for storage.
- The break down of the uredines, in Ni-deficient plants, produces urea which accumulates to toxic level showing its symptoms.
- Hydrogenate, recover the hydrogen for nitrogen-fixation and Ni-deficient plant depress the nitrogen-fixation.



Cobalt

- In nitrogen fixing legumes, the cobalt is essential elements required for the symbiotic nitrogen fixing bacteria but not by the host.
- It is a constituent of vitamin B12 essential for human. Though the beneficial effect of Co in groundnut was reported about three decade ago.
- As Co is scarcely soluble at pH 6 and above, the groundnut grown in calcareous soil may show low Co.
- It is presumed that Co induce N-deficiency, however, there are no known deficiency symptoms of Co deficiency.
- Excess of Co cause chlorosis like that of Fe and Mn deficiencies as it is assumed to replace these metals from their metabolic active sites.
- High Co concentration cause pale to white colour of leaves with marginal necrosis leading to death of the pl



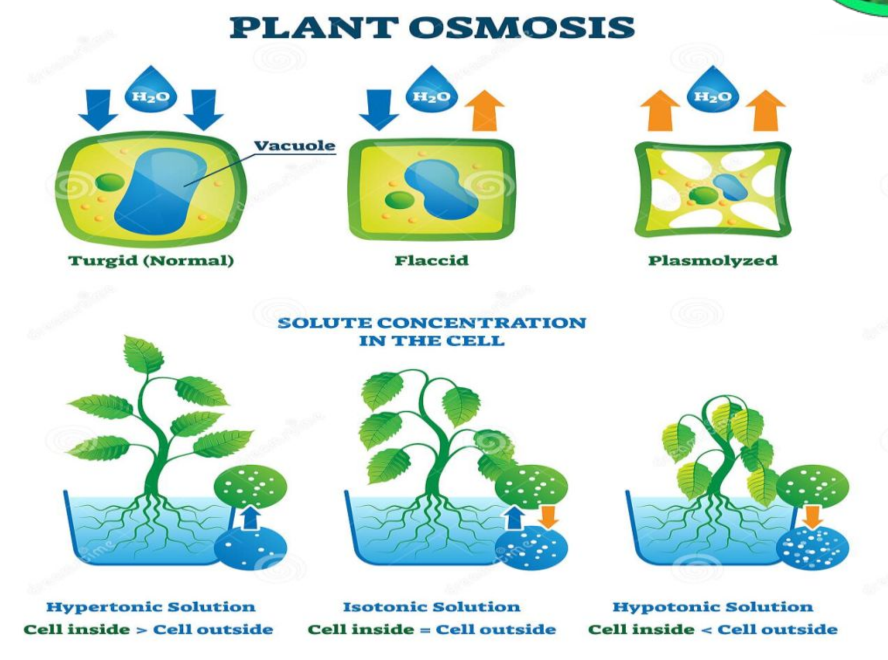


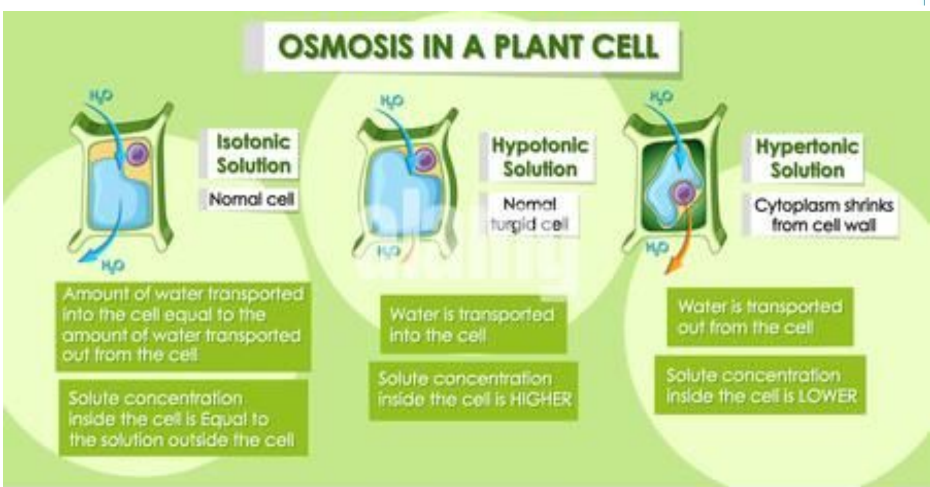
Aluminum (Al)

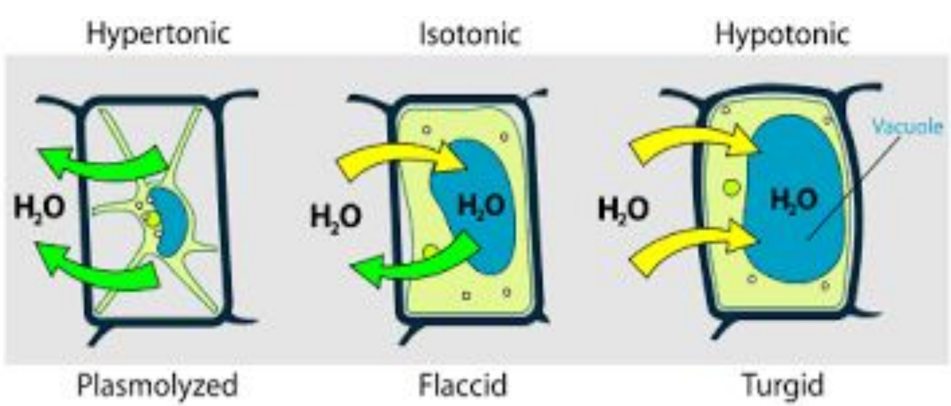
- Al is not considered a plant nutrient, its presence in plants can affect the normal function of some other elements.
- High concentration of Al cause its toxicity and Al-induced Ca and P deficiencies.
- The standardization of Al doses for its toxicity in groundnut, it was observed that **200 µM of Al** was beneficial for some of the groundnut genotypes which showed better growth at this dose than at no Al clearly indicating that some genotypes may require Al and hence possibility of tolerance of higher Al dose in groundnut might exist in nature.
- Most of the genotypes showed **Al-toxicity at 600-1000 µM of Al**.
- The Al concentration up to 200 ppm in groundnut leaf is desirable, but its levels in excess of 400 ppm is undesirable.
- The groundnut plant grown **in acid soils** showed extremely high Al-concentration (960-2500 ppm) and high Fe (1600 ppm) and Mn (1200 ppm) content and low Ca (1.5%) and P (0.15%) content in their tissues (NRCG, 2002)
- The high Al concentration measurement in field grown groundnut is sometimes due to dust and soil contamination as with Fe, probably no accurate measure of the Al status of the plant can be obtained unless the tissue is free from dust and soil contamination.
- Poor soil aeration due to compaction or flooding usually increases Al in plants.

Sodium

Sodium is involved in osmotic (water movement) and ionic balance in plants. It enhances the growth when K is deficient and is an important quality factor in feed stuff. Thus care should be taken to maintain adequate Na, the deficiency of which causes reduced growth, chlorosis and necrosis in leaves

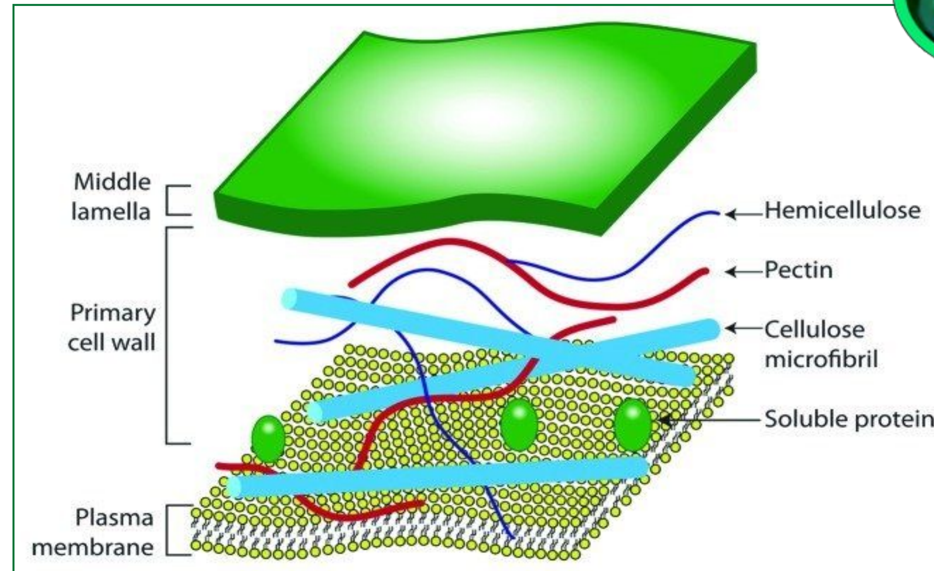


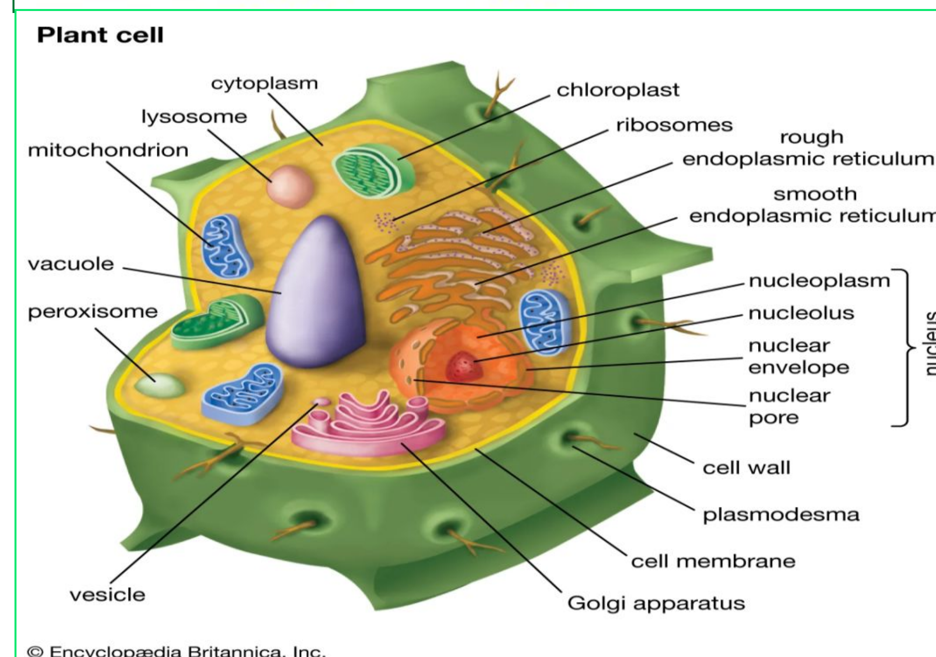




Silicon

Silicon (Si) is a component of cell walls and provide mechanical barrier to piercing - sucking insects and fungi. Foliar sprays reduce populations of aphids on some plants. Enhances leaf presentation; improves heat and drought tolerance, and reduces transpiration. The deficiency of Si cause wilting, poor fruit and flower set, increased susceptibility to insects and disease.





Organic Fertilizers and Groundnut

Soil organic matter (SOM) is a critical component of healthy soils and sustainable agricultural production.
Crops grown in healthy soils perform better and are easier to manage. Soil organic matter is 'all of the organic materials found in soils irrespective of its origin or state of decomposition' that is anything on the soil of biological origin, alive or dead. It is composed mainly of carbon (C; approximately 60%) as well as a variety of nutrients (including N, P and sulfur). It is difficult to actually measure the SOM content of soil directly so we measure the soil organic carbon (SOC) content and estimate SOM through a conversion factor:

$$\text{Soil organic matter (\%)} = \text{organic carbon (\%)} \times 1.72$$

Organic production of groundnut depend entirely on farm management techniques that helps in maintaining the soil fertility by ensuring optimised microbial activity (Jagdish Reddy.2019).This include incorporation of FYM or vermicompost into soil, crop rotation, use of cover crops, cultivation of green manure crops and using organically accepted fertilizers and pesticides that flourish the soil with nutrients and protect plants from pest and diseases (Jagdish Reddy.2019). Within some years, use of organic manures in groundnut production is going to be an inevitable process since it improves the physical, biological and chemical properties of soil along with increased water holding capacity and rise in crop productivity. Organic manure supplied to the soil during production of groundnut mainly includes green manure, neem cake, enriched compost and vermicompost. This ensures the health of plant and hence the crop yield. Seed treatment in organic farming is done using bio-fertilizers and bio-pesticides such as Rhizobium, and Trichoderma Harzianum

My Citation

1. Singh,A.L., M. S. Basu, and N. B. Singh (2004) Mineral Disorders of Groundnut; NATIONAL RESEARCH CENTRE FOR GROUNDNUT (INDIAN COUNCIL OF AGRICULTURAL RESEARCH) P.B. 5, JUNAGADH - 362 001, GUJARAT, INDIA

2.GRDC Grains Research & Development Cooperation (2017) PEANUTS, SECTION 5’ NUTRITION AND FERTILISER

3.Prakash Vaghasiya, Anjali Nair (2021) Groundnut Cultivation: A Novel Approach using Organic Input

♠ **မြန်မာဘာသာဖြင့်ဖတ်ရှုလေ့လာနိုင်သော မြေပဲသီးနှံ စာတမ်းများ**

1.စိုက်ပျိုးရေးဦးစီးဌာန (2017)မြေပဲသီးနှံစိုက်ပျိုးနည်း, REVEAL project manual

2.အောင်ဆန်း(စိုက်ပျိုးရေး); ရာသီဥတုနှင့် စိုက်ပျိုးချိန်၏ မြေပဲအထွက်နှုန်းကို လွှမ်းမိုးနေမှုများ”မြန်မာတောင်သူကြီးများဂျာနယ်

3.အောင်ဆန်း (စိုက်ပျိုးရေး), တစ်ဧကကို မြေပဲ တင်း ၁၀၀ ထွက်အောင် စိုက်ပျိုးနည်း, The Farmer Journal

4.ဆရာဆင်းသီဟ; မြေပဲသီးနှံစိုက်ပျိုးထုတ်လုပ်မှု အောင်မြင်ရေးအတွက်အဓိကအချက်များ”(နည်းပညာအခြေခံ လယ်ယာ ဖွံ့ဖြိုးရန်) တောင်သူကြီးများဂျာနယ်

5.စိုက်ပျိုးရေးသုတေသနဦးစီးဌာန၊ယာသီးနှံများသုတေသနဌာနခွဲ၊ဆီထွက်သီးနှံသုတေသနဌာနစု(28/12/2021)ထုတ်ဝေပြီး မြေပဲ မျိုးများ သရုပ်ပြစိုက်ပျိုးပြသ

6.စိုက်ပျိုးရေးဆိုင်ရာအလေ့အကျင့်ကောင်းများ (မြေပဲသီးနှံ)

7.မြန်မာနိုင်ငံ၏ပဲမျိုးစုံတင်ပို့မှုအခြေအနေ

8.“သီးနှံပင်များ ရှင်သန်ကြီးထွားရေးအတွက် အာဟာရဓာတ်များ၏ လုပ်ဆောင်ချက်များ

9.မြေပဲခင်းတွင် ဂျစ်ပ်ဆမ်(ကျောက်မှုန့်) စနစ်တကျထည့်သွင်းပါ

10. သုတကျော် (2019) ကယ်လ်စီယမ်၊ ဆာလ်ဖာနှင့် မြေပဲသီးနှံ, မြန်မာတောင်သူကြီးများ ဂျာနယ်