The Islamia University of Bahawalpur

University College of Agriculture and Environmental Sciences

SS-606 Trace Elements in Agriculture 3(2-1)

Class: B. Sc. (Hons.) Agriculture,
8th Semester, (session: Fall 2016-20)

Semester: Spring - 2020

Instructor: Dr. Zaffar Malik

Class Room: UCA&ES

Class days and timings: Practical: Monday (09:25 am-11:25 Am)
Theory: Thursday (08:30 am-09:20 am) & Friday (01:00 pm-02:00 pm)

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Course Objective: The course will cover the introduction of trace elements status of Pakistan soils and their response to various crops, assessment of trace element for micronutrients, hazardous effect of trace element to agricultural productivity and human health, their threshold levels in soil and plant and to study their impact on ecosystem along with quality standard in soil and water.

Teaching Methodology:

1. The class will be conducted in a lecture and discussion environment, where the class teacher will lead discussion and students will be encouraged to participate and ask question at the end of each class session. The theory part will be well supported by practical accordingly.
2. Students will be expected to read assignments in advance and these will be tested through quizzes and presentations in the class.
3. Teacher will be available for meeting class students immediately

THEORY

Trace elements status of Pakistan soils and their response to various crops. Use of trace elements as commercial fertilizers. Micronutrients: Forms in soils and factors affecting their availability. Trace elements in agriculture (Zn, Mn, Cu, Fe, Mo, Co, B, Cl): Nutritional aspects, availability, deficiency, toxicity and interactions. Critical limits and functions in plants and their mobility. Trace elements pollutants (Ag, As, Cd, Co, Cr, Hg, Ni, Pb, Se and V) in terrestrial and atmospheric eco-systems and their effects on plants, animal and human health. Study of National Environmental Quality Standards (NEQS) in soil and water.

PRACTICALS

Analytical test of trace elements in soil and plant. Deficiency and toxicity symptoms

BOOKS RECOMMENDED

1. Adriano, D.C. 2001. Trace elements in the Terrestrial Environment: Biogeochemistry, Bioavailability and Risks of Metals. Springer – Verlag New York, USA.
2. Bell, R.W. and B. Dell. 2008. Micronutrients for Sustainable Food, Feed, Fiber and Bio-energy Production. International Fertilizer Industry Association (IFA), Paris, France.

3. Kabata – Pendias, A. and H. Pendias. 2001. Trace Elements in Soils and Plants. 3rd Ed. CRC Press, Inc. Boca Raton, FL, USA.
4. Mortvedt, J.J., F.R. Cox, L.M. Shuman and R.M. Welch. 1991. Micronutrients in Agriculture. 2nd Ed. Soil Sci. Soc. Am. Inc., Madison, WI, USA.

COURSE CONTENTS (Theory):

Session 1	Trace elements status of Pakistan soils and their response to various crops. part -1
Session 2	Trace elements status of Pakistan soils and their response to various crops. part-2
Session 3	Micronutrients: Forms in soils and factors affecting their availability. part-1
Session 4	Micronutrients: Forms in soils and factors affecting their availability. Part-2
Session 5	Trace elements in agriculture (Zn, Mn, Cu)
Session 6	Trace elements in agriculture (Fe, Mo)
Sessions 7 & 8	Trace elements in agriculture (Co, B, Cl)
Session 9	***Mid term Examination***
Session 10	Nutritional aspects, availability, deficiency, toxicity and interaction of trace element
Session 11	Trace Element: Critical limits and functions in plants and their mobility.
Session 12	Trace elements as pollutants (Ag, As, Cd)
Session 13	Trace elements as pollutants (Co, Cr, Hg)
Session 14	Trace elements as pollutants (, Ni, Pb, Se and V)
Session 15	Effect of trace element in terrestrial and atmospheric eco-systems
Session 16	Effect of trace element on plants, animal and human health.
Sessions 17-18	Study of National Environmental Quality Standards (NEQS) in soil and water.
Session 19	***Final term examination***

Practical:

Session 1	General lab instructions
Session 2	Identification of trace element by digestion methods
Session 3	Determination of trace element in Soil
Sessions 4 & 5	Determination of trace element in plant samples
Session 6 - 8	Standard solutions and preparation of % and ppm solutions
Session 9	***Mid-term Examination***
Session 10	Deficiency and toxicity symptoms (Zn, Mn, Cu, Fe)
Sessions 11 & 12	Deficiency and toxicity symptoms (, Mo, Co, B, Cl)
Sessions 13 - 15	Deficiency and toxicity symptoms (Ag, As, Cd,)
Sessions 16 - 17	Deficiency and toxicity symptoms (Co, Cr Hg)
Session 18	Deficiency and toxicity symptoms (, Ni, Pb, Se and V)
Session 19	***Final term examination***

Testing and Grading:

1. Learning will be accomplished through lectures, class exercises, and student participation in classroom discussion and presentations.

2. Grading will tend to focus on your overall performance rather than one or two aspects. A midterm examination and a comprehensive final examination will be given.

3. Another portion of the course grade will include the discussion/attendance grade, quizzes, and/or other assignments.

4. The mid-term examination will be graded for 30% marks and final examination will have a weightage of 50% marks. 20% marks are allocated as sessional both in theory and practical separately. These will be awarded on the basis of attendance, class and practical participation, quizzes, presentations and conduct during the semester etc.

5. Attendance in classes is compulsory as per university rules. Students not meeting the required attendance will not be allowed to take the final examination.

6. Test questions may be taken from textbook readings, additional material discussed in class, questions/ answers covered in the class and practical and/or other assigned readings.

Please Note:

In the unlikely event of an unplanned absence by the instructor, the material to have been covered during that class meeting will be shifted to the next meeting. If a test was scheduled for that class meeting, the test will be given during the next class meeting. In the event of any necessary planned absences, information on schedule changes will be provided in advance.

Appointment with Instructor:
Instructor will be available for meeting class students immediately after each class, and/ or in the office by appointment made in advance.

Topic:
Micronutrient Forms in soil & factor affecting their availability in soil.

Dr. Zaffar Malik

Contents

- What are trace elements & their
- Forms in soil
- Availability
- Deficiency
- Critical limits in plants

What are trace elements?

- A chemical element present only in minute amounts in a particular sample or environment.
- Some trace elements include:
- Zinc
- Manganese
- Copper
- Iron
- Molybdenum
- Cobalt
- Boron
- Chlorine

Zinc(Zn)

- **Forms in soil**
- **Mineral form**
  - Zinc exist as zinc sulphides, Zinc carbonates, and Zinc silicates.
- **Adsorbed form**
  - Zn is adsorbed on the surface of clays, oxide minerals, carbonates and organic matters.
- **Solution form**
  - In soil solution Zn exists as Zn ion and $Zn(OH)^+$.

Organic complex form

- Zn form stable complex with organic colloids. This form is not readily available to plants.

Uptake form

- Zinc uptake by plants in the form of Zn^{+2}

Plant mobility

- Zn not readily translocated, so deficiency symptoms first appear in young leaves.

Zinc amount in plant

- 20ppm

Amount in soil

- **Range(**10 – 300 ppm) **Avg.(**50 ppm)

Functions

- It helps in plant metabolism
- Formation of growth hormone
- Have role in reproduction

Deficiency symptoms

- Retarded growth
- New leaves will be thick and small
- Spots between leaves
- Discolored veins

Manganese (Mn)

Forms in soil

- Manganese in soils is present in three oxidation states: Mn^{+2}, Mn^{+3} and Mn^{+4}.

Plant mobility

- Manganese is highly immobile in the plant so Mn deficiency symptoms are first seen in the young leaves.

Manganese amount in plant

- 50 ppm

- **Amount in soil**
  - **Range(**20 – 3,000 ppm) **Avg.(**600 ppm)
- **Uptake form**
  - Manganese uptake by plant in the form of Mn^{2+}.
- **Functions**
  - Manganese is necessary in photosynthesis
  - Take part in metabolism of plant
  - Helps in nitrogen transformation
- **Deficiency symptoms**
  - Interveinal chlorosis and young leaves die

Copper (Cu)

Form in soil

- Copper occurs in the soil almost exclusively in divalent form. Cu^{2+}

Uptake form

- copper uptake by plant in the form of Cu^{2+}

Plant mobility

- Cu is not readily translocated, so deficiency symptoms first appear in young leaves.
- Cu is immobile in soil.

Amount in soil

- copper Typical Concentrations in Soils is **2 – 100 ppm.(Avg.9ppm)**

Amount in plants

- 6ppm

Functions

- Utilization of iron in chlorophyll synthesis
- Copper is necessary for carbohydrate and nitrogen metabolism
- Enhance disease resistance in plant

Deficiency symptoms

- Young leaves will be small and permanently welt
- Multiple bud at stem tips

Iron (Fe)

- **Form in soil**
  - Ferrous oxide
  - Ferric oxide(hematite)
  - Hydrated Ferric oxide (Limonite)
- **Uptake form**
  - Iron is taken up by plants as ferrous (Fe^{2+}) or ferric (Fe^{3+}) ion
- **Plant mobility**
  - Fe is very immobile in plants, so deficiency symptoms appear in young leaves, causing stunted growth.

Iron amount in plant

- 100ppm

Functions

- Essential for chlorophyll production
- Helps to carry electron to mix with oygen and other elements

Deficiency symptoms

- Molted and interveinal chlorosis in young leaves
- Stunted growth and short stem


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for your
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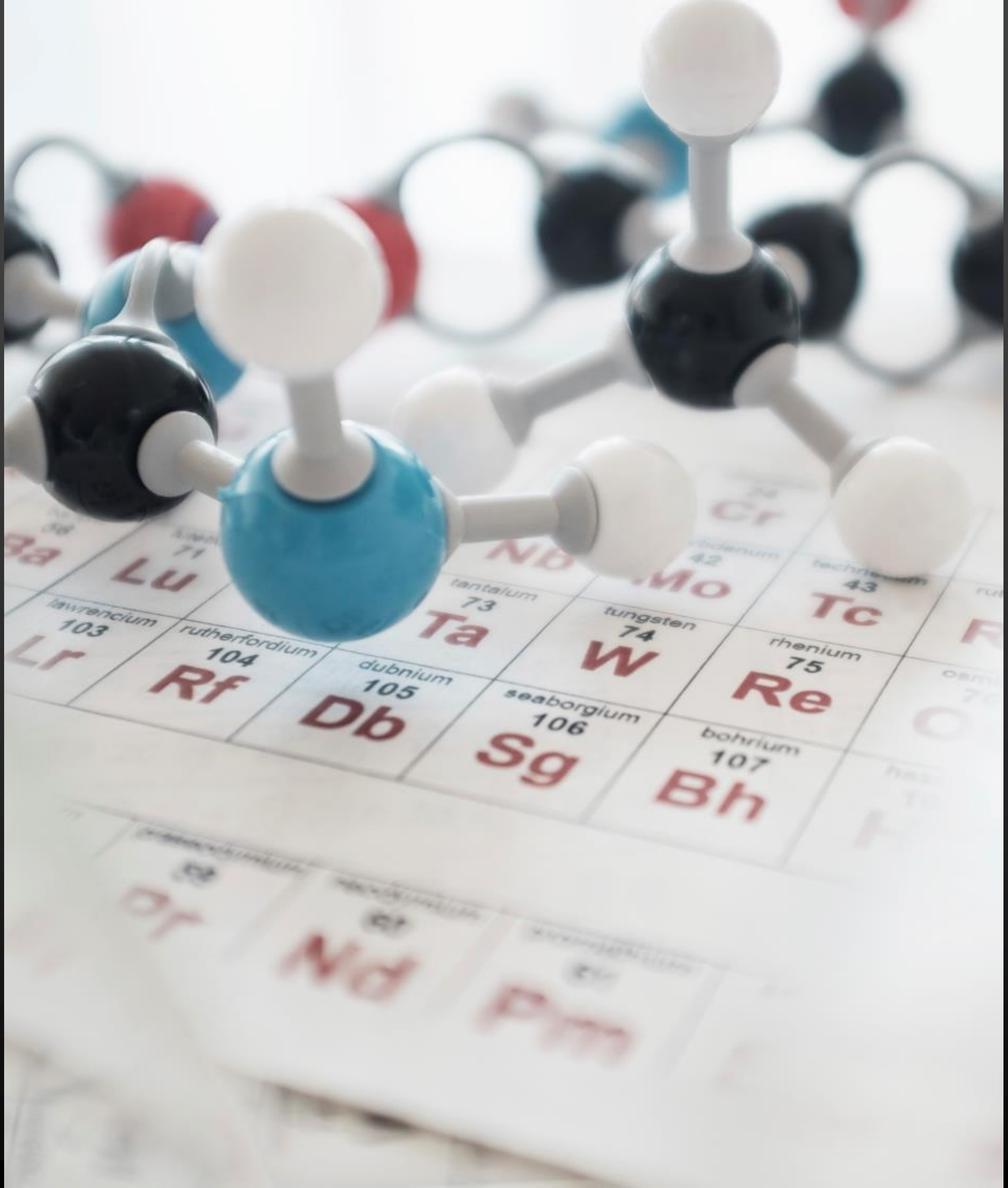
The Briefing Room

Micro-Nutrients



Micronutrients

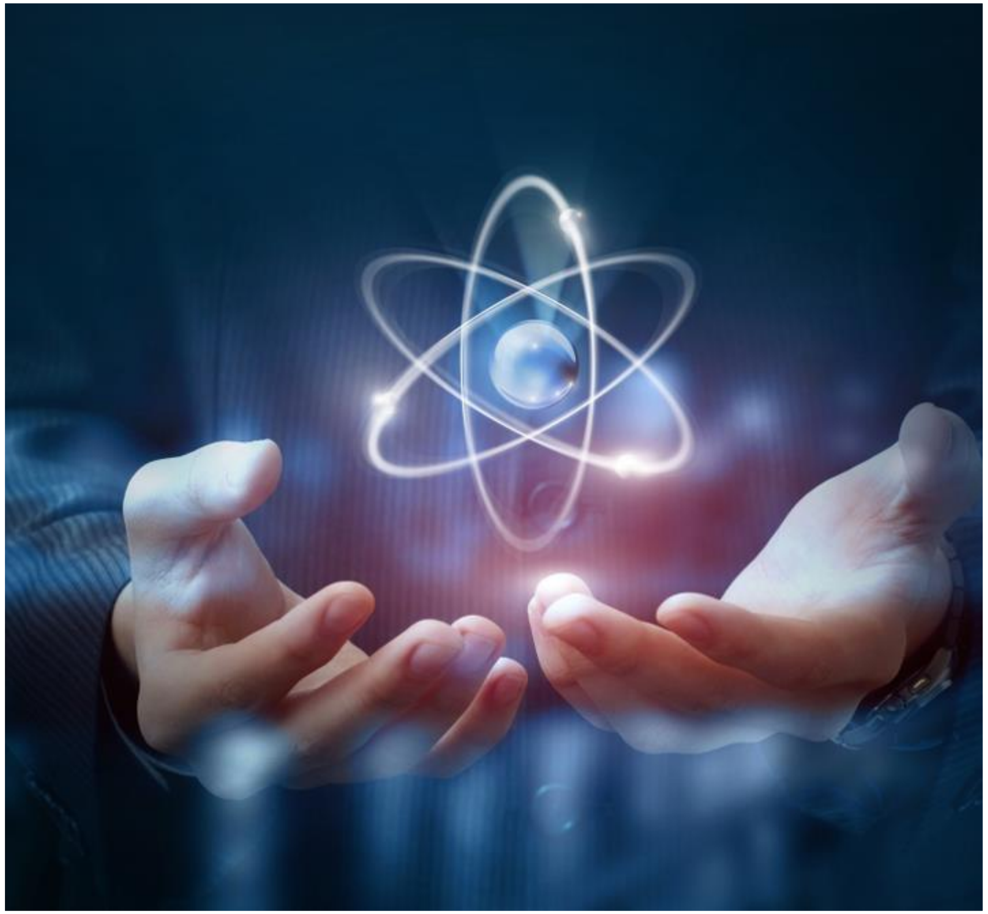
- A chemical element or substance required in trace amounts for the normal growth and development of living organisms.
- There are two types of micronutrients

➢ Cations

Copper, Iron, Manganese, Zinc

➢ Anions

Boron, Chlorine, Molybdenum



Jens Martensson

Boron

- Typically in organic residues, released through decomposition
- Found as anion BO3-or B(OH)3in soil water (for uptake)
- This form leaches easily since soils are negatively charged
- It is an anion so it can be leach down easily from organic matter and boron fertilizer

Jens Martensson

Chlorine

- Often the matching anion salt (Cl-) to soil cations (think KCl)
- Negative charge means it doesn't absorb to soil, so it moves with water flow
- Leaches, but soils must have a balanced charge

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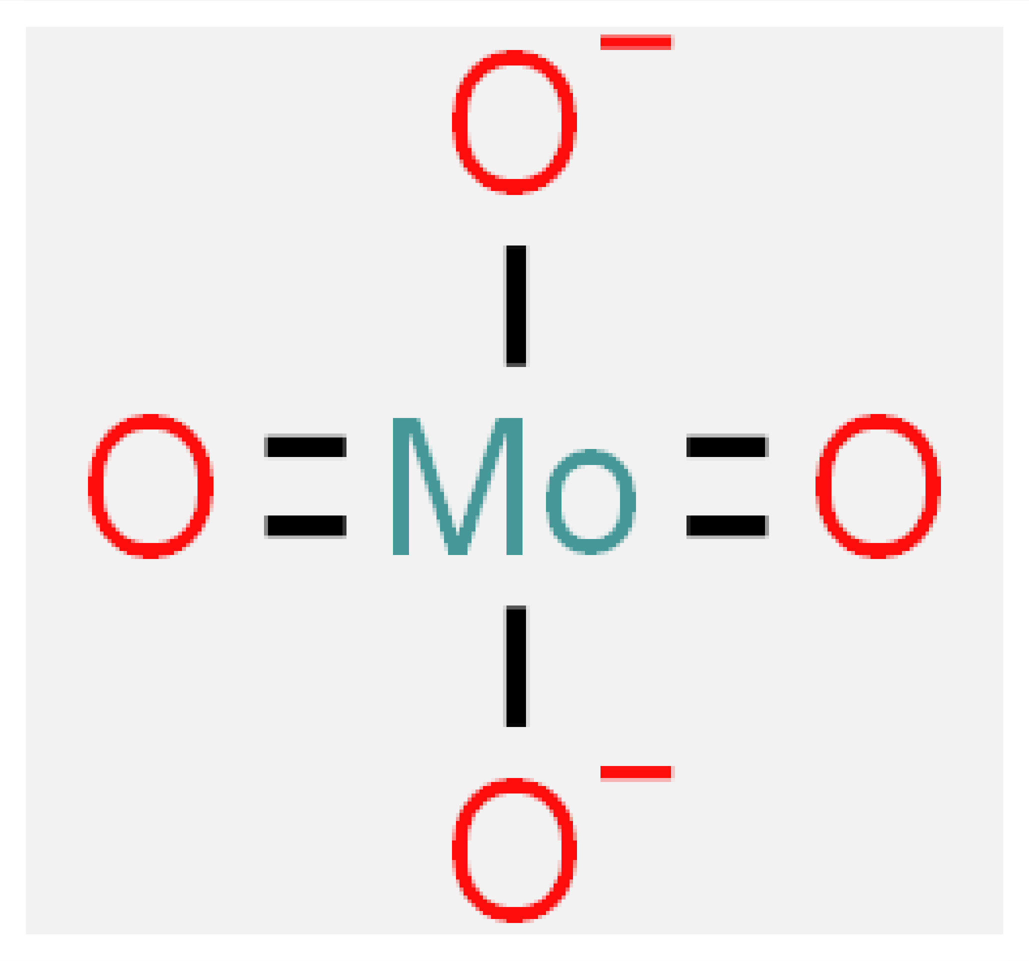
Molybdenum

- MoO4-2 is an anion, so it leaches from soil easily
- Absorbs to iron and aluminum oxides



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Factors affecting availability

There are some factors which affects the availability of soil micronutrients.

- Organic matter
- Soil minerals
- Soil pH
- Soil reduction state
- Cation Exchange Capacity

Factors affecting availability

Organic matter

- Organic matter is very complex
- It may breakdown and release micronutrients
- It may hold micronutrients on its CEC
- It may chelate micronutrients making them more or less available
- Breakdown of organic residues adds micronutrients
- Residues may also produce compounds that increase availability (chelate)
- Or decrease availability (Mn)

Factor affecting availability

Soil minerals

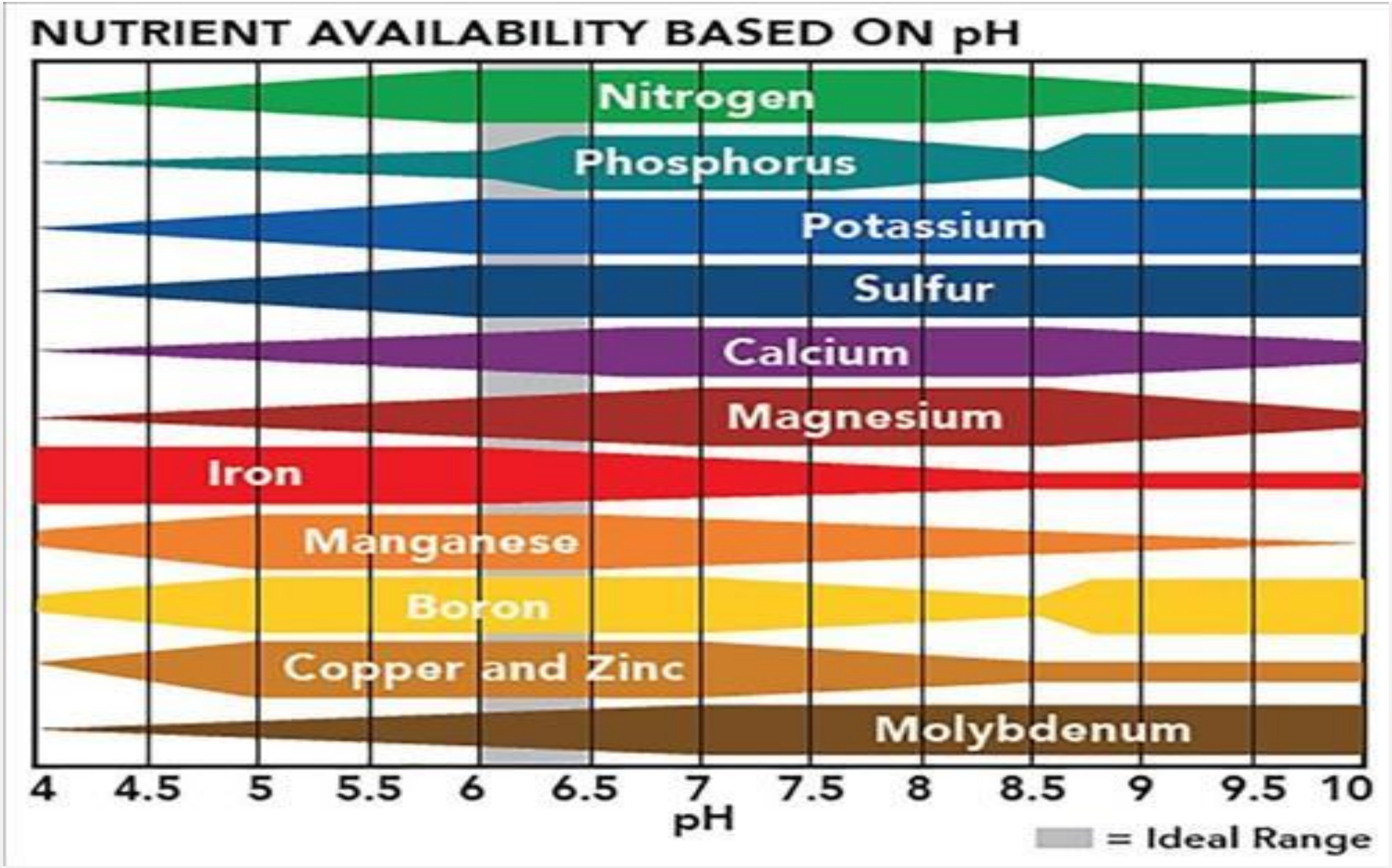
- It is often controlled by pH or reduction.
- For example: at lower pH Fe minerals that coat soil surfaces will dissolve and release free Fe (pH < 5.0)
- Or saturated soils or enzymes may reduce red $Fe^{+3}$to soluble/non-visible Fe^{+2}

Jens Martensson

Factors affecting availability

Soil pH

- The reasons are complex
- In some cases they become solid minerals *Cu(OH)2instead of Cu+2Plants take up ions
- They may absorb to sites on soil minerals and organic matter



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Soil usually high in micronutrients

- Igneous parent material or other rocks high in nutrients
- Clay soils with high CEC or micronutrients in the mineral structure
- Soils with high organic matter (that provide micronutrients through breakdown)

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Soil usually low in micronutrients

- Parent materials low in micronutrients – sandstones, alluvial sandy soils
- Weathered acid soils –where leaching has removed micronutrients
- Sandy soils with low CEC and low micronutrients in the mineral structures
- Organic matter with insoluble humin material that chelates metals and makes them unavailable (no silver bullet!)

USE OF TRACE ELEMENTS AS A COMMERCIAL FERTILIZERS

Forms of Trace Elements Fertilizers

Water Soluble
Trace Element
Fertilizer Mixture

Liquid & Powder
Fertilizer

Multi-Chelated
Micronutrient-Mixture
Fertilizer(Complete EDTA
Chelate)

Blended Fertilizers

Advantages of Trace elements' fertilizer

- Both single and multiple nutrient fertilizers can be blended to obtain a desirable fertilizer grade or ratio fertilizer particles of the same nutrient content, color, and size.
- Advantages of liquid fertilizers are that they can be diluted or concentrated for precise, even application and are easily handled by pumps and machinery. Liquid fertilizers are commonly applied through irrigation water.
- Liquid fertilizers are applied on a volume rather than a weight basis.
- Some solid fertilizers may be coated with a polymer to provide a controlled release of nutrients and greater nutrient efficiency. These specialty fertilizers may not be cost effective for many agricultural systems, but are suitable for horticultural applications or high value cropping system.

Importance of Trace Elements as commercial fertilizers

- ✓ Trace elements are minerals present in living tissues in small amount.
- ✓ All trace elements are toxic if consumed at sufficiently high level for long enough period .
- Commercial fertilizer and amendment use increased substantially worldwide during the latter half of the 20th century and continues to increase into the 21st century.
- As a result, numerous products have emerged, offering a variety of nutrient contents, physical forms, and other properties to meet individual needs.

Trace elements

A chemical element required only in minute amounts by living organisms for normal growth.

Boron

Liquid Boron Fertilizer

- Boron is an individually formulated liquid boron fertilizer made to correct boron deficiencies. Boron deficiencies can be extremely problematic for some crops. Without boron, fruits may lose their shape, firmness, color, and flavor. This can also cause a reduction in seed and grain number and quality.

Item	Formula 1	Formula 2
PH	7-9	7-9
Specific gravity	1.24-1.29	1.34-1.40
B_2O_3	200 g/L	400 g/L
N	40 g/L	50 g/L
Organic matter	200 g/L	200 g/L
Seaweed extract	200 g/L	200 g/L
Appearance	Black brown liquid	Black brown liquid

Boron Liquid

1.Correct Boron deficiency.

2. Involved in the synthesis of cell wall composing.

3. Promote pollen viability, seed set and fruit set.

4. Protect flower and fruit from shedding.

5. Increase nitrogen uptake for plant.

Liquid Iron Fertilizer

- Liquid iron fertilizer can be used to correct iron deficiencies even in alkaline soils. This is made possible through our Flavonol Polymer Technology, which protects nutrients in a plant-based polymer. These polymer chains prevent nutrients from bonding with soil ions, which makes them unusable to plants.
- Iron is an essential nutrient to all plants. It helps to stimulate chlorophyll production, which is why iron-deficient plants will have a yellow tint.
- It is also a key oxygen carrier. Without iron, the crops' respiratory efficiency decreases, which slows cell growth and the transfer of sugars through the plant. Because of its essential role, liquid iron fertilizer is included in a variety of other macro- and micronutrient fertilizer blends.

Liquid Iron Fertilizer

1.Rapidly supplement organic nutrition to leaves, efficiently avoid chlorosis.

2. Prevent leaves from aging and falling.

3. Help leaves to grow green and fleshy.
4. Promote photosynthesis.
5. Increase plant ability to resist disease

6.Chlorophyll development
7.Oxygen transfer

8.Respiration

Manganese

Manganese Sulfate Fertilizer

- manganese sulfate fertilizer works in tandem with other nutrients to improve total nutrient intake and use. Manganese is required for plants to make chlorophyll, which makes it essential for photosynthesis.
- The addition of manganese sulfate fertilizer also helps plants take in additional phosphorus and calcium. This helps to speed up germination and time to maturity. In some crops, manganese sulfate fertilizer can help growers access early market prices or even take in additional harvests.
- Manganese deficiencies are especially problematic for soybeans. This appears in young plants as a yellowing between veins, and then becomes black or brown spots. If it is not corrected, manganese deficiencies will kill some plants and reduce yields.

Manganese Zinc mix fertilizer

1.Promote synthesis of chlorophyll and proteins.

2. Promote photosynthesis and nitrogen metabolism.

3. Prevent leaves and shoots from stunting.

4. Enhance plants resistance to disease
5.Nutrient intake

6.Chlorophyll production

7.Early germination
Faster growth

Zinc

Zinc Sulfate Fertilizer

- liquid zinc fertilizer supports strong growth during critical stages. Zinc is needed for the production of enzymes and proteins which control the growth of stems, leaves, fruits, and seeds. A zinc deficiency will stunt crop growth noticeably, and restoring zinc can dramatically improve growth, plant health, and yield.
- Zinc deficiencies pose unique obstacles to growers and farmers. A zinc deficiency is not always visible, and when it is visible it can be easily confused with other issues.
- liquid zinc fertilizer is designed to resist ionizing in the soil, so it stays usable for plants. By directing applying zinc sulfate fertilizer with other nutrients, you can prevent zinc deficiencies from stunting future crop growth.

Commonly used zinc fertilizers

Sources	Zinc content
Zinc sulphate heptahydrate	21-23 %
Zinc sulphate monohyadrate	33-36%
Zinc oxysulphate	40-55%
Zinc oxide	55-70 %
Zinc nitrate	22%
Zn-EDTA	12-14 %
Zn- HEDTA	9 %

Zinc Sulfate Fertilizer

1.Supports production of proteins and enzymes needed for growth

2.Full growth potential

3.Full seed and fruit potential

4.Plant health

5.Disease, drought and stress resistance

Contoso

Sodium Molybdenum Fertilizer

- sodium molybdenum fertilizer helps to improve nitrogen utilization in a variety of crops. Compared to other micronutrients, moly is needed in the smallest amounts. However, plants that do not have access to moly cannot properly process nitrogen, a vital macronutrient.
- Molybdenum plays a key role in converting nitrogen and phosphorus into amino acids. For this reason, symptoms of a moly deficiency are very similar to a nitrogen deficiency. The leaves of the plant will be misshapen, leaf edges will turn yellow, and flowering, fruiting, and the production of fruit, flowers, and seeds will slow.
- Legumes, cruciferous vegetables, and ornamental plants are particularly vulnerable to a molybdenum deficiency. While plant damage from moly toxicity is very rare, plants with excessive molybdenum can be toxic to cattle.
- Our liquid molybdenum fertilizer is derived from sodium molybdate. It is essential for processing nitrogen. For this reason, it is ideal to combine with nitrogen fertilizers.

Sodium Molybdenum Fertilizer

1. Processing nitrogen
2. Processing inorganic phosphorus
3. Growth of beneficial bacteria
4. Full flower, fruit, and seed development
5. Proper leaf growth

Copper

Copper Sulfate Fertilizer

- copper sulfate fertilizer gives plants a usable supply of copper at any growth stage. Without copper, vital enzymes needed for photosynthesis will deteriorate. This will stunt the plant’s growth, cause leaves to die, and reduce yields. Symptoms of copper deficiency will appear in leaves; they will turn light green before they curl and die.
- Our copper sulfate fertilizer can be safely combined with other micro- or macronutrients to reduce manpower and time. It can also be applied in a variety of ways. Speak with an agronomist to learn about the most efficient method for your crops.

Copper Sulfate Fertilizer

1.Photosynthesis

2.Chlorophyll formation

3.Healthy leaves

4.Sustained growth

THANK YOU


بسم الله الرحمن الرحيم

Heavy metals as pollutant


Heavy Metals

Preamble:

✓

Heavy metal are natural constituents of the earths crust .but indiscriminate human activities have drastically altered their geochemical cycles and biochemical balance. Any toxic metals may be called heavy metals.

✓

Since heavy metal have a propensity to accumulate in selective body of organs. The average safety levels in food and water are often misleading high.

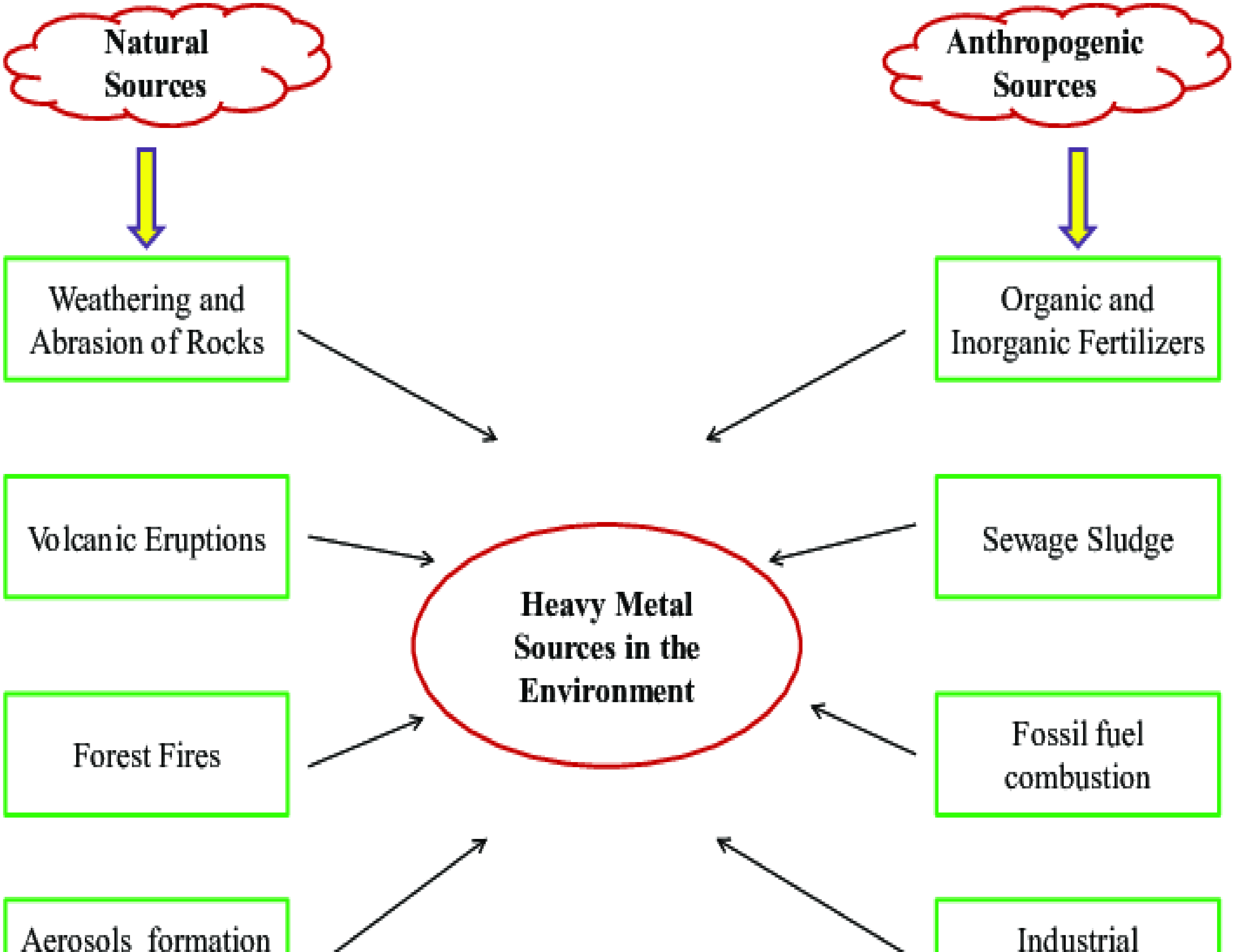
What are Heavy Metals?

Heavy metals are present in earth's crust alongside other metals, minerals, and organic matter. Some examples include: mercury, lead, arsenic, cadmium, chromium, copper, & thallium.

Heavy metals are **defined** as "heavy" in comparison to water, meaning that they have a higher molecular weight than **18 g/mol**. Heavy metals also find their way into watersheds from concentrated wastewater, sewage, industrial activities, and mining operations.

These metals can contaminate soil systems and water sources.

Sources of heavy metal pollutants


Natural Sources
Anthropogenic Sources
Weathering and Abrasion of Rocks
Organic and Inorganic Fertilizers
Volcanic Eruptions
Sewage Sludge
Heavy Metal Sources in the Environment
Forest Fires
Fossil fuel combustion
Aerosols formation
Industrial

- Arsenic is an element that is detected at low concentrations in virtually all environmental matrices. The major inorganic forms of arsenic include the trivalent arsenite and the pentavalent arsenate.

CRITICAL LIMIT

- Arsenic concentrations in air range from 1 to 3 ng/m^3 in remote locations (away from human releases), and from 20 to 100 ng/m^3 in cities.

- Its water concentration is usually less than 10µg/L, although higher levels can occur near natural mineral deposits or mining sites.

- Its concentration in various foods ranges from 20 to 140 ng/kg .

- Natural levels of arsenic in soil usually range from 1 to 40 mg/kg.

Sources of exposure

- **Drinking-water and food**
- **Industrial processes**
- **Tobacco**

Effect on human health

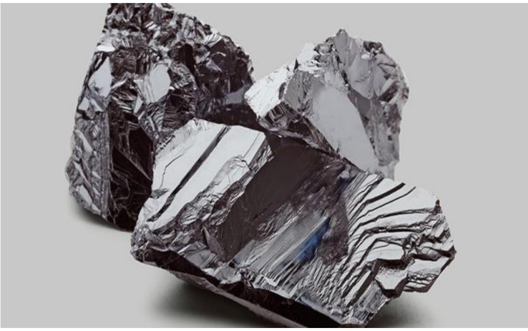
- Long-term exposure to arsenic from drinking-water and food can cause cancer and skin lesions. cardiovascular disease and diabetes.
- Damage to the nervous system.
- Inhalation can also cause lung cancer.
- Hearing loss

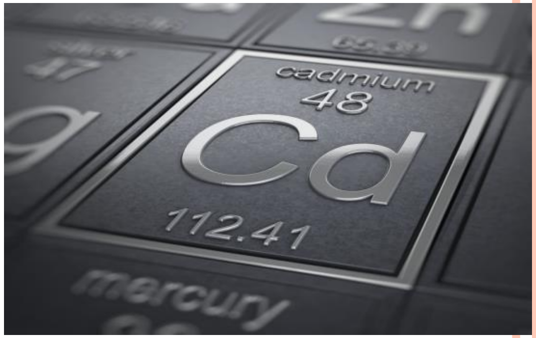
Effect on environment

- The **effects** include death, inhibition of growth, photosynthesis and reproduction, and behavioral **effects**.
- **Environments** contaminated with **arsenic** contain only a few species and fewer numbers within species.
- If levels of **arsenate** are high enough, only resistant organisms, such as certain microbes, may be present

CADMIUM

- Cadmium is a heavy metal of considerable environmental and occupational concern.





- It is widely distributed in the earth's crust at an average concentration of about 0.1 mg/kg.

- The highest level of cadmium compounds in the environment is accumulated in sedimentary rocks, and marine. phosphates contain about 15 mg cadmium/kg.

- Cadmium is frequently used in various industrial activities. The major industrial applications of cadmium include the production of alloys, pigments, and batteries

SOURCE

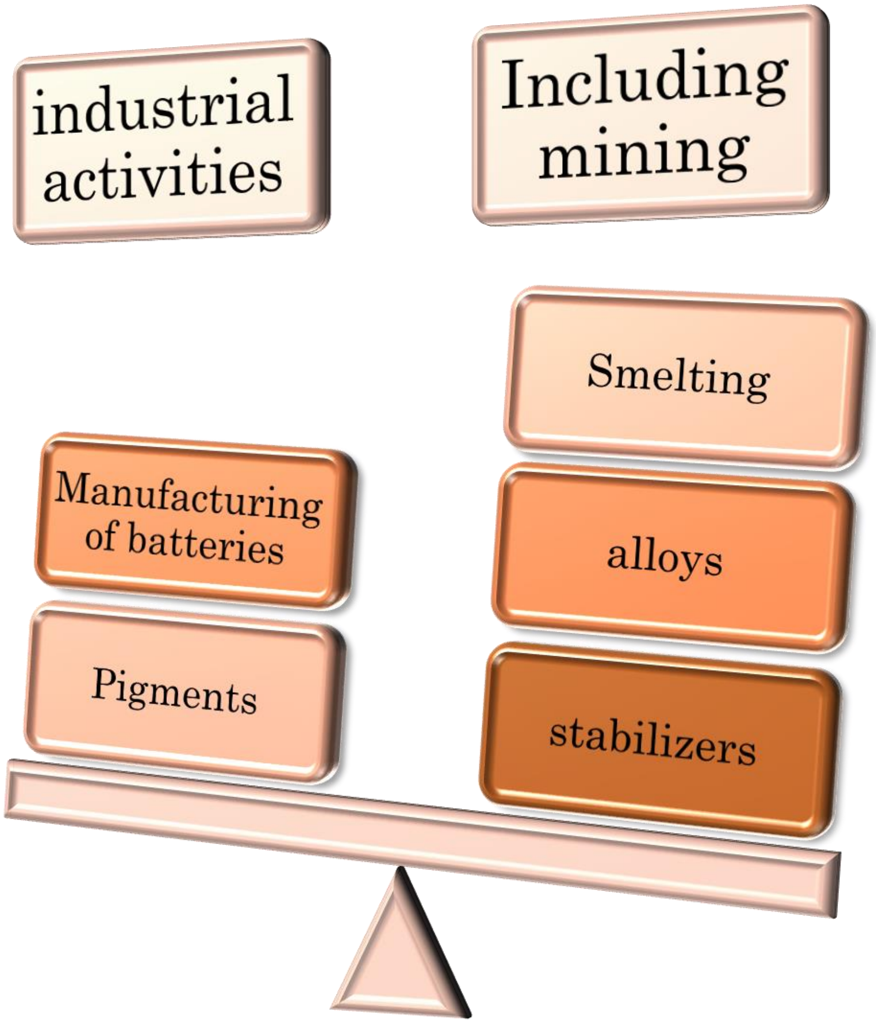
- The main routes of exposure to cadmium are via inhalation or cigarette smoke, and ingestion of food.

- Employment in primary metal industries
- Smoking cigarettes
- Eating contaminated food
- Skin absorption is rare

- Working in cadmium-contaminated work places, with smoking being a major contributor.

Continue….

- Other sources of cadmium include



Effect on human health

Exposure to cadmium is commonly determined by measuring cadmium levels in blood or urine.

Cadmium is a severe pulmonary and gastrointestinal irritant, which can be fatal if inhaled or ingested.

After acute ingestion, symptoms such as

- Abdominal pain,
- Burning sensation
- Vomiting
- Muscle cramps
- Shock,

- Loss of consciousness and convulsions usually appear within 15 to 30 min.

Chromium

- Chromium (Cr) is a naturally occurring element present in the earth's crust, with oxidation states (or valence states) ranging from chromium (II) to chromium (VI).

- Chromium compounds are stable in the trivalent [Cr(III)] form and occur in nature in this state in ores, such as ferrochromite.

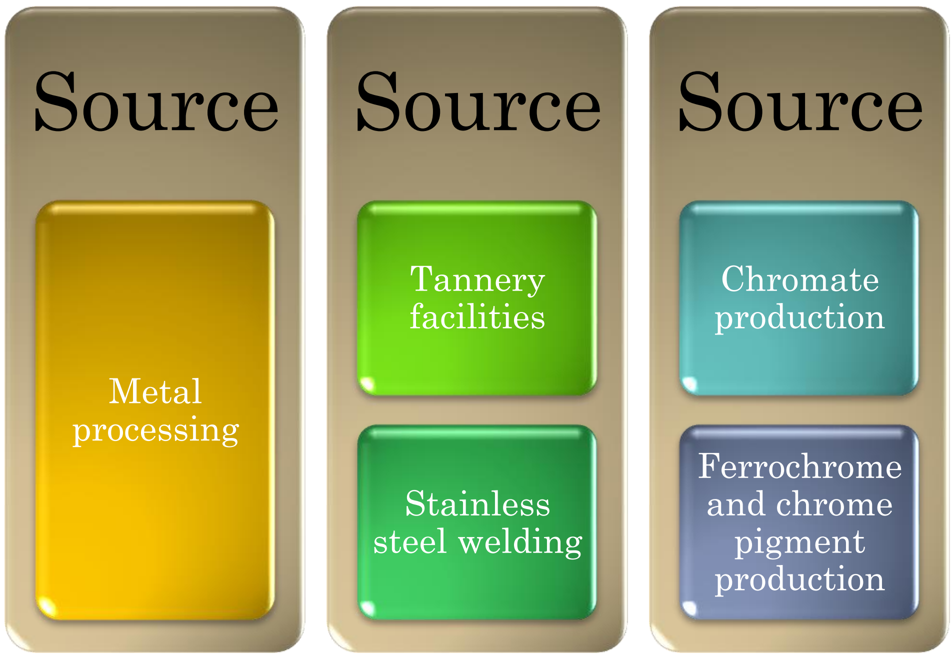
- **Chromium Concentration**

- Chromium concentrations range between 1 and 3000 mg/kg in soil, 5 to 800 µg/L in sea water, and 26 µg/L to 5.2 mg/L in rivers and lakes.

- Elemental chromium [Cr(0)] does not occur naturally. .
- Chromium enters into various environmental matrices (air, water, and soil)

Continue… sources

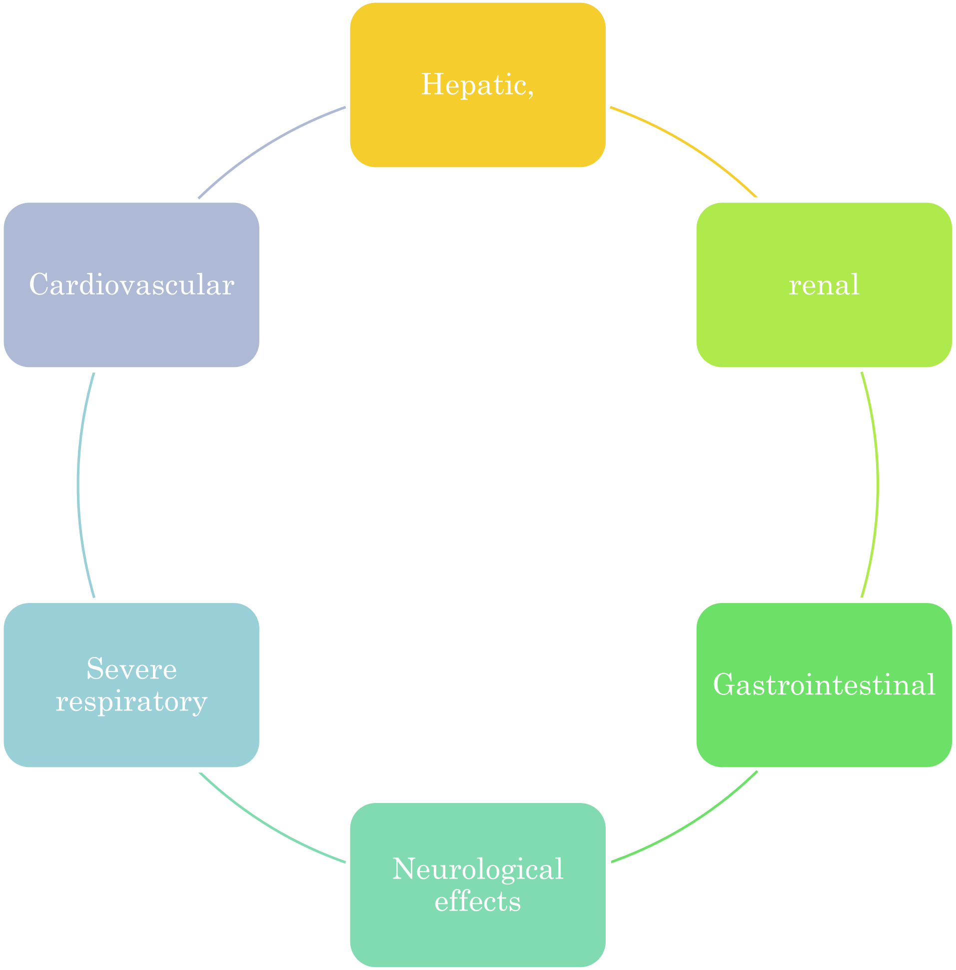
- largest release coming from industrial establishments. Industries with the largest contribution to chromium release include



- The increase in the environmental concentrations of chromium has been linked to air and wastewater release of chromium.

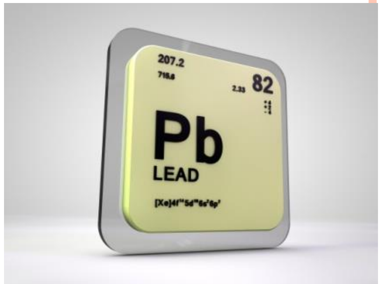
Effect on human health

- Extremely high doses of chromium (VI) compounds by humans has resulted in



LEAD

- Lead is a naturally occurring bluish-gray metal present in small amounts in the earth's crust.
- Although lead occurs naturally in the environment.



- Anthropogenic activities such as fossil fuels burning, mining, and manufacturing contribute to the release of high concentrations.

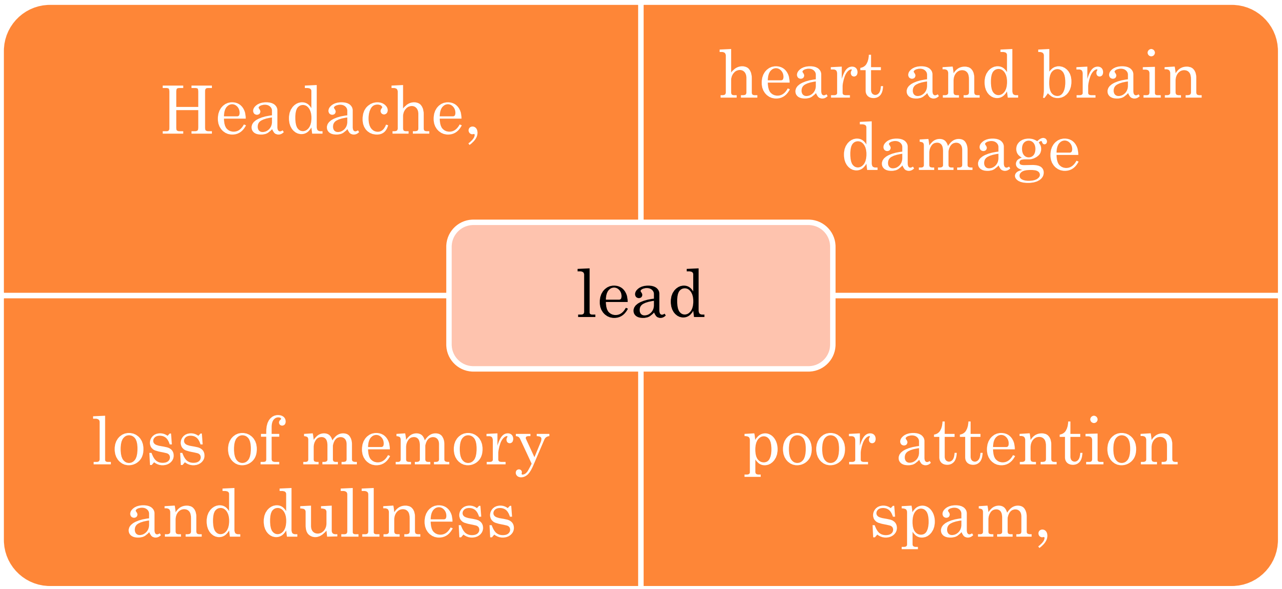
- Lead has many different industrial, agricultural and domestic applications.

- exposure to lead occurs mainly via inhalation of lead-contaminated dust particles or aerosols, and ingestion of lead-contaminated food, water, and paints .

- Adults absorb 35 to 50% of lead through drinking water and the absorption rate for children may be greater than 50%.

- Lead absorption is influenced by factors such as age and physiological status

- In the human body, the greatest percentage of lead is taken into the kidney, followed by the liver and the other soft tissues such as heart and brain, however, the lead in the skeleton represents the major body fraction.



- The nervous system is the most vulnerable target of lead poisoning.
- are the early symptoms of the effects of lead exposure on the central nervous system.

Effect of heavy metals on environment

- Heavy metals are toxic to soil, plants, aquatic life and human health if their concentration is high in the compost.
- Heavy metals exhibit toxic effects towards soil biota.
- . Uptake of heavy metals by plants and subsequent accumulation along the food chain is a potential threat to animal and human health.
- Contaminants in aquatic systems, including heavy metals, stimulate the production of reactive oxygen species (ROS) that can damage fishes and other aquatic organisms.
- Hence the compost has to be use for agriculture it should be free from heavy metals.
- Therefore, the present study evaluated the effects of heavy metal containing compost on soil, plants, human health and aquatic life.

Conclusion

- Above data indicates that heavy metals such as arsenic cadmium, chromium, lead, and mercury, occur naturally.
- However, anthropogenic activities contribute significantly to environmental contamination.
- These metals are systemic toxicants known to induce adverse health effects in humans, including cardiovascular diseases, developmental abnormalities, neurologic and neurobehavioral disorders, diabetes, hearing loss, hematologic and immunologic disorders, and various types of cancer. The main pathways of exposure include ingestion, inhalation, and dermal contact.
- Toxic metals exposure causes long term health problems in human populations


Thank you

HEAVY METALS AS POLLUTANTS

Department of Soil Sciences

HEAVY METALS

What are Heavy Metals?
Heavy metals are present in earth's crust alongside other metals, minerals, and organic matter. Some examples include: mercury, lead, arsenic, cadmium, chromium, copper, & thallium. Heavy metals are **defined** as "heavy" in comparison to water, meaning that they have a higher molecular weight than **18 g/mol**. Heavy metals also find their way into watersheds from concentrated wastewater, sewage, industrial activities, and mining operations. These metals can contaminate soil systems and water sources.

Heavy Metals which I have to discuss are given below.

1. Copper
2. Mercury
3. Nickel
4. Silicon
5. Silver

COPPER

Copper is a very common substance that occurs naturally in the environment and spreads through the environment through natural phenomena. Humans widely use copper. For instance it is applied in the industries and in agriculture. The production of copper has lifted over the last decades. Due to this, copper quantities in the environment have increased.

Routes of exposition

- Many kinds of foods
- Drinking water
- Air
- Addition in water through corrosion of pipes

EFFECT ON ENVIRONMENT

- Copper does not break down in the environment and because of that it can accumulate in plants and animals when it is found in soils.
- On copper-rich soils only a limited number of plants has a chance of survival.
- Copper can seriously influence the proceedings of certain farmlands, depending upon the acidity of the soil and the presence of organic matter.
- The decomposition of organic matter may seriously slow down because of this
- When the soils of farmland are polluted with copper, animals will absorb concentrations that are damaging to their health.
- Mainly sheep suffer a great deal from copper poisoning, because the effects of copper are manifesting at fairly low concentrations.

EFFECT ON HUMAN HEALTH

- Irritation of nose, mouth and eyes
- Headaches
- Stomachaches
- Dizziness
- Vomiting
- Diarrhea
- Liver & kidney damage

MERCURY

It rarely occurs free in nature and is found mainly in cinnabar ore (HgS) in Spain, Russia, Italy, China and Slovenia. Mercury is a compound that can be found naturally in the environment. It can be found in metal form, as mercury salts or as organic mercury compounds. Mercury enters the environment as a result of normal breakdown of minerals in rocks and soil through exposure to wind and water.

Routes of exposition

- Fish
- Cattle breeding products
- Mercury spray on crops

EFFECT ON ENVIRONMENT

- Once mercury has reached surface waters or soils micro-organisms can convert it to methyl mercury, a substance that can be absorbed quickly by most organisms and is known to cause nerve damage.
- Fish are organisms that absorb great amounts of methyl mercury from surface waters every day. As a consequence, methyl mercury can accumulate in fish and in the food chains that they are part of.
- The effects that mercury has on animals are
- ✓kidneys damage
- ✓stomach disruption
- ✓damage to intestines
- ✓reproductive failure
- ✓DNA alteration.

EFFECT ON HUMAN HEALTH

- Brain & Kidney damage
- Lung irritation
- Skin rashes
- Disruption of the nervous system
- Damage to brain functions
- DNA damage and chromosomal damage
- Allergic reactions, resulting in skin rashes, tiredness and headaches
- Negative reproductive effects, such as sperm damage, birth defects and miscarriages

NICKEL

Most nickel on Earth is inaccessible because it is locked away in the planet's iron-nickel molten core, which is 10 % nickel. The total amount of nickel dissolved in the sea has been calculated to be around 8 billion tons. Organic matter has a strong ability to absorb the metal which is why coal and oil contain considerable amounts. The nickel content in soil can be as low as 0.2 ppm or as high as 450 ppm in some clay and loamy soils. The average is around 20 ppm.

Route of exposition

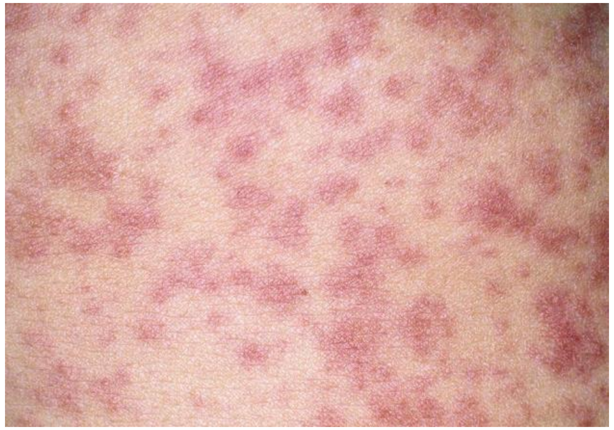
- Chocolate
- Vegetables from polluted soil
- Smoking
- Detergents

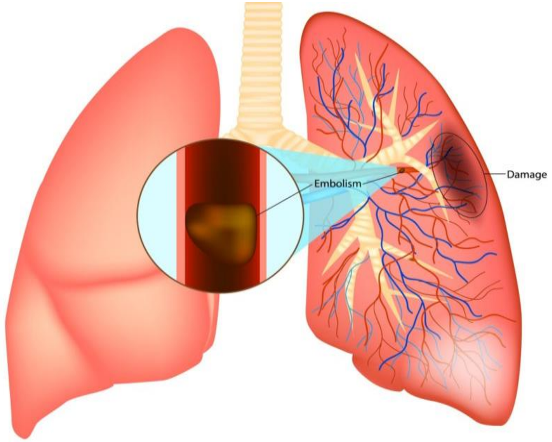
EFFECT ON ENVIRONMENT

- The larger part of all nickel compounds that are released to the environment will adsorb to sediment or soil particles and become immobile as a result.
- High nickel concentrations on sandy soils can clearly damage plants and high nickel concentrations in surface waters can diminish the growth rates of algae.
- In acidic ground however, nickel is bound to become more mobile and it will often rinse out to the groundwater.

EFFECT ON HUMAN HEALTH

- Different types of cancer
- Lung embolism
- Sickness
- Respiratory failure
- Birth defects
- Asthma
- Chronic bronchitis
- Allergic reactions
- Heart disorders





SILICON

The silicon is much more abundant than any other element, apart from the oxygen. It constitutes 27,72% of the solid Earth's crust, while the oxygen constitutes 46,6%, and the next element after silicon, aluminium, is found in a 8,13%.

Sand is used as source of the silicon produced commercially. A few siliate minerals are mined, e.g. talc and mica. Other mined silicates are feldspars, nephenile, olivine, vermiculite, perlite, kaolinite, etc.

Route of exposition

- Glass
- Cement
- Ceramics etc.

EFFECT ON HUMAN HEALTH

- Irritation of skin
- Lung cancer
- Chronic pulmonary diseases
- Skin inflammation
- Arthritis
- Renal diseases
- Mycobacterial infections

بسم الله الرّحمن الرّحيم

Dr. Zaffar Malik

Role of Selenium in Environment

Selenium

- Selenium is a nonmetal (rarely metalloid)
- properties intermediate between the elements above and below in the periodic table, sulfur and tellurium.
- has similarities to arsenic.

CHEMICAL PROPERTIES

- Atomic number 34   Chemical symbol: Se
- 4 oxidative states
  - Elemental Se (0)
  - Selenide(-2)
  - Selenite (+4)
  - Selenate (+6)
- Inorganic forms: selenate, selenite (found in water)
- Organic forms: selenomethionine, selenocysteine(found in veggies and cereal)

PHYSICAL PROPERTIES

- Grey metallic to a reddish glassy appearance
- Found in various rocks and minerals, coal, and oil

HISTORY, USES, and APPLICATIONS

- 1817- Jons Jacob Berzelius- a Swedish Chemist isolated and identified Se
- Medical use: dietary supplement
- Applications:
  - manufacturing of ceramics, glass, pigments, semiconductors, and steel
  - Used in photography and pharmaceutical production

MODE OF ENTRY
Into the Environment:

Water:

- -Through surface and subsurface draining
- -Wet and dry deposition from the atmosphere
- -Selenates and selenites predominate

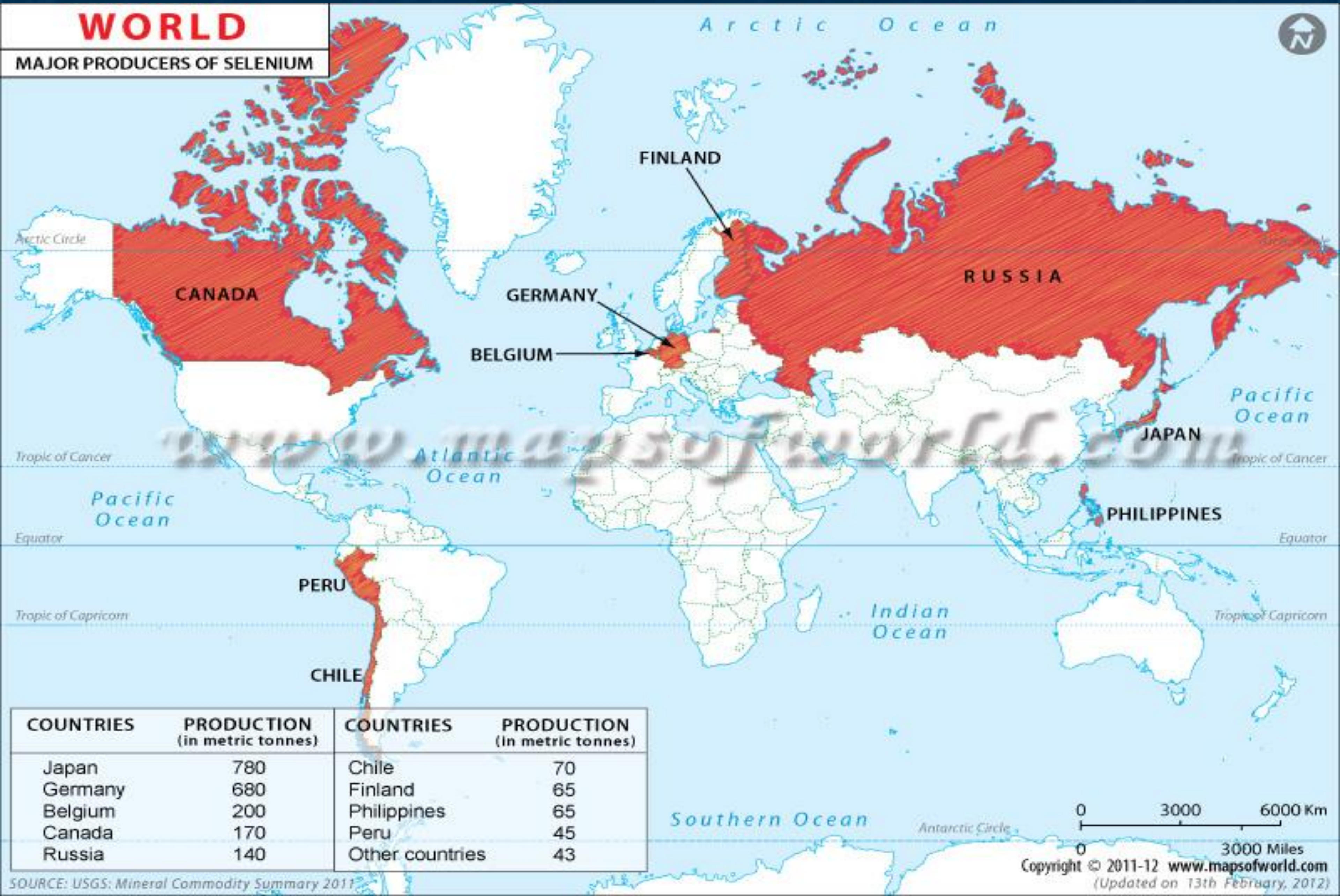
Air:

- -Natural source: Volcanic gas
- -Combustion of fossil fuels and Coal- attaches to fly ash
- -Also incineration of rubber, municipal waste and paper.

Soil:

- -weathering and leaching of parent bedrock
- -Se in sediment can be cycled into food chain for decades from the soil

Se producing countries



COUNTRIES	PRODUCTION (in metric tonnes)	COUNTRIES	PRODUCTION (in metric tonnes)
Japan	780	Chile	70
Germany	680	Finland	65
Belgium	200	Philippines	65
Canada	170	Peru	45
Russia	140	Other countries	43

SOURCE: USGS: Mineral Commodity Summary 2011

Selenium in Environment

- rare elements on the surface of this planet
- Selenium occurs naturally in the environment
- released through both

  1) Natural processes

  2) Anthropogenic activities

Natural Processes

- Weathering of parent rocks is one of the fundamental processes involved in soil formation.

(Zhang et al.,2002)

- average contents of Se in soil profile increased with the Se contents in parent material

(Li,Y et al,.2008)

- Selenium concentrations in the soil vary with type of parent material from which it is formed.

(Fordyce,F., et al,.2000)

- Volcanoes are a major source of inorganic Se because they emit high amounts of Se into the atmosphere

(Wen, H., et al 2007)

Deposition of Se from volcanic emissions in local soils is responsible for high Se concentrations reported in soils around volcanoes.

(Floor, G.H., et al 2012)

Anthropogenic activities

- Agricultural activities that increase Se loading in the soil include irrigation, phosphate fertilizers, application of sewage sludge and farmyard manure.

(Deverel, S.J., et al 1994)

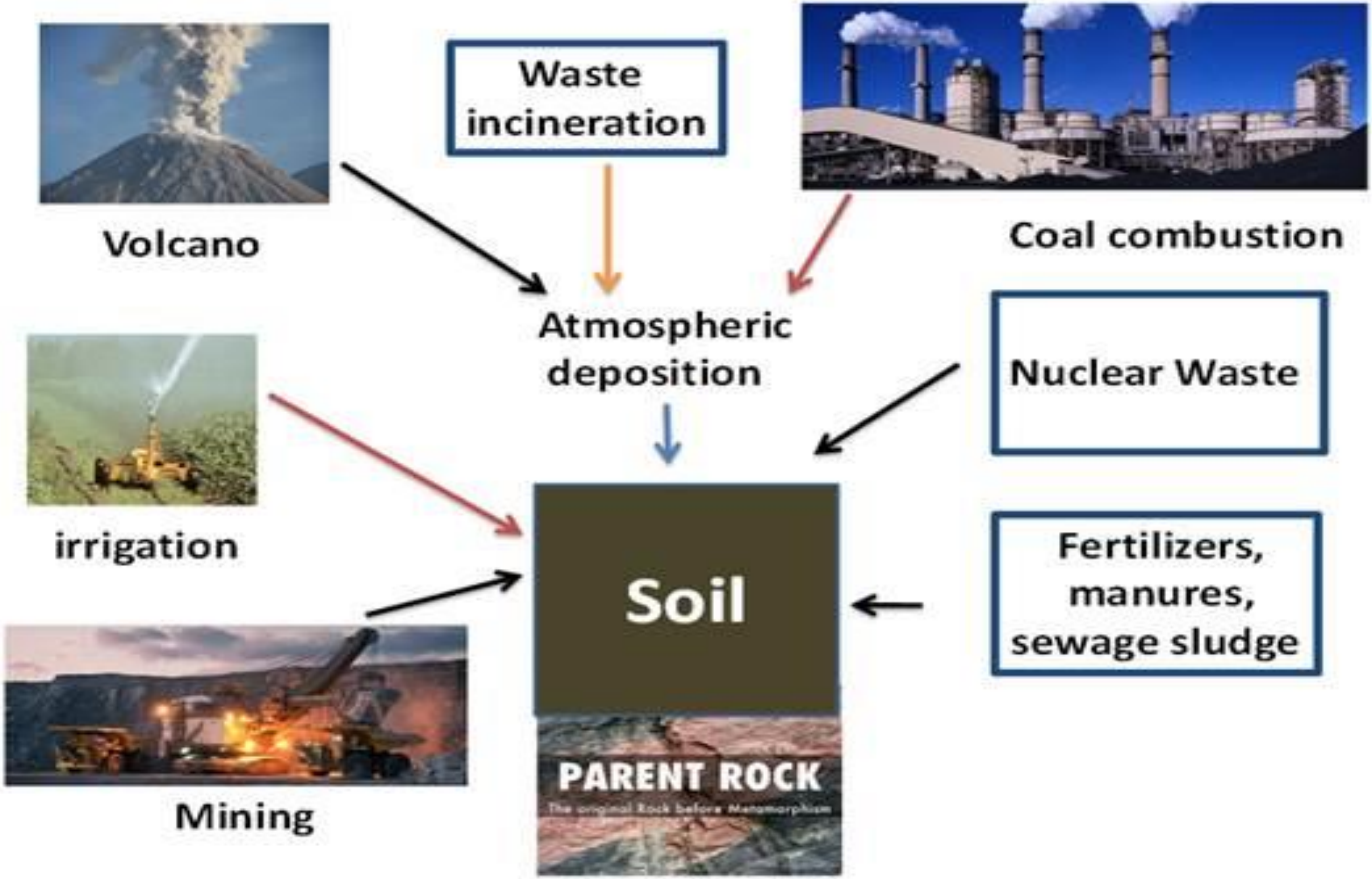
Se mobilized to groundwater & surface water by rainwater or irrigation of selenium rich soils and bedrock.

(Patterson, M.M., et al 2010)

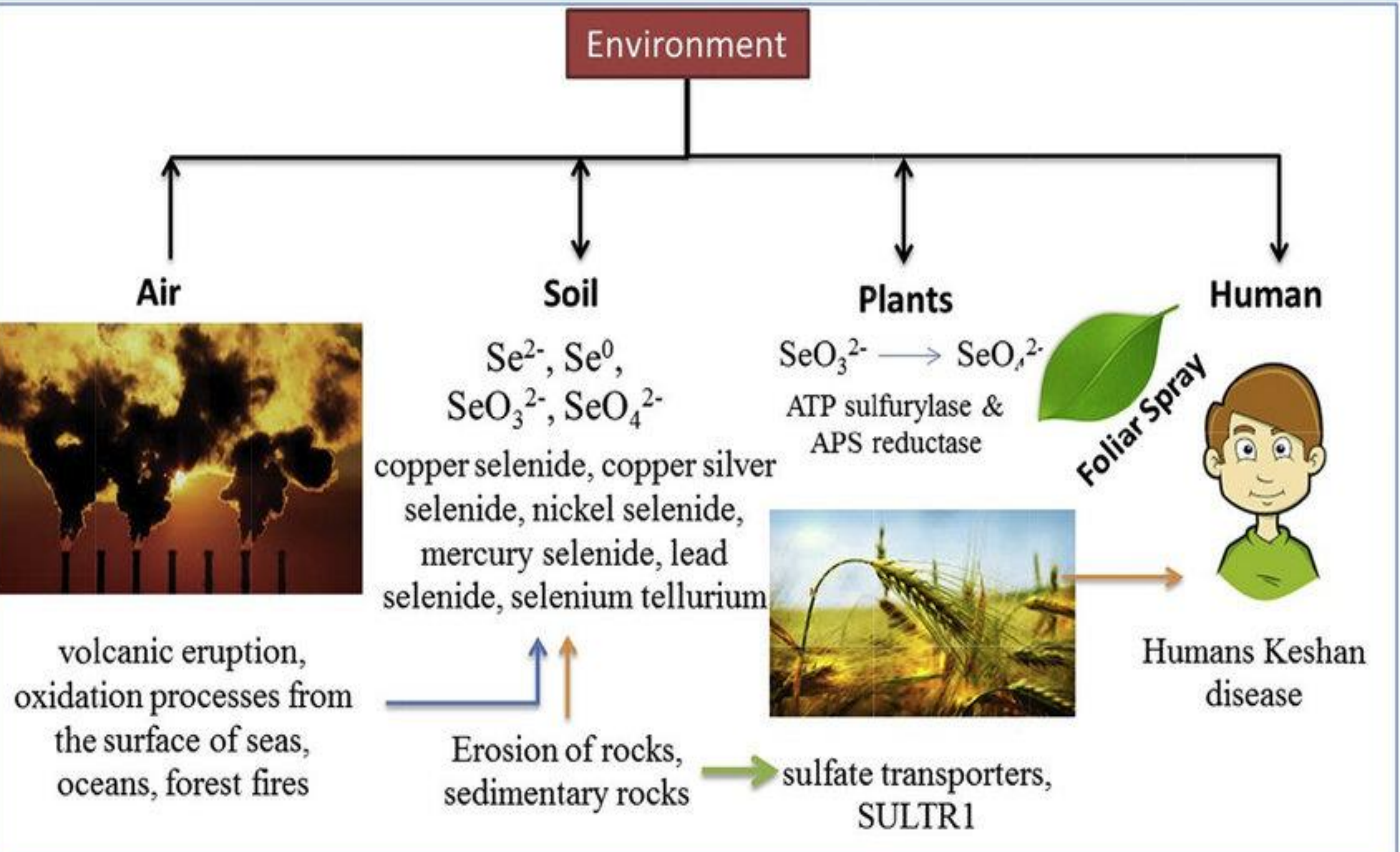
Industrial activities such as fossil fuel combustion, mining, smelting, industrial waste disposal and nuclear fuel increase Se levels in the environment.

(Gerhardht, M.B., et al 1992)

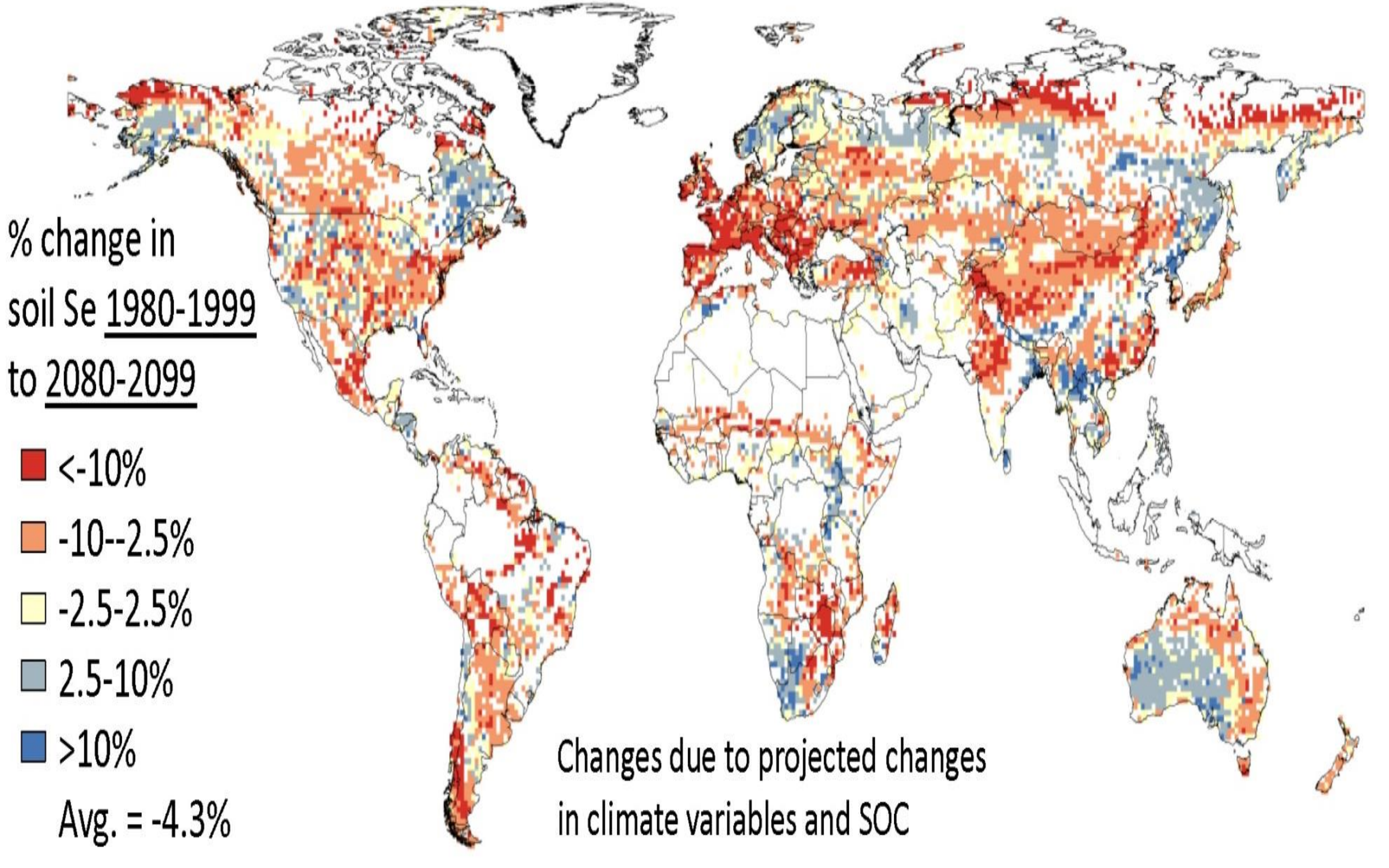
Some sources of selenium in environment



Bio-geo-chemical cycle of Se



Percentage % change in soil Se



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Thank
You


PRESENTATION FINISHED
ANY QUESTION???

Cobalt; biological role, deficiency and toxicity symptoms

Key points

- Introduction
- Properties
- Biological role
- Cobalt deficiency symptoms and its treatment
- Cobalt toxicity symptoms and its treatment

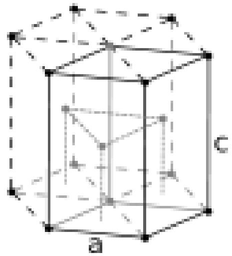
Introduction

- **Element:** Cobalt (Co)
- **Atomic no:** 27
- **Appearance:** Hard lustrous bluish gray metal
- **Group**: 9
- **Period:** 4
- **Block:** d block

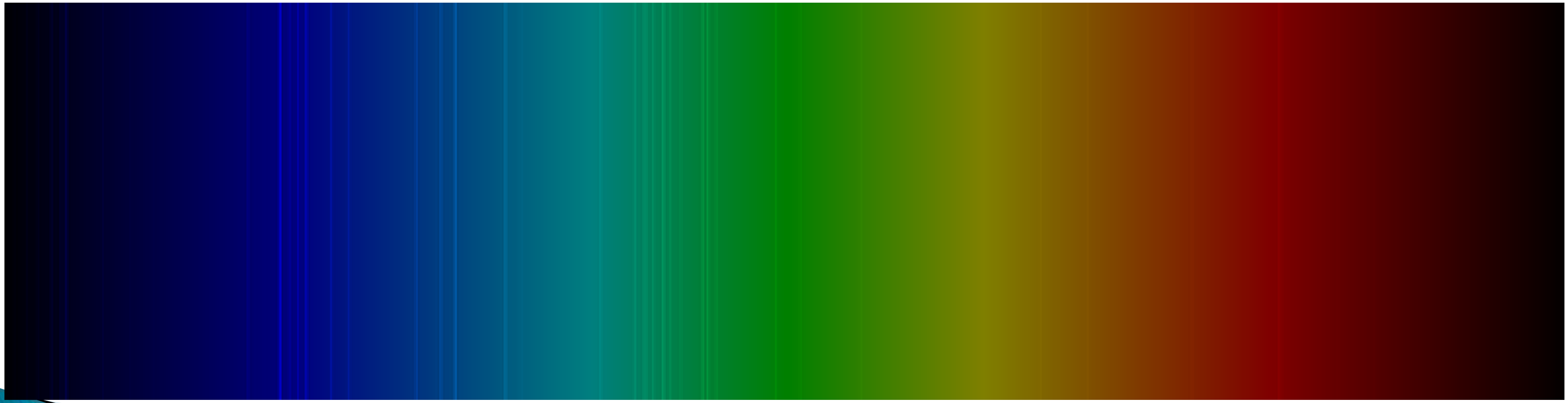
Properties

- **Phase:** Solid
- **Melting point:**1768 K
- **Boiling point:**3200 K
- **Density:**8.90 g/cm3
- **Natural occurance**:Primordial

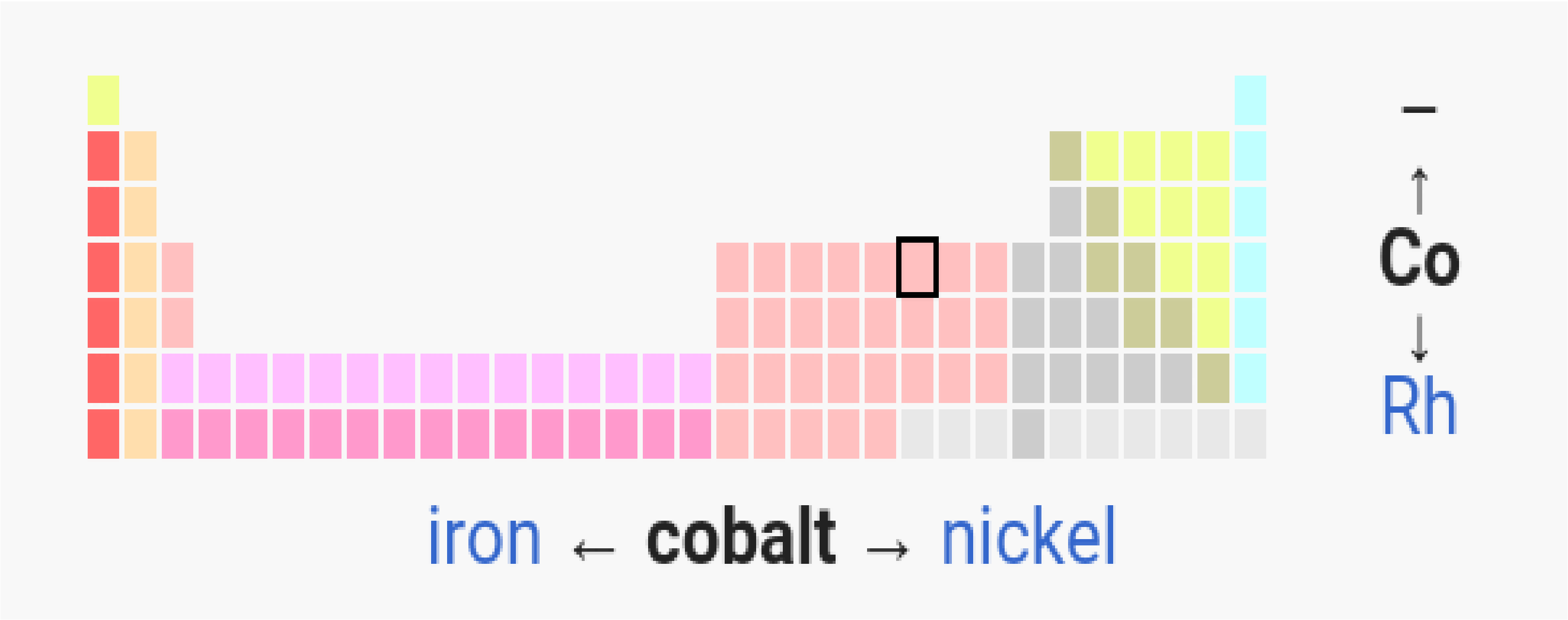
Crystal structure: hexagonal close packed



Spectral lines of cobalt:



Position in periodic table:



Applications

- Cobalt hasbeen used in the production of alloy, rechargable battries, catalysts, pigments ,coloring and radioisotopes.
- Cobalt is also used in electroplating for its attractive apperance, hardness and resistance to oxidation.
- It is also used as a base primer coat for porcelain enamels.

Biological role

- Cobalt is essential to the metabolism of all animals.
- Cobalt is the key component of cobalamin also known as vitamine B12. Bacteria in the stomachs of animal convert cobalt salts into B12.
- A minimal presence of cobalt in soil therefore markadly improves the health of grazing animals.
- An uptake of 0.20 mg/kg a day is recommended.

Cobalt deficiency and symptoms

- **Deficiency**–in plant its deficiency is more likely to be affect in the animals and humans which consume the affected plants.
- **Symptoms**–cobalt deficiency may results in reduced seed germination in dry conditions and reduced plant growths.
- In legumes, cobalt deficiency may results in symptoms of N deficiency.

Treatment of cobalt deficiency

- Symptoms of cobalt deficiency is usually only diagnosed by soil testing.
- If soil test reveals a cobalt deficiency first ensure that the soil pH is around 7 so that the affected plant will be able to uptake cobalt.
- Application of cobalt contaning fertilizers like cobalt sulfate or general trace element fertilizers contaning cobalt is also very helpful.

Cobalt toxicity and symptoms

- **Toxicity**–cobalt toxicity seems to be more common then cobalt deficiency although its dose depends upon the area.
- **Symptoms**–high level of cobalt can results in iron deficiency in plant so symptoms are same as in case of iron deficiency.
- Cobalt can also produce its toxicity symptoms as loss of leaves from a plant, pale colored leaves and discolored veins.


Treatment of cobalt toxicity

- Soil does not show any symptoms of cobalt toxicity but precautionary measures should be taken to reduced cobalt toxicity.
- Cobalt toxicity may be reduced by addition of nickel.


THANK
YOU

ANY QUESTIONS
...

Mercury

DR. ZAFFAR MALIK

SOIL SCIENCE

THE ISLAMIA UNIVERSITY OF BAWALPUR


بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ
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Contents

What is Mercury ?

Mercury is a chemical element with symbol **Hg** and atomic number 80. It is commonly known as **quicksilver** and was formerly named **hydrargyrum**

Name	DES.
Symbol	Hg
color	silvery
Atomic No.	80
Atomic M.	200.592
phase	liquid
density	13.534 $g \cdot cm^{-3}$
Melting point	234.3210 K
Boiling point	629.88 K
Discovery	2000 BC

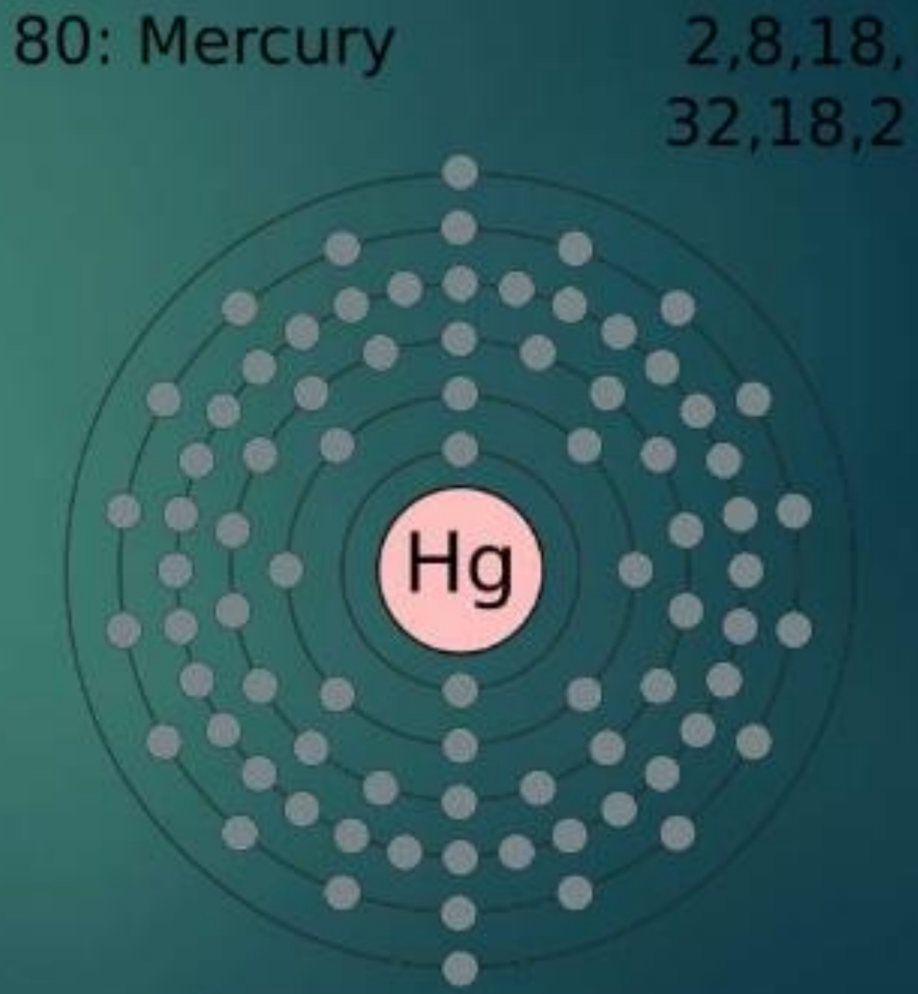
- It is commonly known as **quicksilver** and was formerly named **hydrargyrum** (A heavy, silvery d-block element, mercury is the only metallic element that is liquid at standard conditions for temperature and pressure)

- Mercury occurs in deposits throughout the world mostly as cinnabar (mercuric sulfide).
- The red pigment vermilion is obtained by grinding natural cinnabar or synthetic mercuric sulfide.


Hg
80
200.59
Mercury

History of Mercury

Mercury was found in Egyptian tombs that date from 1500 BC.In China and Tibet, mercury use was thought to prolong life, heal fractures, and maintain generally good health, although it is now known that exposure to mercury vapor leads to serious adverse health effects.



Properties of Mercury

Physical pro.

Mercury is a heavy, silvery-white metal. As compared to other metals, it is a poor conductor of heat, but a fair conductor of electricity. Mercury has a freezing point of −38.83 °C and a boiling point of 356.73 °C, both exceptionally low for a metal, and it is the only elemental metal known to melt at a generally cold temperature.

Chemical pro.

Mercury does not react with most acids, such as dilute sulfuric acid, although oxidizing acids such as concentrated sulfuric acid and nitric acid or aqua regia dissolve it to give sulfate, nitrate, and chloride salts. Like silver, mercury reacts with atmospheric hydrogen sulfide. Mercury even reacts with solid sulfur flakes, which are used in mercury spill kits to absorb mercury vapors (spill kits also use activated carbon and powdered zinc)

Application

Mercury is used primarily for the manufacture of industrial chemicals or for electrical and electronic applications. It is used in some thermometers, especially ones which are used to measure high temperatures. A still increasing amount is used as gaseous mercury inflorescent lamps, while most of the other applications are slowly phased out due to health and safety regulations and is in some applications replaced with less toxic but considerably more expensive Galinstan alloy

sources

- Natural sources of mercury include
- volcanoes
- forest fires,
- cannabar (ore) and
- **fossil fuels** such as **coaled petroleum**
- Levels of mercury in the environment are increasing due to discharge from **hydroelectric**, mining, pulp, and paper industries.

Effects of Mercury

- Mercury at low concentrations represents a major hazard to microorganisms. Inorganic mercury has been reported to produce harmful effects at 5 µg/l in a culture medium.

- Organomercury compounds can exert the same effect at concentrations 10 times lower than this. The organic forms of mercury are generally more toxic to aquatic organisms and birds than the inorganic forms.

- Aquatic plants are affected by mercury in water at concentrations of 1 mg/l for inorganic mercury and at much lower concentrations of organic mercury

- Aquatic invertebrates widely vary in their susceptibility to mercury.
- In general, organisms in the larval stage are most sensitive.
- Methyl mercury in fish is caused by bacterial methylation of inorganic mercury, either in the environment or in bacteria associated with fish gills or gut.
- In aquatic matrices, mercury toxicity is affected by temperature, salinity, dissolved oxygen and water hardness.
- A wide variety of physiological, reproductive and biochemical abnormalities have been reported in fish exposed to sublethal concentrations of mercury

- Birds fed inorganic mercury show a reduction in food intake and consequent poor growth.
- Other (more subtle) effects in avian receptors have been reported (i.e., increased enzyme production, decreased cardiovascular function, blood parameter changes, immune response, kidney function and structure, and behavioral changes).
- The form of retained mercury in birds is more variable and depends on species, target organ and geographical site.

EFFECTS ON HUMANS

- Exposure to mercury – even small amounts – may cause serious health problems.

- Mercury may have toxic effects on the nervous, digestive and immune systems, and on **lungs**,**kidneys**, skin and eyes.

Remeidation Measure

- It is currently well known that the determination of a total mercury concentration is insufficient for understanding the biogeochemical cycle of the metal and for establishing an appropriate remediation method.
- This is mainly due to the lack of information concerning the reactivity (transformation/conversion), bioavailability and toxicity of mercury in soil afforded by such a single determination

- The study of mercury speciation can be used to predicate and explain the behavior of mercury in soil.
- Several approaches such as sequential extraction procedures (SEP),
- pyrolysis,
- X-ray absorption fine spectroscopy (XAFS)
- nuclear magnetic resonance (NMR) and
- electron paramagnetic resonance (EPR) have been used to study mercury speciation in soil .
- Among these methods, SEP, pyrolysis and XAFS are frequently used in mercury speciation analysis

- if there is mercury **waste** in the sewage, mercury emissions can be released during the burning process.

- To **reduce** mercury release into the environment, in 2011, EPA published a rule limiting specific pollutant emissions, including mercury, from public incinerators that burn sewage.


Thank
you!!

Analytical test for mineral elements

Macronutrients

- Dry ashing is carried out usually at an ignition temperature of 550 C to 600 C followed by its extraction in diluted HCl or H_2SO_4 for determining various elements.

K	0.5 to 5 %
Ca	, 0.2 to 2 %
Mg	and 0.1 to 1 %
P	from 0.1 to 0.7 %
Mn and Fe	from 25 to 500 ppm
Cu and Zn	5 to 50 ppm

Apparatus

- Spectrophotometer or colorimeter
- Flame photometer
- Atomic absorption spectrophotometer
- Porcelain crucibles or Pyrex glass beakers

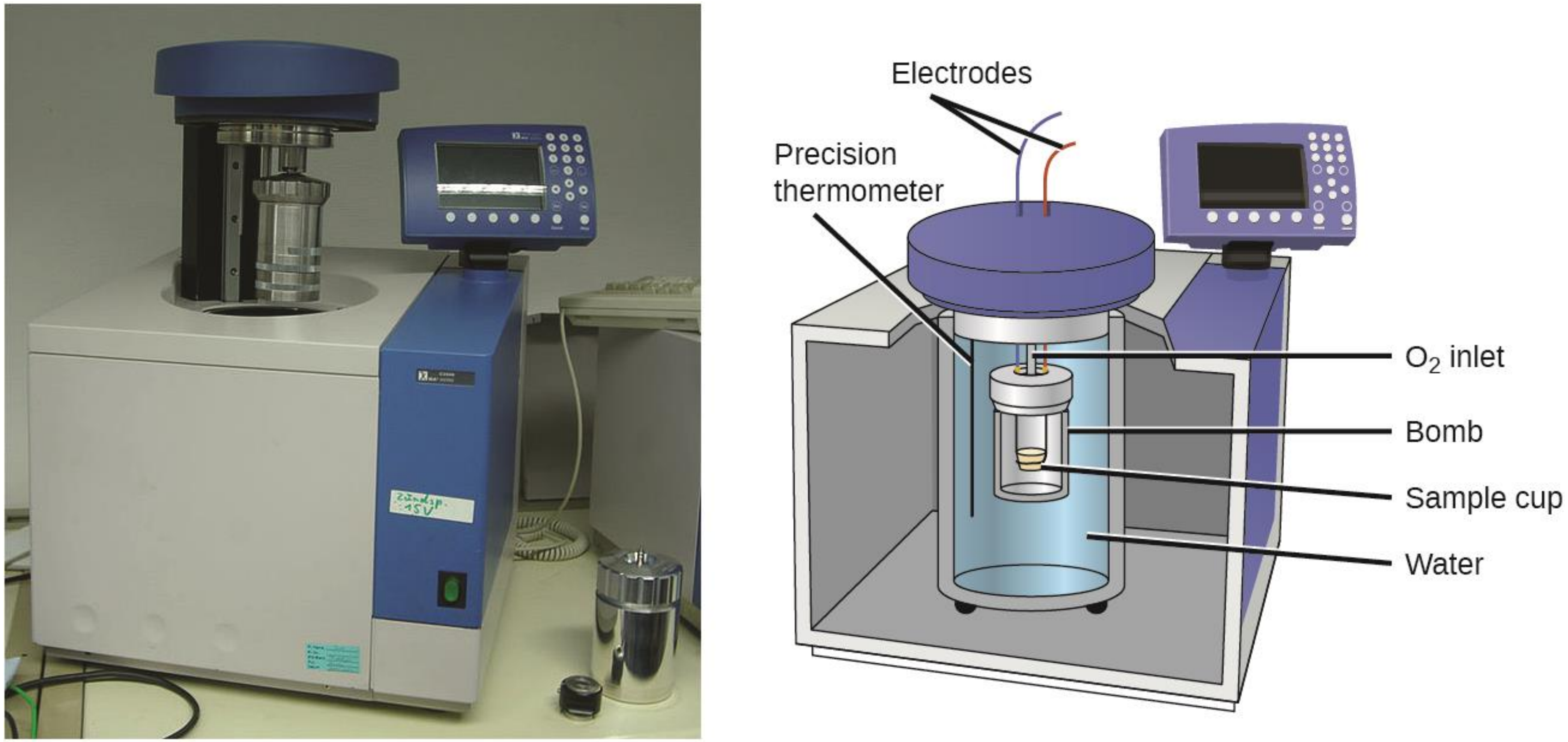
Reagent

- **Hydrochloric Acid (HCl), 2N**
- Dilute165.6 mL concentrated HCl (37%, sp.gr.1.19) in DI water, mix well, let it cool, and bring to 1L volume.

Procedure

- Weigh 0.5 – 1.0 g dry and ground plant material in a 30 – 50 mL porcelain crucibles or Pyrex glass beakers.
- Place porcelain crucibles into a cool muffle furnace, and increase temperature gradually to 550 °C.
- Continue ashing for 5 hours after attaining 550 °C.
- Shut off the muffle furnace and open the door cautiously for rapid cooling.
- When cool, take out the porcelain crucibles carefully.

- Dissolve the cooled ash in 5-mL portions **2 N HCl** and mix with a plastic rod.
- After 15 – 20 minutes, bring to the volume (usually to 50-mL) using DI water.
- Mix thoroughly, allow standing for about 30 minutes, and use the supernatant or filter through Whatman No. 42 filter paper, discarding the first portions of the filtrates.
- Analyze the aliquots for P by **Colorimetry** (by **Ammonium Vanadate-Ammonium Molybdate** yellow color method), for K and Na by **Flame Photometry.**


Electrodes
Precision
thermometer
O2 inlet
Bomb
Sample cup
Water

(a) (b)

Micronutrient (Wet Digestion)

- Full recovery of micronutrient cations (Zn, Fe, Mn, and Cu) in high-silica containing plant tissues (such as wheat, barley, rice, sugarcane, etc.) is not possible by the dry-ashing procedure. Therefore, this kind of plant material should be wet-digested using HNO_3-$HClO_4$. The digestion procedure is adapted from Rashid (1986). Many other elements (e.g., P, K, Ca, Mg, and Na) can also be determined in the same digest.

Apparatus

- Block-digester
- Vortex tube stirrer
- Atomic absorption
- spectrophotometer
- Flame photometer

Reagent

- **Nitric Acid-Perchloric Acid (HNO_3-$HClO_4$), 2:1 ratio**
- Add 1-L concentrated HNO_3 to 500 mL concentrated $HClO_4$.

Procedure

- **A. Digestion**

  - Weigh 1 g dry and ground plant material, and then transfer quantitatively into a 100-mL Pyrex digestion tube.
  - Add 10 mL (**2:1 ratio) nitric acid-perchloric acid** mixture, and allow to stand overnight or until the vigorous reaction phase is over.
  - Place small and short-stemmed funnels in the mouth of the tubes to reflux acid.
  - After the preliminary digestion, place the tubes in a cold block-digester, and then raise temperature to 150 °C for 1 hour.
  - Place the U-shaped glass rods under each funnel to permit exit of volatile vapors.

- Increase temperature slowly until all traces of HNO_3 disappear, and then remove U shaped glass rods.
- Raise temperature to 235 °C. When the dense white fumes of $HClO_4$ appear in the tubes, continue digestion for 30 minutes more.
- Lifts the tubes rack out of the block-digester, cool a few minutes, and add a few drops DI water carefully through the funnel.
- After vapors condense, add DI water in small increments for washing down walls of tubes and funnels.
- Bring to volume, mix the solution of each tube, and then leave undisturbed for a few hour.
- Each batch of samples for digestion should contain at least one reagent blank (no plant material).

- **B. Measurement**

- Operate **Atomic Absorption Spectrophotometer** or **Flame Photometer** according to the instructions provided for the equipment.
- Run a series of suitable standards, and draw a calibration curve.
- Decant the supernatant liquid and analyze Zn, Fe, Mn, and Cu in the aliquots by **Atomic Absorption Spectrophotometer**, Ca and Mg by **Titration** with **EDTA**, and K and Na by **Flame Photometer**.
- Calculate the supernatant liquid concentrations to the calibration curve.

welcome


بسم الله الرحمن الرحيم

Topic:
Role of Barium in Environment

DR. ZAFFAR MALIK

Introduction

Barium is a chemical element with symbol (Ba) and atomic number 56.

It is the fifth element in group 2 and is a soft, silvery alkaline earth metal.

Barium is never found in nature as a free element.

It is only found naturally when combined with other elements, and compounds containing barium.

Atomic weight (average mass of the atom): 137.327

Density: 2.09 ounces per cubic inch (3.62 grams per cubic cm)

Phase at room temperature: solid

Melting point: 1,341 degrees Fahrenheit (727 degrees Celsius)

Boiling point: 3,447 F (1,897 C)

Sources

Combination with other elements because of its high level of reactivity like,

Sulfate and carbonate, but can also form compounds with hydroxide, chloride, nitrate, chlorate, and other negative ions.

About 0.05 percent of Earth's crust is barium.

In order to obtain pure elemental barium, it must be separated from other elements

Barium can be extracted from barium chloride through electrolysis.

Barium can also be obtained by reducing barium oxide.

Functions

Elemental barium does not have many practical uses, again due to its high level of reactivity.

However, its strong attraction to oxygen makes it useful as a "getter" to remove the last traces of air in vacuum tubes.

Pure barium can also be combined with other metals to form alloys that are used to make machine elements such as bearings or spark plugs in internal combustion engines.

Because barium has a loose hold on its electrons, its alloys emit electrons easily when heated and improve the efficiency of the spark plugs, according to Krebs.

Barium sulfate, or barite, is used in lithoponeoil well drilling fluids,glassmaking and creating rubber.

Barium carbonate is used as a rat poison, and barium nitrate and barium chlorate produce green colors in fireworks.

Toxic effects

- **Impact on Human:**

mild stomach cramps.

nausea, vomiting.

loose stools or mild constipation.

Barium can cause vomiting, colic, diarrhea, tremors and paralysis.

Barium in your body

The average adult contains about 22 mg of barium because it is present in foods such as carrots, lettuce, beans, and cereal grains.

These low levels of barium serve no biological role and are not harmful.

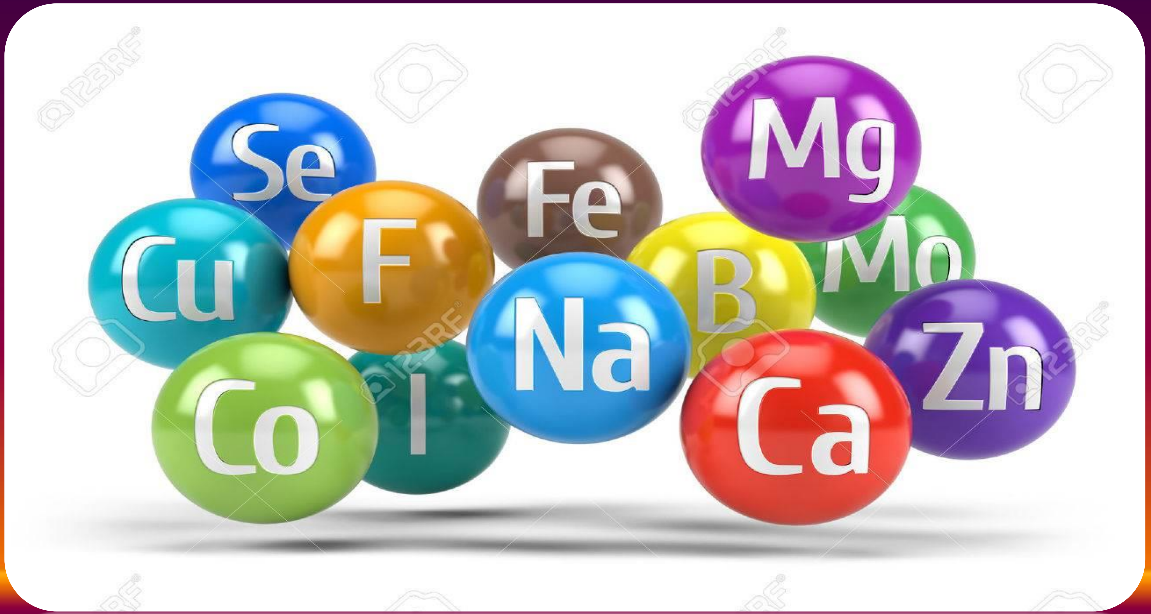
Analysis of the X-ray image from the barium enema enables physicians to diagnose disorders such as ulcerative colitis, Crohn's disease, polyps, cancer, and irritable bowel syndrome


Thank
you!

Trace elements status and their response

Trace elements

- A chemical element present only in minute amounts in a particular sample or environment.
- A chemical element required only in minute amounts by living organisms for normal growth.



Trace elements

- Iron (Fe)
- Boron (B)
- Cadmium (Cd)
- Chromium (Cr)
- Copper (Cu)
- Lead (Pb)
- Manganese (Mn)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Selenium (Se)
- Zinc (Zn)
- Arsenic (As)

Status of iron (Fe)

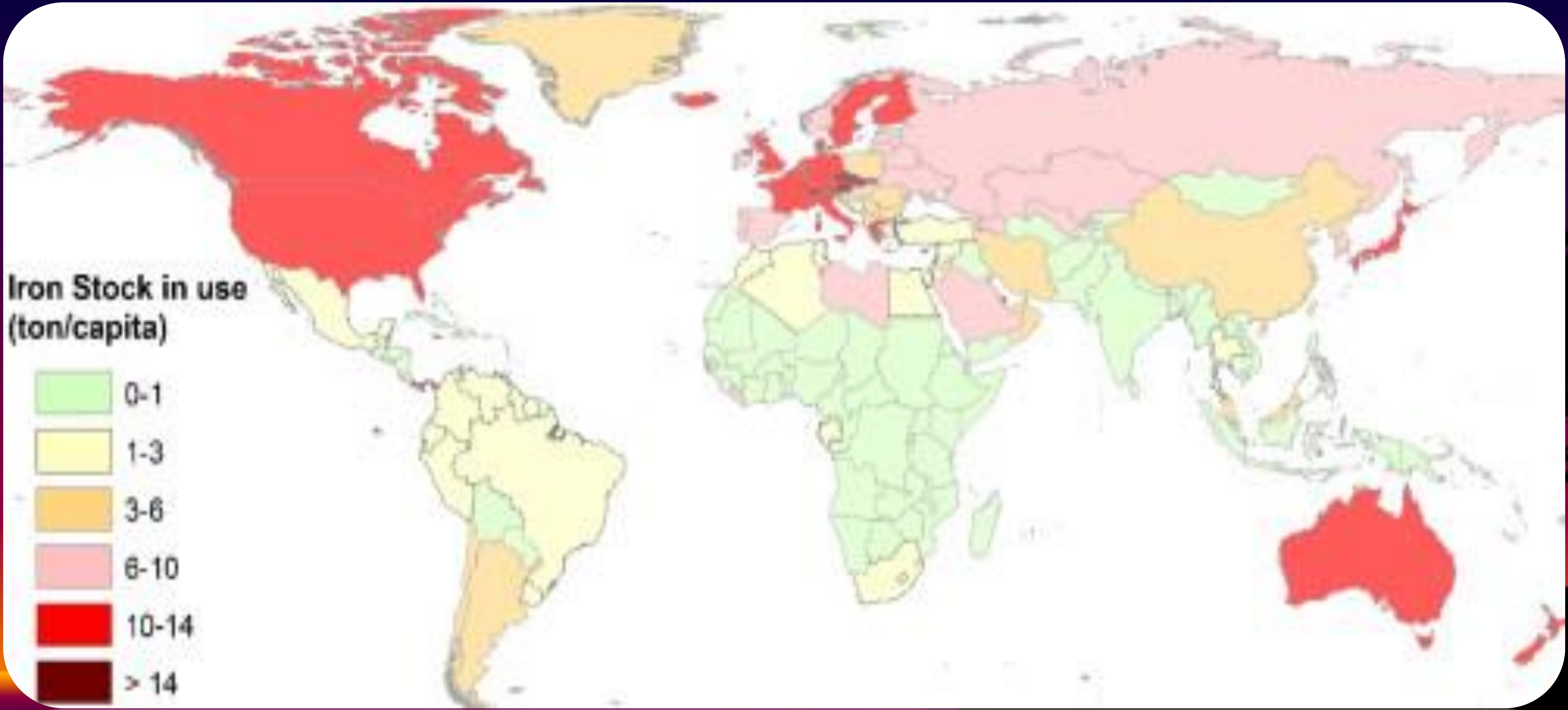
- The amount of iron and its availability in soil is influenced by the following:
- pH
- Organic matter
- Moisture
- Aeration and compaction

  etc

Status of iron (Fe)

- Soil is typically between **1%** and **5%** iron but because most of this iron is unavailable.
- It is difficult to set an ideal amount for soil.
- Some estimates suggest that soil should have at least **0.001 g** of iron in every **100 g** of soil (or **10 mg/kg**).

Fe distribution world wide



Arsenic (As)

Toxic nature. + Diseases. = Effect.

- Arsenic naturally occurs in the soil and elsewhere in the environment and it is the 20th most common element on Earth.
- Environmental protection agencies in **California**, **Canada**, **Norway** and **the United States** publish guidelines for arsenic in soil as well: **0.07 mg/kg**, **12 mg/kg**, **12 mg/kg** and **0.61 mg/kg** respectively.

Boron (B)

Boron is an essential plant micronutrient.

Development of tissue.

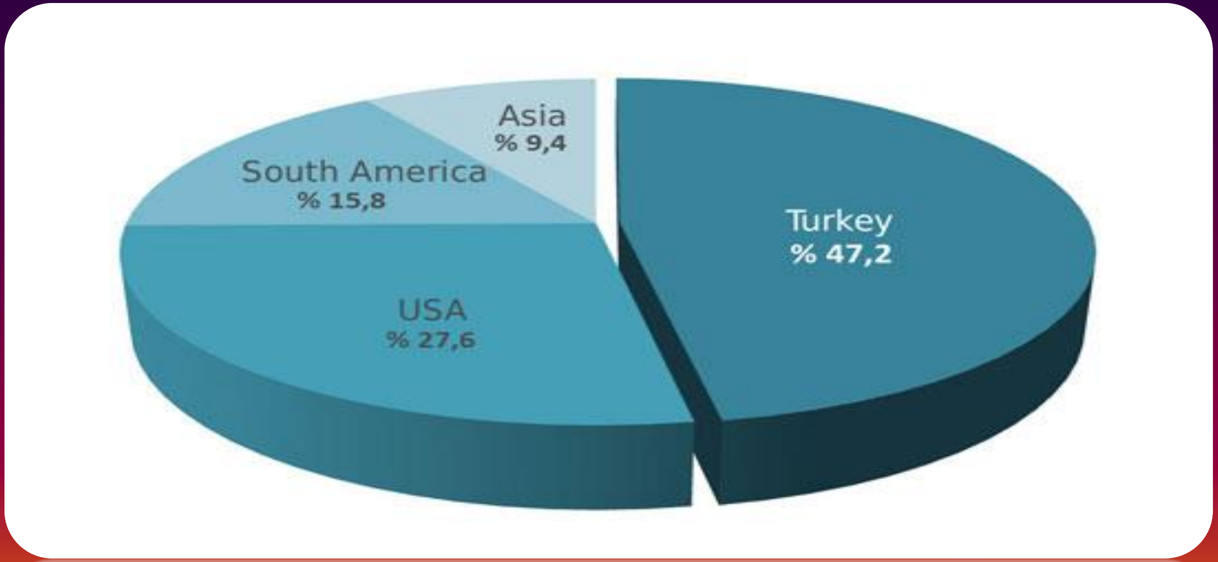
Seed production.

Increase nectar production.

Required for good cell structure.

Excess boron inhibits seed germination.

- Ideally **0.5-4 mg/kg**.
- Some laboratories result **4 mg/kg**.
- Potentially harmful range = **4500 mg/kg** .



Cadmium (Cd)

- Cadmium is a toxic element.
- Industrial activity, such as mining, can increase soil cadmium levels.
- The acute symptoms include:-
- 1-stomach irritation
- 2-vomiting and diarrhoea,
- 3-headaches, flu-like symptoms,
- 4-swelling of the throat and tingling hands.
- Chronic ingestion *

Cadmium

- In Australia:-
- The upper limit of cadmium is **0.1 mg**.*
- Drop level:- **100 and 1000 years** for the levels to drop by **50%**.*

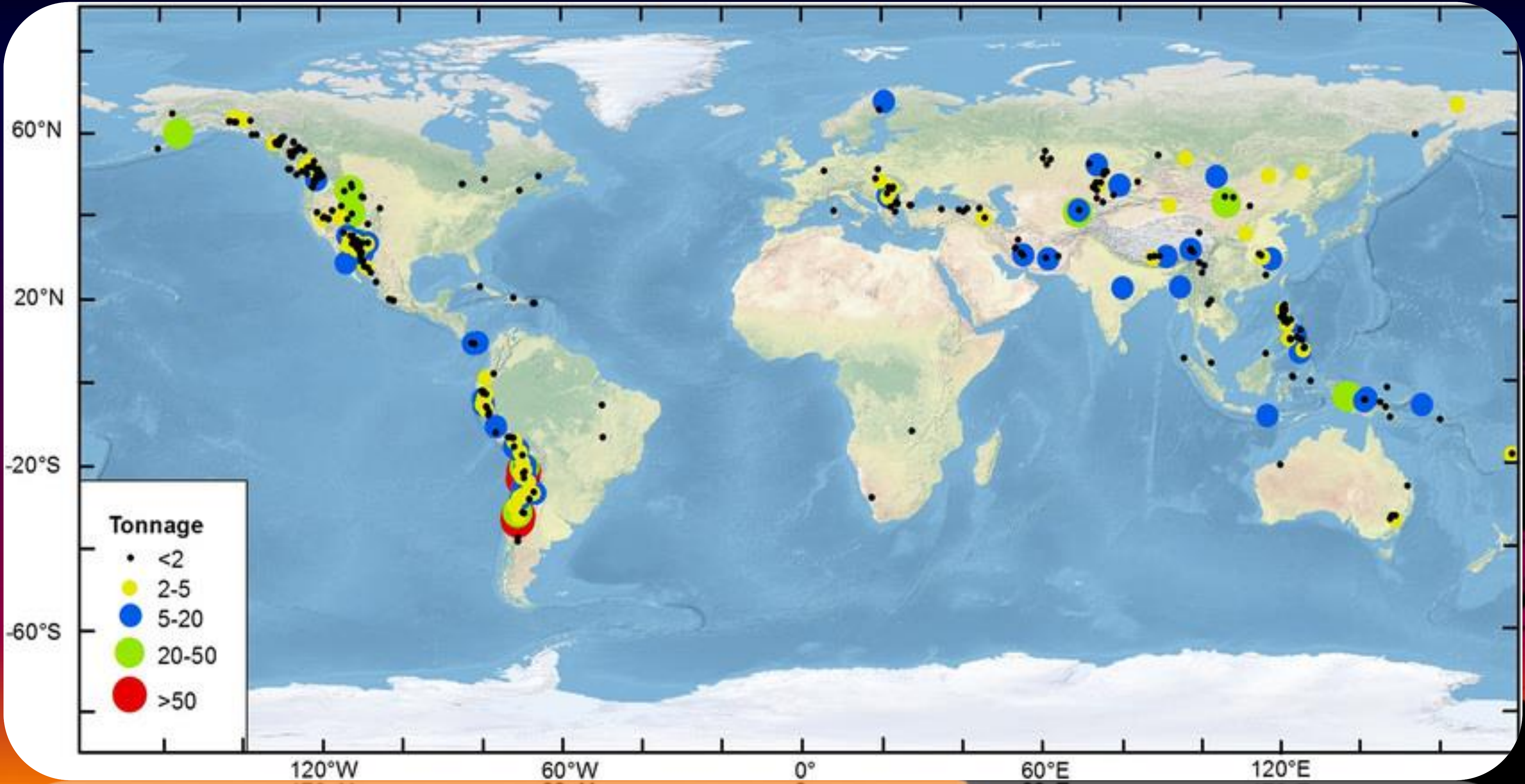

CHROMIUM

Chromium (Cr)

- Natural occurrence.
- Natural soil range.
- Chromium existing states.
- Chromium toxicity.
- Chromium physiological effects.

Copper (Cu)

- Copper as a micronutrient.
- Occurrence.
- Ideal range = **2-50 mg/kg**.
- Higher concentration = greater than **6000 mg/kg.**


60°N
20°N
-20°S
-60°S
120°W
60°W
0°
60°E
120°E
Tonnage
<2
2-5
5-20
20-50
>50

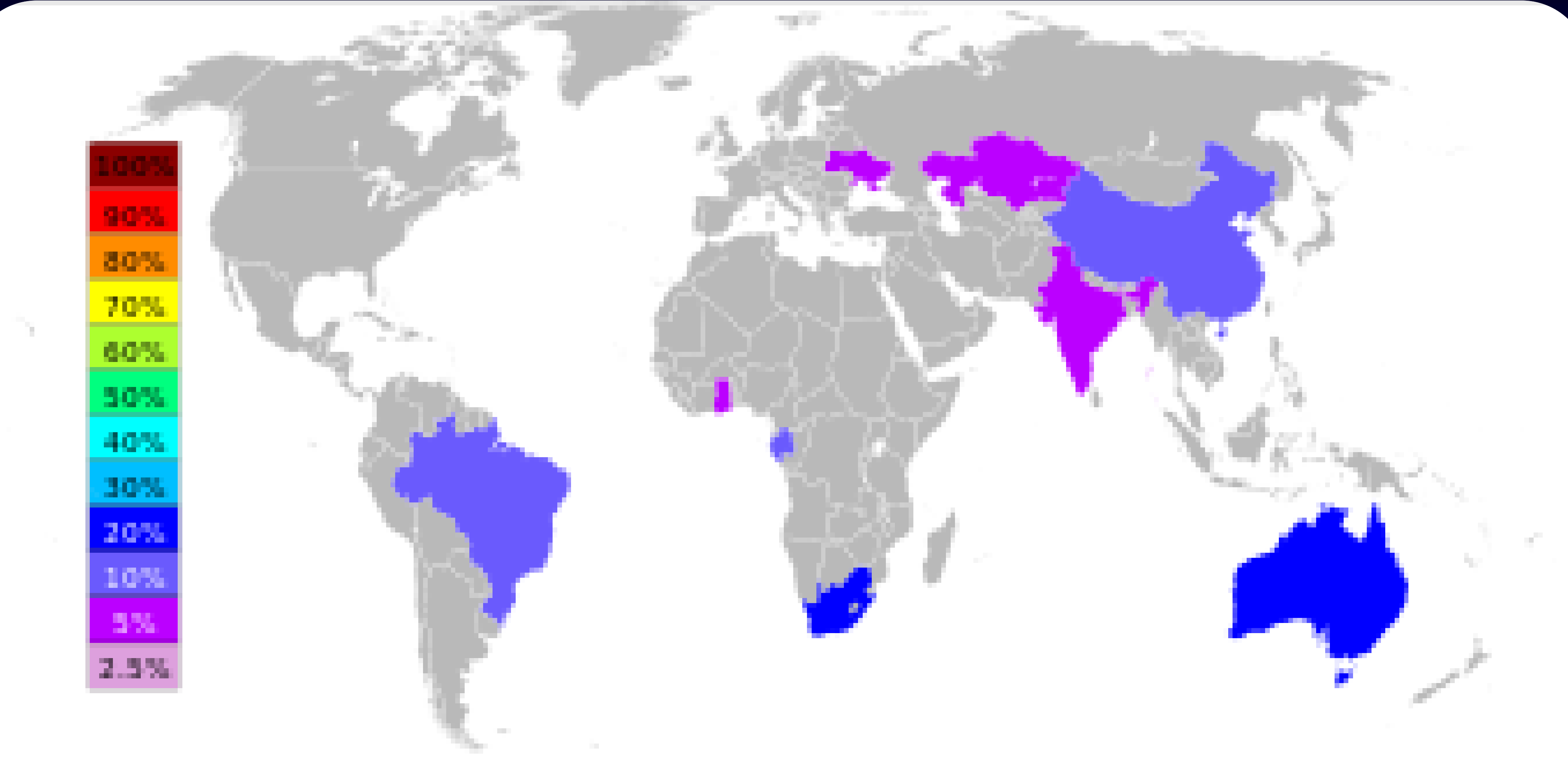

LEAD

Lead (Pb)

- Common occurrence.
- Uses.
- Process of release.
- The maximum recommended soil value is **35 mg** .
- Higher level =**300 mg/kg** .

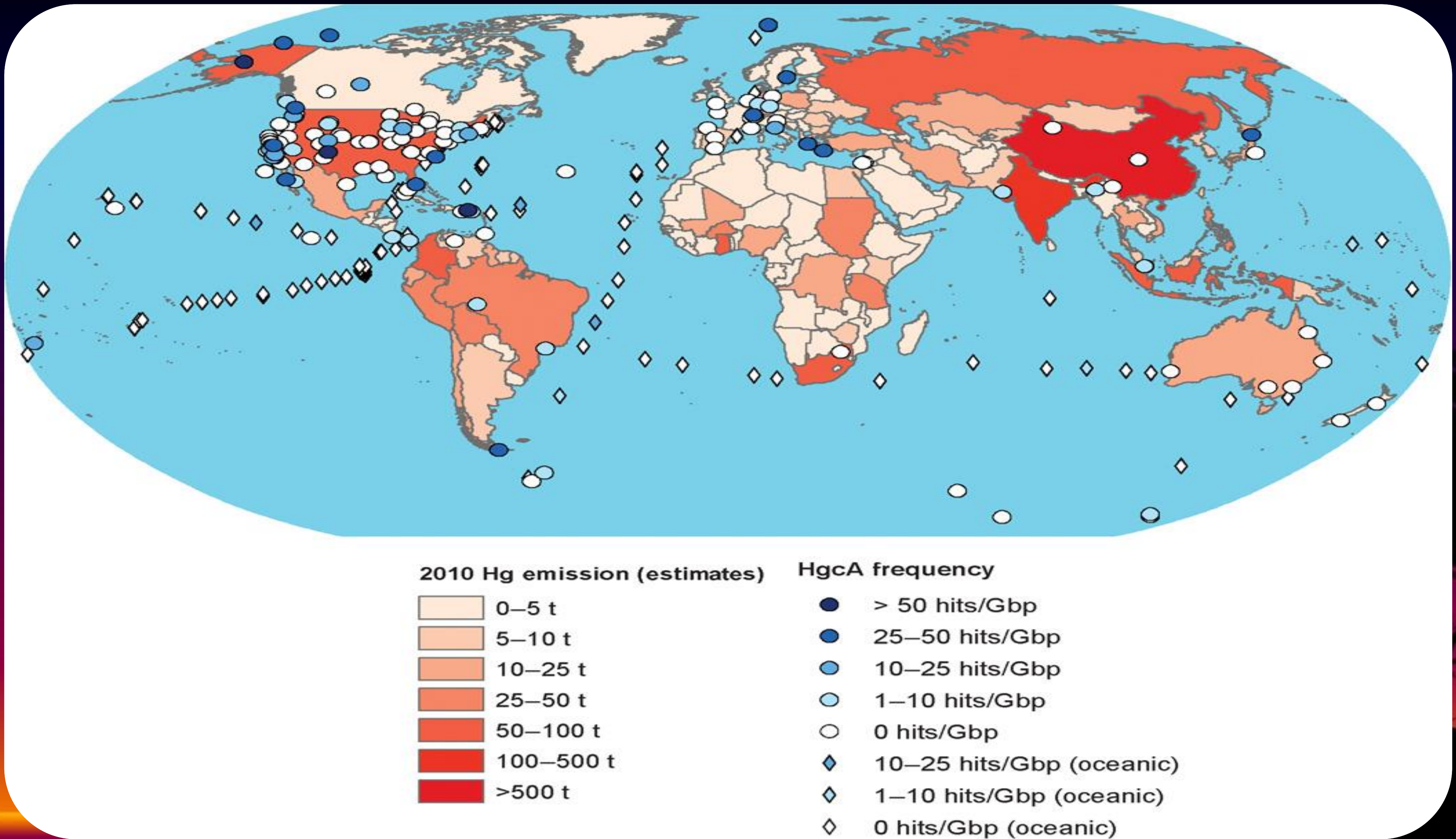
Manganese (Mn)

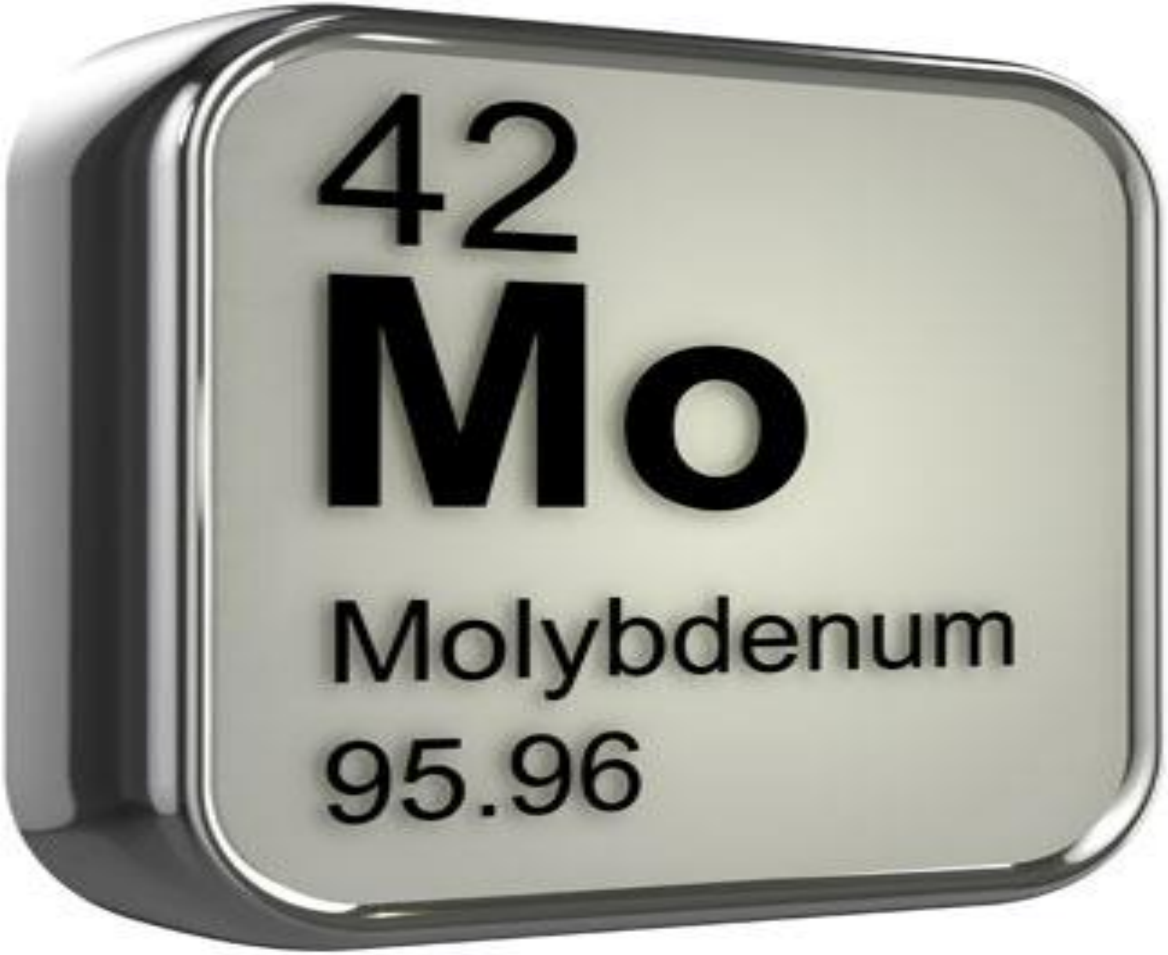
- Manganese is a plant micronutrient.
- Importance.
- Ideal limit = **10-50 mg/kg**.
- Threat level = **3800 mg** .


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
5%
2.5%

Mercury (Hg)

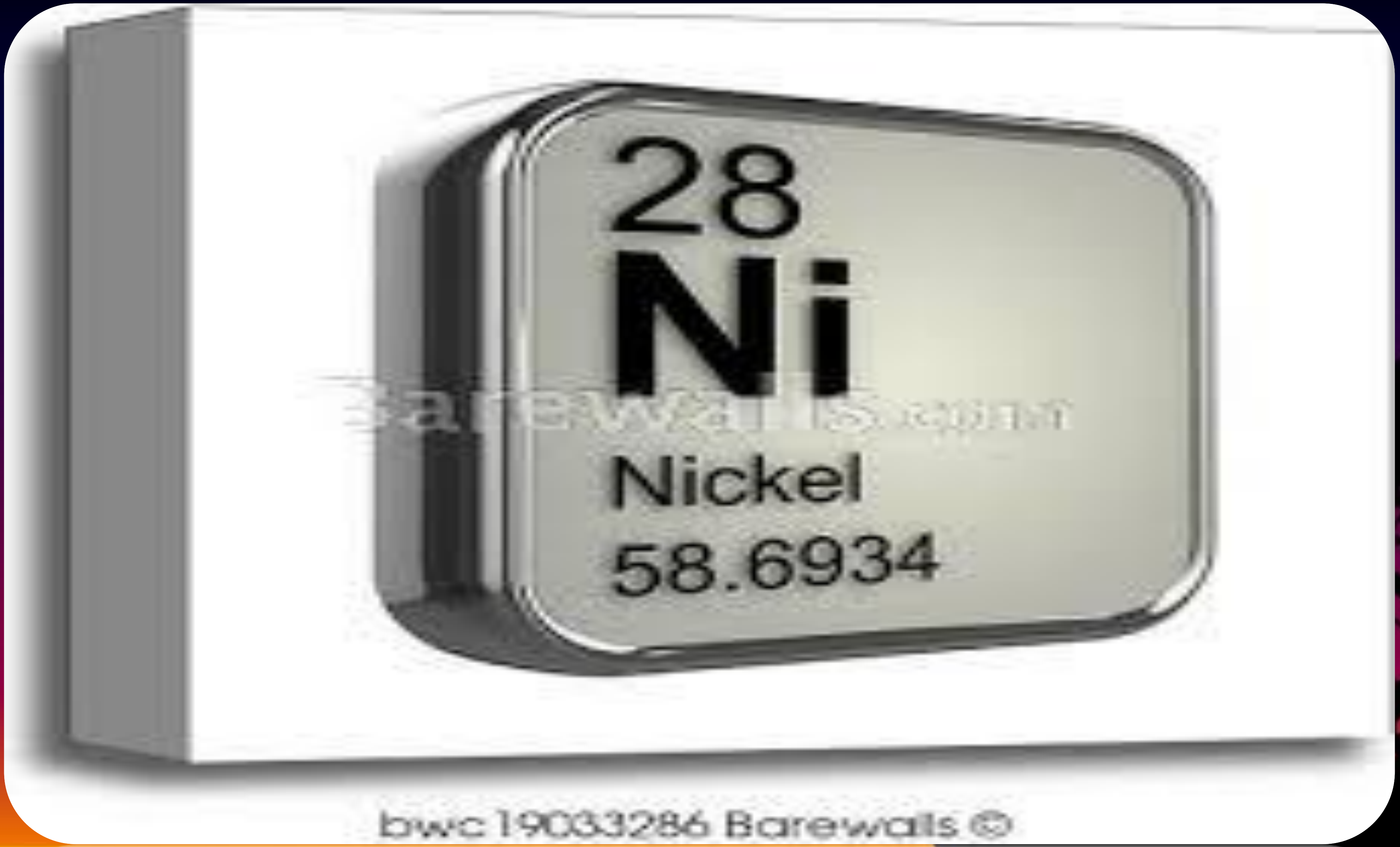
- **Mercury** occurrence.
- The concentration of total **Hg** ranges from <u>**0.5 to 3000**</u> µg **Hg** g^{-1}.
- Of total **Hg** present, we determined that 91% was inorganic, 0.01% organic (as methyl **Hg**), and 6% elemental **Hg**.


2010 Hg emission (estimates)
0–5 t
5–10 t
10–25 t
25–50 t
50–100 t
100–500 t
>500 t
HgcA frequency
> 50 hits/Gbp
25–50 hits/Gbp
10–25 hits/Gbp
1–10 hits/Gbp
0 hits/Gbp
10–25 hits/Gbp (oceanic)
1–10 hits/Gbp (oceanic)
0 hits/Gbp (oceanic)


42
Mo
Molybdenum
95.96

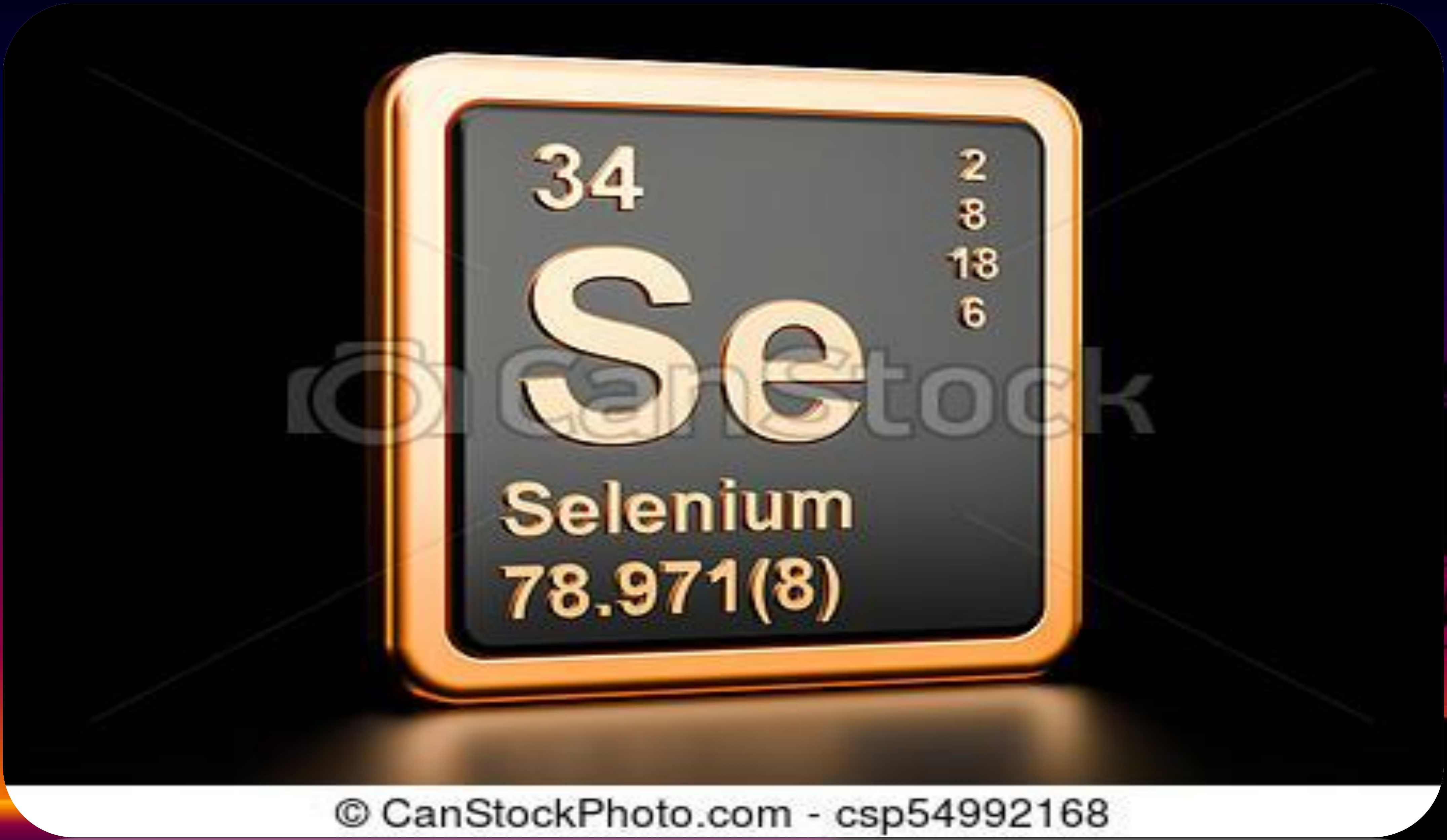
Molybdenum (Mo)

- Molybdenum is a plant micronutrient.
- Molybdenum importance.
- Legumes’ association.
- Ideal concentration at least **2 mg/kg**.


28
Ni
Nickel
58.6934
bwc 19033286 Barewalls ©

Nickel (Ni)

- Plant micronutrient.
- Importance related to bacteria and fungi.
- Ideal concentration **1-20 mg/kg.**
- It would be a good idea to conduct further investigations if the concentration of nickel in your soil exceeds **400 mg/kg.**


34
2
8
18
6
Se
Selenium
78.971(8)
© CanStockPhoto.com - csp54992168

Selenium (Se)

- Selenium is an essential nutrient in animals and humans.
- Beneficial and harmful aspects.
- Toxic to animals and humans.
- Selenium is typically low on acidic soils and in high rainfall areas.
- If your soil contains selenium at a concentration greater than **200 mg/k**. It is dangerous.


30
Zn
Zinc
65.38

Zinc (Zn).

- Essential plant micronutrient.
- Importance.
- Dependence on zinc.
- Maintaining adequate zinc levels.
- Ideal concentration is **1-200 mg/kg**.


Metric tons
5,000,000
1,000,000
300,000
100,000
30,000
10,000
0
Zinc content of
concentrate and
direct-shipping ore

References

- http://plantprobs.net/plant/nutrientImbalances/sodium.html
- http://plantprobs.net/plant/nutrientImbalances/aluminium.html
- http://plantprobs.net/plant/nutrientImbalances/arsenic.html
- http://plantprobs.net/plant/nutrientImbalances/boron.html
- http://plantprobs.net/plant/nutrientImbalances/cadmium.html
- http://plantprobs.net/plant/nutrientImbalances/calcium.html
- http://plantprobs.net/plant/nutrientImbalances/chromium.html
- http://plantprobs.net/plant/nutrientImbalances/cobalt.html

Hope you understand the context ☺

Put forward your questions???

Thank you ☺

Topic:

Role of Zinc in Environment

Introduction

- Essential Nutrients
  - Macro Nutrients
  - Micro Nutrients

- Zn is an important micronutrient for plant growth.
- Essentiality of Zn was discovered by- A.L. Sommer and C.P. Lipman
- In plant Zn content varies from- 27 ppm to 100 ppm
- In Soil Zn content in indian soils varies from-
  - Arid/semi-arid climate - 20-89 mg/kg
  - Humid/sub-humid tropics – 22-74 mg/kg
  - Vertisols - 69-76 mg/kg
  - Oxisols (coarse textured)- 24-30 mg/kg

Katyal and Vlek, 1985

Role of Zinc in Plant system

- **Low Molecular weight complexes of Zinc-** In plant leaves soluble Zinc occurs mainly as anionic compound possibly associated with amino acid.

- **Carbohydrate metabolism-**
  - **Photosynthesis-** Zinc is a constituent of Carbonic anhydrase enzyme, which have role in co_2 fixation.

- **Protein metabolism-** Zinc is necessary for the activity of RNA polymerase enzyme and it protects ribosomal RNA from attack by the enzyme ribonuclease.

- **Membrane integrity-** The role of Zinc in maintaining the integrity of cellular membranes involving structural orientation of macromolecules and maintenance of ion transport systems.

- **Auxin metabolism-** Zinc is required for synthesis of Auxin, zinc is required for synthesis of tryptophan which is precursor of Auxin.

Forms of Zinc in Soil

- **Mineral form**- Zinc exist as Zinc sulphides, Zinc carbonates, and Zinc silicates.

  On weathring Zn ion released.
  Sphalarite- ZnS
  Smithsonite- $ZnCO_3$
  Willemite- $ZnSiO_4$
  Franklinite- $ZnFe_2O_4$

- **Adorbed form-** Zn is adsorbed on the surface of clays, oxide minerals, carbonates and organic matters.

- **Solution form**- In soil solution Zn exists as Zn ion and Zn(OH)+.

- **Organic complex form**-Zn form stable complex with organic colloids. This form is not readily available to plants.

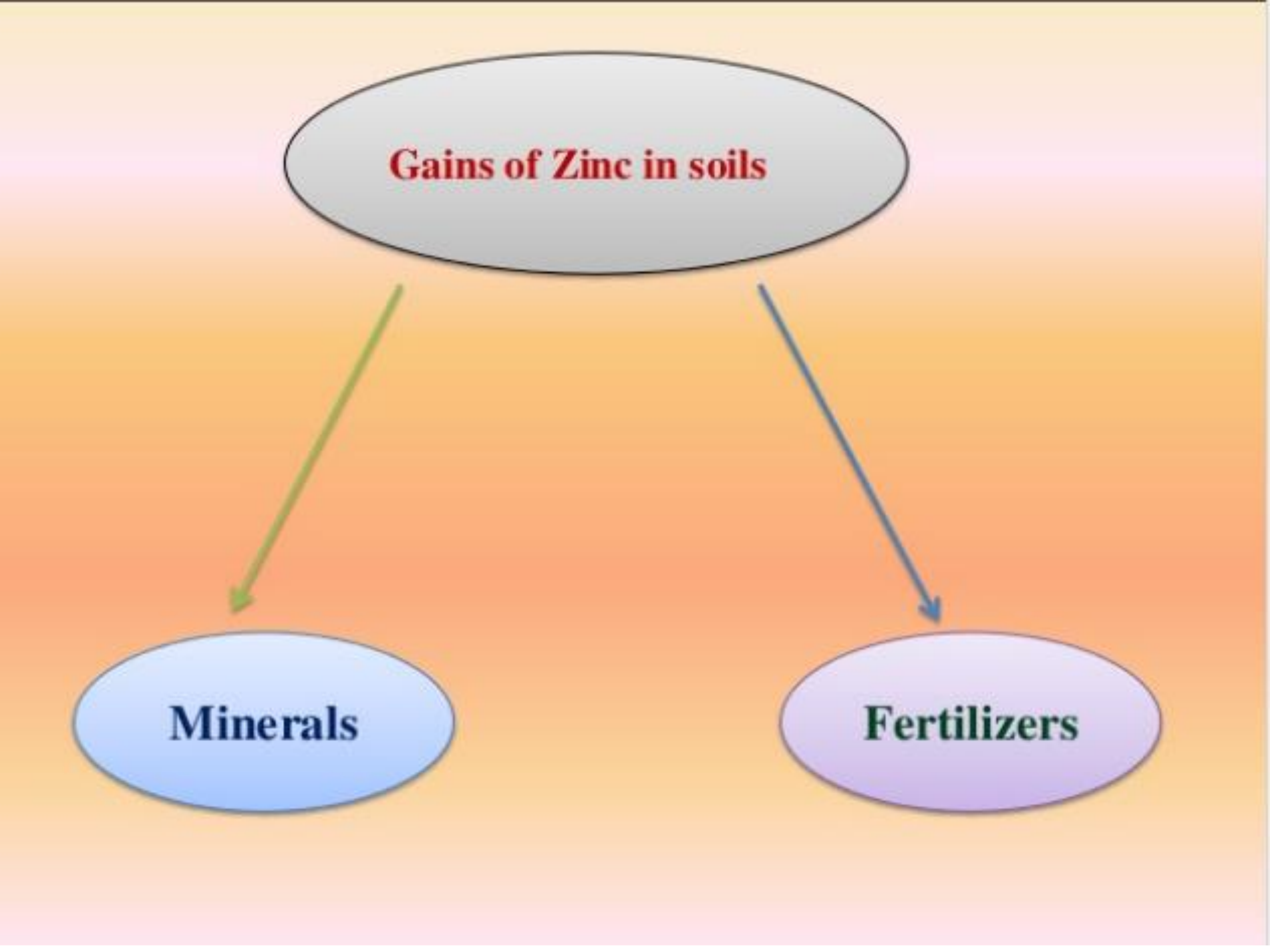
Nutrient Interaction

- Phosphorus is the most important nutrient which interferes Zn uptake by plants.

  Causes-

  - ✓ **Increased plant growth caused by P addition dilutes Zn concentration in plants (Dilution effect).**
  - ✓ **High P hinders Zn translocation from root to Shoot.**
  - ✓ **Disproportionate distribution of Zinc in roots and tops due to lower mobility of Zinc with in plant system compared to Phosphorus.**
  - ✓ **High soil P may reduce VAM development and infection on roots that may decrease Zn absorption and utilization.**

- Other cationic micronutrients , Fe^{2+} , Mn^{2+} , Cu^{2+} may suppress Zn^{2+} uptake, due to ionic competition in soil, competition for same carrier protein in plants.


Gains of Zinc in soils
Minerals
Fertilizers


Losses of Zinc from soil
Plant removal
Soil erosion
leaching

Zinc Deficiency

Soils in which Zinc deficiency may occur

- Alkaline soils
- Calcareous soils
- Leached acidic coarse textured sandy soils
- Peat or Muck Soils (Organic Soils)
- Red/ Laterite soils

Farming practices that may cause Zinc deficiency

- Application of High does of Phosphatic fertilizer
- over liming of acid soils

Zinc deficiency symptoms

- Interveinal chlorosis and reduction in the size of the young leaves
- In acute deficiency, younger leaves show necrosis and dead spots
- Dicot plants show, short internodes (rossetting) and decrease in leaf expansion (Little leaf)
- Premature leaves drop
- Bud fall off
- Seed formation is less
- Fruits are deformed associated with yield reduction.

zinc deficiency symptoms in different crops

- ✓ Khaira disease in Rice
- ✓ White bud of maize
- ✓ Little leaf of cotton
- ✓ Mottled leaf of citrus or frenching of citrus

Zinc deficiency symptoms

Managing Zinc deficiency

- Soil application of Zinc fertilizer
- Foliar Spray

Commonly used zinc fertilizers

Sources	Zinc content
Zinc sulphate heptahydrate	21-23 %
Zinc sulphate monohyadrate	33-36%
Zinc oxysulphate	40-55%
Zinc oxide	55-70 %
Zinc nitrate	22%
Zn-EDTA	12-14 %
Zn- HEDTA	9 %

Recommended Dietary Allowances for Zinc for Infants over 7 months, Children, and Adults

Age	Infants and Children	Males	Females
7 months to 3 years	3 mg		
4 to 8 years	5 mg		
9 to 13 years	8 mg		
14 to 18 years		11 mg	9 mg
19+		11 mg	8 mg

Conclusion

- Zinc is a important nutrient element to boost up crop yield.
- Widespread deficiency of zinc throughout the world arising as a big threat to crop production.
- Zinc deficiency can lead to several physiological disorders and ultimately decrease in yield in major food crops like rice, maize and wheat.
- Judicious application of zinc along with suitable crop varieties can show remarkable increase in economic yield and zinc content in crops.

THANK YOU


بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ
123RF

Topic:

Micronutrient Forms in soil & factor affecting their availability in soil.

Micronutrient:

A chemical, element or substance required in trace amounts for the normal growth and development of living organism is known as micronutrient.

- there are eight trace elements considered to be essential for higher plants,

▪ Fe	Ni
• Zn	B
• Mn	Mo
• Cu	Cl

IRON(Fe):

Form in soil	Chemical formula	color
Ferrous oxide	FeO	Gray
Ferric oxide(hematite)	Fe_2O_3	Red
Hydrated Ferric oxide (Limonite)	$2Fe_2O_3.3H_2O$	Yellow

UPTAKE Forms:

Iron is taken up by plants as ferrous (Fe^{2+}) or ferric (Fe^{3+}) ion

- **Plant mobility:**

Fe is very immobile in plants, so deficiency symptoms appear in young leaves, causing stunted growth.

- **IRON amount in plant**:
- 100ppm
- **Amount in soil:**

range from 0.5 – 50%

Average (3 – 4%)

ZINC(Zn):

- **Form in soil:**

1.MINERAL FORM:

Zinc exist as zinc sulphides,Zinc carbonates, and Zinc silicates.

On weathering Zn ion released.

Sphalarite- ZnS

smithsonite-$ZnCO_3$

Willemite-$ZnSiO_4$

Franklinite-$ZnFe_2O_4$

- **Adsorbed form:**

Zn is adsorbed on the surface of clays, oxide minerals, carbonates and organic matters.

- **Solution form:**

In soil solution Zn exists as Zn ion and $Zn(OH)^+$.

- **Organic Complex form:**

Zn form stable complex with organic colloids. This form is not readily available to plants.

Uptake forms:

Zinc uptake by plant in the form of

Zn^{2+}

Plant mobility:

Zn not readily translocated, so deficiency symptoms first appear in young leaves.

- **Immobile in plants**

- **Zinc amount in plant**:

  20ppm

- **Amount in soil:**

  Range(10 – 300 ppm) **Avg.(**50 ppm)

Manganese(Mn):

Forms in soil:

Manganese in soils is present in three oxidation states: Mn^{+2}, Mn^{+3} and Mn^{+4}.

Plant mobility:

Manganese is highly immobile in the plant so Mn deficiency symptoms are first seen in the young leaves.

- **Manganese amount in plant**:

  50ppm

- **Amount in soil:**

  Range(20 – 3,000 ppm) **Avg.(**600 ppm)

- **uptake form:**

  Manganese uptake by plant in the form of Mn2+.

COPPER(Cu):

FORM in SOIL:

Copper occurs in the soil almost exclusively in divalent form. Cu^{2+}

- **UPTAKE FORM:**

copper uptake by plant in the form of Cu^{2+}

Plant mobility:

- Cu is not readily translocated, so deficiency symptoms first appear in young leaves.
- Cu immobile in soil.

- **COPPER amount in soil:**

copper Typical Concentrations in Soils is **2 – 100 ppm.(Avg.9ppm)**

- **Amount in plant:** (6 ppm)

Boron (H_3BO_3):

- **forms in soil:**

Boron is generally **present in soils** as $B_4O_7^{2-}$, H_3BO^{3-}, HBO_3^{2-} and BO_3^-. Each of these ionic **forms** are readily leached under high rainfall conditions.

- **Uptake form:**

H_3BO^{3-}, BO_{3-}

- **Plant Mobility:**

Boron immobile in plants, so deficiency symptoms appear in young leaves.

- **Amount in soil:**

Typical Concentrations in Soils is 2 – 200 ppm.(Avg. 50 ppm)

- **Amount in plant: (20 ppm)**

Molybdenum (MoO_4^{2-}):

- **Forms in soil:**

Molybdate (MoO42-), Hydroxy-oxido-dioxomolybdenum$HMoO_4^-$.

- **plant uptake form:**

Molybdenum uptake by plant in the form of MoO_4^{2-}

- **Plant mobility:**

molybdenum show variable mobility(*Variable Mobility = Retranslocated from old leaves to new growth only under some conditions)*

- **amount in soil:**

range(0.2 – 5.0 ppm) **Avg.(**1.2 ppm)

- **Amount in plant: (0.1 ppm)**

•Summary of Micronutrient Forms

ANIONS–B, Mo –so more likely to leach

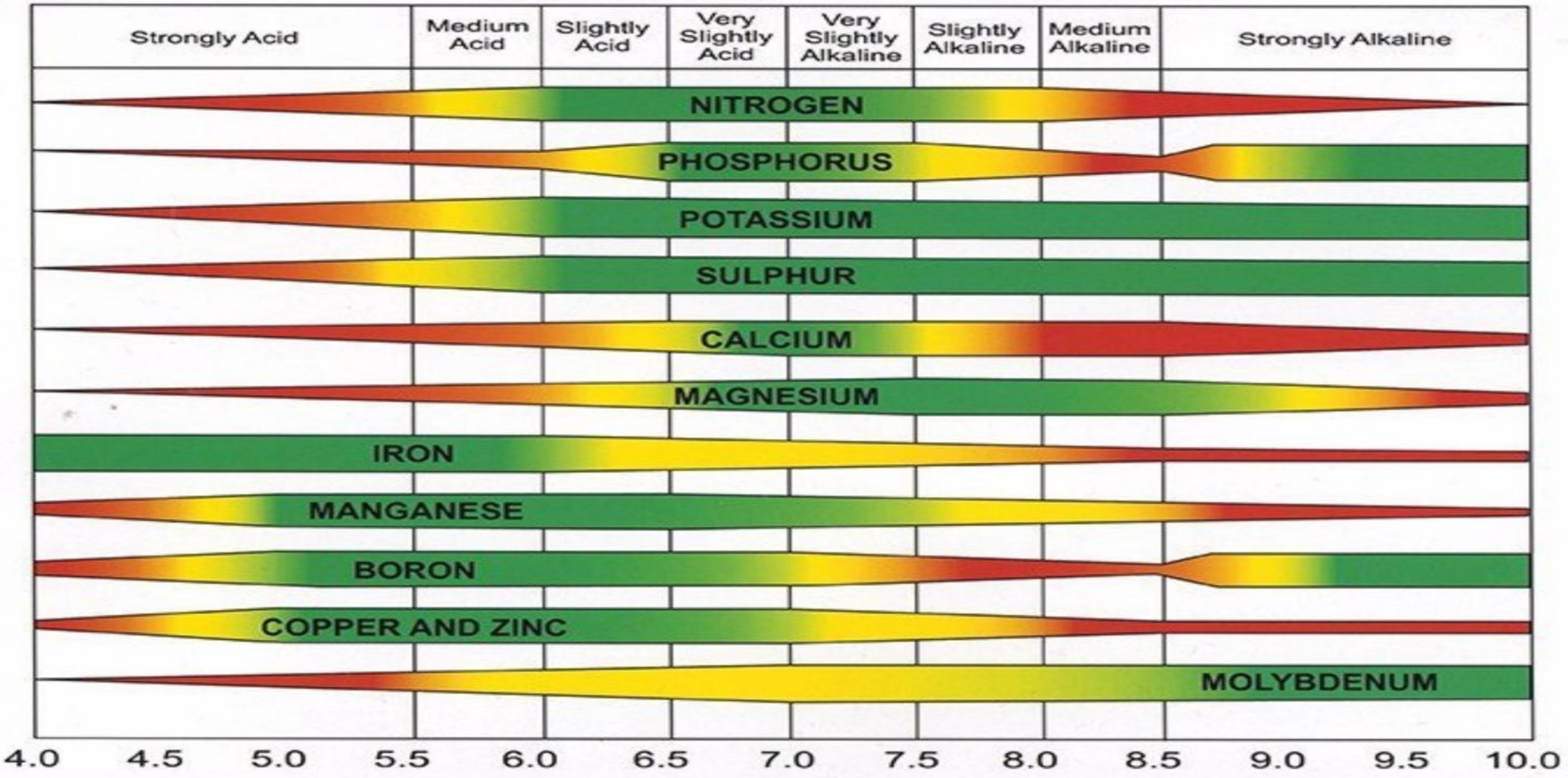
CATIONS –Cu, Fe, Mn, Zn –may associate with CEC, oxides or organic matter

- Factors affect the availability of micronutrient:
- Cation:

- ❑ Soil pH:
- ❑ Oxidation State and pH:
- ❑ Inorganic Reaction:
- ❑ Organic Combinations:
- ❑ Poor Drainage:
- ❑ Soil Temperature and moisture:

- **Soil pH:**
- The micronutrient cations are most soluble and available under acid condition. In very acid soils there is a relative abundance of the ions of iron, manganese, zinc and copper. In fact, under these conditions the concentrations of one or more of these elements is often sufficiently high to be toxic to common plants.
- As the pH is raised, their solubility to plants decreases because ionic form of cations are changed to the hydroxides or oxides. The desirability of maintaining an intermediate soil pH. Generally, zinc-fixation is found at high pH value.

How soil pH affects availability of plant nutrients.



SOURCE: https://www.emporiumhydroponics.com/what-is-ph-1-to-14

- **Oxidation State and pH:**
- Three of the trace element cations are found in soils in more than one valent state. These are iron (Fe^{++} Fe^{+++}), manganese and copper. The lower valent states are encouraged by conditions of low oxygen supply and relatively higher moisture level.
- The oxidised state of iron, manganese and copper i.e., hydroxides or hydrous oxides are insoluble. The micronutrient cations and molybdenum and somewhat more are available under conditions of restricted drainage. Flooded soils generally show higher availability than well-aerated soils.

- **Inorganic Reaction**:
- The availability of iron and zinc may be reduced in the presence of excess phosphates.
- From a practical standpoint, phosphate fertilizers should be used in only those quantities that are required for good plant growth.
- . **Organic Combinations:**
- Each of the micronutrient cations may be held in organic combination. These complexes may protect the micronutrients from certain harmful reactions, such as the precipitation of iron by phosphate.
- On soils high in organic matter, complex formation by copper is thought to be responsible for the deficiency of this element

- **Poor Drainage:**
- Highly leached acidic sandy soils; resulting in leaching of micronutrients, thus deficiency of micronutrients occur.
- **Soil Temperature and moisture:**
- Soil temperature and moisture are important factors. Cool, wet soils reduce the rate and amount of micronutrients that may be taken up by crops.

- **Factors Influencing the Availability of the Micronutrient :**
- **Anions:** Anions i.e., chlorine, molybdenum and boron are relatively little common in comparison to cations. Chlorine, molybdenum and boron are quite different chemically, so very similarity would be expected in their reaction in soils.

1. **Chlorine:**

The chloride ions are not tightly adsorbed by negatively charged clays and as a result are subject to movement. In semi-arid and arid regions, a somewhat higher concentration might be expected, the amount reaching the point of salt toxicity in some of the poorly drained saline soils.

- **Boron:**
- The availability and utilization of boron is determined to a considerable extent by pH. Boron is most soluble under acid conditions. It apparently occurs in acid soils in part as boric acid which is readily available to plants. Boron is held in organic combinations from which it may be released for crop use.
- **Molybdenum:**
- Soil conditions affect the availability of molybdenum much the same as they do that of phosphorus. For example, molybdenum in quite unavailable in strongly acid soils. The liming of acid soils will usually increase the availability of molybdenum.

THANK YOU!