A Review of Diagnostic techniques of visual symptoms of nutrients deficiencies in plant

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Authors' contributions

All authors contributed to the completion of this work. The manuscript's original draft was written by author MHH. Author QA oversaw the literature searches while author SGS edited and rewrote the work in accordance with the journal's style. The final manuscript was read and approved by all writers.

Abstract

Visible symptoms of nutrients are one of the popular methods to recognize the deficiencies of elements in plants. Some plants' essential elements translocate in plants but others move less or do not move from one to another part of the plant, therefore, this movement of nutrients in plants help us to identify particular symptoms of nutrient. Plant nutritional disorder appears in different shape and typeswhich are useful for diagnosis the of element deficiency. At the same time, biotic and abiotic factors also produce similar symptoms of nutrients that are occurred in different conditions. If some confusionhas occurred, it is necessary to analyze plant tissues or soil for the correctness of the problem. These chemical analyses help us for a better understanding of future similar occurrences. The common plant nutrients deficiencies symptoms are chlorosis, necrosis, rosetting, pigmentation, and stunted.

Keywords: Visual deficiency symptoms, Nutritional disorders, Macro, and micronutrients.

1. Introduction

Of the 92 natural elements, 17 elements are essential for plants, without them plants cannot grow well and accomplish their life cycles (Brady & Weil, 2016), and only these elements can accomplish the essentiality criteria proposed by Arnon and stout (Osman, 2013). Mitra (2017) has mentioned that may cobalt is also necessary for the plant. Plants obtain Carbon, Oxygen, and Hydrogen from the air and water, and the rest from the soil solution (Barker &Pilbeam, 2007). Plants are largely constituted of carbon, oxygen, and hydrogen, which are referred to as structural components. Macronutrients are a group that includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. More than 1000 mg/Kg dry weight of macronutrients is considered normal in plants. Small amounts of what are known as micronutrients, which include iron, manganese, copper, zinc, boron, chlorine, molybdenum, cobalt, and nickel, are absorbed. Less than 100mg/Kg dry weight of the micronutrient is considered necessary in plant tissue (Tomar, 2010). Some other elements are not essential for all plants, but they can increase the production of some plants, whichare called beneficial elements. These elements are Cobalt, Sodium, and Silicon (Mia, 2015).

When nutrients apply to the soil for plant growth, they respond against the nutrients in three manners. (a) plant growth is increased by the addition of nutrients when the plants have deficiencies. (b) With The proper amount of nutrients supplied to plants, the growth is maximized and remains more or less unaffected. (c) The excessive amount of nutrients supply decreases the growth of plants; they occur toxicity to plants (Römheld, 2012).

Soil is the biggest reservoir of nutrients, sometimes it cannot provide enough essential elements for plants, therefore the plants show some visible symptoms of starvation. Every nutrient indicates its particular sign to distinguish it from another nutrient. In some cases, the nutritional disorder's symptoms in plants vary interspecies and intraspecies. Sometimes it is very difficult to differentiatefrom each other because some elements show similar symptoms, but it needs enough experience (Viégas et al., 2018).

Visual deficiency signs, soil testing, plant tissue testing, and crop responses to chemical fertilizers or organic manures are the four ways for identifying nutritional disorders in agricultural plants (Fageria, 2009). It is one of the simplest, fastest, and least expensive approaches to identifying the visible signs of nutrient insufficiency in plants. This method doesn't require any additional equipment and saves time and money (Mia, 2015). The drawbacks of this approach include the confusion that results from the identical symptoms brought on by biotic and abiotic plant stress. The same symptoms may occasionally be caused by multiple nutrient deficiencies as well as other reasons (McCauley et al., 2009; Fageria et al., 2011).

The Benefits of Plant Nutrients visual deficiency symptoms Observation are: (a) Plants' visual examination of deficiencies of nutrients is a potent and cost-effective approach for immediately diagnosing nutrient deficiency. (b) The procedure is simple and inexpensive to implement in the field. Farmers may receive training to use this strategy. This system requires no technical knowledge to operate. (c) It can recognize symptoms of plant nutrient deficiency and advise farmers to take the appropriate precautions. If the problem is recognized early, corrective measures can be implemented during crop growth. The entire farm may be examined in a relatively short period. (d)To identify the actual insufficiency, further information such as soil pH, water content, nutrient status, and organic matter content of the soil must be gathered (Baset Mia, 2015).It is crucial to research further and define the precise amount of fertilizers for upcoming varieties of the same species of the plant because different species and varieties of plants require varying amounts of nutrients (Barker &Pilbeam, 2007; Fageria et al., 2011; Brady & Weil, 2016). Farmers may damage plants, animals, and the environment if they use fertilizer improperly or excessively to treat symptoms. The catastrophe will affect the next generation. Modern agriculture now contributes to environmental pollution in a variety of ways. The global rate of eutrophication and hypoxic zones in the ocean is rising. The planet will be in crisis if it uses resources in an irresponsible way (Brady & Weil, 2016).

2. Causes of abnormal plant

Many reasons can affect plant growth and development. The following reasons are mentioned that influence plant life.

2.1 Unsatisfactory environment: Unsuitable environmental conditions prevent the plants from growing well. Flood, drought, frost, strong winds, soil salinity, excessive heat or cold, wetness or dryness, and other climatic conditions have an impact on plant life (Kumar & Sharma, 2013; Shrivastava & Kumar, 2015).

2.2 Nutritional starvation: Plants do not take up enough essential elements, they appear deficiency symptoms of nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and so on (Kumar & Sharma, 2013).

2.3 Nutritional and other toxicities: plant takes up an excessiveamount of micronutrients (Fe, Zn, etc) from the soil, and they show toxicity signs(Kumar & Sharma, 2013).Reduced root growth, an increase in pathogen infection, and a decrease in the capacity to actively absorb nutrients are all effects of plant nutrient toxicity (Hopkins, 2015). Heavy metal toxicity results in abnormal cell division, which leads to chromosomal abnormality in plants, which results in chlorosis in the leaves (Zafar-ul-Hye et al., 2020).

2.4 Excess application of manures, fertilizers, and other soil amendments: Usage of non-decomposed or fresh organic manure, excess application of fertilizers, and over-liming of acid soils can affect plant growth(Kumar& Sharma, 2013). Excess fertilizer can be harmful to plants, thus extreme caution must be taken while using it. Fertilizer burn occurs when too much fertilizer is applied, causing plant damage or even death (Shahena et al., 2021). Moreover, the excess of fresh manure could burn seeds and roots (Iguisi et al., 2023).

2.5 Wrong or excess application of herbicides or pesticides: These chemical materials can influence the life and development stages of plants by application of Toxic doses, drift effects, wrong selection, residual effects, and so on(Kumar& Sharma, 2013). Herbicides are not only sprayed to target plants, but they also come into touch with non-target plant species. Non-target plant species are harmed when these chemicals are sprayed and sublethal amounts reach plants by droplet drift, vapor movement, runoff, leaching, erosion, and improper disposal. Pesticide spraying damages plants, causing epinasty, leaf mottling, withering, yellowing, leaf and stem twisting, necrosis, and bud deformity (Hashimi et al., 2020).

2.6 Biological hazards: Many harmful biological organisms (fungal, bacterial, viral, etc) threaten plants and cause different diseases. Weeds, insects, nematodes, mites, birds, and other organisms also attack and damage crops(Kumar & Sharma, 2013). Plant diseases reduce crop yields and quality while also reducing farmers' resource efficiency. Besides viruses and insects,unwanted plants (weeds) are a major growth limitation, causing significant crop losses (UlHaq& Ijaz, 2020).

2.7 Genetic deformity: Sometimes the plants appear abnormal by Inbreeding depression, chlorophyll-less mutants, variegated mutants, and so on(Kumar& Sharma, 2013). The term "deformation" refers to a distortion or malformation of an infected plant's organ. Deformations include things like fruit ugliness, leaf curling, threadlike

leaves, leaf wrinkles, thicker or stiff leaves (doubling), and leaf wrinkles. The disturbance of absorption processes or the passage of nutrients is the cause of the deformation (Khakimov et al., 2022).

3. The nutritional disorders' properties

3.1 Conditions of occurrence: There are two reasons that plants show their hunger signs. The first one is, the soil cannot supply enough nutrients to plants due to the lack of nutrients in the soil. The second is, that plants cannot take up an adequate amount of nutrients from the soil due to liming, application of urea, phosphorus, and potassium decrease iron, calcium, zinc, and magnesium uptake to plants, respectively. Iron and manganese deficiencies happen in alkaline soils. Phosphorus, calcium, potassium, and magnesium deficiencies are common in acid soils, where soil pH is below 6(Kumar & Sharma, 2013).

3.2 Pattern of appearance: The deficiency symptoms of nutrients appear in particular parts of plants. Nitrogen, phosphorus, potassium, and magnesium deficiency symptoms occurred in older leaves and continued upward the deficiencies. Iron, manganese, copper, zinc, calcium, sulfur, molybdenum, and boron deficiency symptoms are seen in younger leaves and expended downward. These patterns of nutrients are very important for the diagnosis of deficiencies of nutrients in plants (Stevens et al., 2002; Kumar & Sharma, 2013).

3.3 Specificity of the symptom: Every plant that is suffered from a lack of an element shows some special characteristic symptoms to distinguish the lack of another nutrient deficiency. The white specks develop in the interveinal of the leaf, the white bands develop on both sides of the midrib and margin of the leaf, and pale yellow chlorosis develops between the vein of the leaf, showing deficiencies of manganese, zinc, and iron, respectively (Stevens et al., 2002; Kumar & Sharma, 2013). Zinc-deficient mango internodes are shortened in the stems, causing the leaf rosetting (Uchida, 2000).

3.4 Stages of development: The plants are suffered from a deficiency of a nutrient; it appears different symptoms from start to end. In the mild iron deficiency condition, the top leaves of the plant progress fading of interveinal tissues with prominent green veins. When deficiency increases pale-yellow chlorosis expend in interveinal tissues with clear green veins. In the later stages of deficiency of iron, appears the prominent green veins turn to fade, light green, and finally pale-yellow color (Kumar & Sharma, 2013).

4. Visual Symptoms as a Diagnostic Tool

It is necessary to analyze plants and soil for confirmation of nutrient visible deficiency symptoms in plants. Some nutrients stress symptoms that show their deficiencies include the following:

4.1 Similar symptoms: Many nutrient deficiencies may look the same way (Bradley and Hosier, 1999). For example, Nitrogen and sulfur deficiency symptoms are similar, but their locations are different (McCauley et al., 2009). Nitrogen deficiency symptoms first appear in older leaves, but sulfur deficiency symptoms first appear in younger leaves of plants (Stevens et al., 2002; Kumar & Sharma, 2013). In the severity condition of nitrogen, chlorosis is occurred by the death or dropping of older leaves (Uchida, 2000). Other causes for the yellowing of leaves include poor soil drainage, damaged roots, compact roots, high alkalinity, and nutrient deficiencies. Because they are unable to produce carbohydrates, the damaged plants or leaves eventually wither and perish (Bhatla et al., 2018).

4.2 Multiple deficiencies or toxicities: It is impossible to identify which nutrients are inadequate when two or more are deficient at the same time (Bhatla et al., 2018).Sometimes more than one deficiency or toxicity can occur symptoms at the same time. Correction of one deficiency can induce another deficiency. For instance, excessive application of phosphorus can cause zinc deficiency (Chatterjee & Dube, 2004; McCauley et al., 2009), & Mn deficiency induces Fe deficiency or vice versa (Basit Mia, 2015).

4.3 Crop species and varieties: various species and varieties have different abilities to adapt to nutrient deficiencies and toxicities. For example, maize is more sensitive to zinc deficiency than barley (McCauley et al., 2009). Different crops may exhibit various deficiency symptoms for a particular element, therefore understanding the symptom in one species may not apply to another. For instance, Zn can cause symptoms like tiny leaves on fruit plants, and it can cause whitish new leaves in maize (de Mello Prado &Rozane, 2020; de Mello Prado, 2019).

4.4 Pseudo (false) deficiency symptoms: In the field, pests and pathogens may interfere with the plant and obscure the accurate identification of the problematic nutrient (de Mello Prado &Rozane, 2020; de Mello Prado, 2019). Sometimes diseases, drought, excess water, genetic abnormalities, insecticide, insects, and soil compaction also appear as similar symptoms, like occurring from nutrient deficiencies (Stevens et al., 2002; Chatterjee & Dube, 2004; McCauley et al., 2009). As each element exhibits a different sort of deficiency, this system can be confused with the insufficiency of other elements. The interaction of different ions can result in a deficiency that such a system cannot remedy (Basit Mia, 2015). Heavy metals in high concentrations inhibit important enzymatic reactions by altering protein structure or substituting crucial elements, resulting in deficiency symptoms. As a result,

poisoning symptoms such as chlorosis, growth retardation, and root browning might be recognized (Ranganathswamy et al., 2019)

4.5 Hidden hunger: sometimes plants suffer hidden hunger, but do not show any particular signs (Chatterjee & Dube, 2004; McCauley et al., 2009;Afghani & Hashimi, 2015). Hidden hunger is a condition in which yield is low due to insufficient nutrition (Bhatla et al., 2018). A hidden hunger occurrence commonly influences the final yield and product quality. Grain yield and quality may be lower than predicted for grain crops; for fruit crops, abnormalities such as blossom-end rot and interior abnormalities may occur, and post-harvest features of fruits and flowers will result in poor shipping quality and limited durability. Another example is K deficiency in corn, which is not visible until maturity when plants easily lodge (Jones, 2012).

4.6 Field symptoms: In the field, deficiency symptoms may differ from those described in professional publications because contrary to what is written in these works, deficiency symptoms may be minor in the field while being severe in these works (McCauley et al., 2009; de Mello Prado &Rozane, 2020; de Mello Prado, 2019). Nutrient deficiency symptoms are extremely complex since each nutrient has numerous physiological and metabolic activities, each of which may interact with environmental circumstances. Furthermore, the emergence of these symptoms differs in chronic deficiency states. If complete symptoms are not visible clearly in plant parts, it is extremely difficult to understand and diagnose (Basit Mia, 2015).

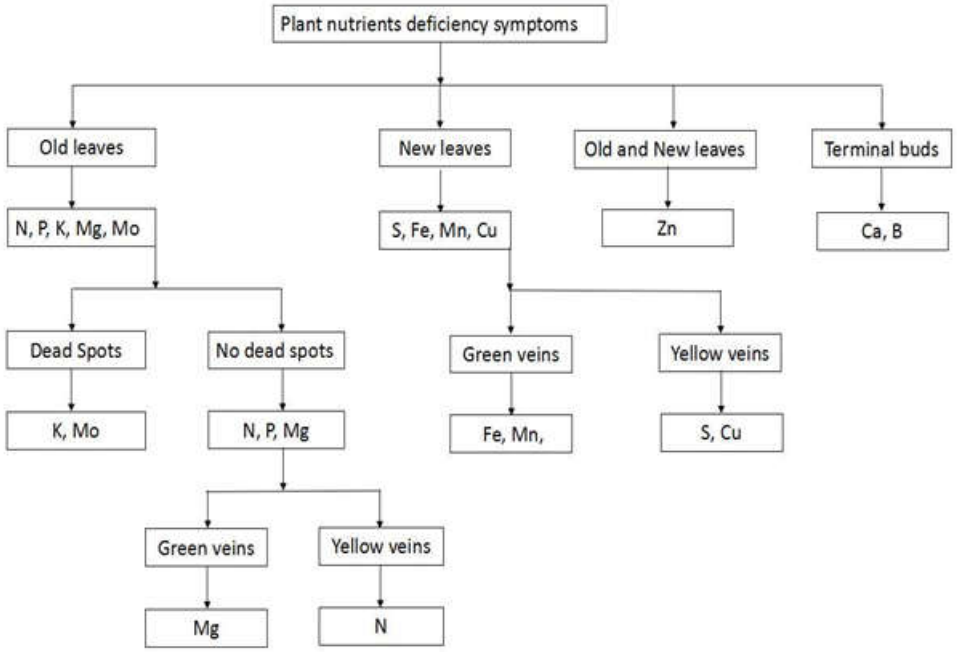
4.7 Different parts of the Plant: In general, the concentration of nutrients in different plant parts, such as the root, stem, leaves, and fruits, is not equal, which can lead to nutrient deficiencies in different plant parts, confusing the diagnosis system (Mia, 2015; Basit Mia, 2015).

4.8 Naked eye observation: The appropriate application of the visual diagnosis technique requires professionals with deep experience of the crop in their region. Furthermore, the visual diagnostic does not quantify the level of nutrient deficiency or excess nutrients (de Mello Prado &Rozane, 2020; de Mello Prado, 2019). It is not a stand-alone procedure, but rather a supplement to another analysis system for identifying nutrient deficiency (Basit Mia, 2015). Naked eye observation cannot find any precise solution or problem source, therefore, plant, and soil analysis are needed for accuracy (Mia, 2015).

4.9 Nutrient deficiency symptoms in different plants: Various crops exhibit specific visual deficiency symptoms as a result of nutrient inadequacy. Calcium deficiency has been linked to disorders such as blossom end rot in tomatoes, pepper, and pepper; bitter pit in apples; and black heart in celery. Whereas Zn deficit caused Khaira disease in rice and the white bud of maize (Karthika et al., 2018).

5. Visual Diagnoses of Plant Nutrient Deficiencies

Visual deficiency symptoms (figure 1) of nutrients in plants are identified in the growing season, as well as the parts of the plant also checked which part has affected (older or younger leaves).finally, the symptoms of the disorder (chlorotic, necrotic,deformed) are recognized (Fageria et al., 2011). The above focal points help us to identify the disorder. Although diagnostic features can be used to identify deficiencies, it might be challenging to do so on occasion because: Sometimes a condition is extremely advanced before evident visual signs develop, leading to a loss in yield or quality; A plant's lack of symptoms does not necessarily indicate that its nutrition is sufficient; When more than one factor contributes to the same deficiency symptoms, visual symptoms can be unreliable. Moreover, some symptoms may manifest as a result of changes in certain environmental stresses (Bhatla et al.,



2018).

Figure 1 shows different nutrients and visual deficiency symptoms (Tomar, 2010; Jeyakumar&Balamohan, 2020).

Chemical reactions occur in soil, sometimes the density of one matter is increased or decreased,and it affects another matter.similarly, soil pH also affects the absorption of nutrients by plants. Higher and lower pH can decrease some nutrients for plants. Soil organic matters, water contents, soil erosion, leaching, denitrification, immobilization, weeds, and biotic and abiotic factors influence the absorption of nutrients and influence the growth and life of plants. Symptoms of disorders, guide us to recognize nutrient deficiency in plants (Savoy, 2004; Barker &Pilbeam, 2007; Fageria, 2009).Diagnosing plant nutrients disorder needs enough experience and professional knowledge. In general, these symptoms should be verified and confirmed by soil and plant analysis to take accurate action for correcting (Sims&McGrath, 2012).Finding the location and pattern of the symptoms is the most crucial diagnostic aspect of nutritional deficiency symptoms. Symptoms of nutritional deficiency typically appear in certain organs like leaves, roots, shoots, or developing points(Bhatla et al., 2018).Some common symptoms of nutrients deficiency shown by plants are:

5.1 Chlorosis:The yellowing of leaf tissue as a result of a lack of chlorophyll is referred to as chlorosis. Plants with deficiencies in N, S, and/or Cu exhibit chlorosis symptoms in their leaves(Hashimi, 2013; Bhatla et al., 2018).

5.2 interveinal chlorosis: Interveinal chlorosis is the yellowing of the areas between the green veins of a leaf. Mg, Fe, and Mn deficiencies in plants occur as Symptoms of interveinal chlorosis in plant leaves(Bhatla et al., 2018).For instance, On each side of the midrib, which starts at the base of the leaf and extends toward the tip, the young maize leaves have light streaks or whitish bands. The leaf's midrib and margins also are green (Kumar & Sharma, 2013; Hashimi, 2021).

5.3Necrosis: Necrosis is the symptom of dead plant tissue and its color is brown. It occurs on tips, margins, or interveinal parts of the leaves(Savoy, 2004; Barker &Pilbeam, 2007; Chandrasekaran et al., 2010). Necrosis occurs when affected plant tissue turns brown to black. It results from the mortality of plant cells. Necrotic signs can appear everywhere in the plant, including storage organs, green tissues, and woody tissues. Plants exhibit necrosis symptoms when P, K, and B are deficient (Bhatla et al., 2018).

5.4 Rosetting: Growth stopping or terminal development culminating in rosette formation (Bhatla et al., 2018).A bunch of leaves appears on the crown part of the plant and a lack of new terminal growth of axillary buds. Sometimes the terminal portions of the plant are dead(Savoy, 2004; Barker &Pilbeam, 2007; Chandrasekaran et al., 2010). Rosetting symptoms develop when plants are deficient in N, K, Mo, Zn, and S (Savoy, 2004; Bhatla et al., 2018). In some plants especially apples and pears, the shoot elongation is reduced, and small crowded leaves appear in the terminal (Gulzar et al., 2020; Hashimi, 2021)

5.5Pigmentation: the reddish or brownish colors happen on leaves and some parts of the plant due to sugar accumulation(Savoy, 2004; Barker &Pilbeam, 2007; Chandrasekaran et al., 2010). Pigmentation occurs when carbohydrates are not metabolized in plant cells, resulting in anthocyanin accumulation. Anthocyanin (a glycosylated form of anthocyanidins) concentration can cause the leaves to turn purple. Nitrogen and phosphorus reduction promotes anthocyanin formation in diverse plant parts. additional reasons for rosetting are Low temperatures, disease, drought, and even maturation of some plants can all produce anthocyanin accumulation, making this sign extremely difficult to identify(Bhatla et al., 2018). The accumulation of anthocyanin causes a reddish purpling of the leaves, which is typically more prominent on the underside of older leaves (Jones, 2012).N, P, S, and Mg deficiency in plants accumulate anthocyanin pigment in leaves, the leaves turn a purple and reddish color (Bhatla et al., 2018).

5.6 Dwarf or stunted plants: The plants reduce their normal growth, and the leaves turn a yellow color(Savoy, 2004; Barker &Pilbeam, 2007; Chandrasekaran et al., 2010).Plants with a Zn deficiency show delayed maturation, reduced growth, and decreased crop yield (Karthika et al., 2018).Plants with deficiencies in N, P, K, Zn, and Ca grow slower and appear stunted(Bhatla et al., 2018). A severe Zn deficiency results in shorter internodal distances delayed terminal growth and dwarfed and stunted plants. Due to a lack of auxin, maize stems shorten because auxin is essential for stem elongation (Hashimi, 2021).

5.7 Deformations: When there is a calcium deficiency, meristematic tissues weaken. Younger leaves can appear tiny, malformed, and chlorotic, which are typical indicators of Ca deficiency. In severe Cu shortage, leaf malformation is later seen to cause premature abscission (Karthika et al., 2018). Boron deficiency resulted in deformed leaves and fruits, while Zn deficiency resulted in plant deformity (de Mello Prado, 2021).As well as, zinc deficiency also caused the reduction of the younger leaves' size and becomes malformed cotton leaves (Hashimi, 2021).

5.8Premature fall of leaves and buds: Deficiencies in phosphorus and nitrogen cause older leaves to fall off as well prematurely (Karthika et al., 2018). Plants with N, K, and P deficiencies shed premature leaves and buds (Bhatla et al., 2018; Karthika et al., 2018).

5.9. Delayed flowering: Male flowers of plants become sterile when they lack copper. Moreover, it causes senescence and delayed flowering (Karthika et al., 2018).Under P and N limits, plant maturity is also delayed; however, these changes differ depending on the crop species (Malhotra et al., 2018). Additionally, Zinc-deficient plants show delayed seed development along with other symptoms (Khan et al., 2018). Plants with N, S, and Mo deficiencies delay flowering (Bhatla et al., 2018).The following Table 1shows different nutrient deficiency symptoms in plants.

Table 1: Different plants show various nutrients visible deficiency symptoms

Nutrient	Common Visual deficiency symptoms
Nitrogen	Older leaves develop chlorosis, which in severe cases causes the entire plant's leaves to turn yellow. The plants appear small and occur premature leaves. Reduced tillering in cereals(Karthika et al., 2018).
Phosphorus	Necrotic spots develop on older leaves as a result of leaves prematurely drying up and falling off (Karthika et al., 2018).
Potassium	Older leaves exhibit chlorosis as a visual symptom. This starts at the leaf margins and moves inward later. In advanced stages of insufficiency of potassium, leaves will curl and wrinkle (Karthika et al., 2018).
Calcium	Early symptoms of deficiency included necrosis of young meristematic regions, such as the tips of roots and young leaves or developing tissues, and newly emerging leaves or developing tissues (González-Fontes et al., 2017). The new leaves become white and growing points die and curl (Fageria et al., 2011). Certain physiological disorders, such as tomatoes and pepper blossom end rot, bitter pit in apples, black heart in celery,internal browning in Brussels sprouts, Cavity spot in carrots (Karthika et al., 2018), Tip hooking in cauliflower (Mali et al., 2022), and Empty pops in peanut (Kadirimangalam et al., 2022; Vu et al., 2022) are brought on by calcium shortage in some fruits.
Magnesium	Reduced growth of roots, and shoots and the emergence of necrotic areas on older leaves are some of the most visible signs of magnesium deficiency. These symptoms are mostly caused by a decrease in chlorophyll content and a decrease in carbon metabolism (Sharma et al., 2017). Interveinal chlorosis and streaked or patchy effects on leaves are some of the Mg deficiency symptoms. The intercostal regions can occasionally become necrotic (Karthika et al., 2018)
Sulfur	Growth stunting, leaf yellowing, the synthesis of anthocyanins, and early but restricted flowering are some of the indications of sulfur deficiency (Zheng &Leustek, 2017).
Iron	Interveinal chlorosis first emerges on the younger leaves. The leaf margins and veins remain green. Later, these veins eventually become chlorotic, and under conditions of persistent insufficiency, the entire leaf turns white (Karthika et al., 2018).
Manganese	Due to the Mn deficiency, the young leaves are pale in color, and the veins and venules are dark green and reticulated (Hasanuzzaman et al., 2017). There are some of the most common Mn shortage symptoms that have produced physiological problems in several crops and fruits: Grey speck of oats; Speckled yellow of sugar beet; Pahala blight of sugarcane; Marsh spot of peas and Frenching of tung trees (Karthika et al., 2018).
Copper	Plants suffer from copper insufficiency, which presents as young leaves chlorosis, rolling, and dieback (Fageria et al., 2011). Copper deficiency causes several physiological disorders in crops and trees including reclamation disease of cereals and legume crops (Raut et al., 2020), stem melanosis of wheat, and citrus dieback (Kumar et al., 2020).
Zinc	Interveinal chlorosis (mottling), a lighter green to pale yellow color that occurs between the midrib and secondary veins, is the initial symptom of zinc deficiency in all plants. The internodes are short and the developing leaves are smaller than usual (Barker &Pilbeam, 2015).

	Khaira disease in rice, the White bud of maize, little leaf of cotton, mottle leaf or frenching of citrus, rosette disease of apple, and crown choking in areca nut are the most common Zn deficient disorders symptoms in plants (Karthika et al., 2018; Hashimi, 2021).
Boron	Boron is not mobile in plants, hence signs of boron deficiency occur first in the younger leaves or developing tips (Fageria, 2009). Plants experience discoloration of buds and breaking and dropping of buds (Hasanuzzaman et al., 2017). Boron deficiency inhibits development and causes internode shortening. In the case of sorghum and corn, white or transparent lesions occur in interveinal tissues on young leaves, typically while they are still within the whorl (Fageria, 2009). Internal cork of apple, top sickness of tobacco, crown rot/heart rot in sugar beet, browning and hollow stem of cauliflower, the cracked stem of celery (Karthika et al., 2018), hen and chicken of grapes (Swathi et al., 2019), and hollow heart of groundnut are some of the physiological disorders that commonly result from boron deficiency (Sagun et al., 2022).
Chlorine	Reduction in leaf surface area, wilting of the plant, and constrained, highly branching root systems are some of the main indications of chlorine deficiency (Ali et al., 2020).
Molybdenum	Older leaves develop general yellowing, marginal chlorosis, and interveinal chlorosis, as well as sticky secretion from the dorsal leaf (Hasanuzzaman et al., 2017; Gulzar et al., 2020). Several plants experience physiological insufficiency disorders of molybdenum, including citrus yellow spot (Prashar et al., 2022), and whiptail of the cauliflower (Kumar et al., 2020; Pokhrel, 2021)
Nickel	Nickel deficiency results in leaf chlorosis and leaf tip necrosis (Hasanuzzaman et al., 2017).

6. Conclusions

The mobility of nutrients in the plant helps us to identify the particular elements of deficiency symptoms. Nitrogen, phosphorus, potassium, and magnesium elements move from older leaves to younger leaves, therefore the older leaves appear some shortage of signs of elements. The micro-elements do not move from one to another place in the plant, and thus their deficiency symptoms first come into view in the younger leaves or the growing parts.There are some special signs to indicate the deficiency of nutrients in plants. These marks (chlorosis, necrosis, rosetting, dwarf, purple color) of deficiencies of nutrients help us to recognize the particular element lacking.Sometimes, plant visible symptoms are very difficult for recognizing their causes, because many factors show similar symptoms. Therefore, plant and soil analysis are necessary to diagnose the factor.

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