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Plant Nutrition and its Role in Plant Growth: A Review

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Abstract:
Plants are incomparable organisms which will absorb nutrients and water through their root, also as carbondioxide from the atmosphere. For plant distribution and growth soil quality and climate are the main determinants. The combination of soil nutrients, water, and CO_2 , alongside sunlight, allows plants to grow. Plants require only light, water and about essential elements to support all their biochemical needs. Essential elements are often divided into two groups macronutrients and micronutrients. Macronutrients include carbon, oxygen, hydrogen, nitrogen, phosphorous, potassium, calcium, sulphur, magnesium and micronutrients involve iron, boron, chlorine, manganese, zinc, copper, molybedum and nickel. Severity in these nutrients particularly the macronutrients affect plant growth. Depending on the precise nutrient, a scarcity can cause stunted growth, slow growth, or chlorosis (yellowing of the leaves). High deficiencies may result in leaves indicating signal of cell death.

Keywords: *Nitrogen; potassium; calcium; boron; zinc; molybedum; deficiency symptoms*

Introduction

Plant nutrition is the study of the chemical elements and compound required Plant require at least fourteen essential elements. Essential elements are often divided into two groups macronutrients and micronutrients.Macronutrients include carbon, oxygen, hydrogen, nitrogen, phosphorous, potassium, calcium, sulphur, magnesium and micronutrients involve iron, boron, chlorine, manganese, zinc, copper, molybedum and nickel. Crop production is usually restricted by low photoavailibility of essential mineral elements and or presence of enormous concentration of probably toxic mineral elements like sodium,chlorine,boron,iron,manganese and aluminium in soil solution[1].

Through plant roots mineral elements are obtained from the soil solution. They traverse the basis via apoplastic (extracellular) and/or symplastic (intracellular) pathways to the stele, where they're loaded into the xylem for transport to the shoot. All cytotoxic cations must be transported either through the apoplast or through the symplast during a chelated form[1]. Many mineral elements are retained within the roots of some plant species. Examples are Ca, Mo, Na, Cd and Al[2]. Plants appear to be composed of fairly few different cell types [3]. Every cell types is assumed to perform a particular physiological function and, consequently, to possess a singular ionome [4,5]. The ionome is defined as per [6]. It involves all mineral elements, whether crucial or nonessential for all times ,in whatever chemical form they occur.
Mn is needed by plants for the manganese-protein in photosystem II and the manganese-containing superoxide dismutase and also acts as a cofactor for several enzymes that catalyse redox, decarboxylation and hydrolytic reactions [2].B is crucial for cross-linking the pectic polysaccharide rhamnogalacturonan-II in primary cell walls, but high tissue B concentrations are harmful to plants[7].

Role of Macronutrients

1. Role of Calcium

Plant growth is affected by calcium of soil directly through its important role as a crucial element and indirectly through its effect on the chemical, physical, and microbiological properties of athe soil.Calcium has been assigned variety of physiological roles in plant nutrition. one among the roles, first proposed was that of neutralizing oxalic acid by the formation of relatively insoluble calcuim oxalate, thus preventing the buildup of oxalic acid to a detrimental degree[8]. It's also been suggested [9] that calcium plays a role in neutralizing other organic acids formed by the metabolic activities of plants. Another function assigned to calcium is that of serving as a structural component of the cell wall[8].Calcium pectate is one among the components of the middle lamella, and plays a crucial role in the absorption and retention of ions by the cells [10]. The buildup of carbohydrates in the absence of calcium has also been noted by several investigators, and it's been suggested that the role of calcium during this respect is to get rid of potassium oxalate which presumably intrude with the diastase activity necessary for carbohydrate translocation[8]. Calcium is mandatory in nitrate reduction within the plant, is additionally shown by the fact that reductase activity is low in the absence of calcium [11].

It has also been shown that calcium is most effective agent in counteracting the detrimental effects of an unbalanced supply of other ions to the plant. Calcium scarcity plants are specifically of low stature as a results of failure of the internodes to elongate. Meristematic tissue is extremely affected by calcium deficiency, and under extreme conditions the terminal bud may die. An sufficient supply of calcium also appears to be essential for the well establishment and functioning of the symbiotic relationship between bacteria and host legume[8].

2. Role of Potassium

Potassium (K) plays a crucial role in plant growth and metabolism of all the mineral nutrients and it contributes largely to the survival of plants that are under various biotic and abiotic stresses. The significance of K fertilizer for the formation of crop production and its quality is known.It is an vital nutrient and is furthermore the most abundant cation in plants[12]. K plays important part in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport, cation-anion balance and stress resistance [13].

K fertilizer is extensively reported to reduce insect infestation and disease incidence in many host plants[12]. Perrenoud [14] reviewed 2449 references and found that the utilization of K significantly reduced the incidence of fungal diseases by 70%, bacteria by 69%, insects and mites by 63%, viruses by 41% and nematodes by 33%. Meanwhile, K amplified the yield of plants infested with fungal diseases by 42%,bacteria by 57% , insects and mites by 36%, viruses by 78% and nematodes by 19%.

Higher K^+concentrations reduced the interior competition of pathogens for nutrient resources [15]. This nutritional values helps plants to allocate more resources for building stronger cell walls for protection agianst pathogen infection ,insects attack and to recieve more nutrients to be used for plant defense and damage repair [16].K is further important for the performance of several plant enzyme functions, and it manages the metabolite design of higher plants, finally changing metabolite concentrations [16,17]. An adequate K supply is important to enhancing drought resistance by increasing root elongation and maintaining cell wall stability[12].

An sufficient K level may facilitate osmotic adjustment, which maintains higher turgor pressure, relative water content and lower osmotic potential, thus improving the power of plants to tolerate drought stress [18,19]. Suficient levels of K nutrition enhanced plant drought resistance, water relations, WUE and plant growth under drought conditions [19]. The adequate K level increased cell wall stability, root growth, leaf area and total dry mass for plants living under drought conditions and also improved water uptake and conservation[12] .K^+ deficiency notably increased the negative effects that were prompt by salt in the photosynthesis of barley and was convoyed by rise in salt sensitivity [20]. The vacuole and the cytosol are the two main pools of K in plant cells. Cytosolic K^+ concentrations are maintained at a consistent level and are necessary for plant metabolism, while vacuolar K^+ concentrations may vary dramatically[12].Under K^+-deficient conditions, a consistent cytosolic K^+ concentration was credited to the consumption of vacuolar potassium [21].

The result of increasing K^+ applications on yield and cold tolerance studied by Devi et al. [22] in panax ginseng showed that a high K+ concentration triggered the plant's antioxidant system and increased levels of ginsenoside-related secondary metabolite transcripts, which are related to cold tolerance. Higher concentrations of K^+ shielded against freezing by lowering the freezing point of the plant's cell solution[12]. Also, adapted cytosol K^+ concentration is also crucial for enzyme activities that are engaged in regulating frost resistance [18]. Higher K tissue concentrations decreased chilling damage and increased cold resistance, finally increasing yield production [16,18]. K additives under waterlogging increased plant growth, photosynthetic pigment, photosynthetic capacity and improved plant nutrient uptake as a results of higher K^+ ,Ca^{2+}, N, Mn^{2+} and Fe^{2+} aggregation [23].

Role of Micronutrients

1. Role of Boron

Boron (B) is an important element for plants and single non-metal among plant micro nutrient. In 1808 boron was discovered by Gay Lussac and Thenard [24].

Boron is especially involved in carbohydrate metabolism and cellular division . Except these two it additionally affects a minimum of 14 functions in plant. Beside from this many scientists has disclose that boron is extremely important in carbohydrate synthesis and its translocation to the other side of the membrane towards meristem regions of roots and tops [25,26,27,28,29]. The second important role of boron in plant metabolism is cellular division and maintaining the cell membrane structure [30,31,32,33,34,35].

Boron insufficiency symptoms are sign of sugar deficiency within the cambia, stem tips, root tips, flowers and fruits [36]. Boron lacking hinders flowering and fruiting by delaying pollen germination and pollen tube development processes. B insufficiency decreases fertility and fruit growth becomes slower or non-existent, based on the acuteness of the deficiency. Sometimes plant fails to set flowers or in case if flowers are set anyhow they're terminatedS due to B deficiency. Deformed flowers are a usual symptom of boron deficiency [2,27,28,29,37].According to Dugger [38], boron insufficiency plays an vital role in auxin biosynthesis in the meristem of the plant, thus its inadequacy affects IAA metabolism. In 1974, Shkolnik [39] described the physiological role of boron with the fact that auxin and phenolic compounds exhibit aggregation in the absence of boron.

2. Role of Zinc

Zinc is plant micronutrient which is associated in many physiological functions its insufficient supply will decrease crop yields. Zinc is important for the development in animals, humans, and plants it's important to the crop nutrition as needed in various enzymatic reactions, metabolic processes, and oxidation reduction reactions[40]. Zn plays crucial role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase, stabilization of ribosomal fractions and synthesis of cytochrome [41]. Plant enzymes activated by Zn are associated in carbohydrate metabolism, sustaining of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis and pollen formation [2]. The regulation and maintenance of the gene expression needed for the tolerance of environmental stresses in plants are based on Zn [42]. As Zn is needed for the formation of tryptophan which is precursor of IAA, it also has a lively role in the production of an important growth hormone auxin [43,44].

Zn deficiency

Zinc deficiency are found in almost every part of the world and most crops respond positively to application of Zn [45]. Micronutrient Zn deficiency can negatively affect the standard of harvested products; plants susceptibility to injury by high light or temperature intensity and to infection by fungal diseases also can increase [2,42]. Deficiency causes several indicators which usually appear two to three weeks after transplanting of rice seedlings, with leaves developing brown blotches and streaks which will fuse to fully cover older leaves, and plants remain stunted, whereas in critical cases, the plants may die, while those which recover will show substantial delay in maturity and decrease in yield [46,47,48].Zinc deficiency stress in crops can be caused due to higher phosphate level in soils that come from native P or due to application of phosphate fertilizers[49].

Zinc Deficiency Symptoms in Plants

The most frequent indicator of Zn deficiency include: stunted growth, shortened internodes and petioles, and little malformed leaves (small leaf) which ends up in the "rosette" symptom in the early growth stages of dicotyledons and "fan shaped" stems in monocotyledons [50]. Zinc insufficient plants are unthrifty, lack vigor; give patchy look with short and thin stems. In young plants intersveinal areas are with dark brown necrotic lesions [51].

Zinc critical levels in Plants

The critical limits of Zn in plants indicates deficiency as suggested by [52] are :< 10 mg kg-1 definite Zn deficiency, 10–15 mg kg-1 very likely,15–20 mg kg-1likely and >20 mg kg-1unlikely (sufficient). In most crop species leaf sufficiency range for Zn 15 to 50 ppm within the dry matter of mature plants and in most cases 15 ppm Zn is taken into account as critical value [51].

3. Role of Molybedum

Molybdenum is essential micronutrient .Molybdate is predominant form available to plants and is needed at trace levels and it's known to engaged in various redox reactions in plants as a part of the pterin complex Moco. Moco is especially involved in enzymes, which participate directly or indirectly with nitrogen metabolism[53].

The accessibilty of molybdenum for plant growth is strongly hooked on the soil pH, concentration of adsorbing oxides (e.g. Fe oxides), extent of water drainage, and organic compounds found within the soil colloids[53]. Mineral forms of molybdenum located in rocks incorporate molybdenite (MoS_2), wulfenite ($PbMoO_4$) and ferrimolybdenite [$Fe_2(MoO_4)$][54]. The remarkable influence of molybdenum on plant nitrogen metabolism is in nitrogen-fixing legumes. The symbiotic bacterial enzyme nitrogenase is made up of two subunits one of them is the MoFe protein directly involved in reduction of N_2 to NH_3. To provide molybdenum and Fe to bacteroids is therefore a key process and presumably a key regulatory component in the maintenance of nitrogen fixation in legumes[53].

Molybedum deficiency symptoms in plants

Plants grown in nutrient solution in absence of molybdenum developed particular phenotypes including mottling lesions on the leaves, and altered leaf morphology where the lamellae became involuted, a phenotype commonly mentioned as 'whiptail' [55]. Molybdenum-insufficient oat and wheat develop necrotic regions on leaf blades, and seeds are weakly developed and shrivelled [56,57]. In maize, molybdenum deficiency shortens internodes, reduces leaf areas and causes the event of chlorotic leaves[58]. In grapevines, molybdenum severity has recently been suggested as the main cause of bunch development disorder called Millerandage or 'hen and chicken'[59]. Spinach plants grown under molybdenum-severity conditions, it was observed that leaf NR activity was decreased and overall less yeild was obtained than the control plants with sufficient level of molybedum [60].

Conclusion

This Review summarizes that for standard growth each nutrient must be present in proper amount ,lack of any of these nutrient restricts standard growth.This review also focus on how each nutrient is useful in plant function.Crop production is usually restricted by low photoavailibility of essential mineral elements and or presence of enormous concentration of probably toxic mineral elements likesodium,chlorine,boron,iron,manganese and aluminium in soil solution.

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