LGU Journal of
LIFE SCIENCES

LGU Society of Life Sciences

Review Article
Vol 2 Issue 3 Jul-Sep 2018

LGU J. Life. Sci
ISSN 2519-9404
eISSN 2521-0130

Importance of Nutrients on Growth and Development: A Review

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ABSTRACT*: Macronutrients are very important for plant development and growth. They can be important constituents of various structural units and redox sensitive agents. Moreover, macronutrients can improve the yield, quality and growth of crops. Now a day, biotechnologists, plant physiologists and ecophysiologists have been investigating other blind features of these minerals, as macronutrients are involved in every aspect of plant life. Each macronutrient has its own characteristic features, and are involved in different metabolic processes of plant life.*

Key words: *macronutrients, calcium, sulphur, phosphorus*

INTRODUCTION

Macronutrients are important source to provide energy and calories. Nutrients are important substances which are considered necessary for metabolism, growth and maintaining proper body functions. As "macro" means large, so they are nutrients necessary in large amount (McKinley Health Center, 2014).

According to the requirements of the body for healthy lifespan started from foetal development to the infanthood, childhood, adolescence, adulthood and finally geriatric period, nutrition is important for adequate, balanced and proper intake of nutritional elements. The balanced diet is mainly

comprised of three components of macronutrients carbohydrate, proteins and fat which provide 50%, 30% and 20% of the total calories respectively and also includes minerals and vitamins. Balanced nutrition allows mental development, physical growth, productivity, enhanced performance and sustainable life (Ozdemir, 2016).

Macronutrients are considered necessary in large amount for plant and human survival as they play important role in their various metabolic activities (Tripathi et al, 2014). Plants requires macronutrients in relatively large amount for synthesizing large molecules, such as ATPs are source of power cellular reactions, protein act as plant cells tool box, RNA and DNA for transmitting and storing genetic information. Molecule containting macronutients play central role in process like respiration, photosynthesis, storage and transport involved in utilization and synthesis of sugars by the plant. They are also important in controlling various cellular processes (Strelch et al., 2002). In macromolecules various minerals are present as structural components performing various functions: like cofactors in enzymatic reactions (Grusak, 2001). Plant nutrients are compounds or chemical elements which are essential for development, growth and better yield, however also playing counter roles in metabolism and external activities of plants (Kow and Nabwami, 2015).

Macronutrients can be classified into two major groups, on the basis of their functions. (Tripathi et al., 2014). The plants have thirteen essential minerals. However, six are required in relatively higher amount than others. Nitrogen, phosphorous, sulphur, potassium, calcium and magnesium are found as essential macronutrients (Muchukuri et al., 2004).

Primary Macronutrients

Primary nutrients are required at higher rates than micronutrients as they are utilized in large quantity by crops (Tukeer, 1999). The primary macronutrients are mainly composed of potassium, nitrogen and phosphorus. Nitrogen improves foliage growth and green leaves. Phosphorous stimulates strong root growth and helps in the development of seeds, flowers, and fruits. Potassium improves proper growth of fruit and flowers, maintaining colour, good size and quantity (Jankowski et al, 2015).

Nitrogen

Nitrogen is the primary constituent of proteins, nucleotides and chlorophyll in plants. Although 78% nitrogen in atmosphere, due to the presence of a triple bond its diatomic form makes it inaccessible to plants. To maintain optimum yields Modern plant agriculture heavily relies on industry nitrogen fertilizers. However, nitrogen fertilizers are quadrupling in price from 1999 to 2008 and expensive. In green house gas emissions the contribution of production and use of nitrogen fertilizers also significant. Due to denitrification, leaching and volatilization, efact that nitrogen is reactive, mobile and hard to contain makes it very vulnerable to losses. The reactive form of nitrogen Leached are capable of causing sever econsequences to human health and wide spread environmental effects (Eskin et al, 2014). N is present in amino acids. Amino acids may be used in forming protoplasm, and thus for plant development and growth (Uchida, 2000). Nitrogen plays avital role in cellular metabolism as a constituent of all proteins and amino acids (Grusak, 2001). All plant enzymes are made of proteins. The necessary

component of several vitamins are nitrogen (Uchida, 2000).

Additionally, nitrogen is a constituent of DNA and RNA and nucleotides is important for the translation, transcription, and replication of genetic information. Nitrogen is obtained as the ammonium or nitrate ions from the soil environment, which chemically reduced to incorporate into organic molecules (Grusak, 2001). Nitrogen (N) is needed for RNA, DNA, protein synthesis and energy transfer (Conley et al, 2009). Nitrogen not only improves the yield but also enhance the quality of food. Optimum rate of N increases and production, leaf area duration, photosynthetic processes as well as net assimilation rate (Leghari et al, 2016). By increasing of crop yield nitrogen plays key role in agriculture. Developing the proper nutrient management scheme is very significant (conley et al, 2009). Nitrogen is an important constituent of chlorophyll and is associated with vigorous vegetative growth, dark green colour and high photosynthetic activity.The most common cause of nutritional stress is the Lack of nitrogen (Groot et al., 1991). Lack of nitrogen leads to chlorosis. dyingOR "Firing" of the lower leaves is also observed. The nitrate ion is the primary source of nitrogen for many plants (Murungi, 2012). The leaves are the main site of nitrate reduction as nitrate is a major transported form of N (Ohyama, 2010)

Phosphorus

To crops phosphorus (P) is an important macronutrients which improve their yield, growth and product quality. Phosphorus is as an essential macronutrient for limiting factor for crop productivity and for all living organisms. From soil P is taken up by plants preferentially by specific phosphate transporters in the orthophosphate forms. This macronutrient in essential molecules has been found such as nucleic acids, ATP and phospholipids. Also, it is important in metabolic processes such as carbon metabolism, energy transfer and protein activation (Wu et al. 2003). P plays a key role in energy transfer as DPN and TPN (di- and triphosphopyridine nucleotide), ADP and ATP (adenosine di- and triphosphate) and energy storage. Phosphorus is essential part of the RNA and DNA structures. Mature plants possess high concentration of Phosphorus. Phosphorus helps in flower initiation, root development, fruit and seed development. Phosphorus has been found to improve the quality of certain crops and has been shown to reduce disease incidence in some plants (Uchida,2000). So, the major constraint for crop growth and production is the low availability of these macronutrient (Khavari-Nejad, 2013). When the supply of P is too low growth is reduced. Phosphorus transfers from older to younger tissues (Zekri and Obreza,)

Phosphorus symbol: P; available to plants as orthophosphate ions (HPO_4^{2-}, $H_2PO_4^-$) (Uchida, 2000).

Potassium

Potassium (K) is the most abundant cation in plant and one of the three important macronutrients. As a major osmoticum in the vacuole, K enables cell expansion by the generation of turgor pressure. In the vascular tissue, in the generation of 'root pressure' K is an important participant, Plants attain K at the root surface through K permeable proteins. Since in the soil available K concentration may vary hundred fold, multiple K uptake systems is developed by plants for adapting to this variability (Yang et al, 2014). For plant growth Potassium (K+) is an essential element

and in soil system is an extremely dynamic ion. Potassium in importance for plant physiology, many plant physiologists considered it second only to nitrogen. In plant tissue levels potassium is second to nitrogen with ranges of 1 to 3% by weight. As an ion, potassium is moderately mobile in the soil system while it is highly mobile in the plant system. throughout the plant in the xylem, Potassium also plays a major role in the transport of water and nutrients. In order to maintain the water content of the vacuole a sufficient concentration of salts in the water is required to sustain the osmotic concentration and potassium is the salt most plants seem to prefer to do this (Rande Malvi, 2011).

In plants K does not form any vital organic compounds. Unlike N and P, However, K is known to be an enzyme activator that promotes metabolism thus the presence of K is vital for plant growth, K helps in the plant growth, used water by controlling the opening and closing of leaf stomata, where the plant is cooled by the release of water

•In photosynthesis, K play a role in order to maintain the electrical charges balance at the site of ATP production.

• For plant growth or storage in fruits or roots, K promotes the process of photosythates

• K is involved in protein synthesis, Through its role support to ATP production

• In plants K play a role to improve disease resistance, improve the size of seeds and grains, and increase the quality of vegetables and fruits (Uchida, 2000).

Potassium interrelationships with macronutrients

Many years back the relations between potassium and nitrogen is well reprsented at Rothamsted Station by research started in 1852. Between these two nutrients in crop growth there is a strong relations.It was observed when the interchangeable potassium content of a soil is below the optimal level then the crop response to applied nitrogen fertilizers decreases. Without adequate potassium it is impossible the "reading" of the genetic code to produce proteins and enzymes in plant cells. Although, in production of proteins nitrogen is fundamental, an abundance of available nitrogen plants deficient in potassium will not produce proteins despite (RANADE-MALVI, 2011).

Secondary Macronutrients

The calcium, magnesium, and sulfur are the secondary macronutrients. (Manohara and Belagali, 2014). The secondary nutrients such as calcium, magnesium and sulfur are required in less quantity as compared to primary nutrients. Dolomitic lime is the major source for supplementing the soil with magnesium and calcium, although from a variety of fertilizer sources these nutrients are also obtainable. Sulfur in the form of potassium and magnesium sulfate, gypsum (calcium sulfate), and elemental sulfur is available in fertilizers (Tukeer, 1999). The essential part of cell wall structure is Calcium, which is must be present for new cells formation. Magnesium is the important for photosynthesis (Manohara and Belagali, 2014)

Calcium

Calcium plays significant role in bone mineral formation and enzyme activity is

also regulated by calcium and in addition to this it also transfer secondary messages within a cell. In humans, the consumption of daily dietary calcium is around about 1000 mg, from which the absorbed quantity is 400 mg. The changes in bone mass is shown by modifications in calcium homoeostasis, and vice versa (stein et al, 2014). Moreover Calcium is the essential plant nutrient. It also play a structural roles in the cell membrane as well as cell wall, as a counter-cation in the vacuole for organic and inorganic anions, and in the cytosol it act as an intracellular messenger (Marschner, 1995). Calcium enter the roots from the soil solution and transported to the shoot through the xylem. either through By the cytoplasm of cells which is related through plasmodesmata or by spaces between the cells it may pass through the roots. Plants in their natural habitats growing with adequate Ca and have shoot concentrations of Ca between 01 and 5 % d. wt (Marschner, 1995).

Magnesium

Magnesium is the fourth most common cation and in the human body the second commoniest intracellular cation.In more than 300 reaction of enzymes it plays a vital role as cofactor (e.g. muscle contraction, cardiac excitability, energy metabolism and neuronal activity) (stein et al, 2014). Magnesium is a component of the chlorophyll molecule, which is the dynamic force of photosynthesis. It is also necessary for the carbohydrates (sugars) metabolism. In the synthesis of nucleic acids (DNA and RNA) it may act as enzyme activator. The uptake of the other essential elements regulated through it, by plants it helps in transfer of phosphate compounds, facilitates the process of carbohydrates (sugars and starches), and improves the production of fats and oil. (Tukeer, 1999). Magnesium is absorbed in the form of highly soluble divalent cation, in plants it may act through ionic bond to relate its capability which interect with several ligands. Several enzymes and enzymatic reactions require magnesium, including phosphatases, adenosine triphosphatases and carboxylases. Additionally, in green tissues magnesium play a significant function is its role as the central atom in the porphyrin structure of the chlorophyll molecule (Grusak, 2001).

Sulfur

Sulfur is an important macronutrient for plant growth. It is needed in the synthesis of proteins, coenzymes, prosthetic groups, amino acids and vitamins (Gigolashvili and kopriva, 2014). Sulphur is one of vital macroelements which is necessary for proper plant development nd growth. It constitutes the part of amino acids and proteins and plays an important role in redox processes in cells (Honsel et al, 2012). Sulfur is also needed for synthesis of chlorophyll. Sulfur increases yield of forage and grain crops (Tukeer, 1999). Sulphur is found in oligopeptides (phytochelatins and glutathione), vitamins, amino acids (Cystine and Methionine) and cofactors (biotin, CoA, thiamine and S-adenosyl-Met) (Khan and Mazid, 2011). Plants utilize inorganic sulfur and further metabolize it to organic sulfur compounds which is necessary for plant growth, stress mitigation and development. Moreover, a number of sulfur-containing metabolites provide the characteristic smell and tastes to our food, and many of them are known to have health promoting and protective properties (Maruyama et al, 2006; Kopriva et al., 2015).

CONCLUSION

Macronutrients are important for living things to develop and grow. So, they can be very important by biotechnologists, plant physiologists and ecophysiologists. As each mineral has its own characteristic features, so can be essential for all living beings.

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