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PLANT NUTRITION: A CHALLENGE FOR SUSTAINABLE DEVELOPMENT

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In scientific language, plant nutrition is the word to describe the whole process of absorption, translocation and assimilation of nutrient by the plant. As par the essential requirement of nutrients, basic nutrients are carbon (C), hydrogen (H), oxygen (O); primary nutrients- nitrogen (N), phosphorus (P), potassium (K); secondary nutrients- calcium (Ca), magnesium (Mg), sulphur (S) which are required in large quantity. Besides, micro nutrients also have similar importance in plant nutrition, but it is required in small quantities viz., iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B), molybdenum (Mo), chlorine (Cl) and nickel (Ni). These seventeen nutrients are very much essential in plant growth and its metabolism process. In continuation of essentiality criteria, the deficiency of particular nutrient in the soil can be corrected by that nutrient only and lastly it is found that the deficiency of nutrients results in failure to complete the life cycle. So, the presence of nutrients in the soil (soil fertility) and the ability of the soil to avail that nutrients for plants (soil productivity) are much essential. Usually, soil fertility is the function of nutrient status of soil and soil productivity is the function of soil fertility, management and climate. In another way, it can't find that fertile soil always be productive, but it would be productive when several factors like soil nutrient, soil environment, climate and also management part will favourable for nourishing the plant.

Role of different essential elements in plant system

All these 17th essential nutrients along with different beneficial nutrients (sodium, silicon, cobalt & vanadium) are so functional for the nourishment of plant. Therefore, it is an urgent need to study the functions of these (21th) nutrients. Among these functional nutrients,

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C, H, O are the basic nutrients which are the major constituents of organic material and the role of remaining nutrients are discussed in the following:

Primary (Macronutrients):

- Nitrogen (N): It requires in large amount for adequate plant growth. it is the component of amino acid and integral part of chlorophyll which imparts green colour to the plants.
- Phosphorus (P): It is responsible for energy transfer and an important structural component of nucleic acid (DNA, RNA).
- Potassium (K): It takes part in disease and drought resistant in many crops and also helps in osmotic and ionic regulation.

Secondary (Macronutrients):

- Calcium (Ca): it plays a major role in cell division, maintenance and in membrane integrity.
- Magnesium (Mg): component of chlorophyll and act as a cofactor for many enzymatic reactions.
- Sulphur (S): it is associated with chlorophyll formation and sulphur containing amino acids (Methionine, cysteine, cystine).

Rest of the nutrients are required in trace amount (micronutrient) and beneficial element (not established as an essential but required) for the plant.

Factors affecting the Phytoavailability

As it was discussed in the previous section that all fertile soil doesn't have productivity or sometimes fertile soil unbales to provide the nutrients as per the requirement of the plant. Therefore, it is important to know the reason how fertile soil is incapable of supplying the nutrients for the plants?

- ✓ **Soil organic matter (SOM)**

Soil organic matter influences the improvement in soil structure, porosity, water holding capacity (WHC) in a results soil moisture and soil temperature is maintained, which is primary prevailing conditions for nutrient availability. It improves the chemical properties like Cation exchange capacity (CEC) and buffering capacity of the soil., those are directly

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responsible for supplying available nutrient. Otherwise, it is well known that SOM act as a food source and storehouse for microbes and nitrogen, respectively. Thus, its deterioration by any means mostly tillage operation from the soil, hamper the nutrient availability and affect in nutrient retention in soil.

- ✓ **Problem soil**

Acid soil is predominant in areas where high rainfall has occurred as a result exchangeable bases are leached and Al, Fe are dominant in surface layer which produced toxicity to the plant. However, soil acidity affects in different nutrient availability like phosphorus availability is decreased and decreased amount of Ca^{+} & Mg^{+} is found in acidic soil etc. Microbes like bacteria and actinomycetes activity are decreased when soil pH dropped below 5.5. Another problem of soil is sodic or alkaline soil that contains an excess amount of sodium. Sodic soil caused the dispersion of soil colloid, and due to dispersion soil aeration, water intake, hydraulic conductivity, drainage, and microbial activity are hampered. Among the problem soil, saline soil is one of the, which contain an excess of soluble salts. Due to salt accumulation at the root zone of the plant and high solute concentration in saline water, the plant doesn't take water even though water is available in the soil. India has 24.3 mha area under problem soils (2010) which consist of acidic soils- 17.9 mha, alkaline soils- 3.7 mha, saline soils-2.7 mha (GOI, 2016, New Delhi). Other than, submerged soils are soils that are saturated with water for a long time. It has three distinct horizons like 1) partially oxidized 'A' horizon 2)a mottled zone where oxidation-reduction alternately happened 3) a permanently reduced zone. Rice is the only food crop with stand-in submergence. It exhibits several unfavourable conditions for a plant like a greater amount of soil solution, decreased oxygen level in a result, reduced microbial activity and altered chemical status of the soil. In submerged condition following nutrients transformation is occurred:

- Nitrogen losses through volatilization, leaching and denitrification
- Phosphorus level has been decreased over the time of submergence
- Exchangeable K^{+} content is increased which may replace by Fe^{2+} & Mg^{2+} ions
- Sulphate (SO_4^{2-}) in submerged condition produced H_2S
- Micronutrient zinc (Zn) availability is decreased due to submergence

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✓ **Nutrient mobility**

Nutrient mobility is one of the reasons of nutrient deficiency in any system either in soil or in plant. In soil, most of the anionic nutrients are mobile in nature as because they are doesn't fix in clay colloid, except manganese (Mn^{++}) and most of the cations (NH_4^+, K^+, Ca^+, Mg^{++}, Cu^{++}) are absorbed by the clay complex in a result their mobility is reduced. Likewise, nutrient mobility has also importance in plant system, or knowledge of the nutrient mobility in the plant helps in finding what nutrient is deficient.

Table 1: Different nutrients deficiencies due to its mobility

Nutrients	Nature of mobility	Deficiencies Symptoms	Deficiencies in which portion
N, P, K, Mg	Highly mobile	• N-Yellowing of leaves including veins • P-Bronzy appearance • K-Nacrotic spot at margin or top of leaves • Mg-Yellowing take place (between veins)	Old leaves
Zn	Moderately mobile	• 'Khaira' disease of rice • Plants appears bushy due to reduce internodal elongation	Middle leaves
S, Fe, Mn, Cu, Mo	Less mobile	• S- Light yellowing without any dead spot • Fe- Interveinal complete chlorosis • Mn- Chequered appearance • Cu- Leaves are yellowish tending towards whiteness • Mo- Translucent spots	New leaves
Ca, B	Immobile	• Ca- Chlorosis start from tip to base • B- Chlorosis starts from base to tip	Terminal buds

✓ **Nutrient interaction**

Some of the nutrients have antagonism effect with other nutrients as a results deficiency occurred. Likewise, excess phosphorus (P) encourages the deficiencies of zinc (Zn); Iron (Fe) has antagonistic effect with copper (Cu), zinc (Zn) & manganese (Mn); high level of nitrogen (N) shows the deficiency of Cu & Zn; high level of sodium (Na) or potassium (K) affect manganese (Mn) uptake.

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Agronomical interventions

✓ **Reclaim problem soil**

Those area are prone to acidity, alkalinity and salinity, it is recommended to ameliorate that condition through agronomical interventions for growing of crops. Use of liming material like oxide, hydroxide and carbonate of Ca and Mg for reclaiming the acid soil. However, rock phosphate and press mud also help in reclamation of soil acidity.Soil alkalinity also creates problem in establishing agriculture in some areas. To lower down the pH of that soil, it is recommended to apply gypsum ($CaSO_4$, $2H_2O$) and iron pyrites (FeS_2). Accumulation of salt at the root zone of the crop cause salt injury to the crop. This type of salt stress can be avoided through some general procedures like flooding followed by leaching, irrigation with quality water, adequate drainage facilities and growing of salt-tolerant crops.

- **Flooding followed by leaching**: Combination of flooding then after leaching is the most effective method to eradicate salts from surface soil. Leaching of basic cation below the root zone lower down the pH of the soil into neutral condition.
- **Quality of irrigation water**: Apply water through irrigation after analyzing the electrical conductivity (EC), total soluble salts (TSS) and pH. Besides, it is essential to reduce the conveyance loss which influences the salt accumulation trough seepage during irrigation.
- **Drainage facilities**: Proper drainage through proper lining is the effective method in salinity condition—good drainage facility retards the salt accumulation in surface soil.
- **Growing of salt tolerant crop**: The use of salt resistant crops is an important feature of successful management of saline soil.

Table 2: Salt resistant crops

Degree of resistance	Crops
High	Barley, sugarbeet, cotton, dhaincha, mustard, tobacco
Moderate	Wheat, rice, maize, sorghum, pearlmillet, oat
Low	Beans, reddish, sunhemp, pea, ground nut, moong, urd, black gram, green gram

Rice is the only food crop growing in submergence condition. However, proper drainage facility in submerged soil give favourable condition for growing of other crops.

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✓ **Sustain optimum soil condition**

"Healthy soil yields the healthy crops". But what is healthy soil and how to achieve it? Therefore, it is advisable to go with the diversification of crops with crop rotation, modern tillage (Minimum & zero), the establishment of micro-irrigation, increasing the soil organic carbon (SOC) and do not disturb the microbial diversity. Diversification of crops with crop rotation helps to reduce the soil erosion through permanent soil cover throughout the year, and diverse crop improves the soil health. Tillage has a negative impact on the soil as it burns the of soil organic carbon and creates soil compaction. It is found that soil organic carbon increases the nutrient use efficiency by reducing the nutrient losses with its chelation property. As soil microbes are an important component of healthy soil so, it is acceptable to protect them by any means. Microbes is a potential indicator of soil quality because it solubilizes the nutrient into an available form, secretes phytohormones and stimulates the immune system against pest-diseases which is beneficial for growth and development of plants.

✓ **Fertilizers management**

Indiscriminate use of chemical fertilizers over a long period and no use of organic manure destroy the soil structure as a results soils are prone to erosion and decrease the soil fertility. As soils don't have the capacity to retain nutrients, thus nutrients are losses through the different process like volatilization, denitrification and leaching. Therefore, efficiently use of fertilizers by the crop is the prime objective of fertilizer management. In fertilizer management, four main things are very much important like the quality of fertilizer, frequency of application, time of application and placement of fertilizer. In this perspective, the frequency of application means fertilizer are applied in different split doses like nitrogen at a specific stage of crop when it requires. However, placement of fertilizer is an important thing which helps to increase the fertilizer use efficiency (FUE).

Conclusion

Nutrients availability to the plant is the main constrain of obtaining high crop yield that can be corrected by only agronomical management in an economical manner. Keeping view of all the above-discussed aspects, it is concluded that the use of agronomical interventions increases the yield of the crop, the productivity of land and protect the environment in a sustainable manner.

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