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Perspective

Plant Nutrients and It's Impact

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Introduction

Increasing world population is a great challenge for agriculture to meet the increasing food demand in sustainable manner. Injudicious use of fertilizer and poor soil management practices have made this task more difficult. Soil is a living medium consisting of physical part - called as soil particles, chemical part - consisting of various compounds/ minerals as well as biological part - consisting of various microbes, vertebrates, invertebrates inhabiting in soil. Unless all these components are kept in harmony, the crop plants would suffer by poor nutrient availability. Nutrients are made available to crop roots through the living media of soil. Crop plants mainly depend on soil for their food. However, plant do not get nutrients from one source. Air, water and soil are the primary sources of plant nutrients (Figure 1). Through crop harvest, the nutrients are removed from the soil. This reduces soil nutrient content. With continuous cropping on the same piece of land, the yield decreases and as a result even soil fails to sustain the crop growth. Many people confused with plant nutrition to plant fertilization. Plant nutrition is the elements required by the plant and these nutrients are supplied to plant from external source in the form of chemical or organic are called fertilizers.

Figure 1: Sources of Plant nutrients.
Source: Soil science chapter 37: by Yufang

The modern system of farming, is becoming unsustainable as evidenced by declining crop productivities, damage to environment, chemical contaminations, etc. The crops are conventionally grown by applying chemical fertilizers, continuous use of fertilizers has resulted into number of ecological problems like drinking water pollution, loss of soil fertility besides reduced effectiveness in increasing the crop yields such soils thus fail to provide optimum yields. The necessity of having a sustainable agriculture method which can function in a friendly eco-system while sustaining and increasing the crop productivity is realized now.

Indian farming have to move from traditional mode to modern farming by adopting advanced or high-tech farming techniques that includes improved and genetically modified seeds, micro irrigation, green house cultivation, integrated pest management, hydroponics, farm mechanization and integrated nutrient management. But in the race of higher production applying higher doses of Urea and DAP can cause imbalance nutrition resulting poor soil health and reduced crop yield.

Feeding soil rather than feeding crop will help for sustainable and balanced nutrition to crops. Healthy soil can meet most of the essential nutrient requirement of the crop. Poor soil cannot nourish the plant no matter how good the seed is planted. However, soil-test based fertilizer application is advised to avoid soil nutrient depletion and to feed the plant at each stage with all essential 16 nutrients required to perform the crop life cycle. Use of chemical pest management practices to achieve the higher productivity is a vicious cycle. On one side the chemicals are entering into food chain and ecosystem and on another side it is increasing the cost of cultivation. It leave the farmers in debt, since chemicals are costly and sourced on credit. Alternatively balance nutrition to plants will increase resistance from pest and disease as food is cheaper than medicine. So proper plant nutrition can reduce the use of harmful chemicals.

Due to lack of awareness and inadequate information, farmers are applying only primary nutrients nitrogen, phosphorus and potassium as fertilizer in the form of Urea, DAP and MOP respectively, instead of using the 16 nutrients required by the plants. Despite of increased use of all the three primary nutrients in farming, the yield and the area under cultivation remained stagnant. Government subsidy especially on these three primary nutrients leads to the injudicious use of them as they are cheaper.

A plant requires 16 nutrients to complete its life cycle. Each of the nutrient play a unique role in plant physiology, productivity and growth cycle. Based on their use all 16 nutrients are categorized as structural, primary, secondary and micronutrients. Micronutrients means they are required in small quantities, yet they cannot be replaced by any other nutrients.

Micronutrient deficiency

Overuse of only primary nutrients and ignoring of secondary nutrients (Sulphur, Magnesium and Calcium) and micronutrients (Molybdenum, Boron, Zinc, Iron, Copper, Manganese and Chlorine) results in imbalanced nutrition. Three structural nutrients (carbon, hydrogen and oxygen) are freely available to plant from water and air. The uses of micronutrients in a typical balanced crop nutrition should be four percent of quantity used of the major (primary and secondary) fertilizers. However, the use of micronutrient ratio with major nutrients is as low as 0.87 per cent. The results of soil tests conducted by the Institute of Soil Science in18 Indian states were alarming. Since almost one of every two samples tested were deficient in Zinc, similarly every third sample was deficient in Boron. Although the test results varied from state to state, so design of customized formulations of micronutrients based on test results for each geography is the need of the hour.

Cost saving

Addressing micronutrient deficiencies in farming will be a great economic benefit. Many progressive farmers in different states have observed the increased productivity due to balanced crop nutrition. Micronutrients are available in two forms organic (chelated) and inorganic (sulphate forms). The cost benefit ratio is higher 6:1 with chelated micronutrient application and 2.5: 1 by the use of sulfate based micronutrients. It will be a cost saving for farmers by declining the overs use of traditional primary fertilizers and costly pesticides. Balanced nutrition will develop more resistance in plants resulting in less use of pesticides. Reduced pesticide residues will attract better price since they have better keeping quality and more farm gate realization.

Health impact

Health is directly connected to our food. There is a popular saying "Jaisa khaye ann waisa hoye mann" it means our mood and health is directly affected by the food we intake. According to World Health Organization report, "Top 20 Risks to Human Life": Iron and Zinc deficiencies ranked ninth and eleventh respectively. In India, Anemia in children and mother is due to Iron deficient food intake. Zinc plays a vital role in body immune system, reproduction organs, insulin storage and dark vision adaptation. Similarly deficiency of Magnesium causes low birth weight and maternal mortality; Calcium deficiency results in weak bones; deficiency of Boron and other micronutrients affect hormones and metabolism. Balance nutrition in crop production not merely improve agricultural productivity but also helps to improve the human health.

Food security

Loss of soil fertility due to soil erosion is a barrier in meeting the demand for food and raw material. There is a need to intensify crop production to meet such demand for food with sustainable farming practices. Regeneration, restoring, maintaining and improving soil fertility are the major priorities of agriculture, particularly in developing countries where soils are inherently poor in fertility. Zero tillage, farm residue recycling, integrated nutrient management and crop rotations are some measures to restore the soil fertility and optimize nutrient balance in the soil.

Soil health and conservation

Increased soil organic matter will improve soil health, by increasing the soil microbial population, water infiltration and water holding capacity. High organic matter in the soil is an indication of balanced nutrition, porous and good soil pH. In sandy soil, added organic carbon can improve water and nutrient retention capacity, whereas in clay soils, it can improve drainage. Soil pH means potential hydrogen ion in the soil, is a measurement of acidity or alkalinity. Generally, deficiency of one plant-nutrient limits the efficiency of another plant nutrient uptake. Deficiency of micronutrient may be caused by an excess of another nutrient. Excess and deficiency of a particular nutrient leads to yield loss.

Injudicious use of fertilizers is not only economic loss but also wastage of the scare resources. Figure 2 Imbalanced nutrition and crop yield. To increase the agricultural production balanced use of chemical fertilizers have to play a key role. Providing information's to farmers on efficient plant nutrition is the best way to promote the intensification and sustainable agriculture.

Figure 2: SNutrient Deficiency V/s sufficiency.
Source: Plant physiology third edition fig.5.3 Sinaeur Associates, Inc. 2000

It is also true that amount of nutrient removed by crop production can rarely sufficient via plant and animal residues recycling to compensate the nutrient balance in the soil. Soil conservation should be the utmost priority because it may take centuries for a soil to become fertile through the breakdown of rock and the accumulation of organic material. Fertilizers, Irrigation and Erosion are all important for soil conservation.

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