Trends in Agriculutre Science
Vol.1, Issue 7, September, 2022, Page: 307-315

Nutrient Management Constraints in Fruit Crops and Measures to Mitigate Them

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AICRP on Long Term Fertilizer Experiment
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Introduction

Since time immemorial, edible fruits have played a very vital role in supplementing the diet of the people of the Indian Subcontinent. Apart from customary use as food, wild edible fruits have various health advantages as it potentially gives immunity to many diseases. India is one of the largest fruit producer and consumer in the world. Annually more than 88977-million-ton fruits are produced from more than 7216 thousand of the area. The nutrition value of fruits places them on the crest of our edibles. Nutrition scientists advise us to take at least 115 g of fruit every day for a balanced diet. But, at present, our country has the capacity to provide each of us with only 38 g of fruits every day.

Fruit contains important nutrients and phytochemicals and are an essential component of balanced and healthy diets. They contribute to food security and provide key molecules such as vitamins, minerals, essential micronutrients, fiber, proteins, carbohydrates, and bio functional components. In particular, their richness in phytochemicals and their benefits on health make them invaluable for physiological functions. They help prevent a number of extremely serious non-communicable chronic diseases, including cardiovascular diseases, diabetes, cancer, respiratory diseases, and obesity, as well as preventing micronutrient and vitamin deficiencies.

Indian arid zone is characterized by high temperature and low and variable precipitation, which limit the scope for high crop productivity. However, these conditions greatly favor the development of high-quality produce in a number of fruit crops such as date palm (*Phoenix dactylifera*), ber (*Ziziphus mauritiana*), aonla (*Emblica officinalis*), bael (*Aegle marmelos*), pomegranate (*Punica granatum*), kinnow, lasoda *(Cordia myxa.)*. The area and yield potential of arid horticultural crops has increased many-fold because of the development of new varieties and agro-techniques in arid region.

Production of fruit crops

Major fruits grown in India include bananas, mangoes, oranges, apples, grapes, pineapples, papayas and melons.

Global Scenario

In the global map, India is the top producer of mangoes and bananas. The domestic market was the main destination for most of India's fruit and vegetable production. Nearly, three-fourths of fruits and vegetables were consumed in the domestic market itself. While about 2 % of fruits and vegetables produced in India are being further processed, only about 1 % of the total production is being exported to various markets. Over 20 % of the production accounted for loss in value or wastage. Considering the recommended per capita dietary allowance of 120 g per day, post-harvest losses, processing requirements and the population growth, the current national demand works out to 63.25 million tonnes (Singh and Kumar, 2012).

Table 1. Major fruit producing countries in the world (2012-13)

Country	Area in '000 ha	Production in '000 MT	Productivity in MT/ha
China	11834	137067	11.6
India	6982	81285	11.6
Brazil	2325	38369	16.5
USA	1138	26549	23.3
Indonesia	797	17744	22.3
Phillipines	1240	16371	13.2
Mexico	1257	15918	12.7
Turkey	1103	14975	13.6
Spain	1539	13996	9.1
Italy	1126	13889	12.3
Others	27925	270595	9.7
World	**57265**	**646758**	**11.3**

Source: Handbook of Horticulture Statistics-2014, Government of India, Ministry of Agriculture, New Delhi

Nutrient Management in Fruit Crops

Perennial fruit crops represent hardly 1% of the global agricultural land area, but Mediterranean region covers maximum of 11% area, which are of great economic importance in world trade and tariff. On the other hand, Indian fruit industry occupies 6.82 million ha with a total production of 80.96 million tons. Approximately 1.7 million (2.8%) of deaths worldwide are attributable to micronutrient deficiency induced through lesser consumption of fruits and vegetables and regarded as top 10 selected risk factors for global mortality.

Fruit crops by the virtue of their perennial nature of woody framework (Nutrients locked therein), extended physiological stages of growth, differential root distribution pattern (root volume distribution) and growth stages from the point of view of nutrient requirement and preferential requirement of some nutrients by specific fruit crop, collectively make them nutritionally more efficient than the annual crops. There will be an increasing importance of nutrient efficient cultivars that are higher producers. Nutrient efficient plants are defined as those plants, which produce higher yields per unit of nutrient, applied or absorbed than other plants (standards) under similar agro-ecological conditions. Horticultural crops occupy 10% of cultivated area.

Optimum macronutrients: There are varied fertilization and doses schedules followed across a variety of crops **(Table 2)**.

Table 2– Optimum nutrient requirement for different fruit crops.

Fruit crop (g/tree)	**N**	**P_2O_5**	**K_2O**
Mango (*Mangifera indica* L.)	800	200	300
Acid lime (*Citrus aurantifolia* Swingle L.)	800	200	100
Guava (*Psidium guajava* L.)	500	250	250
Grape (*Vitis vinifera* L.)*	300	500	1000
Pomegranate (*Punica granatum* L.)	400	100	300
Ber (*Zyzyphus mauritiana* Lank)	500	200	300
Aonla (*Emblica officinalis* Gaertn)*	212	55	234
Sapota (*Achras zapota* Mill.)	400	100	300
Date palm (*Phoenix dactylifera* L.)	460	500	500
Fig (*Ficus carica* L.)**	430	200	430
Phalsa (*Grewia subinaeuqualis* DC)	200	75	100
Apple ((*Malus domestica* Borkh.)	1065	650	1500
Litchi (*Litchi chinensis* Sonn.)***	600	350	140
Pear (*Pyrus communis* L.)	1000	2000	1500
* Figures in kg/ha; ** Addition of 280 g/tree Ca;* ** Addition of B at 7 g/plant			

Source: Srivastava and Malhotra (2014), Indian Journal of Fertilisers

Micronutrients

The nutrient elements which are required comparatively in small quantities are called as *micro or minor nutrients* or trace elements. Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. The requirement of micronutrients (boron, iron, copper, zinc, manganese, chloride and molybdenum) is only in traces, which is partly met from the soil or through chemical fertilizer or through other sources. The major causes for micronutrient deficiencies are intensified agricultural practices, unbalanced fertilizer application including NPK, depletion of nutrients and no replenishment.

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Foliar micronutrient is one tool to maintain or enhance plant nutritional status during the growing season. Often quick effects are seen and deficiencies can be corrected before yield or quality losses occur. Foliar fertilization also allows for multiple application timings post planting. In addition, there is reduced concern for nutrient loss, tie up, or fixation when compared to soil applications.

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Nutrient Management Constraints in fruit crops

At present, soil and leaf analysis are the two major tools available for diagnosing nutrient status of any fruit crop. Soil analysis gives idea about the actual status of nutrient availability for the uptake by the plant. While leaf analysis, as a method for assessing the nutrient requirement for given crop, is based on the as assumption that within the certain limits, there is a positive relationship between the doses of the nutrient supplied, leaf nutrient content, and the yield.

Technological Constraints

It was observed that respondents had insufficient knowledge about application of exact dosage of fertilizers, pesticides and water management. They were also lacking in skills for pruning, thinning and soil sampling etc.

A) Soil Testing:

The soil testing is vital in identifying nutrient requirements and applying fertilizers to orchards nevertheless growers were not aware of its importance. It was clear from the responses of growers that only 5.53% respondents tested their orchard soils regularly once in a year.

Causes:

Usually, growers do not collect samples properly, randomly only one or two depths are sampled. Obviously, collected soil samples do not adequately represent the whole orchard area and there is no guarantee that sampling spots are located in intense root activity from which tree gathers its mineral nutrition. Therefore, even after following recommended doses of fertilizers as per soil lab reports the crop yield would not increase.

Effects:

The absence of soil specific nutrient doses may result in yield losses even after making huge expenditure on account of fertilizers. For instance, deficiency of boron element causes cracking of mature fruits. Besides it improper fertilizer application also leads to deterioration of soils.

B) Leaf Analysis

Leaf is the principal site of plant metabolism; therefore, changes in nutrient supply are reflected in the composition of the leaf / petiole. These changes are more pronounced at certain stages of development and the leaf nutrient concentration at specific growth stages are related to crop performance. Soil test, particularly in perennial fruit trees and grapevines has not been found very useful in making nutrient recommendation due to their specific root distribution and low plant density. Leaf analysis as a guide to fertilization is based on the premise that “crop behaviour is related to concentrations of essential minerals in the index tissue. Environmental and procedural factors vitiate the leaf nutrient concentration in large number of fruit crops. However, a carefully worked out sampling technique for index tissue will make a sound foundation of leaf analysis data such as "Diagnosis and Recommendation Integrated System" and "Boundary Line Approach" can be adopted to diagnose the growth / yield limiting nutrient and to recommend optimum use of fertilizers.

Leaf Analysis is based on the premise that plant behaviour is related to the concentrations of essential minerals in leaf tissue. Leaf analysis as a method for assessing the nutrient requirements of a given crop is based on the assumption that, within certain limits, there is a positive relation between dose of the nutrient supplied, leaf content and yield .The leaf analysis can be useful in one of the following ways (Marathe *et al.*, 2016).

1. To develop a nutrient guide for recommendation of manures and fertilizers for economic optimum yield.
2. To correct defective manure and fertilizer application used by the growers which often lead to soil, water and environmental problems
3. To determine whether or not the supply of one or more nutrients is inadequate, satisfactory or unnecessarily high
4. To provide a common denominator for making parallel comparison from solution, sand, soil and field cultures, location, year and climate.
5. To show that the lack of response to applied nutrients result from their failure to make into the leaves, thereby preventing a wrong conclusion from being drawn and directing attention to the cause of the lack of absorption.

Leaf sampling technique:

The general principle in leaf sampling is to collect 'recently / Youngest mature leaf or petiole (Raghupathi and Bhargava, 1996). Depending on rates of growth, the age of recently mature leaves varies. The nutrient concentration in the index tissue is influenced by factors associated with the plant or with environment and soil or those related to sample handling and processing.

Measures to mitigate nutrient management constraints in fruit crops

Diagnosis and Recommendation Integrated System (DRIS):

DRIS represents a holistic approach to the mineral nutrition of crops and has impact on integrated set of norms representing calibrations of plant tissue and composition, environmental parameters and farming practices as functions of yield of a crop. Once such norms have been derived, it is possible to make a diagnosis of the condition of the crop thereby isolating the factors which are likely to be limiting growth and production.

Table 3. Index tissue sampling technique in fruit crops

Crop	**Index tissue**	**Stage**	**Particulars**	**size**
Grape (*Vitis vinifera* L)	Petiole	Bud differentiation	5th petiole from base for yield forecast	200
	Petiole	Bloom	Petiole opposite to bloom for quality	200
Banana AAA group (*Musa cavendish* sub-group)	Petiole or Midrib	Bud differentiation	Petiole of 3rd open leaf from apex	15
Ber(*Zizyphus maurotoama* Lamk.)	Leaf	2 months after pruning	6th leaf from apex from secondary or tertiary shoots	40
Papaya(*Carica papaya* L)	Petiole	6 months after planting	6th petiole from apex	20
Pomegranate (*Punica granatum* Linn)	Leaf	Bud differentiation	8th leaf from apex	50

The most important advantages of DRIS approach and its ability to make diagnoses at any stage of crop development and to list the nutrient elements in the order of importance in limiting yield. DRIS has been developed to fulfil the predictive use of leaf analysis (Raghupati and Bhargava,1998)

DRIS has advantage over other methods as it allow index tissue sampling for a wider period of time since the diagnosis is based on large number of nutrients and can also reveal hidden hunger. The degree of reliability of DRIS can be evaluated by comparing the nutrient diagnosis using leaf analysis data and soil fertility parameters.

Integrated Nutrient Management in Fruit Crops

The increasing cost of fertilizers with poor purchasing capacity and their negative effect on soil health has led to intensified attempts to the use of bio-fertilizers and organic matter along with inorganic fertilizers. Integrated Nutrient Management (INM) is a system that helps to restore and sustain crop productivity, and also assists in checking the emerging micro-nutrient deficiencies. Further, it brings economy and efficiency in the use of fertilizers. Integrated plant nutrient management can also be referred to as maintenance of soil fertility and plant nutrient supply to optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. It envisages the use of chemical fertilizers in conjunction with organic manures, green manures, crop residues, and legumes in a cropping system (Shrivastava, 2009).

Biofertilizers In Fruit Crops

Use of biofertilizer as a supplementary source of nutrient helps to check the emerging deficiency of the nutrients besides bringing economy and efficiency in fertilizer use. Biofertilizers can help in reducing the input of inorganic fertilizers for an extent of 25 per cent for obtaining the same or higher yield (Hazarika and Ansari, 2007)

Biofertilizers are microbial preparations containing live or latent cells of specific microorganisms to apply to the seed or soil, so that the cells can multiply and bringing out the activities of nitrogen fixation or phosphate solubilization / mobilization in the root region or in association with the root system of crop plants. Among the various nutrients, nitrogen is one of the key elements for higher productivity. Nitrogenous fertilizers and biological nitrogen fixation represent the major inputs of nitrogen for crops. Although improved technologies of nitrogen production and increased efficiency of fertilizer use by plants could make more nitrogen available for the plants, alternate technologies are being sought to reduce the dependence of plants on fertilizer nitrogen.

Conclusion

Application of organic manures and organic amendments increases nutrient availability of soil and leaf. Application of organic and bio-fertilizer are increase soil health. The nutrients should be applied in a balance ratio ensuring periodical application of organics to maintain soil health. Organic manures maintaining a better growth and nutrient status of the plant.In respect of soil heath condition, the bio-fertilizer application make it more fertile. Available nitrogen, phosphorus and potassium in soil were influenced significantly due to integrated application of organic and inorganic (NPK) nutrients.

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