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Quality of Fruits in Relation to Nutrient Management

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ABSTRACT

Production of good quality fruits is influenced by many factors such as soil, weather conditions, nutrients in soil and etc. Present article briefly describes importance of different nutrients in managing quality of fruits in relation to different nutrients and physiological disorders. On the other hand, increase in productivity of horticultural produce removes large amounts of essential nutrients from the soil. Without proper management, continuous production of crops reduces nutrient reserves in the soil. This leads to deficiency of nutrients in the soil and ends with the serious physiological as well as nutritional disorders in fruit crops. In Banana (Choke throat, chilling injury, chlorosis and bunch deformation) has been found. Little leaf formation in mango due to lack of Zn. Fruit drop and granulation are serious problems in citrus fruits. Boron (B) deficiency found in papaya and guava. Fruit drop in sapota and fruit cracking in pomegranate which is overcome by spraying of calcium compounds or GA3 at 120ppm on young fruits.

Key words: *Status of fruits, Nutrients, Physiological and Nutritional disorders.*

INTRODUCTION

India has been bestowed with wide range of climate and physio-geographical conditions and as such is most suitable for growing various kinds of horticultural crops such as fruits, vegetables, flowers, nuts, spices and plantation crops. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2015-16, India produced 90.2 million metric tonnes of fruits and 169.1 million metric tonnes of vegetables. The area under cultivation of fruits stood at 6.3 million hectares while vegetables were cultivated at 10.1 million hectares. India ranks first in the production of Bananas (25.7 %), Papayas (43.6 %) and Mangoes (including mangosteens and guavas) (40.4 %).

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Nutrient removal (uptake) by fruit crops: India's wide range of fruit crops collectively contributes to a large variation in nitrogen (N), phosphorus (P), and K removals. Nutrient removal by fruits and its use efficiency indicate mining of nutrients from soil. The nutrient use efficiency of N ranged from 20 to 40 %, P from 5 to 20 % and K from 50 to 100 %, depending on the variety, growth rate and production potential. Most fruit crops are heavy feeders of plant nutrients and a number of fruit crops may absorb 500-1000 kg of N + P_2O_5 + K_2O /ha/year or even more under good management conditions. Nutrient uptake by many fruits and vegetable crops is equal to or high than that of cereal crops. To replenish the removal and to supply sufficient amount of nutrients at each stage of crop growth, adequate rates are needed in the fertilizer application programme of these crops. **Nutrient removal by some important fruit crops:** Litchi will commonly remove the most N (22 kg N/t), grapes remove the most P (2 kg P_2O_5/t), and banana the most K (20 kg K_2O/t). An average 11.9 t per ha fruit crop removes 91 kg N/ ha, 23 kg P_2O_5 /ha, and 153 kg K_2O/ha – with an N: P_2O_5: K_2O ratio of 100:29:152. Thus, the average uptake of K in contrast to N is 1.5 times larger. Continued nutrient depletion has resulted in many soils being re-categorized as medium or lower in K fertility status where earlier they were classified as high or medium. Economic responses to applied K on soils having low and medium K fertility status are common. Sustained production in high K soils is also ensured with application rates designed to maintain soil fertility at an advantageous level.

Fruit quality: is one of the most important terms of the fruit industry, especially juice and pulp ones, quality is defined as the absence of defect or degree of excellence it includes appearance, colour, injury, flavor, taste, aroma, nutritional value and being a safe for consumers. By the point of consumer level it can be divided in to two categories. Quality is meeting the customer's needs in a way that exceeds the customer's expectations.

Primary acceptability: Fruit size, Appearance, Color

Secondary acceptability: Fruit recovery, Aroma, Taste

1. Total soluble solids or sugar: During the development of the flesh of a fruit, in many species, nutrients are deposited as starch, which during the ripening process is transformed into sugars. The progression of the ripening process leads to increasing sugar levels. This document describes an objective test to determine the total content of soluble solids (TSS) or sugar in a fruit by means of the refractometer. The method is especially suitable for ripe and juicy fruit, with significant sugar content, as the determination of TSS is based on the capacity of sugars in a juice to deviate light.

2. Firmness: The firmness of a fruit is linked to the state of maturity and ripeness and may be influenced by the variety as well as the region of production and the growing conditions. This document describes an objective test to determine the firmness of fruit by means of a penetrometer.

The penetrometer is used by producers, packers and distributors to help to determine the stage of ripeness of a fruit and by the retail trade to determine palatability for the consumer and shelf life for their own records. The determination of firmness of a fruit by means of the penetrometer is based on the pressure necessary to push a plunger of specified size into the pulp of the fruit up to a specific depth.

3. Fruit Acids: so is an indicator of commercial and organoleptic ripeness. At the beginning of the ripening process the sugar/acid ratio is low, because of low sugar content and high fruit acid content, this makes the fruit taste sour. During the ripening process the fruit acids are degraded, the sugar content increases and the sugar/acid ratio achieves a higher value. Overripe fruits have very low levels of fruit acid and therefore lack characteristic flavour. Titration is a chemical process used in ascertaining the amount of constituent substance in a sample, e.g. acids, by using a standard counter-active reagent, e.g. an alkali (NaOH). Once the acid level in a sample has been determined it can be used to find the ratio of sugar to acid[11].

There are two methods specified for the determination of the titratable acidity of fruits:

- Method using a coloured indicator;
- Potentiometric method, using a pH meter, which should be used for very coloured juices.

4. Juice content: The juice content is an essential parameter to determine the quality of different fruits, especially for citrus fruit.

5. Dry matter: The accepted method for determination of percent dry matter is drying the sample in a (vacuum) oven at 70 °C until consecutive weighings made at 2 h intervals vary by less than 3 mg. Although several samples can be dried at any one time, this method has the disadvantage of usually requiring samples to be dried overnight to complete the test. Microwave drying technology has its merits due to its speed, simplicity, low cost, and repeatability, but it results in localised drying and gives a high variability in drying times dependant on power settings and sample type.

6. Starch: During the development of the flesh of a fruit, nutrients are deposited as starch which during the ripening process is transformed into sugars. The progression of the ripening process leads to decreasing starch levels. This document describes an objective test to determine the amount of starch in the flesh of a fruit using an iodine solution. Iodine turns a blue-black colour when it comes into contact with starch. As a fruit ripens more starch is converted to sugar, and the blue-black area becomes less prominent. Ripening usually takes place from the core of the fruit towards the skin. Ripening fruit will generally show an increasing white ring around the core, if treated with iodine. But other patterns (i.e. an increasing star around the core) are possible depending on variety. This test is particularly suitable for fruit such as apples, and to a lesser extent to pears. But it is useful only to determine the ripeness of fruit at harvest time. At the subsequent stages of marketing the starch content – even of underdeveloped and unripe fruit may have decreased without sufficient increase of ripeness.

7. Skin Colour: The colour of fruit skin is a good indicator to describe the ripeness of a fruit or uniformity concerning presentation. The use of colour gauges permits to define a colour stage or a range of colour stages to describe a certain grade of ripeness/maturity. To get an objective result different colour gauges are elaborated.

PHYSIOLOGICAL & NUTRITIONAL DISORDERS IN FRUIT CROPS: The productivity as well as the quality of fruit crops is affected to a greater extent due to the physiological and nutritional disorders. Disturbance in the plant metabolic activities resulting from an excess or deficit of environmental variables like temperature, light, aeration and nutritional imbalances result in crop disorders. In fruit crops, the deficiency of micronutrients causes many more disorders than that of macronutrients. Nutritional disorders have become widespread with diminishing use of organic manures, adoption of high density planting, use of root stocks for dwarfing, disease and salt tolerance, unbalanced NPK fertilizer application and extension of horticulture to marginal lands. To get high quality fruit and yields, micronutrient deficiencies have to be detected before visual symptoms are expressed. The deficiencies of Zn, Mn and B are common in sweet orange, acid lime, banana, guava and papaya in India. To correct both visual and hidden micronutrient deficiencies, appropriate foliar and soil applications are necessary. The description of physiological and nutritional disorders in crops include a number of technical terms and it is essential to understand the terms for better identification of symptoms. Some common terms are,

BANANA

Choke throat: It is due to low temperature affecting active growth of the plant. Leaves become yellow and in severe cases, the tissue gets killed. In case of normally flowering plants, the stalk carrying bunches elongates freely so that the entire inflorescence comes out of the pseudostem and hangs down. Bunch development is normal, but when the time of flowering synchronizes with low temperature, the bunch is unable to emerge from the pseudostem properly. The distal part of the inflorescence comes out and the basal part gets stuck up at the throat. Hence, it is called Choke throat. Maturity of the bunch is delayed by taking 5-6 months instead of 3.5-4 months for harvest. Provision of shelter belts using Casuarina or Eucalyptus to prevent the effect of cold wind blowing into the orchard and planting low temperature tolerant varieties like Kullan check the disorder[6].

Chilling injury: Chilling occurs when pre-harvest or post-harvest temperatures fall below 14°C for various time periods. The peel of banana become dark and the fruit exhibit uneven ripening. Ripening fingers show dull yellow to smoky yellow colour and watery dark patches are observed on the skin. Brittleness of the fruit and fungal invasion is also observed. The vascular bundles of the sub epidermal layer show brown streaks. The discoloration is ascribed to the enzymatic oxidation of dihydroxy phenylalanine[12].

MANGO

Black tip: Coal fumes of brick kilns containing sulphur dioxide, ethylene and carbon monoxide are observed to be responsible for black tip. The damage has been noticed in the mango orchards located up to 200 metres of distance from brick kiln[4]. It is characterised by depressed spots of yellowing tissues at the distal end of the fruit, which gradually increase in size, become brown and finally black. The necrotic area is always restricted to the tip of the fruit. The growth of the fruit is almost at stand still and the fruit becomes soft after premature ripening. Such fruits never reach full maturity and drop earlier. The preventive measure is to have orchards 1.5km to the east and west and 0.75 km to the north and south away from the kilns. Spraying of 2 % sodium carbonate or 0.6 % borax is recommended as control measure[10].

Spongy tissue in fruit: A non edible sour patch developed in the mesocarp of mango fruit is broadly termed spongy tissue. The malady has been reported only in Alphonso. The peculiarity of this malady is that external symptoms of the fruit affected by spongy tissue are not apparent at the time of picking or at the ripe stage. These can be detected only on cutting the ripe fruit. This malady renders the fruit unfit for human consumption. It is a physiological disorder in which fruit pulp remains unripe because of unhydrolyzed starch due to physiological and biochemical disturbances caused by heat in mature fruit at pre-and post-harvest stages. Single and double preharvest dip of fruits in calcium solution significantly increased the calcium content in the ripe fruits, whereas there was no significant increase in calcium content by post harvest Ca dip treatment. The pre harvest dip significantly reduced the occurrence of spongy tissue in the ripe 'Alphonso' fruits. The use of wind-breaks for protecting the orchard from warm air during May, and use of proper precautions at post-harvest stage checks the disorder[10].

Malformation: Among all the known diseases and insect pests of mango, malformation is undoubtedly the most serious. Depending on the plant part affected, two categories of the malformation, vegetative and floral, have been recognized. In vegetative malformation, the vegetative buds in the leaf axils or at the apical meristem of the younger plants, on activation, develop abnormally as compact rosette-like shootlets, bearing tiny leaf rudiments. Many such shoots may arise to form a bunch, hence it is also sometimes known as bunchy top. The problem is not serious in the grown-up trees. The affected new shoots on the old trees, however, become thick, stunted, and develop a whorl of small leaves. Floral malformation, in contrast, is very virulent and can cause the loss of the entire crop. It affects the fruit production directly by converting the panicle to a barren one. Floral malformation exhibits all sorts of symptoms, but any deviation of a part of the panicle, or all the parts of a panicle, from the normal to abnormal should be considered as a symptom of this malady. In severe form, the affected panicle, appears like a compact mass, being more green and sturdy. It bends down due to its own weight. It is found that the application of 200 ppm NAA during the first week of October as spray resulted in considerable reduction of floral malformation. Early deblossoming, combined with NAA spray during October, may reduce the extent of malformation considerably[10].

Fruit drop: In mango, there is a heavy drop of hermaphrodite flowers and young fruits amounting to 99 % or more. In general, in mango 0.1 % or less hermaphrodite flowers develop fruits to maturity. The maximum drop of fruits in 'Langra' and 'Dashehari' takes place in the first three weeks of April and differs significantly from the drops in the following weeks. Fruit drop is to some extent associated with the variety, as the variety 'Langra' is more prone to fruit drop than 'Dashehari'. Deficient nutrition of many developing embryos may be the most important internal factor leading to post-fertilization drop in mango. This results due to competition among overcrowded fruitlets on panicle. Degeneration of the embryo in the initial stages of its development may yet be another cause of drop. This occurs invariably, if the flowers are self-pollinated. 2,4-D produced better results at concentrations below 20 ppm, because at higher concentrations fruit and seed development is retarded. Single spray of NAA or 2,4-D each at 20 ppm or Alar 100 ppm at pea stage of fruit gives promising results[10].

CITRUS

Fruit drop: The most pronounced stages of fruit drop are, (i) immediately after fruitset at marble stage which lasts for a month after full bloom, referred as post-set drop, (ii) the second wave of intense fruit drop occurs at the onset of hot summer weather during May-June, known as June drop, and (iii) preharvest drop or premature drop occurring during ripening period, which lasts from August to December-January. Higher summer temperature, excess or deficiency of soil moisture, lack of nutrients like zinc, phosphorus and potash and attack of fungal diseases like anthracnose, styler-end rot and stem-end rot are some of the primary factors responsible for fruit drop. Application of 2,4-D 10 ppm combined with aureofungin 20 ppm in the first week of September provides excellent check against physiological and pathological pre-harvest fruit drop in citrus[8].

Granulation: Granulation is a serious problem of citrus, especially under North Indian conditions. This abnormality is initiated at the stem end of the fruit which gradually extends towards the stylar end. The affected juice sacs become hard and dry, fruits become grey in colour, enlarged in size, have flat and insipid taste and assume a granular texture. Granulated fruits contain less extractable juice as most of it turns into gelatinous mass. This results in more quantity of rag and thus low pulp/rag ratio. The terms granulation, crystallization and dry end are used to describe this trouble. It is much more prevalent in larger sized fruits than in small fruit, in young than in old trees and in humid than in dry areas. Several factors like luxuriant growth, rootstock and the variety, frequent irrigation, mineral constituents in plant tissue, time of harvest, exposure to sunlight, etc., are found to be associated with this malady. In the areas with high incidence of granulation, the plant tissues contain high Ca and Mn, and low P and B. The incidence is relatively high in the fruits of younger plants as compared to those in older plants. The vigorous rootstocks like rough lemon increase the incidence of granulation as compared to less vigorous rootstocks. Late maturity and persistent cold weather throughout the period of maturity have been found to increase the incidence of granulation. The incidence of granulation could be reduced to 50 % by applying two to three sprays of NAA (300 ppm) in the months of August, September and October. Spraying of GA 15 ppm followed by NAA 300 ppm in October and November also reduce granulation[6].

GRAPES

Flower-bud, flower and berry-drop: This problem has been reported from the states of Punjab, Haryana and Rajasthan in North India. The malady has been investigated and the association of a number of factors such as, improper nitrogen application, improper fertilization, ambient temperature, heavy crop load, uneven ripening and endogenous auxin deficiency at a particular stage of berry development are reported to cause the malady. To control bud, flower and berry drop, the following measures are suggested; making 0.5 cm wide girdle from the trunk about 10 days before full bloom which results in better berry set; judicious application of fertilizers under a given set of conditions, particularly N fertilizers, for ‘even’ ripening; 500 ppm ethrel at veraison stage should be applied; dipping of bunches in NAA 100ppm 10 days before ripening reduces berry drop, heavy irrigation at bloom should be avoided[2].

Blossom-end rot: A black sunken spot develops at the blossom-end of the berry which later on spreads with water-soaked region around it. Defective calcium nutrition and assimilation appear to be the cause for it. Spray of 1.0 % calcium nitrate may correct it[2].

Boron deficiency: The presence of small sized fruits and large sized fruits in the same bunch is known as hen and chicken disorder. The fruits are sour in taste. The symptoms include death of growing tips, leaf fall and brittleness of young shoots. The leaves may be deformed with interveinal chlorosis spreading from margins to inwards and this is particularly evident after the fruiting. Spraying of 0.2 % boric acid a week before bloom and another at full bloom control the disorder effectively[2].

Iron deficiency: The leaves turn yellow (chlorosis) during iron deficiency and the entire shoot become yellow to yellowish green under extreme conditions. Iron deficiency may occur due to the presence of excess calcium in the soil (lime induced chlorosis). The corrective measure is two sprays of 0.2 % ferrous sulphate, one before bloom and the second after fruitset[2].

GUAVA

Die-back: The disease infects young as well as the old bearing trees. Some trees are more prone to attack. The typical symptoms include withering of lowermost branch of the tree from top downwards. The growing tip turns dark brown and necrotic areas extend backwards. A typical lesion develops at the junction of the diseased and healthy areas which advances down the healthy areas. The infected branches defoliate giving them a barren appearance. Application of 1.8 kg lime or gypsum reduce the mortality of trees by maintaining soil pH[3].

Bronzing: Bronzing in guava is a complex nutritional disorder. When fruiting starts in a soil marginal in P and K, the nutrients are mobilised from older leaves to the fruits, causing bronze coloured leaves which results in reduced photosynthate transfer to the roots and reduced uptake. In mild symptoms, mixture of 20 kg of FYM, 1 kg of SSP, 0.5 kg MOP and 100 g $ZnSO_4$ /tree should be applied in soil. In severe cases, the dose may be doubled except FYM and foliar spraying of DAP 0.3 % and SOP 0.5 % is to be given 45 days after the emergence of leaves[3].

Boron deficiency: The disorder is identified with appearance of red spots on the newly emerged leaves Leaves become dry and brittle. Spraying of 0.3 % boric acid 10-15 days before flowering correct the deficiency. In general, foliar application of 0.5 per cent zinc sulphate and 0.4 per cent boric acid 10 to 14 days before flowering effectively eliminate the zinc and boron deficiencies[3].

SAPOTA

Fruit drop: Sapota has the problem of low fruit setting and shedding. Only about 10-12 % of the total fruits set, develop and retained until maturity. Most of the fruit-drop occurs immediately after fruit setting. Increase in fruitset and retention are possible by spraying NAA and GA3 at 25 to 100 ppm during flowering and at 15-day interval[9].

POMEGRANATE

Fruit cracking: Fruit cracking is a serious problem of pomegranate. The malady is thought to be due to boron deficiency in young fruits while in developed fruits it may be caused due to variations in soil moisture content and atmospheric humidity. At the time of fruit ripening, if the soils become too dry and then irrigated heavily or there is some rains, cracking may occur. Some cultivars, like Guleshan, Khog, Kazaki are reported to be resistant to fruit cracking. Regular irrigation to maintain soil moisture at desired level, spraying of calcium compounds or GA3 at 120 ppm on young fruits are reported to minimize the fruit cracking[5].

RESULTS

Without proper management, continuous production of crops reduces nutrient reserves in the soil. This leads to deficiency of nutrients in the soil and ends with the serious physiological as well as nutritional disorders in fruit crops. In Banana (Choke throat, chilling injury, chlorosis and bunch deformation) has been found. Little leaf formation in mango due to lack of Zn. Fruit drop and granulation are serious problems in citrus fruits. Boron (B) deficiency found in papaya and guava. Fruit drop in sapota and fruit cracking in pomegranate which is overcome by spraying of calcium compounds or GA3 at 120 ppm on young fruits.

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