FRUIT CRACKING, ITS CAUSES AND MANAGEMENT

Abstract

Cracking is the term used to describe the phenomena of surface or tissue cracking at a variety of degrees depending on varietal susceptibilities, nutritional inadequacies, and environmental factors. Fruit cracking is one of the main quality issues, and research on the status of the nutrient calcium has shown that it plays a role in the physiological process of cellular adhesion loss. Although various external factors classified as environmental circumstances (e.g., drought, high temperature, excessive water, and strong sun radiation) have been proven to be crucial for cracking resistance, calcium represents the most researched internal factor involved in tissue cracking. Its management is focused on maintaining balanced mineral availability throughout the initial phases of fruit formation. Although the thresholds and distribution ranges causing the disorder have not been determined for each commodity, it is possible that silicon and boron, which are essential to the formation of cell walls, were also involved in cracking. In order to manage this mineral deficiency, a combination of weather patterns and crack-resistant genetic material is required. Simply using mineral supplements has not increased structural minerals or prevented cracks.

Keyword: Fruit cracking, mineral deficiency, environmental factor

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I. INTRODUCTION

Fruits play an important part of a healthy diet and along with vegetable are termed as protective food due to their richness in vitamins and minerals which are indispensable to protect our body from different diseases/disorder. A severe kind of cracking called splitting occurs when the cracks go all the way through the flesh. Varietal characteristics, orchard soil management, inadequate water levels at maturity stage, light, temperature, and micronutrients may all affect how much fruit cracks. Litchi, sweet cherry, apple, pomegranate, gooseberry, black currant, water apple, citrus, and other fruits and vegetables commonly contain it. Fruit cracking causes losses that vary from 50 to 85% on average. If they are not fungus-affected, all broken fruits lose their value for the fresh market and can only be utilised for processing (particularly for fruit juice). Fruits with cracks are more likely to develop storage diseases and have a lower shelf life since various pests can enter through the cracks. It is made clear that fruit breaking is significantly influenced by the shape of the fruit. Three distinct and well-defined types of cracking exist. A similar fine crack can be found at the fruit's apex, there are numerous, frequently deep cracks on the side of the fruit, which is referred to as later cracking, and there are also two types of cracking: radical cracking and cavity cracking. Radical cracking occurs when the cracking moves from the radical part of the stem toward the fruit's centre. Nectarines' fruit cracks when exposed to radiation or the sun's rays. This sort of splitting occurs in nectarine, and other types of splitting include concentric cracking, which occurs when a single fruit splits into multiple pieces, such as cherries.
This article summarizes various causes of fruit cracking and its management.

II. CAUSES OF FRUIT CRACKING

There are many factors which cause cracking of fruit.

1. **Temperature:** It significantly affects the ratio of fruit cracking. Arid and semi-arid regions with higher temperatures and low humidity or rainfall are more prone to cracking. In general, cracking increased linearly with rising temperature. The permeability of cell walls, cell biochemistry, and other variables may also be impacted by temperature. The presence of loo/hot winds throughout the summer is a typical occurrence in north India. The fruit peel becomes hard and inelastic as a result of water loss when such a hot wind blows over it. Subsequently, a quick change in the moisture level causes the litchi fruit to break.

2. **Rainfall:** During high rainfall fruit peel absorbed water, which causes high osmotic pressure which is another cause of cracking. In case of cherry, The causes of cracking include both internal and extrinsic factors. When cherries split in the rain, the first type of cracking related with external factors is the most prevalent and is readily apparent. As a result of the fruit's high osmotic potential, rainwater is absorbed through the cuticle. The fruit's high sugar content is what gives it such a strong osmotic potential. To balance the potential, water flows through the membrane. The fruit rips open as the cherry swells to the point where the skin can no longer contain the growth. (Long, 2005)Besides, long dry period makes the fruit peel hard, and turgid, and after that sudden rainfall causes more imbibition of cell, and this time due to internal pressure cracks happen. Over maturity enhance fruit cracking due to more osmotic pressure.

3. **Fruit size:** According to conventional belief, huge and kidney-shaped fruits are more likely to crack than smaller, rounder fruits. Since cultivars with a kidney or heart shape have deeper stem cavities where raindrops can remain for longer periods of time and possibly absorb more water through the skin, these types of fruits are more prone to fruit cracking. It has been discovered that fruits with firm flesh, like litchis, are more prone to fruit cracking than fruits with soft flesh. Fruits crack when they absorb too much water, causing the skin to break. A protracted dry period, moisture imbalance, heavy rainfall, irrigation, and abrupt and significant changes in the water supply to plants can all result in cracking of the leaves. In moisture stress condition, there is limited sap flow is occurred through the plant root system, for this fruits can't get optimum amount of water, this time fruit peel becomes hard, after certain period of this condition the sudden rain leads to crack the peel due to more osmotic pressure.

4. **Micronutrient deficiency:** The deficiency of boron and calcium is responsible for cracking in cherry, pomegranate and litchi. Boron is present in cell wall, and calcium is present in cell membrane, potassium maintain the cell osmotic pressure, thus these micronutrient maintain cell turgidity, and the deficiency of these micro nutrient take the fruits towards cracking. Sometimes cracking occur due to many insect or pest attack. Due to sunburn, litchi develops microscopic, black water-like spots that eventually take on the appearance of elevated marks. These fruit areas receive longitudinal cracking and begin to split open, spilling juice. A rising physiological abnormality of developing mango fruits called internal necrosis (IN) is caused by boron deficiency and may also cause fruit shattering (FC). (S. Ram; L. D. Bist; and S. C. Sirohi 1989)

III. SOME MOJOR FRUIT CROP CRACKING, CAUSE AND MANAGEMENT

1. **Litchi cracking:** Litchi (*Litchi chinensis* Sonn.), is an evergreen, subtropical fruit tree native to South China that belongs to the Sapindaceae family. It has been cultivated since 1766 B.C. The antioxidant properties of the phenolic compounds found in litchi fruit are also abundant, albeit they may decline after harvest (Hu et al., 2010). For optimal production, the litchi plant needs a chilly, dry winter and a warm, rainy summer. Low and high temperatures, fertilisers, and irrigation can all lead to unfavourable output losses or lowered fruit quality (Li et al., 2001). Due to fruit cracking and pericarp desiccation and browning, the litchi has a brief postharvest life. When the skin on litchi fruits cracks, the aril is exposed to the outside environment and given access to fungi that cause deterioration quickly. Litchi has a short post-harvest or storage life as a result. The litchi cultivars also have a lot of genetic diversity, which manifests itself in distinct variations in fruit colour, size, form, and susceptibility to cracking, as well as flushing pattern, flush colour, and flowering ability.

   The drop in litchi production is due to a variety of issues, but one of the most significant is litchi cracking. In litchi, skin cracking of developing fruit is a major issue that is exacerbated by high temperatures, low humidity, and dry soil. The skin of the fruit becomes hard and inelastic (sun-burned) due to insufficient moisture during the early stages of fruit growth, and it may shatter when subjected to increased internal pressure as a result of rapid aril growth after watering (Menzel, 1984). Cultivars with thin skin, few tubercles per unit area, and rounded to flat shapes are often less likely to crack. Water stress increased the incidence of fruit cracking by reducing the zinc accumulation in fruit peel, particularly during rapid aril growth. Zinc levels in the leaves and fruit peel were dramatically raised by spraying a solution containing zinc compounds, and the rate at which fruit cracked was significantly decreased. In addition to cultivars, cultural methods like irrigation and the administration of nutrients like Ca, Mg, and B affect the quality and cracking of litchi fruit (Qui et al., 1999). Fruit crack can occur for a variety of reasons, and the phenomena might vary from one orchard to another or from one region to another. The third stage of fruit development is when fruit cracks appear.

Cell division in the skin stops about 70 days after fertilisation, according to scientists. Cell stretching occurs in the skin from this stage until the conclusion of the fruit growth cycle, or after a further 35 days (Stage III). The edible part (aril), which develops between the seed and the skin, expands extremely quickly during this time, creating a great deal of internal tension against the skin, which subsequently needs to stretch out very quickly. The number of cells created during the first 10 weeks of fruit development determines skin strength, or resistance to shattering. The best conditions for cell division must be established during fruit growth Stages I and II because the litchi skin has this poor trait. At this point, a lack of nutrients or water prevented sufficient cell formation. Skin cracking would be caused by Stage III's extremely high cell tension.

Skin degradation during Stage III, when just cell stretching occurs, is another factor in fruit crack. Damaged cells cannot repair themselves during this time, and since they are dead at that point, they are also unable to stretch. As a result, the skin tears due to the increased tension (pressure) of the expanding aril inside the skin. The skin cracks at weakened or damaged areas as a result of this tension. When relative humidity is low, bug, hail, and sunburn damage are the most frequent variables that affect this.

Management: The best technique to reduce fruit orchard rain drainage is through site selection. The ideal location should have minimal to no rain at the period of harvest. Select cultivars that have some resistance to fruit break caused by rain. Fruit plants may be covered just on top and allowed free air flow into the sides to prevent the problem of cracking at the maturity stage. Calcium application at 2 m/l liquid formulations and Gibberellin application at 20 ppm decreased cellulose activity and hence decreased cracking. 2,4-D and NAA sprayed at 20 ppm or 20 mg/liter quantities lessen cracking. When fruit reaches maturity, consistent moisture and the right level of humidity are required. Fruit cracking can be significantly reduced by irrigation when the available soil moisture has been reduced by 30–40%. According to reports, installing drip and micro sprinklers beneath the canopy area can effectively reduce fruit cracking. Stabilizing the temperature and moisture content in the root zone can be greatly aided by mulching. A hospitable microclimate is created that lessens fruit cracking by planting maize or sugarcane as a border crop and watering it regularly. Wind break plants around the orchard offer protection from hot, desiccating breezes. Planting a suitable wind break at a right angle to the direction of the prevailing wind should be done around the perimeter of the orchard. Wind breaks can be created by a row of tall trees, such as seedling mango and jamun. Spraying of Borax or Boric acid @ 2g/l at the beginning of aril growth with adequate soil moisture in the root zone dramatically reduced fruit cracking. It was advised to grow cracking-resistant cultivars like Swarn Roopa, which was created in Ranchi, Jharkhand. The skin of litchi cultivars with few tubercles per unit area, rounded to flat shape, and relatively thin skin is less likely to crack. More sensitive than late cultivars are early cultivars.

2. **Pomegranate cracking:** One of the earliest known edible fruits is the pomegranate (Punica granatum), which is a member of the punicaceae family. In the world's tropical and subtropical regions, pomegranates are commonly grown. It is an advantageous fruit for marginal land because of its excellent tolerance to a variety of situations, notably stress conditions. For farmers with limited resources, it is advised. Pomegranate trees and fruits can be used in a variety of ways, and they are anticipated to become a significant source of raw materials for industry.

Fruit cracking was described as a pre-harvest disorder that was caused by the variation of soil moisture and relative humidity. Fruit splitting due to erratic irrigation techniques or excessive rain during the maturity phase is acknowledged as a major fruit defect. It is common knowledge that some fruits break in their latter stages of development. Farmers suffer a significant economic loss as a result of fruit loss due to cracking. Pomegranate fruit cracking is a severe issue. Additionally, it has been hypothesised that calcium and boron deficiency contributes to apple breaking. Extreme differences between day and nighttime temperatures might result in fruits that are still developing breaking. When fruit is ripening, cracking may happen if the soils get too dry, then there is a lot of irrigation or rain. Fruit cracking can also be caused by a protracted delay in picking completely matured fruits or a serious pest or disease infestation.

The regulation of water uptake by plant roots is greatly influenced by zinc. Fruit splitting was controlled using a variety of chemicals. In the first two weeks of September, El-Kassas (1986) noted that a tiny percentage of Manfaluty pomegranate fruit split. Scientists found that soil applications with $ZnSO_4$ reduced the percentage of splitting pomegranates fruit tree, meanwhile increased fruit yield/tree and juice acidity and reduced TSS and reducing sugars but did not reduced peel thickness as compared with those untreated control.

Management: Fruit cracking is a serious malady in pomegranate especially under dry condition of arid region. Cracked fruits are sweeter but damage fast and become fruit unfit for transport. Fully developed fruits show cracking mainly due to moisture imbalance or rising of air temperature during development. Varietal variation noticed in intensity of fruit cracking. Thickness and texture of fruit rind are characters influencing the proneness of varieties to cracking. Deficiencies of calcium, boron and potassium cause cracking of fruits. Intensity of the problem varies with the season also. Damage amounts to 63% in spring crop, 34% in winter crop and 9.5% in rainy season crop. Since fruit cracking is a complex problem, integrated approach is the only remedy. Cultivation of tolerant resistant varieties like Sur-Anar, Francis, Shirvan, Krasnyl, selection of proper planting material, controlled and systemic irrigation during fruiting season, regulation of bahar, using pinolene (5%)as vapour guard, GA_3 (15ppm) and boron (0.2%) sprays can reduce fruit cracking.(sing et al.,2006). According to Singh et al., frequent watering at weekly intervals and the administration of macronutrients such 1% $MgSO_4$ and 1% KNO_3 decreased fruit splitting in pomegranate fruits. Pomegranates' propensity to break differs between varieties as well. Francis and Wonderful are two varieties that are regarded as being resistant to cracking, whilst King and Molar are more susceptible.

3. **Cherry cracking:** Some fruit species, such as cherries and grapes, experience major economic problems due to fruit cracking and splitting brought on by rain before harvest. In many cherry-producing regions, rain-induced cracking prior to harvest in the sweet cherry is the most significant crop loss. Both internal and exterior factors might result in cracking. When cherries split in the rain, the first type of cracking related with external factors is the most prevalent and is readily apparent. As a result of the fruit's high osmotic potential, rainwater is absorbed through the cuticle. The fruit's high sugar content is what gives it such a strong osmotic potential. To balance the potential, water flows through the membrane. The fruit rips open as the cherry swells to an extent beyond which the skin cannot stretch. This condition is characterised by cracks that appear on the fruit's skin after a rainstorm, sometimes extending deep into the flesh and harming the fruit's cheeks, calyx end, and stem end (side cracks). These smashed cherries can only be sold locally or to the processing industry as they lose their commercial worth for the fresh fruit market. For a long time, it was believed that rainwater entered the fruit through the roots and produced cracking; however, more recent research have shown that water is actually absorbed into the fruit through the epidermis. The fruit that is turgid before a rain will break more severely than fruit that is slightly water stressed before a rain event. The firmer kinds are most prone to cracking. Warmer air temperatures increase the risk of skin breaking. According to Oregon research, very little splitting took place at 40 degrees, but at 77 degrees, the splitting potential was 50% more than it was at 59 degrees. How much and how rapidly water is absorbed by the fruit depends on its osmotic potential. The passage of water through the fruit's skin and into its meat increases along with the fruit's sugar content. The cherry's skin or wall has a pretty intricate architectural design. It is composed of three layers, the cuticle, the epidermis, and the hypodermis. The cuticle is made up of a waxy exterior layer that is embedded in a spongy carbohydrate matrix, giving the waxy layer some substance. A pectin substance holds this to the cherry's outer layer of cells. The epidermis, which is only one cell thick, is the name of this outer layer. The fruit wall develops pores in this surface that become non-functional lenticels but nevertheless permit gas exchange and moisture loss through transpirationThe hypodermis, which is made up of smaller, spherical cells that are three to seven cells deep and lies beneath the epidermis, is where the fruit's flesh is found. The fruit's capacity to absorb water through its skin grows as its internal sugar level does, which leads to cracking of the fruit's skin.

   Management: Due to variations in the rate of water absorption and the capacity of the peripheral tissues to expand to accommodate the increased fruit volume that arises from water absorption, sweet cherry varieties differ in their sensitivity to cracking. Slow rate of absorption and high capacity for expansion cultivars are more resistant to cracking than cultivars with a rapid rate of absorption and low capacity for expansion. Fruit cracking is reduced by any therapy that slows the rate of water absorption or boosts the fruit tissue's ability to stretch without rupturing.It is reported that spray of $CaCl2$ at 300g to 350g per 100 litre water applied at weekly interval before harvest checked the fruit cracking in Bing and Lamber., however, observed no relationship between the morphology of fruit skin and its sensitivity to cracking.They further reported that spraying of $CaCl2$ increased the calcium level in the fruits but did not affect cracking .Spraying of $GA3$(2000 ppm)on Hedelfingen and Ekero cultivars 3 weeks before harvesting reduced the amount of fruit cracking caused by heavy rainfall following drought reported that the spray of

NAA(1ppm)at 25-30 days before harvest reduced cracking in cultivars Bing, Marmotte. Some resistant varieties are Sam, Sue, Victor, Windsor, Lapins, Viscount.

4. **Citrus cracking:** Among other widely consumed fruits around the world, citrus fruits hold a significant position. Due of their higher capacity to adapt to various climate conditions, citrus fruits are grown in tropical, subtropical and even in temperate regions. At present, Unites States of America is having the largest area i,e. about 40% of total acerage under various citrus fruits in the world. Splitting is common feature in citrus. In India fruit splitting is observed in pummelo, mandarin, and sweet orange, grape fruits, lemon etc (Nauriyal, 1955).Splitting usually begins in the peel at the style end of the fruit although it may originate midway between the ends. Two types of splitting i.e. longitudinal and transverse are noticed. In both fruits crack down to the core and in extreme cases there is a complete splitting of fruits. Often cracked surface of the fruits get infected by weak parasites like *Aspergillus, Alternaria, Fusarium* etc.

   Researchers reported that fruit cracking in citrus is associated with sudden change in weather conditions. Cracking occurred after rains following drought. High temperature during drought makes the rind of the fruit hard and less elastic and during rain the tissue inside the fruit expand. As the peel fails to expand as fast as pulp,then cracks occur. Lemons are more prone to fruit cracking.

   Management: Early harvesting and crop thinning have been proposed as solutions to increase ring thickness. By providingtimely and frequent irrigation during the summer, it can be reduced. Fruit cracking in lemons can be significantly reduced by a foliar application of CaCl2 (0.5 percent) without having any negative effects on fruit size, yield, or quality. According to Singh et al., calcium, boron, and potassium deficiency led to an imbalance that resulted in fruit breaking. Before splitting, choosing the right spraying schedulefor nutrients and growth regulators can help control cracking.

IV. SOME OTHER FRUITS CRACKING

The splits are always caused by inconsistent watering. The apples swiftly expand when the tree suddenly receives a lot of water after a period of drought, which frequently results in the skin splitting. The split can cause rotting in mature apples even though the fruit typically develops a corky, scab-like coating. Throughout the second half of the growing season, the fruit of several apple varieties has a tendency to crack. Occasionally, only the stem end of the fruit will fracture; other times, the skin will split in other places on the fruit's surface. Cracking is particularly common after heavy rains when the humidity is high. Cells quickly increase as a result of root water uptake mixed with rainwater absorbed through the skin. within the fruit. The fruits' larger cells exert internal pressure that strains the skin, causing it to split. Heavy rains that come after a drought-stricken time frequently cause severe cracking. Fruit that is growing on the edge of the tree canopy, has a high sugar content, and has russet-colored skin are the ones that are most prone to crack. When 'Gala' fruit reaches maturity, there appears to be differential cell growth within the fruit. The cultivars "Stayman," "Fuji," and "Gala" are the most vulnerable to breaking. The reasons for fruit cracking in wax apples can be numerous and differ between species. In Taiwan and Southeast Asia, the wax apple (*Syzygium samarangense*) fruit is a significant agricultural product. Cracking is the biggest issue in the wax apple's manufacture, which lowers its market value. The purpose of this study is to pinpoint the elements that contribute to fruit cracking in wax apples. During fruit development, there is a rise in total soluble sugars and a decrease in total titratable acid, which lowers tissue osmotic potential. The reasons for fruit cracking in wax apples can be numerous and differ between species. In Taiwan and Southeast Asia, the wax apple (*Syzygium samarangense*) fruit is a significant agricultural product. Cracking is the biggest issue in the wax apple's manufacture, which lowers its market value. The purpose of this study is to pinpoint the elements that contribute to fruit cracking in wax apples. During fruit development, there is a rise in total soluble sugars and a decrease in total titratable acid, which lowers tissue osmotic potential.

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