AgriCos e-Newsletter
ISSN: 2582-7049
Volume: 02 Issue: 03 March 2021 Article No: 19

Physiological Disorders in Litchi

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SUMMARY

Litchi cultivation and its potential yield is affected by many physiological disorders like fruit cracking and splitting, flower and fruit drop, sunburn, retarded fruit development, irregular bearing and black spot etc. Therefore, it is necessary to know the causes and symptoms properly to manage these disorders for increased quality production. The incidence and severity of these physiological disorders vary with locality, season, cultivar and orchard management practices.

INTRODUCTION

Poor fruiting/ non fruiting/ irregular fruiting are the problems in litchi growing area of the country. It has been observed that capacity of litchi shoots to bear is varietal in nature, while some bearing terminals of current year are more productive (70-95%) in the next year. Non adoption of good management practices lead to irregular bearing, even in regular bearing cultivars of perfect management practices include late application of manures and fertilizers (particularly nitrogenous fertilizers), high frequency and heavy irrigation just before the panicle emergence and flowering period. Cultivar China is generally known as irregular bearer, can bear fruits every year with adoption of improved management practices accurately. Irrigation, nutrition and environmental factors are also responsible for the cause of irregular bearing in litchi. Type of soil coupled with management practices also found to be associated with irregular bearing or alternate bearing. Late harvesting and severe pruning and training operations may lead to non bearing in that particular year of operation.

Usually, heavy crop is followed by a light crop in some varieties, while in some varieties production is quite consistent every year. In some cases at the time of bearing panicle/ inflorescence, trees start giving vegetative flush and that particular year becomes off year, while in some case only part of the tree bear long panicle with leafy growth at the base,
resulting only few flowering terminals and fruit set is also very poor. Sometimes, inspite of heavy bearing of flowers and enough fruit set, harvest of mature fruits is very poor due to heavy flower and fruit drop at various phases during flowering to fruit maturity.

Management

- Varieties chosen for planting must be regular in bearing, apart from other desirabl characters.
- The cultivars Shahi, Rose Scented, Dehradun are regular bearer, while China, Seedless and Late Bedana are irregular/shy bearers.

- On the basis of age of the trees, the commercial orchards should be properly fed with
- balance nutrition immediately after fruit harvest and irrigation at right time through right method, particularly at aril development stage.
- The plant protection measures to control major pests and diseases should be followed. Proper pruning and training at the time of harvesting and just after harvesting is needed, while harvesting of the fruit bunches, the branches having 8-10 inches length should be plucked to give rise strong and healthy flush to bear fruits in next year.
- Late pruning and training should be avoided. The tree should be trained to give canopy shape in a semicircular manner or an open umbrella shape.

Flower and Fruit Drop

Sometimes even after profuse flowering and fruit set, poor yield has been observed as because litchi trees suffer a heavy flower and fruit drop between flowering and fruit maturity. Only a small proportion of it (2-18%) is carried to maturity in different cultivars. The flower and fruit drop is thought to be due to failure of fertilization, embryo abortion, nutrition and hormonal imbalance and external factors like high temperature, low humidity and strong westerly winds as well as due to fruit borer and heavy mite attack. The young bearing tree suffers fewer drops than the older trees. Studies revealed maximum fruit drop during the first fortnight after fruit set and at harvest the retention varies between 3.0-39.6% among the cultivars. The specific relationship between auxin production in developing fruit and abscission in litchi has also been taken into consideration. In litchi, male functional flowers drop after pollen formation. The heavy fruit drop has been observed at different stages due to the formation of abscission layer. Although fruit drop continue up to maturity but most of the flowers and fruit drop occur during the first month after the pollination. The initial fruit set in litchi is very high but a very small proportion finally mature. The premature fruit drop commences soon after fruit set and continues till fruit maturity, with most fruit abscising in the first 2-4 weeks.

Management

- High fruit retention in litchi can be ensured by controlling winter shooting, flowering period and flower quality.
- Timely treatment of plants for strong and healthy shoot production delays flowering
- phase and increases the female flower ratio and finally the fruit setting rate.
- Honey bees are the main pollinating agent in litchi. Increasing bee population in orchards ensures better pollination and fertilization which increases the fruit set and retention.
- It is advised not to do any type of spray at the blooming stage of the orchard.
- Spraying of ZnSO4 @ 0.2% at 30 days before panicle emergence induces healthy
- inflorescence leading to more fruit set.
- Foliar application of 0.2% Boron, 2-3 times during the period of fruit growth and
- development enhance fruit retention, minimize cracking, improve fruit colour, sweetness and enhance maturity leading to increased percentage of quality production.
- Two foliar applications of planofix @ 4 ml/5 litre water may be done at an interval of 15 days from peanut size fruits.
- Treatment with growth regulators like NAA at 20-30 ppm, GA, at 20-25 ppm, 2,4-D at 10-20 ppm are effective in minimizing fruit drop when sprayed on panicles, before the flower opening.
- The fruitlet drop can be reduced by the sprays of ZnSO4 and synthetic auxins like 3,5,6- trichloro-2-pyridyl-oxyacetic acid (3,5,6-TPA) on fruits increasing yield.

Fruit Cracking

It is the most important disorder in litchi found occurring in almost all the important litchi growing tracts of the country or even in the world (mainly throughout Asia and the Pacific).It is a major problem in litchi in India which causes loss as high as 5-70%. This may occur due to varietal characters, orchard soil management, inappropriate levels of water at maturity stage, light, mechanical injuries, temperature and micro-nutrient

deficiency. All cracked fruits lose their value for fresh market and they are used for processing only (especially for fruit juice) if they are not affected by fungus. Cracked fruits are susceptible to storage disease, have shorter storage as well as shelf-life. In India most of the cultivars are found susceptible to fruit cracking. It occurs when trees are subjected to drought soon after fruit set and if the drought is severe enough, fruit development is affected, particularly the development of the fruit skin, resultantly the cell division is reduced and the fruit skin becomes inelastic, and often splits when the aril grows rapidly before harvest. This can occur after irrigation or heavy rain, or just an increase in relative humidity. The poor managed orchards receiving heavy irrigation at once or heavy rains abruptly after a long gap creating imbalance between temperature and moisture in the environment, cracking becomes more pronounced. Deficiencies in nutrient affect fruit development resulting in fruit cracking. Role of calcium is also found associated with fruit cracking in boron deficient soils. Injury to skin by pest or mechanically during pericarp development phase may also lead to fruit cracking. The relationship between fruit cracking and endogenous growth substances have been also established the fact that the higher concentrations of abscisic acid (ABA) and lower level of Gibberellins found in the fruit pericarp, seed and aril of cracked fruits. Insects, hail, and the sun can damage the skin during cell expansion and induce cracking towards harvest. These damaged areas cannot expand with the rest of the fruit, creating a weakness in the skin that splits.

Field observations showed that the litchi cracking occurs mainly after the colour break in fruits, coinciding with the peak phase of aril growth. The cultivars with thick skins are less susceptible to cracking than those with thin skin and that of early ripening cultivars observing poor management practices are more susceptible to this disorder. The cracking injury in litchi may vary from short cracks, generally skin deep to larger ruptures extending to most of the length of the fruit. As the underlying aril gets exposed to dry air, it withers rapidly. The cracks on the skin may be longitudinal or horizontal. The cracked fruits deteriorate rapidly and thereafter suffer secondary infestation by disease causing organisms and insect-pests become non-marketable.

Factors Influencing the Fruit Cracking

Environmental Factors

Influence of temperature: Temperature plays a very important role in the ratio of fruit cracking. Arid and semi-arid zone where temperature is more and humidity or rainfall is very low favours cracking. In general, there was a linear increase in cracking with temperature increase. Temperature may also affect other factors such as permeability of the cell walls and biochemical processes of the cells etc.

Wind: In north India, occurrence of loo/hot wind during summer months, a common phenomenon. When such hot wind passes from the litchi fruit surface due to water loss, it becomes hard and inelastic and in case of sudden fluctuation in moisture level leads to cracking in litchi fruit.

Fruit Characteristics

Maturity: Over maturity, which lead cracking of fruit epidermis.

Fruit size: It is generally supposed that large fruits are more prone to the cracking then the smaller one.

Fruit firmness: It is found that firm fleshed fruit such as litchi is more susceptible to fruit cracking than soft fleshed ones. Cracking of fruits is caused by excess uptake of water resulting in bursting of skin.

Lack of Orchard Management

Moisture stress: Moisture imbalance and heavy rainfall or irrigation after a prolonged dry spell, sudden and high fluctuation in the water supply to plants may cause cracking of the fruits.

Nutrient: The deficiency of boron and calcium is responsible for cracking in cherry, pomegranate and litchi.

Insect-pest and disease: In litchi, due to sun burn, there is the appearance of small dark watershaped spots, which is finally assuming the shape of raised spots. These areas on the fruit develop longitudinal cracks and starts oozing out from the splits.

Bagging: It is also a remedial operation to escape the sunlight from the plant surface because water is loosed by transpiration though stomata.

Early picking: Early picking of fruits is also a remedial measure to overcome cracking. This does not allow to over maturity or over ripening which cause cracking of fruit, however it is not practicable in litchi.

Management

- Selection of site is a most effective way to minimize rain drainage of fruit orchard. The appropriate site should be with little or no rain incident at near harvesting time. To choice cultivars which show some resistance to the rain induced fruit crack. Physically producing fruit by water resistance covers from heavy rainfall.
- To save the cracking problem at maturity stage, fruit plants may be covered only on the top and permit free air flow into the sides Application of calcium @ 2 m/l liquid formulations and Gibberellins @ 20 ppm, reduces the activity of cellulose and thereby reduced cracking. Sprayings of 2,4-D and NAA at concentrations 20 ppm or 20 mg/litre reduces cracking. Constant moisture and appropriate humidity are needed at the time of fruit maturity. Irrigation at 30-40% depletion of available soil moisture is quite helpful in reducing cracking of fruits. Installation of drip as well as micro sprinkler below the canopy area has been reported to be effective in reducing the fruit cracking.
- Mulching can play a big role in stabilizing the temperature and moisture level in root zone. Planting of maize or sugarcane around the litchi orchard and daily irrigation in such border crop creates congenial microclimate which reduces fruit cracking.
- Planting wind break around the orchard provides protection from desiccating hot winds. Suitable wind break should be planted around the orchard boundary and it should be at a right angle to the direction of prevailing wind. A row of tall growing trees, such as seedling mango and jamun are suitable wind breaks
- Boron sprays in the form of Borax or Boric acid @ 2g/l at the initial stage of aril development with enough soil moisture in the root zone checks fruit cracking significantly.
- There is also need to develop or find out cracking resistant cultivars as only one cultivar i.e. Swarn Roopa developed at Ranchi, Jharkhand (India) is reported to be tolerant to this disorder. Litchi cultivars which have relatively thin skin few tubercles per unit area and rounded to flat in shape are less prone to cracking. Early cultivars are more susceptible than late cultivars.

Sunburn

Sunburn also known as lesion browning or pericarp necrosis is a serious problem in litchi producing areas. Climatic factors and cultivars in particular growing areas are determinants for incidence and severity of sunburn disorder. The damage caused due to sun burning which occurs up to 0.9-19.13% in different varieties. Apart from environmental factors, varietal, hormonal, nutritional and soil moisture factors are associated with this disorder. This disorder is physiologically related with PPO (Poly-phenol Oxidize) activities and it also varies with cultivars, Sunburn is pronounced in ill managed orchards having sandy or sandy loam soils or light soils receiving/exposed to high temperature (>400C) and very less RH (<50%). It is a type of direct thermal injury and in case of higher temperature, the tissue coming in contact/exposure gets sunburnt/ sunscalded. Sunburn problem is also seen more in early ripening cultivars. Fruits on shaded branches suffer less damage than those more exposed to sun. Lower translocation of calcium in the pericarp region also found to favour sunburn disorder. In

case of sunburn light brown blotches appear on the portion of the fruit skin facing direct sun rays. In severe cases more than half of the surface area becomes discoloured, blotchy light brown. The blotches become intense in few days and the blotchy area dries up blocking of the aril growth and finally destroying the market value of the fruit. The symptoms appear more on the south west side than the north-east side as on the latter side fruits remain almost in shade except during early hours of the day, which is not harmful. Under similar climatic conditions the bearing of the fruit may suffer with this disorder due to the position of the fruit on the tree.

Management

- Irrigation at regular interval during the fruit growth and ripening stage reduces the sunburn.
- Planting wind break around the orchard provides protection from desiccating hot winds, thereby low sunburn.
- Irrigation through sprinkler system during hot hours increases humidity, cools the orchard atmosphere thus decreases the incidence of sunburn.
- In light and sandy soil only light irrigation with increased frequency (4-5 days interval) is found beneficial.
- Feeding trees with sufficient quantities of organic manures particularly compost, FYM, cakes, green manure, vermi-compost along with applied irrigation at regular interval during fruit development and ripening stage have been found useful.
- Planting of maize or sugarcane around the litchi orchard and daily irrigation in such border crop creates congenial microclimate which reduces sun burn.

Retarded/ Underdeveloped Fruits

This disorder is not well documented but somewhat causing considerable loss due to poor quality fruits or ill developed fruits. The fruit size remains smaller than the normal and juice content or aril development is also very poor. This type of fruits remain in glossy pale green colour for a longer period and then only dull reddish colour appears and just after the problem of prematurely fruits drop also starts. In fruit growth of litchi, seeds develop initially at a high rate, followed by membranous mesocarp and aril, which grow very fast towards the later stage of fruit development. During these phases, sometimes it happens that there is no aril development or aril development incomplete with portion of testa uncovered also give rise to the development of retarded/underdeveloped fruits. Lack of proper fertilization because of less visits of pollinators may lead to improper fruit set and retarded fruit growth. Insect-pests attack and physical jerk also cause retarded or underdeveloped fruits. Unavailability of moisture during development stage of fruit is also one of the causes for retarded/ underdeveloped fruit. It is more prevalent in poor managed orchards having poor pollination.

Management

- Proper nutritional management of orchard needs to be done
- Putting enough number of honey bee colonies during flowering to fruit set stage increases fruit set with better fertilization leading to normal and healthy fruit growth.
- Spraying plain water in early morning hours of the day during the advanced stage of growth and development have been found highly effective in better growth of fruit and quality.
- Arrangements of sprinklers system of irrigation has also been found to be effective in reducing this disorder.

Black Spot

The occurrence of black spot is not wide spread in litchi but it has been found infesting and damaging the quality harvest of litchi. In Indian condition, this disorder has been observed in existing plantation mainly in vicinity of urban areas and there are no other reports in litchi about its occurrence. It is caused due to deleterious effect of smoke fumes which contain sulphur dioxide, acetylene and carbon dioxide as found in case of mango.

The symptoms of black spot become apparent when the fruit attain certain size and remain in developmental phase i.e. from March end to mid-May. The first symptom appear as the development of a small etiolated area at the distal end of the fruit against the normal green colour of the fruit pericarp, which gradually spreads, turns

nearly black and covers the distal end completely. The infested fruit show discolouration and overall slow pace of development resulting very poor development of aril, seed, size and colour.

Management

- The disorder can be reduced by applying proper nutrition and irrigation particularly during fruit growth and aril development stage.
- Spraying with micronutrients like zinc ($ZnSO_4$ @ 0.2%) a month prior to flower panicle initiation and boron (borax @0.2%) during fruit growth stage can reduce the problem.

Pericarp Browning

Pericarp browning is the first visual sign of fruit decline. Browning that occurs during the first few days after harvest is usually caused by dehydration of the pericarp. This problem has been reported in several litchi producing areas and involves the appearance of necrotic spots which may expand and affect a significant portion of the fruit. Fruits start to brown once they lose a few percent of the harvested pericarp fresh weight. Below 50 percent of its initial fresh weight, the pericarp is entirely brown. Browning of the pericarp occurs at ambient temperatures of 20-30°C within 24 hours of harvest. Water loss (desiccation) of litchi results in brown spots on the bright-red shell (pericarp). Other factors also cause the fruit to brown, including mechanical stresses of various sorts (tugging the pedicel at harvest, sliding the fruit down a rough picking bag, dropping fruit from short heights); microbial and insect attack; and extremes of temperatures. In short, anything likely to accelerate cell breakdown is likely to increase fruit browning. This occurs as a result of damage (due to causes unknown) to the parenchymatous cells of the thin wall of the mesocarp. This damage speeds up a characteristic hypersensitive reaction, leading to necrosis of these cells, which then spreads to the epicarp and endocarp. Skin-browning is associated with an increase in polyphenol oxydase and perioxydase enzyme activity and with ascorbic acid oxidation. Losses may be considerable, although the aril is not affected; the fruit is not suitable for marketing. In extreme cases, the pericarp may crack. Through the use of fungicides and refrigeration, litchi fruit have a storage life of about 30 days. However, when they are removed from storage, their shelf life at ambient temperature is very short due to pericarp browning and fruit rotting.

Management

- Packing fruit into moisture-proof (plastic) bags and punnets can substantially reduce water loss and slow the rate of browning. More permeable barriers such as paper, wicker baskets and cardboard, offer less protection.
- Cool temperature storage also slows browning. Low temperatures slow evaporation as well as respiration and probably slow tissue senescence. It has been reported that fruit treated with polyamines, suspected anti-senescence agents, then wrapped and stored at 5°C, had lower membrane permeability and less browning than controls. This implicates senescence as a significant co-determinant of the life of well-packed, cool-stored litchi.
- A controlled atmosphere of 3 to 5 per cent O_2 and 3 to 5 percent CO_2 has also been shown to slow water loss. Fruit stored under such an atmosphere for 30 days at 1°C lost only a quarter of the water lost by the controls.

However, the mechanism of the response is not clear. Such an environment may affect the metabolism of the fruit as well as that of the pathogens.

- Sulphur dioxide fumigation has been used extensively in South Africa and Israel. There have also been many experiments in China and Thailand. However, sometimes the fruit are tainted. There are also concerns about high sulphite residues in relation to sulphursensitive individuals. Sulphur and acids, or combinations, can be used to stabilize the red colour of the pericarp but sulphur results in the formation of a colourless anthocyaninsulphite complex. Consequently, sulphur-treated fruit are somewhat bleached relative to controls. Sulphur is also anti-fungal if applied correctly. Sulfur dioxide fumigation effectively reduces pericarp browning, but some countries do not permit due to concerns over sulfur residues in fumigated fruit. Thus, sulfur-free postharvest treatments that maintain fruit skin colour are increasingly important. Alternatives to SO2 fumigation for control of pericarp browning and fruit rotting are pre-storage pathogen management.

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