International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(8): 1396-1399
www.biochemjournal.com
Received: 07-05-2024
Accepted: 09-06-2024

Harsh S Hathi
Ph.D. Research Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

SB Zankat
Ph.D. Research Scholar, Department of Vegetable Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India,

DN Oza
M.Sc. Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

Dr. NK Patel
Assistant Professor, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

Dr. BM Tandel
Associate Professor, Department of Fruit Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

Corresponding Author:
Harsh S Hathi
Ph.D. Research Scholar, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India

Causes and management of fruit drop in subtropical fruits

Harsh S Hathi, SB Zankat, DN Oza, Dr. NK Patel and Dr. BM Tandel

DOI: https://doi.org/10.33545/26174693.2024.v8.i8r.2017

Abstract
The subtropical zone, situated between the temperate and tropical zones, is known for producing subtropical fruits. Cultivating these fruits can be challenging and less profitable due to various factors, with fruit drop being a major issue. Several factors contribute to fruit drop, including plant stress from nutrient deficiencies, pest infestations, high temperatures, and excessive pruning. Additionally, premature ethylene production can cause physiological fruit drop. Other causes include poor pollination, self-incompatibility, embryo abortion, and competition among developing fruits. To manage the fruit drop effectively and ensure a successful harvest, growers should focus on several key practices. Implementing effective irrigation and cultural practices, providing adequate nutrients, using mulch to retain moisture and regulate soil temperature, and applying plant growth regulators and micronutrients can all help improve fruit set and retention. By addressing these factors, growers can enhance fruit retention and increase their yields.

Keywords: Abscission, Auxin, cause, fruit drop, management, subtropical

Introduction

Fruit drop (What & How)

Fruit drop occurs when a fruit detaches from its branch or plant due to the formation of a separation layer of cells in the fruit stalk. This detachment results from a series of physiological and biochemical processes. In this process, the substances that hold the cells of the separation layer together dissolve, causing the cells to separate from one another. The middle lamella, which is the layer holding cells together, becomes softer due to the action of hydrolyzing enzymes like pectin esterase. At this point, the fruit remains connected to the plant only by a vascular bundle. The mechanism behind fruit drop is known as abscission, which is regulated by a complex interaction of cells in the fruit's pedicel. The abscission layer forms at the base of the fruit stalk, leading to the fruit falling from the stem. This layer is a dark band of cells located at the base of the fruit stalk, where the vascular tissue runs through the center of both the stem and the fruit stalk.
Olsson and Butenko (2018) [13]

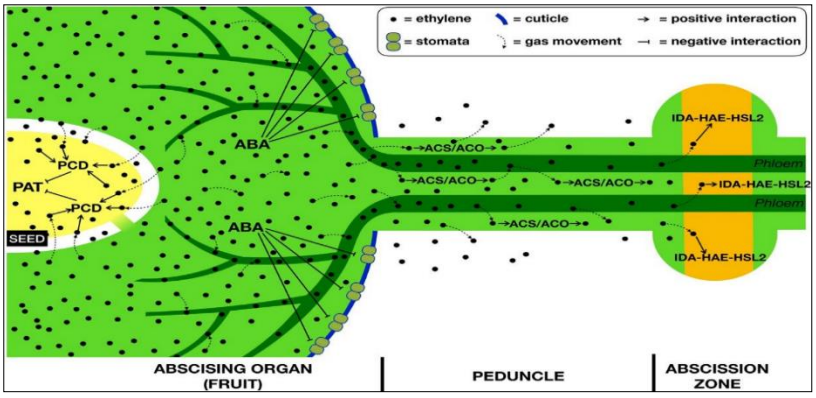

Fig 1: Role of ethylene in fruit abscission: A detailed mechanism

When fruit abscission begins, ethylene and abscisic acid (ABA) are produced within the fruit. Ethylene blocks polar auxin transport (PAT) by triggering programmed cell death (PCD) in the embryo, which reduces auxin flow and makes the abscission zone (AZ) more responsive to ethylene. ABA causes stomata to close, trapping ethylene inside the fruit. Ethylene then diffuses through the liquid phase into the vascular system, specifically the phloem, via the peduncle. In the peduncle, ethylene either escapes or stimulates its own production through the enzymes ACS (Aminocyclopropane-1-carboxylic acid synthase) and ACO (Aminocyclopropane-1-carboxylic acid oxidase). This process allows ethylene to accumulate and activate the AZ, leading to fruit drop. Botton and Ruperti (2019) [2]

Causes of fruit drop

Genetic variability among plant species or among cultivars in respect to sex ratio, position of perfect flowers, development of sex organs etc., all regulate the fruit drop. Some fruits would bear good crop initially, but may drop off heavily afterwards. Climatic factors such as temperature, relative humidity, heavy rain and wind have been considered to have profound influence on fruit drop in many fruit plants. Among them, when temperature is invariably high, the rate of transpiration is usually high from the leaves and young fruits. Consequently, such fruits are unable to withstand the moisture stress and shed easily. A good proportion of fruit drop occurs due to the incidence of various insect-pests and diseases. Physiological Factors viz., defective flowers or sex organs, deficiency of nutrients, embryo abortion, hormonal imbalance and distributed water relation also cause a great loss to fruits. Biochemical facto (formation of abscission zone) is different in different fruit crops. Some enzymes are also involved in abscission layer formation which is basically required for fruit drop.

Factors affecting fruit drop

Factors which affect the fruit drop are mainly divided into biotic factors (varietal differences, canopy direction, pollinators, fruit number, position and growth, short growth, structural peculiarities) and abiotic factors (wind velocity and diurnal variations). The eastern and western sides of the tree retain more fruits due to better sunlight. Low pollinator populations, such as honey bees, lead to poor fruit set and increased drop. Panicles deeper in the tree drop more fruit due to less light. Structural traits like dioecy and protandry can cause fruit drop at different stages. Early rapid fruit growth leads to competition for nutrients, increasing drop later. High wind velocity dries stigmatic fluid, impairing pollen germination and causing more fruit drop. Daytime fruit drop is nearly double that of nighttime due to better night-time water relations.

Management of fruit drop

To reduce fruit drop, one should implement practices like planting tall windbreak trees around the orchard to improve the microclimate and protect against high temperatures and desiccating winds. Use pollinizers, such as 10% pummelo for Kagzi Kalan lemon and 10% Rajapuri for mango, to enhance cross-pollination. Provide 4-5 beehives per hectare to boost fruit set and retention. Ensure proper orchard maintenance with timely irrigation, weeding, manuring, fertilization, and pest control. Use mulching materials like paddy straw, plastic sheets, or dry leaves to regulate soil temperature and moisture. Apply water adequately to prevent moisture stress, especially during critical stages of flowering and fruit development, with increased irrigation in summer. Utilize plant growth regulators (PGRs) like NAA, GA_3, and 2,4-D, along with $FeSO_4$, $ZnSO_4$ and nano urea. Triazole regulators like paclobutrazol can enhance flowering, while biostimulants such as humic acid and *jeevamrut* support growth and resilience.

Review of Literature

Mango

Mahida *et al*. (2018) [11] found that the higher fruit set at marble, pea and maturity stage (27.20, 9.54 and 2.69%, respectively) with fruit retention (2.95%), number of fruits per tree (284.23) and yield (82.36 kg/tree) was recorded with the foliar spray of $FeSO_4$ (0.50%) and $ZnSO_4$ (0.50%) at flowering, pea and egg stages on twenty years old Kesar mango trees.

It was proved by Patel *et al*. (2018) [15] that foliar spray of NAA (60 ppm) on the appearance of inflorescence and pea stage of mango cv. Kesar could produce more number of fruits at pea and harvesting stage accompanying fruit retention and yield. Still, maximum fruit weight was noted with GA_3 (50 ppm) sprayed at the same stage.

The application of KNO_3 (2%) + NAA (50 ppm) + *Jeevamrut* (5%) at pea stage in Kesar cultivar resulted in minimum fruit drop at marble and harvest stage (58.89 and 49.44%, respectively) with maximum fruit retention (48.89%) (Ramoliya *et al*., 2023) [18].

Citrus

It was investigated by Pooja *et al*. (2019) [17] that maximum fruit retention (26.32%) with lesser June (44.96%) and pre-harvest drop (12.69%) were observed in kinnow mandarin plants treated with 2,4-D (20 ppm).

Sakhidin *et al*. (2019) [22] determined that the fruit thinning at 45 days after full bloom by maintaining one fruit per branch in four years old plants dropped less number of fruits in both years of the experiment.

Rathod *et al*. (2022) [19] noticed that the humic acid (40 ml/l) + $ZnSO_4$ (0.5%) at pea stage and 30 days after first spray in thirteen years old acid lime plants thrieved best for minimum pre-harvest fruit drop (16.16%).

Guava

The treatment of 100% RDN on guava cv. Lucknow 49 given by Bhatti *et al*. (2023) [1] resulted in higher fruit set (73.41%) and lesser fruit drop (26.59%). In addition to that, among various concentrations; the foliar application of nano urea (0.1%) sprayed before flowering, at full bloom and two weeks after second spray in three years old trees recorded for higher fruit set (75.33%) and minimum fruit drop (24.67%).

Dabhi *et al*. (2023) [4] noted in both the years, that the maximum fruit set in guava cv. Lucknow 49 and more number of fruits per plant were recorded with the application of Novel Organic Liquid Fertilizer (4%) which was imposed in two frequencies in four years old tress.

Pansuriya *et al*. (2024) [14] concluded that five years old plants treated with $ZnSO_4$ (0.8%) twice *i.e.* second fortnight of June and after 20 days of first spray were noted with better fruit set and retention (59.66 and 56.00%, respectively) having minimum fruit drop (34.00%).

Ber

Brar *et al*. (2020) [3] indicated that fifteen years old plants of ber var. Gola mulched with 10 cm thick layer of paddy straw were observed with minimum fruit drop (22.82 and 20.45%) in both the years of research work.

It was registered by Patel *et al*. (2023) [16] that maximum fruit set (11.65%), yield (11.88 kg/tree) with lesser drop (40.83%) were found with two foliar sprays of NAA (400 ppm) at flowering stage and 30 days after in ber.

Aonla

Rathod *et al*. (2019) [20] reported that maximum fruit set (68.75 and 70.91%, respectively), retention (33.57 and 35.65%, respectively) and minimum drop (19.11 and 28.43, respectively) were obtained with three foliar sprays of borax (0.5%) and NAA (20 ppm), respectively at one month of interval in Aonla cv. Gujarat Aonla 1. Moreover, combined effect of borax (0.5%) + NAA (20 ppm) produced maximum fruit retention (36.25%).

Pomegranate

Jat *et al*. (2021) [10] revealed that higher fruit set (69.45%) with minimum drop (13.18%) were recorded with 100% RDN through poultry manure + PSB (50 ml) + KMB (25 ml) + *Trichoderma viride* (5 g) + *Paecilomyces lilacinus* (5 ml) per plant in two years old plants of pomegranate cv. Bhagwa.

Bael

Ghosh *et al*. (2020) [7] examined that black polythene mulching (200 guage) with no irrigation had maximum fruit set (55.95%). Nevertheless, higher fruit retention (23.82%) and minimum fruit drop (66.14%) were filed in plants given basin irrigation (15 l/plant) at 10 days interval and mulched with black polythene.

Jain *et al*. (2024) [9] evaluated that the application of Farm Yard Manure (50 kg) + boric acid (200 g) lead to minimum fruit drop in bael cv. NB 9.

Date Palm

According to Munir (2020) [12], twelve years old date palms cv. Khadrawy received foliar application of pollen grain (4 g/l) positively affected in terms of fruit drop (35.33%), fruit set (88.00%) and yield (28.21 kg/tree).

El-Abbasy *et al*. (2024) [6] showed that lesser fruit drop in kimri and bisir stage with higher fruit retention and yield were observed in Hayany plants which received putrecine (1.0 mM).

Custard Apple

Sanghani and Varu (2022) [23] stated that twenty years old trees hand pollinated with 100% pollen using paint brush twice produced maximum fruit set at pea and marble stage (72.68 and 71.26, respectively) in cv. Sindhan.

Jamun

Deepika *et al*. (2019) [5] suggested that 25% pruning of terminal shoot + paclobutrazole (1.5 g a.i. m^{-1}) of canopy diameter gave more fruit set (56.68%) in nine years old trees of jamun. Yet, higher yield (69.58%) was documented with the same pruning treatment along with paclobutrazole (1.0 g a.i. m^{-1}) of canopy diameter.

Litchi

It was found by Gupta *et al*. (2022) [8] that higher fruit set (62.50%), retention (30.55%) and minimum drop (69.45%) were reported with foliar spray of borax (0.4%) before flowering and at the pea stage of fruit.

Conclusion

The foliar treatment of micronutrients viz. borax, $ZnSO_4$, $FeSO_4$ + $ZnSO_4$ and humic acid + $ZnSO_4$, nano urea, Novel Organic Liquid Fertilizer and pollen grain at various stages; sole application of PGRs like NAA, GA_3, 2,4-D, putrecine and combined effect with organic input KNO_3 and *Jeevamrut* at different stages, cultural practices such as thinning, mulching, pruning and hand pollination were reported for maximum number of fruits, higher fruit set and retention, fruit weight and yield along with minimum fruit drop in various subtropical fruits. In pomegranate, maximum fruit set and minimum drop was noticed with poultry manure + *PSB* + *KMB* + *Trichoderma viride* + *Paecilomyces lilacinus*. FYM + boric acid in bael reduced fruit drop.

Future Thrust

Fruit drop is often caused by factors like environmental stress, nutrient deficiencies, pests, and poor farming practices. Extension activities can help educate farmers on effective remedies. Research should focus on how different cultivars, growth regulators, nutrients, and agricultural practices affect fruit drop, with studies conducted in specific locations. Additionally, advanced methods like pollen grain suspension spraying machines can offer mechanical solutions to control and reduce fruit drop.

Acknowledgement

I humbly acknowledge the co-authors for their assistance and guidance to review the papers and provide the necessary editings/corrections for the same. The author declares having no conflict of interests.

References

1. Bhatti D, Varu DK, Dudhat M. Effect of different doses of urea and nano-urea on yield and quality of guava (*Psidium guajava* L.) CV. Lucknow-49. Journal of Pharmacognosy and Phytochemistry. 2023;12(6):4151-4156.
2. Botton A, Ruperti B. The yes and no of the ethylene involvement in abscission. *Plants*. 2019;8(6):187.
3. Brar JS, Gill KS, Kaur K, Kaur G. Soil temperature and horticultural traits as influenced by mulching materials and orchard floor management practices in ber (*Zizypus mauritiana* Lamk.). Journal of Agricultural Meteorology. 2020;22(4):201-508.
4. Dabhi DM, Patel M, Macwan SJ. Effects of organic substance and plant growth regulators on yield attributes and quality of guava cv. Lucknow 49. Bangladesh Journal of Botany. 2023;52(4):971-978.
5. Deepika V, Rajangam J, Swaminathan V, Venkatesan K, Janaki D. Effect of paclobutrazol on floral bud initiation, flowering, and fruit set of jamun (*Syzygium cuminii* Skeels.). Journal of Pharmacognosy and Phytochemistry. 2019;8(5):1547-1549.
6. El-Abbasy UK, El-Dengawy ER, AL-Hindi K, El-Khalek A, Fathy A. The effect of spraying with some growth regulators and amino compounds on fruit drops, yield, and fruit quality and rutability in 'Hayany' date palm. Journal of Sustainable Agriculture and Environmental Sciences. 2024;3(2):1-11.

7. Ghosh S, Mahato S, Halder S. Effect of mulching and supplementary irrigation on fruit set, fruit drop, fruit retention, and yield of bael (*Aegle marmelos* Correa.). Journal of Crop and Weed. 2020;16(3):38-43.
8. Gupta A, Tripathi VK, Shukla JK. Influence of GA3, zinc, and boron on fruit drop, yield, and quality of litchi (*Litchi chinensis* Sonn.). Biological Forum – An International Journal. 2022;14(3):1079-1083.
9. Jain S, Pratap B, Sonkar A, Hassanzai RG. Mitigating fruit cracking and premature dropping in bael (*Aegle marmelos*) cv. NB-9 under subtropical conditions: Evaluating the effects of bio-formulations and boric acid. Journal of Advances in Biology & Biotechnology. 2024;27(5):940-947.
10. Jat RK, Joshi PC, Verma P, Jat ML, Wankhade VR. Influence of different organic sources of nutrients on growth and flowering behavior of pomegranate (*Punica granatum* L.) cv. Bhagwa. Journal of Natural and Applied Sciences. 2021;13(1):26-33.
11. Mahida A, Tandel YN, Mantri A, Patel N, Parmar VK. Effect of Fe and Zn fertilization on fruit setting and yield attributes of mango cv. Kesar. International Journal of Chemical Studies. 2018;6(5):532-534.
12. Munir M. Influence of liquid pollination technique on fruit yield and physicochemical characteristics of date palm cultivars Khadrawy and Zahidi. Journal of Applied Horticulture. 2020;22(1):12-17.
13. Olsson V, Butenko MA. Abscission in plants. Current Biology. 2018;28(8)
14. Pansuriya RR, Tandel BM, Patel NK, Sahu AK, Vagh NS. Effect of foliar spray of nutrients on fruiting and yield attributes of guava (*Psidium guajava* L.). Journal of Scientific Innovation Research. 2024;13(2):28-31.
15. Patel AH, Singh V, Bhanderi DR, Ahlawat TR, Tank RV. Response of pre-harvest chemicals spray on fruit retention and yield of mango cv. Kesar. International Journal of Chemical Studies. 2018;6(3):3113-3115.
16. Patel YJ, Polara ND, Gondaliya RR, Patel DV, Patel S. Effect of different chemicals on yield attributing parameters and yield of ber cv. Gola. Journal of Pharmacognosy and Phytochemistry. 2023;12(9):789-792.
17. Pooja, Kumar A, Nain S, Komal. Effect of plant growth regulators and nutrients on fruit drop and yield of Kinnow mandarin. Journal of Pharmacognosy and Phytochemistry. 2019;8(1S):369-372.
18. Ramoliya MP, Chaudhari MN, Butani AM, Dodiya KD. Effect of various organic and inorganic formulations on fruit setting and yield in mango cv. Kesar. International Journal of Plant & Soil Science. 2023;35(22):269-274.
19. Rathod K, Patel V, Nisar V. Impact of humic acid and zinc sulphate on pre-harvest fruit drop and fruit growth of acid lime (*Citrus aurantifolia* Swingle). Journal of Pharmacognosy and Phytochemistry. 2022;11(5):1821-1826.
20. Rathod RK, Ramdevputra MV, Jadeja SR, Parmar LS, Jivani LL. Effect of foliar application of micronutrients and growth regulator on fruit yield of aonla (Emblica officinalis Gaertn.) cv. Gujarat Aonla-1. Journal of Pharmacognosy and Phytochemistry. 2019;8(5):133-137.
21. Roemer MG, Hegele M, Wünsche JN, Huong PT. Possible physiological mechanisms of premature fruit drop in mango (*Mangifera indica* L.) in Northern Vietnam. Acta Horticulturae. 2008;903:999-1006.
22. Sakhidin, Purwantono AS, Suparto SR. The influence of fruit thinning on fruit drop and quality of citrus. Environmental Earth Sciences. 2019;250:1-4.
23. Sanghani J, Varu D. Effect of different pollination methods on fruit set and yield in custard apple cv. Sindhan (*Annona squamosa* L.). Journal of Pharmacognosy and Phytochemistry. 2022;11(9):2426-2430.