

ALTERNATE BEARING IN FRUIT PLANTS

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Abstract: Fruit trees exhibit a characteristic called "alternate bearing," which means that some fruit trees have fewer flowers in years when they have a lot of fruit. Pollination, temperature, carbohydrate concentration, family, cultivator, fruit load, and environmental pressures are physiological and biochemical factors contributing to alternate bearing in trees. Phytohormones are also considered very important for fruit production, both in good years and in bad ones. The alternate bearing index (I) determines how often crops grow in different places. When done right, trimming, thinning, and controlling when flower buds start to grow can lead to normal fruiting. Also, genetics, management practices, and biotic and abiotic stresses can cause a bird to change how it bears its young. To reduce the effects of alternate bearing, it's important to use good management techniques and choose types that are less likely to do this.

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Introduction

Many fruit trees have a problem called "alternate bearing," which means that the "on-year" has a high yield and the "off-year" has a low or no output (Monselise *et al.*, 1982b). Farmers now have to worry most about how to keep gardens and trees from producing fruit at different times (Meland, 2009). Local farmers and agronomists have said that it is a complicated event, and how it works have been studied (Shalom *et al.*, 2012). The lack of secondary bearing is known to be directly linked to the canopy staying in place. The most important parts of alternate bearing are the steps of flower initiation and energy storage at bud break (Wood *et al.*, 1991). This could be caused by cultural and environmental factors like temperature, pruning, drought, insufficient chilling hours, and light strength, all of which affect how the flower bud forms. (Hartmann 1953) Some people also think that endogenous phytohormones play a role in the process of different bearing. Gibberellins stop plants from flowering very well. Even though we don't fully understand how alternate bearing works, we do know that trees do it have traces of Absciscic acid, Gibberellic acid-like substances, Indole Acetic Acid, and kinetin-like cytokinin in their cells (Baktir *et al.* 2004). The number of seeds in each fruit also affects how they grow. Neilsen *et al.*, (1997) found that the way the leaves used carbon dioxide also affected whether they bore fruit every year or every other year (Singh 2002). The way different cultivars of the same species grow fruit is also different. Some

types of the same species bloom every year, while others bloom every other year. In place of these physical factors, the alternate bearing could be caused by genetic factors (Sharma *et al.* 2019; Giulivo, 2011). Pruning has not yet been shown to be the best way to stop alternate bearing.

You can figure out the alternate bearing by using the following formulas; (Monselise *et al.*, 1982b)

Formula 1: Alternate bearing index (I) = (yield of 1st year – yield of 2nd year)/ (yield of 1st year + yield of 2nd year). If I=1, there is full bearing; if I=0, there is no alternate bearing.

Formula 2: Alternate bearing = (current year's yield) - (5-year running average yield)/5-year running average yield. If the current year's yield is 20% higher than the 5-year running average yield, it is an on-crop (high yield) year. If the current year's yield is 20% lower than the 5-year running average yield, it is an off-crop (low yield) year.

Functions of physiology and biochemistry Things with a different weight:

The amount of carbohydrates

The process of photosynthesis uses light energy and water to turn carbon in the air into molecules rich in carbon. Respiration oxidizes these carbon-rich compounds, which gives off energy plants can use to make intermediate carbon compounds important for many biochemical processes. It's called the carbohydrate process. Some tests have shown that the

rate of photosynthesis is lower during the "Off" year than during the "On" year. Proteins used by photosynthesis machinery and stored in leaves are thought to play a key part (Evans 1989). During the "Off" year, photosynthesis in the lower leaf reduces the flow of photoassimilates to the area where buds grow. This causes the plant to make too many proteins used in photosynthesis and take in more CO₂, which speeds up the rate of photosynthesis. So, the fact that photosynthesis happens faster during the "Off" year gives us a clue about its role in alternate bearing. Studies of different mango cultivars showed that the ones with regular fruiting had almost the same number of mesophyll cells that used CO₂ very well. This led to the same rate of photosynthesis, which suggests that the rate of photosynthesis has something to do with flowering and setting fruit (Singh 2002). During the "Off" year, Pistachio trees only need a small number of carbs, but they still store some starch (Rosecrance *et al.* 1998). The number of carbohydrates in different parts of the pistachio plant, like buds, leaves, fruits, and shoots, was analyzed. After 70 days of bloom, all the cells had the same amount of carbohydrates. After that, many of the "On" trees' cells had less sugar and starch, which are soluble carbohydrates. Also, as time passes, different parts of "Off" trees start to store more soluble sugars, suggesting that the craving for carbohydrates is increasing. This showed a negative relationship between bud, leaf, sucrose in the root, sucrose in fruit, and flower bud abscission, which shows the source-sink link. Different patterns of how carbohydrates are stored and used in regular and alternate-bearing trees indicate that soluble sugars are important for alternate bearing. Spann *et al.* (2008) and Sharma *et al.*, (2019) Also found that the leaves of "On" and "Off" trees had different amounts of minerals and carbs. Carbohydrate storage and release followed the same trend in citrus (Spann *et al.* 2008).

Temperature

Flowers need to grow in a cold place. Temperature is the most important factor that starts the flower bud, anthesis, and growth of the flower parts. The temperature must be cold for tropical and subtropical perennial fruit trees to grow. (Singh and Ravishanker) Cold temperatures start the flowering process in subtropical trees after the buds open. (Olesen 2005) Whether a vegetative or a reproductive shoot comes out depends on the environment's warmth. When the temperature goes from high to low, the roots move from the growing phase to the reproductive stage. If the temperature doesn't go down far enough, the reproductive phase doesn't start, which stops the plant from making flowers (Sharma *et al.* 2019). Because of the unusually warm temperatures during the early stages of flower bud development, the chance of fruit set goes down. So, if the temperature requirements aren't met, the bearing will change direction (Valavi *et al.*).

Pollination

It has been found that crops pollinated by the wind tend to have alternating bearings even when grown on a big scale. Crops fertilized by wind may change a pattern of reproduction every two years if they are bred and produced in a certain way. Over-adding farming nutrients can cause crops that insects pollinate to keep making fewer seeds and bear them at different times. When you only grow one type of plant and plant it too close to other plants, pests are more likely to attack. This can trigger an endogenous process driven by the plant's resources and causes alternate bearing (Garcia *et al.* 2021). Too much pollination could cause alternate bearing since apple types that can pollinate themselves seem to have more of it than those that can't. Both self-fertile and self-incompatible mandarins have different effects. Some types without seeds still have heavy alternate bearings.

Families, Genera, and Species

Some fruit trees grow fruit every other year, while others don't. Some types of horticultural plants show alternate bearing in a big way. This means that there must be some genetic process that can cause and stop alternate bearing (Monselise *et al.*, 1982b).

Fruit Overload

Fruit overload is always and everywhere the most important cause of alternate carrying. People say a few other things cause trees to give fruit at different times, but fruit overload is the most important. A population of growing fruits that needs a steady source of nutrients creates a cumulative sink. A fruit set has a lot of small sinks but only a few big organs that require a lot of nutrients. When the crop is late, it stops flower buds from forming, which means less fruit is made. Minerals and organic nutrients come from materials that have been assimilated or stored in different places. The stocks are used up too quickly during the year, leaving too few for the next fruit set. This causes the off-year (Monselise *et al.*, 1982b).

Differences in cultivars

Most types of the same plant species have flowers that come out at different times. There are lists of the different kinds of apples and pears that bear fruit at other times. How versions of the same species behave when they have more than one baby at a time varies from place to place. The "modified alternate bearing index" separates plants into four groups. "No Susceptible Group" has "Braeburn and Jersey Mac" in it. Topaz, Granny Smith, Mondial Gala, Jonagold, Starkrimson Delicious, and Clear Red are all "medium alternate bearers." "Highest Alternate Bearers" include "Kassel 37, Kassel 41, and Golden Reindeers". The idea is based on the fact that cultivars can be different, which leads to the occasional bearing (Sharma *et al.* 2019). This often happens with apple and mango trees, where varieties with axillary fruit-bearing habits show less alternate bearing than types with terminal fruit-bearing patterns. Mango varieties "Dashehari, Langra, and Chaunsa" are less alternate bearers, while "Totapuri Red Small, Bangalore, and

Neelum" are known to be "regular alternate bearers" (Sharma *et al.*, 2020).

Edaphic Stresses

There isn't much known about how soil texture, water penetration, soil aeration, or salinity affect alternate bearing, even though these things play a big role in figuring out output because they affect how the roots work. By making the leaves fall off, salinity indirectly lowers the amount of food used to produce fruit. Soil wetness stress makes leaves fall off and make flowers sterile. Low fruit growth can also be caused by drought in the summer. Drought also affects alternate bearing because it causes sexual organs, leaves, and vegetative growth to fall off more quickly. This uses the plant's nutrients and forces them into the alternate bearing.

Pigment concentrations

It was found that the ON years had more chlorophyll and carotenoids than the OFF years. The chlorophyll level was different. In ON years, the leaves of different types of plants have a lot of chlorophyll, but in OFF years, they have less chlorophyll. Also, the levels of carotenoids were a lot higher in the ON year and a lot lower in the OFF year. The anthocyanin amount varies significantly between the ON and OFF years. Anthocyanins were higher during the ON year and lower during the OFF year. This helped Baktir *et al.* (2004) determine their role in the alternate bearing.

Phytohormones

Plant hormones are important for determining when flowers bloom. Phytohormones directly control flowering (Domagalska *et al.* 2010). The time these hormones are released, the tissues they target, how sensitive the tissues are to the hormones, and the quantity of the hormones all affect when the flowers bloom and how they interact with other plant chemicals that cause alternate bearing. The appearance of fruit sends a signal that stops the plant from flowering. (Sharma *et al.* 2019) Plant phytohormones from the outside can also affect the shift to flowering. (Ionescu *et al.* 2017).

Auxins

The ATA theory explains the role of auxin in stopping plants from flowering in the ON year and the OFF year. (Callejas *et al.*, 1997). Gibberellic acid production in the meristem acts as the dynamic signal, which stopped FI signaling when auxin was present. Gibberellin, the first messenger, causes the development and movement of the second messenger, auxin (Monselise *et al.*, 1982a). Polar transport of Auxin through a dominant sink, which sends a mobile signal to start blooming, causes the fruit to thin out. (Callejas *et al.*, 1997) Ito and his colleagues (2001) also found that adding Auxin from the outside inhibited several crop trees. Shalom *et al.* (2014) found that the amount of Auxin in "OFF" buds after de-fruiting is smaller than in "ON" buds.

Gibberellin

Goldschmidt and Lakso (2005) found that gibberellin stops many perennial fruit trees from flowering. In

OFF years, GA4 makes apples blossom (INOUE 1990). GA7 (Tromp, 1982) has the most effect on stopping flowers from opening. It is usual in horticulture to add GA from the outside during the OFF year to prevent too much flower inhibition. Schmidt *et al.* (2009) and Baktir *et al.*, (2004) found that high amounts of GA3 stop the plant from flowering, while ABA and cytokinin make the plant flower more.

Abscisic acid

Jones *et al.* (1976) found that crops from "ON" years have high levels of abscisic acid and the isomer t-ABA, while yields from "OFF" years have lower levels of ABA and t-ABA. This is because "ON" year crops put more stress on the tree by having too many fruits. (Garcia-Luis *et al.*, 1986) found that when ABA was put on orange plants, it stopped buds from opening and many flowers from growing. The use of ABA also showed that it might be possible to speed up flowering. When ON-year crops are thinned, the amount of ABA goes up. (Okuma *et al.*, 2011). In the biochemical process of NCED3 (Cs5g14370), 9-cis-violaxanthin is broken apart by a substance called "xanthoxin," a precursor of ABA. The amounts of ABA in the peel are in sync with the cycles of drought and watering of the leaves. In "On" years, the amount of ABA made is greater than in "Off" years.

Table 1: Some of the fruit trees bearing alternation

Serial No.	Species	Common Name
1	<i>Mangifera indica</i>	Mango
2	<i>Pistacio vera</i>	Pistachio net
3	<i>Corylus avellana</i>	Hazel nut
4	<i>Vaccinium macrocarpon</i>	Cranberry
5	<i>Aleurites fordii</i>	Tung
6	<i>Carya illinoensis</i>	Pecan
7	<i>Persea Americana</i>	Avocado
8	<i>Olea europaea</i>	Olive
9	<i>Malus sylvestris</i>	Apple
10	<i>Pyrus communis</i>	Pear
11	<i>Prunus domestic</i>	Plum
12	<i>Prunus armeniaca</i>	Apricot
13	<i>Coffee abarica</i>	Coffee
14	<i>Citrus sinensis</i>	Orange
15	<i>Citrus reticulata and hybrids</i>	Tangerine and Tangor
16	<i>Citrus unshiu</i>	Satsuma
17	<i>Litchi sinensis</i>	Litchi

Strategies for Managing Alternate Bearing

It has been reported to be a disorder in some crops (mango, avocado, and pecan), while in others (apple, citrus, and olive), it has been partially managed (Monselise *et al.*, 1982b) (Table 1). The main goal is to lower the yield in the good year and increase the

fruit set or yield in the bad year. This will lead to a balanced bearing.

Regulating Flower Bud Formation

Control over the buds can lead to control over the heading. When GA₃ is used on Australian oranges, it slows down the bud starts in commercially important years, which makes it possible to avoid alternation. It will only work if used at the right time and in the right way. It has been said that NH₄ ions (Grasmanis and Edwards 1974), cytokinin (Ramirez *et al.*, 1978), and maleic hydrazide (Luckwill 1970) can start flowering, while Bromacil (Buban and Sagi 1976) can stop blooming. KNO₃ has also been used in the Philippines to control alternation in poly-embryonic farmers (Bondad and Linsangan, 1979).

Exploring the Benefits of Pruning and Fruit Thinning Practices

Pruning aims to: 1. Change the form of trees as needed; 2. Get rid of broken or dead branches; 3. Let light into the ground zone; 4. Start new growth and get rid of pests (Bedker, 1995). Recent research (Verdin Filho *et al.*, 2016) shows that trimming coffee has increased crop growth. It is also said that castor beans and Jatropha give better results. Pruning depends on the species and what people want, leading to a low fruit load in one year and a well-balanced crop. Lazare *et al.*, (2021) reported that if you want to improve the yield of jojoba, you should prune the top more than the sides. Fruit thinning reduces the number of fruits on the tree in a given year, making the standard bearing even more. It is said that different types of fruit trees have different ways of trimming and thinning. It is best to have a peach tree with a short length of 4 fruits per meter if you want to get the most fruit without getting fruit every other year (Bussi and Génard 2014).

Conclusion

A natural process called "alternate bearing" causes many trees to have big fruit crops in one year and light crops in the next. This can greatly affect how much fruit is available in a given year and the business of orchardists and growers whose income depends on a steady supply of fruit. Growers and orchardists can better care for their crops and get the most out of them if they know what causes and effects alternate bearing.

Conflict of interest

The authors declared absence of conflict of interest.

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