

Fragaria × ananassa

Monograph



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Agricultural Science 2025-2026

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Introduction

Fragaria x ananassa, commonly known as the cultivated strawberry, is one of the most widely grown and economically important fruit crops in the world. It is a hybrid species that originated in Europe during the 18th century. Since its development, this species has been extensively cultivated due to its desirable characteristics, including large fruit size, appealing flavour, and adaptability to a wide range of environmental conditions.

This monograph provides a comprehensive analysis of *Fragaria x ananassa*, covering its ecology, biology, propagation, and management practices, as well as its economic importance and uses. The study examines the environmental conditions required for optimal growth, the biological characteristics that influence its development and reproduction, and the agricultural techniques used to maximize yield and quality.

1.0 ECOLOGY

The hybrid species *Fragaria x ananassa* was first described as *Fragaria chiloensis* var. *Ananassa* by Richard Weston in 1771. It was later formally named and classified by Antoine Nicolas Duchesne, a French botanist, and published by Francois Rozier. Duchesne is recognized as the authority who correctly described the species and has the botanical citation (*Weston*) *Duchesne ex Rozier*.



1.1 TAXONOMY

Table 1

Taxonomy of *Fragaria x ananassa* (Britannica 2024)

| Taxonomic Rank | Taxon Name (Authority) |
|-----------------------|-------------------------------|
| Kingdom | <i>Plantae</i> |
| Subkingdom | <i>Tracheobionta</i> |
| Super division | <i>Spermatophyta</i> |
| Division | <i>Magnoliophyta</i> |
| Class | <i>Magnoliopsida</i> |
| Subclass | <i>Rosidae</i> |
| Order | <i>Rosales</i> |
| Family | <i>Rosaceae</i> |
| Genus | <i>Fragaria</i> |
| Species | <i>Fragaria x ananassa</i> |

Like in **Table 1**, there are different levels of the *Fragaria x ananassa*. It starts with the Kingdom, which is the *Plantae*, which includes all plants. Includes multicellular, eukaryotic organisms that typically produce their own food through photosynthesis using chlorophyll and have cell walls made of cellulose. Plants are vital to ecosystems, providing food, oxygen, and habitats.

Then, there is the Subkingdom *Tracheobionta*, which refers to the vascular plants.

These plants are categorized by the presence of conductive tissues, or vascular tissues, for the transport of water and nutrients. This adaptation allows for greater size and complexity.

The Subdivision Spermatophyta means seed plants. These plants make seeds instead of tiny spores to reproduce. A seed is like a protective package; it keeps the baby plant (the embryo) safe and gives it food so it can grow better. That's why seed plants are so important in nature.

The Division of Magnoliophyta is a flowering plant. They are distinguished by their reproductive structures: flowers and fruits. These facilitate pollination and seed dispersal.

Class Magnoliopsida includes dicotyledons, which typically have two embryonic leaves (cotyledons), net-like leaf venation, and flower parts in multiples of four or five.

Subclass Rosidae is a large group within dicots, known for its economic importance, and it includes many fruit-bearing plants. They often have compound leaves and stipules

. Order Rosales contains families like Rosaceae and Ulmaceae. Rosales are characterized by their floral structure and often produce fleshy fruits

. Family Rosaceae Juss. The rose family includes over 3,000 species. It is defined by its actinomorphic flowers, usually with five petals, and often produces aggregate fruits.

Genus *Fragaria* L. includes strawberries, which are herbaceous perennials with trifoliate leaves and runners. The genus is known for its edible aggregate accessory fruits.

The species *Fragaria x ananassa* is a hybrid between *F. chiloensis* and *F. virginiana* developed in Europe in the 18th century. It is the most widely cultivated strawberry species globally due to its large fruit and adaptability.

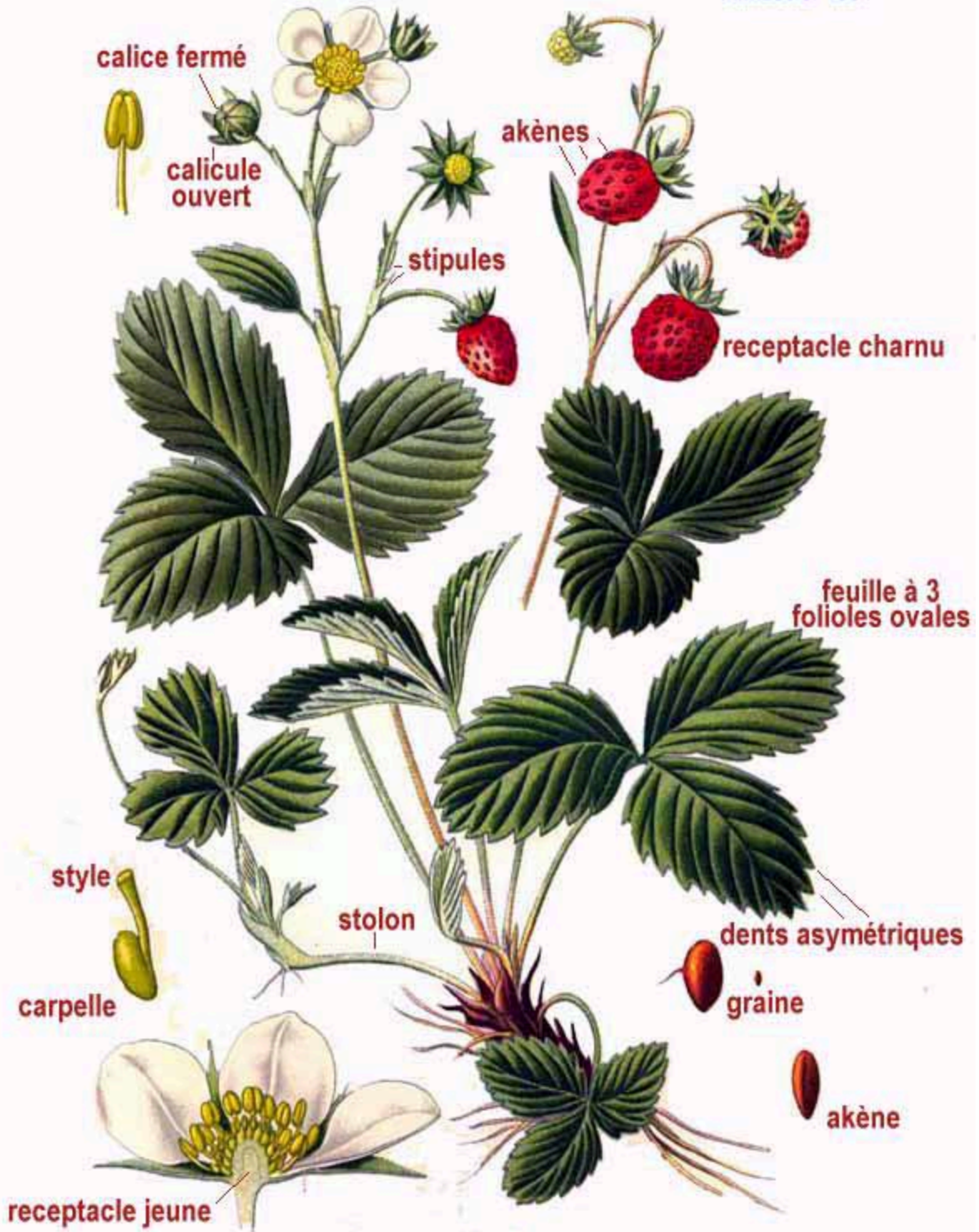
1.2 FOSSIL RECORD

There is no fossil record for *Fragaria x ananassa*. This is because it's a relatively recent hybrid species developed through human cultivation in the 18th century. It emerged only about 250 years ago, far too recently for fossilization to have occurred. Also, it was created through human agricultural practices, not natural evolutionary processes, and strawberries are composed of soft, fleshy tissues that decompose rapidly and are unlikely to fossilize. However, its progenitors are wild octoploid species that descended from diploid ancestors over a million years ago (*Phytozome*, n.d.).



1.3 ORIGIN AND CURRENT DISTRIBUTION

It's a cultivated hybrid, not a naturally occurring species. The parent species is the *Fragaria virginiana*, which is native to eastern North America and is known for its aromatic flavor and cold tolerance. The *Fragaria chiloensis* is native to the Pacific coast of South America (especially Chile), valued for its large fruit size and healthy growth (*Botanikks*, n.d.). Current distribution: it is now cultivated globally, with major producers including the United States, Spain, Turkey, Egypt,t and China (*EPPO Global Database*, n.d.).



Pl. 95. Fraisier commun, *Fragaria vesca* L.

1.4 ECOREGION AND ELEVATION

The elevation range is cultivated from sea level to 2,000 meters, depending on climate and cultivar.

Sierra-Almeida et al., 2025). The zones where it grows are the temperate, subtropical, and tropical highland zones, including open fields, valleys, and forest edges. Also, the *Fragaria x ananassa* blooms in humid temperate, Mediterranean, and subtropical climates. Climate modeling shows suitability shifting due to warming trends. (Da Silva et al., 2024).

1.5 CLIMATE

For the temperature range, the optimal growth occurs between 15 and 25 °C. Growth slows below 10 C and above 30 C (GreenThumb, 2025)

Photoperiod sensitivity: Cultivars are classified as short-day, long-day, or day-neutral, which influences flowering and fruiting cycles (GreenThumb, 2025)

Humidity and rainfall: preferred moderate humidity and 500-700 mm of rainfall per season (GreenThumb, 2025)

1.6 GEOLOGY AND SOIL REQUIREMENTS

Soil texture: loamy or clay loam soils with good aeration (GreenThumb, 2025).

pH range: Optimal between 5.5 and 6.5 (GreenThumb, 2025).

Drainage: Requires well-drained soils, raised beds used to prevent root rot (GreenThumb, 2025).

Organic matter: high organic content improves fertility and moisture retention (GreenThumb, 2025).



1.7 WATER MANAGEMENT

Seasonal requirement: About 500-700 mm of water per growing season.

Monthly needs: Around 60-100 mm/month, with peak demand during flowering and fruiting

Dry spell sensitivity: Shallow roots make it vulnerable to drought; frequent irrigation is essential.

Irrigation method: Drip Irrigation. It's preferred for efficiency and disease control.

1.8 LIGHT AND TEMPERATURE REGIMES

Light requirements: Full sun (6-10 hours/day), artificial full-spectrum light is used in vertical farming

Temperature sensitivity:

- **Ideal daytime:** 18-25C
- **Nighttime:** Not below 5 C

Heat stress: Yields decline above 30 °C; shading or cooling may be necessary

Photosynthetic Efficiency: Strong correlation between light quality and fruit yield, especially under controlled environments (Choi, H. G et al., 2016).

2.0 BIOLOGY

2.1 Chromosome complement

Fragaria x ananassa is a allo-octoploid species represented by the formula $2n = 8x = 56$ (Edger, P et al., 2019).

2.2 Genomic origin:

It arose from a spontaneous hybridization between two wild octoploid species: *F. chiloensis* and *F. virginiana*.

Complexity: Its genome is highly complex, consisting of four distinct sub-genomes derived from diploid ancestors (including *F. vesca* and *F. iinumae*). This polyploidy contributes to the plant's vigor, fruit size, and adaptability (Edger, P et al., 2019)

2.3 Life cycle and phenology

The strawberry is a perennial herbaceous plant. Its life cycle follows a predictable pattern of vegetative and reproductive phases (Edger, P et al., 2019)

1. **Establishment:** initial growth from a runner (stolon) or seed (Edger, P et al., 2019)
2. **Vegetative Growth:** Productive of a “crown” (shortened stem), leaves, and stolons for asexual reproduction (Edger, P et al., 2019)

3. **Dormancy:** Triggered by shorter day lengths and lower temperatures in autumn, winter (Edger, P et al., 2019)
4. **Reproduction:** Post chilling, the plant produces inflorescences (cymes) from the terminal buds (Edger, P et al., 2019)

2.4 Phenology

Phenological stages are often categorized by the BBCH scale

- Leaf development: rapid emergence in early spring
- Flowering (Anthesis): Typically occurs 30-40 days after the start of spring growth, depending on the cultivar (Short day vs Day neutral)
- Fruit Ripening: Usually takes 20-50 days from anthesis to full maturity
- Runnering: Peak stolon production occurs during the long days of summer after the primary fruiting season

2.5 Reproductive biology:

2.5.1 Sexuality

While many wild *fragaria* species are dioecious (separate male and female plants), *Fragaria x ananassa* cultivars are predominantly hermaphroditic pistils (female) located on a receptacle, surrounded by a ring of stamens (male)

2.5.2 Pollen

- **Structure:** Strawberry Pollen is small, ellipsoidal, and tricolpate.
- **Viability:** Pollen release occurs as the anthers dehydrate and longitudinal slits open.

Viability is highly sensitive to temperature; extreme heat or frost can lead to sterile pollen and subsequent fruit deformity.

2.5.3 Pollination and Potential Pollinators

- **Mechanism:** While strawberries can self pollinate cross pollination significantly improves fruit quality
- **Pollinators:** Primary pollinators include honeybees (*Apis mellifera*), bumblebees, and various hoverfly species. Wind plays a secondary, less reliable role,

2.5.5 Fruit development and seed set

- **Botanically,** the strawberry is an aggregate accessory fruit.
- **Seed set:** The true botanical fruits are the achenes (the tiny “seeds” on the surface)
- **Hormonal control:** Auxins produced by the developing achenes are what trigger the receptacle to swell. If achenes are not fertilized due to poor pollination, the fruit will develop asymmetrically.

3.0 PROPAGATION AND MANAGEMENT

3.1 Natural regeneration

It occurs primarily through vegetative propagation via **stolons**, which are known as runners. These runners grow from the parent plant and develop new genetically identical plantlets (clones). *Fragaria x ananassa* rarely rely on natural regeneration through seeds because they have low viability and genetic variability. Seed propagation is mainly used in breeding programs rather than commercial cultivation, as seedlings lack uniformity in fruit quality and yield (FAO, 2020)

3.2 Vegetative Regeneration

The primary mode of regeneration in strawberries is vegetative, through runners (stolons). Runners develop from the mother plant and produce daughter plants, ensuring genetic uniformity and rapid multiplication. Studies show that under protected conditions, runner initiation happens within 30 days, with up to 10 runners per plant in shade-net houses. (CSRL, 2021)

3.2.1 Nursery propagation

Nursery propagation of strawberries involves establishing runner plants in a controlled environment before transplanting. Micropropagation techniques, including tissue culture, are

increasingly used to produce disease-free, uniform plants. Optimized protocols for micropropagation of varieties like 'Aroma` have shown high acclimatization success rates (Neri et al, 2022)

3.2.2 Cuttings

Strawberries can be propagated through crown division or root division. This method is used when runner production is limited, ensuring the preservation of elite genotypes. However, cuttings are less efficient compared to runner propagation (Preece and Read, 2005)

3.2.2.1 Plantings

Planting requires well-prepared beds with proper spacing (typically 25-30 cm between plants). Raised beds improve drainage and reduce disease incidence. Planting is usually done with runner plants or tissue-cultured transplants to ensure uniformity and vigor (Pandey et al., 2023).

3.2.2.1.1 Management of pests and diseases

Fragaria x ananassa is susceptible to pests such as aphids, spider mites, and diseases like powdery mildew and *Botrytis* (gray mold). Integrated Pest Management (IPM) strategies, including resistant cultivars, biological control, and cultural practices, are essential for sustainable production (Baldwyn Torto, 2026)

3.2.2.1.2 Pest and Disease Control

Specific control measures include the application of fungicides against Botrytis, the use of predatory mites against spider mites, and sanitation practices to reduce inoculum sources.

Biological control agents are increasingly favored to minimize chemical residues (Dent, 2000)

3.2.2.1.3 Cultivation

Cultivation practices for strawberries include mulching, drip irrigation, and weed management. Mulching conserves soil moisture, suppresses weeds, and reduces fruit rot. Drip irrigation ensures efficient water use and minimizes foliar diseases (Brady and Weil, 2017)

3.3 Fertilizing

Strawberries require balanced fertilization; it responds strongly to balanced nitrogen (N), phosphorus (P), and potassium (K) with higher N and P rates, increasing plant vigor and fruit yield, and K supports total production (Silva et al., 2015). Field trials show that these combinations can improve yield and soil microbial activity while lowering fertilizer costs (Sun et al., 2023)

3.3.1 Growth stages

Strawberry growth is described by the BBCH scale, with stages 0-1 for bud rest and leaf development, stage 5 for inflorescence and flower bud emergence, and stages 7-8 for fruit development and maturity (Meier, 2001). Stolons form an intermediate BBCH range, allowing clonal spread (PFAF, 2024)

3.3.2 Fruiting

Fruiting in *Fragaria x ananassa* begins 3-4 months after planting, with June support producing one main flush, and day-neutral types yielding multiple flushes from spring through autumn under good conditions. (PFAF, 2024) Excessive vegetative growth reduces fruit size and sugar content, and diverts photoassimilates from berries (Silva et al., 2015)

3.4 Harvesting

Harvest occurs when fruits are fully red, glossy, and firm, usually 4-6 weeks after flowering; they do not sweeten more after picking. (EarthOne, 2025) In peak season, fruits are picked every 1-3 days, preferably in cool, dry mornings to maintain quality. (Meier, 2001)

3.4.1 Pruning and replanting

After the final harvest, June supporting plants are resonated by mowing leaves to 2.5-5cm above the crown, narrowing rows, and thinning plants to reduce disease and improve airflow,

while runners are managed to maintain a compact matted row (Manitoba Agriculture, 2022)

Beds are typically replanted every 2-4 years as older plants exhibit declining yields and

increased soil-borne disease (PFAF, 2024)

4.0 Importance, markets, and uses

The cultivated strawberry, *Fragaria x ananassa*, is one of the most economically significant fruit crops worldwide. Its importance extends across local, regional, and international scales due to its high market demand, nutritional value, and versatility in processing. Strawberries are widely appreciated not only as a fresh fruit but also as a key ingredient in a variety of value-added products, making them a major contributor to the global horticultural economy (PFAF, 2024).

At the global level, strawberry production exceeds 9 million metric tons annually, with major producers including China, the United States, Turkey, Egypt, Mexico, and Spain (EPPO, n.d.). China is the largest producer, contributing a significant proportion of global output, while countries like the United States and Spain dominate export markets. The high productivity of

Fragaria x ananassa, combined with its relatively low production cycle, makes it an economically attractive crop for both small-scale farmers and large commercial operations (PFAF, 2024).

Regionally, strawberries play an important role in agricultural economies. Latin American countries such as Mexico are major exporters, supplying fresh strawberries to North American markets. In Colombia, strawberry production is concentrated in highland regions where climatic conditions are favorable. Although production volumes are smaller compared to global leaders, the crop contributes significantly to rural employment and local income generation, especially among small and medium-sized producers (FAO, 2020).

From a market perspective, strawberries are both a domestic and export-oriented crop. Due to their highly perishable nature, a large proportion of strawberries is consumed locally shortly after harvest. However, international trade is facilitated through cold chain systems, allowing fresh strawberries to be exported over long distances. Additionally, processed forms of strawberries have longer shelf lives, increasing their market reach and economic value (PFAF, 2024).

The value of strawberries is significantly enhanced through thoughtful processing. While fresh consumption represents a major portion of the market, strawberries are widely used in the production of jams, jellies, juices, purees, frozen products, dairy items such as yogurt, and

confectionery products (FAO, 2020). Processing not only extends shelf life but also reduces post-harvest losses and increases profitability for producers.

In addition to their economic value, strawberries have important nutritional benefits. They are rich in vitamin C, antioxidants, and dietary fiber, which contribute to their popularity among consumers seeking healthy diets. Their bioactive compounds, including anthocyanins, are associated with various health benefits, further increasing their demand in global markets (PFAF, 2024).

In conclusion, *Fragaria x ananassa* is a high-value horticultural crop with significant economic, nutritional, and industrial importance. Its global production, strong market demand, and wide range of uses from fresh consumption to processed goods make it a key commodity in modern agriculture. The continued expansion of its market is supported by advances in cultivation techniques, improved distribution systems, and increasing consumer preference for functional and health-promoting foods.

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