Passiflora edulis Sims

Monograph

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Chapter 1: Introduction

Passion fruit is a fruit that is very common in Colombia and around the world. It is a fruit that needs to be taken care of while they are growing due to the fact that they have lots of insects and pests.

In this monograph, we are going to talk about *Ecology* in this chapter there will be touching the Distribution:

- Affinity
- Origin
- fossil record
- Present distribution

Environmental Factors

- elevation and climate,
- rainfall, temperature,

Geology
Vegetation Components,
Relationship with animal and insects

- Primary pests.

Now the second chapter is *Biology* which will include:
Chromosome complements
Flowering and pollination
Chromosome Complement
Flowering and Pollination

- Life cycle and phenology
- Phenology

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- Sexuality
- Anthesis
- Pollination and potential pollinators
- Fruit development and seed set
- Ovule Development

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- Germination

The third chapter will be *Propagation and Management* this will include the following
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- Asexual:

- Sexual:

Nursery Propagation

- Vegetative Propagation

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Management

- Tending.

Lastly the fifth chapter will be *Market* uses which will include the uses, such as edible and medical uses.

Market

Uses

- Edible uses
- Medical uses

Other uses

Chapter 2: Ecology

2.1 Distribution

As soon as it was discovered, it was made available to planters in Queensland and northern New South Wales. The commercial culture of the passion fruit began in Kenya in 1933, it was expanded in 1960, also introduced into Uganda. These productions were hit by easily spread diseases and pests. It became necessary to abandon large plantations for smaller ones that were isolated plantings , this is because they could be better protected and cared for. South Africa in 1947 produced 2,000 tons of purple passion fruit, all for domestic consumption. It was doubled by 1950. In 1965, it spread over large areas of Transvaal to meet the market demand and there had not been any setbacks, such as diseases, to stop the production.(Morton,1987)

- highlands of Java,
- Sumatra,
- Malaya,
- Western Samoa,
- Norfolk Islands,
- The Cook Islands,
- The Solomon Islands,
- Guam,
- the Philippines,
- the Ivory Coast,
- Zimbabwe
- Taiwan.

The yellow passion fruit was introduced into Fiji from Hawaii in 1950, it was distributed to farmers in 1960,it became the basis of a small juice-processing industry. Fiji has exported to Australia, New Zealand, and Canada as well as to nearby islands. When it arrived in South America, it became a commercial plantation in 1975.(Morton,1987)

2.1.1 Affinity

Passion fruit, ***(such as sour passion fruit, yellow passion fruit, black passion fruit, and purple passion fruit)*** comprises about 520 species of dicotyledonous plants in the family of Passifloraceae. *It* is also a medicinal plant distributed in warm temperatures and tropical regions. In the traditional system of medicines, this species has a key role in the management or treatment of various

diseases. Properties traditionally recognized include anxiolytic, anti-inflammatory, sedative, antioxidant, antispasmodic, antioxidant, and neuroprotective.(Taïwe & Kuete, 2017)

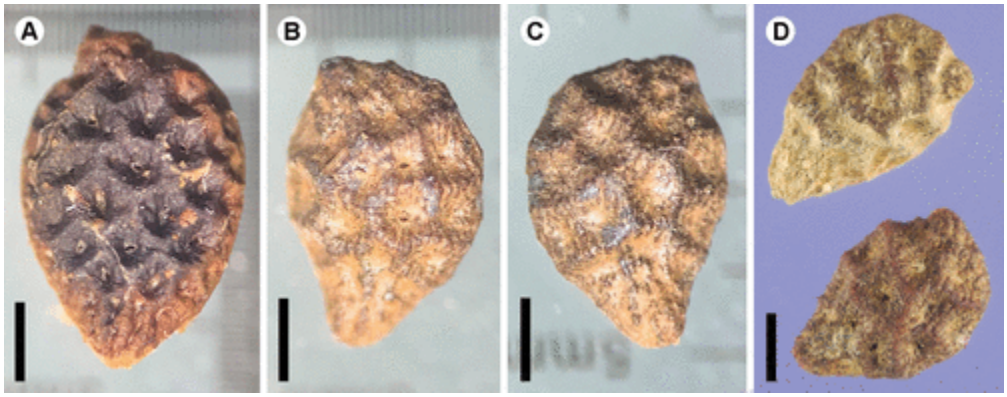
The purple species is more resistant to cold injury, is less acidic, and is considered superior from the yellow passion fruit, this is in their aroma and flavor. The yellow form grows faster, it has a greater resistance to soil fungi. It has more vigorous vines, bears crops over longer periods, and it has a greater yield of fruit and pulp, larger fruits, and more acid juice.(Rodriguez-Amaya, 2003)

2.1.2 Origin:

The purple passion fruit is native from southern Brazil to Paraguay to northern Argentina. The yellow form of passion fruits, which is different from the purple passion fruit, has an unknown origin, or they also say that the purple passion fruit can be native to the Amazon region of Brazil, or it can be a hybrid between P.edulis and P.ligularis. Some say that the yellow passion fruit came from Australia and that the seed went through Hawaii and then to the United States in 1923. The purple is preferred to be eaten fresh and the yellow works more for fruit processing and preserves.(Morton,1987)

2.1.4 Fossil Record

Figure 1:



(Hermsen, 2021)

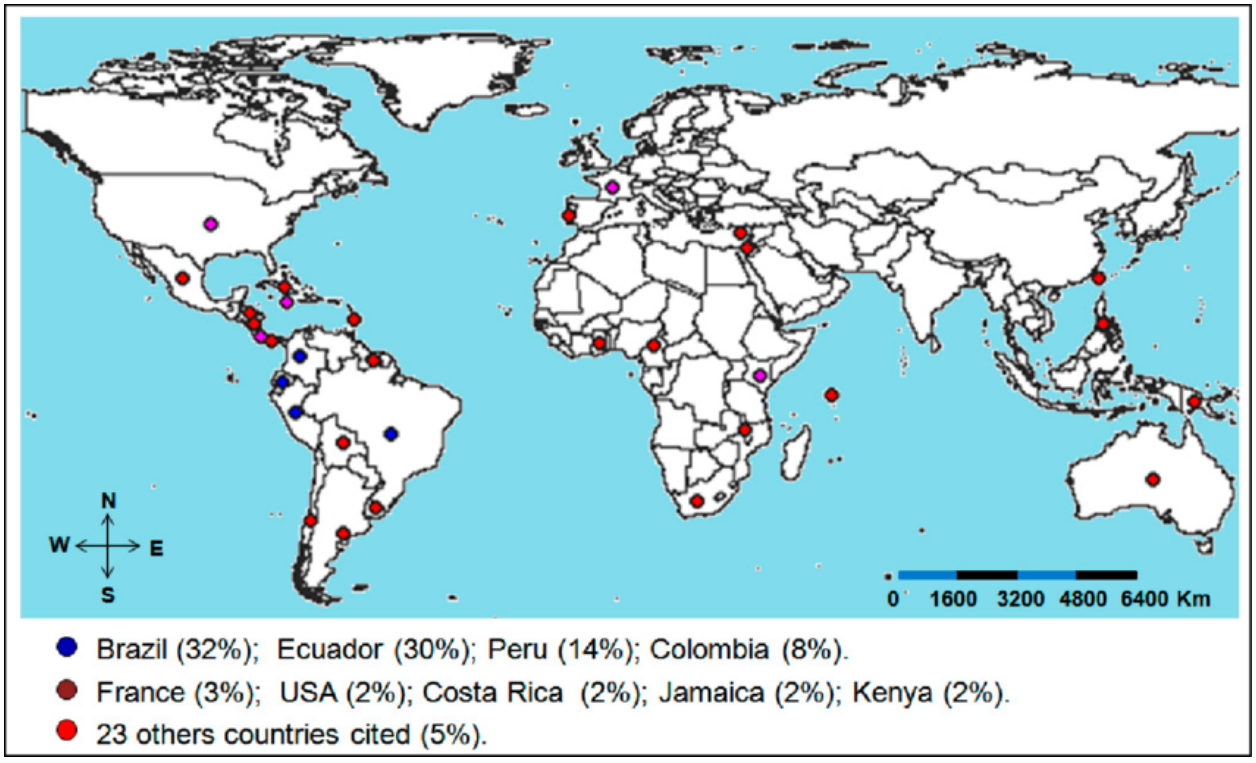
This picture represents the fossil of a passion fruit. The fossil is

2.1.5 Present Distribution

New Zealand, in the early 1930s, had a small but thriving purple passion fruit industry in Auckland Province, but for the cause of diseases that this plant is very sensible, this type of

passion fruit plantation started to reduce in just a few years. Good local marketing and export prospects have brought about a revival of efforts to control infestations and increase acreage, mostly in the Bay of Plenty region. Today, passion fruits, these fruits and juice are being exported. A profitable purple passion fruit industry has also developed in New Guinea.

Figure 2



(Cerqueira-Silva et al., 2014)

1. Brazil
2. Ecuador
3. Peru
4. Colombia
5. France
6. USA
7. Costa Rica
8. Jamaica
9. Kenya
10. Malawi
11. South Africa
12. Mexico
13. Honduras

14. Nicaragua
15. Panama
16. Cuba
17. Trinidad y Tabago
18. Guyana
19. Bolivia
20. Chile
21. Argentina
22. Uruguay
23. Bolivia
24. Portugal
25. Ghana
26. Australia
27. New Guinea
28. Philippines
29. Taiwan
30. Maldives
31. Jordan
32. Syria

2.2 Environmental Factors Affecting Distribution

2.2.1 Elevation and Climate

2.2.1.1 Rainfall and Altitude

The yellow passion fruit is tropical or near-tropical. In Western Samoa, it is grown from near sea level elevation of 2,000 ft (600 m). Both forms need protection from wind. Annual rainfall should be at least 35 in (90 cm), but in the Northern Transvaal, in South Africa (~500m), with precipitation of only 24 in (60 cm). It is reported that annual rainfall in passionfruit-growing areas of India ranges between 40 and 100 in (100-250 cm)(Morton, 2016)

2.2.1.2 Temperature Regime

Huila produces almost half of the sweet passion fruits in Colombia and other important competitors are Nariño, Antioquia and Cundinamarca. You may find this species in altitudes between 1800 - 2400 mamsl. and temperatures between 8 - 16 °C. It's the passion fruit with the highest amount of ascorbic acid (Vitamin C).(Ruiz,2020)

Where purple passion fruit is best stored at 4–5 °C, yellow passion fruit prefers a higher temperature of 10 °C. The main market for both forms is the processing industry and most of the export consists of juice.(Schotsmans & Fischer, 2011)

2.2.3 Geology and Soils

Passion fruit vines are grown on many soil types but light to heavy sandy loads of medium texture are most suitable, and pH should be from 6.5 to 7.5. The soil cannot be too acidic but if it is, lime must be applied, so that it can be good for the passion fruit. It is better to have good drainage to minimize the incidence of collar rot.(Julia F. Morton, 2016)

2.2.5 Relationships with animals and Insects

2.2.5.1 Primary pest

Lepidopterous Defoliators

Control measures are crop inspection, which includes hand-picking and destruction of eggs and caterpillars (Rossetto et al., 1974). This takes time and is impractical for large scale plantations. Infesting passion fruit must be controlled with insecticidal sprays. Choosing an insecticide that is selective for the best and less toxic to pollinators, predators and parasitoids are important in these agro-ecosystems. (Rossetto et al., 1974).

Coreid Bugs

This pest causes or damages the less mature passion fruits. According to (Chiavegato, 1963), “both mature and immature bugs can damage the passion fruit, it injures the crop, this is done by piercing stems, leaves, fruits and flowering bud, this is done by sucking plant juices.” In small passion fruit-producing areas, hand-picking, and destruction of eggs, nymphs, and adults is recommended (Mariconi, 1952). To stop this, they have to check the crop very often, and the removal of these bugs can prevent the denseness of the parasite.

Stem Weevil

There has to be a periodical inspection of the crop, so that this can be detected before it is too late and that the crop can be saved. When there has been detected steam that has been effective, this has to be pruned and burned. According to Leão (1980) and Costa et al. (1979), a contact

insecticide (e.g. decamethrin at 25% (5–10 g a.i. ha−1)) should be applied during early afternoon hours for stem weevil control, at the time of adult emergence.

Flies

If the fruit is very small and umature it may cause this bud to fall down. If the fruit is well-developed, it may continue to mature. At the time of ripening, the area around the puncture has the appearance of a small, woody crater, which disfigures the outer appearance of the fruit, but does not impair pulp quality. Punctured fruits may persist on the plant to maturity but are not acceptable for fresh market sale because of the damage (May, 1953; Hargreaves, 1979)This may cause the production of this fruit to decrease and also the quality to go down. Passion fruit increases rapidly in size during the first 10–15 days after the fruit is set. During this period, the skin of the fruit is turgid and easily punctured by the ovipositor. Infested immature fruit shows characteristic skin blemishes. The woody tissue, which forms around the eggs, develops a hard raised area around the puncture mark. It has to be well taken care of to prevent this pest from getting in the fruit and damaging the whole harvest, and this is seen when it is already mature, so while it is maturing it needs extra care.

Chapter 3: Biology

3.1 Chromosome Complement

The passiflora is diploid with the passion fruit, and it normally contains 18 chromosomes 2n=18, which are 9 pairs; what this helps for the plant is it is helpful in the breeding to obtain interspecies hybrids.

3.2 Flowering and Pollination

Pollination in passion fruit is mainly performed by bumblebees, these animals are attracted to the sweet nectar of the fruit. (Nishida, 1963; Ángel et al., 2011; Nates et al., 2012). In another study in *P. edulis f. edulis, P. quadrangularis L., P. foetida L. and P. edulis f. flavicarpa*,the largest number of fruits formed (set) occurs when the flower styles (gynoecium) were completely curved, allowing greater pollen responsiveness (Kishore et al., 2010).Successful outcome and reproductive capacity are related to the time the flower takes to open and the time until it closes, or the time it can remain open. This depends on the environmental condition of each area that is planted. In some species of Passiflora the opening occurs when sunlight appears, as in *P. foetida*.(Amela and Hoc, 1998b)*, P. edulis f. edulis* (Ángel et al., 2011). The difference in altitude affected the number of visitors and pollinators

3.2.1 Life cycle and phenology

Life cycle
It takes about 18 months to have fruits.

1. Seed

The passion fruit seed does not keep well, but if it is well with the right moisture, temperature and soil then they will be triggered to germinate. Some seeds need more specification to be able to germinate, such as smoke, or being exposed to stomach acid. This main growing tip (the apical meristem, later lateral ones are just meristems) is responsible for all the plant's growth above ground & similar growing tips at the end of the roots are responsible for all growth below ground.(Mifflin, 2012)

2. Seeding

The stem once it has grown up towards the light & leaves unfold like if they were solar panels absorbing the sun & further growing tips split off to produce new stems. As the stems grow upwards, the plant also pushes roots down into the surrounding soil. This helps to stabilize it, and also it provides water & minerals to help all the parts stay above ground. This is 3. non-reproductive vegetative growth, which continues as a priority until the plant matures.(Mifflin, 2012)

3. Photosynthesis

After this process the plant is ready for photosynthesis, what the plate does is absorb light energy from the sun using carbon dioxide & water to produce sugars and other organic molecules. When the sunlight is low, the plant does a respiration process in which sugar is broken down, and which releases water and carbon dioxide to keep the energy production going.

4. Bud

When the plant is already mature, which is the ability to be able to produce ripe fruit, the master gene helps the flowering sequence which helps the plant continue growing while at the same time producing buds. (Mifflin, 2012)

5. Flower

The flower buds then develop into flowers, which are pollinated by pollinators such as bees, moths, butterflies & other insects, bats & hummingbirds.(Mifflin, 2012)

6. Fruit

When the flowers are pollinated, it turns into a fruit as the fertilized ovary swells with the seed inside & the flower crumples. The fruit usually drops to the ground once ripe.(Mifflin, 2012)

7. Seed

Plants can take from one season to many years to go through this cycle. I have mentioned there are 3 of the amount of time they can live, it depends on the plant.(Mifflin, 2012)

8a. Annual

P. gracilis, the Annual Passion Flower, lives for a season or year only; it will complete the whole cycle, and die within the year.(Mifflin, 2012)

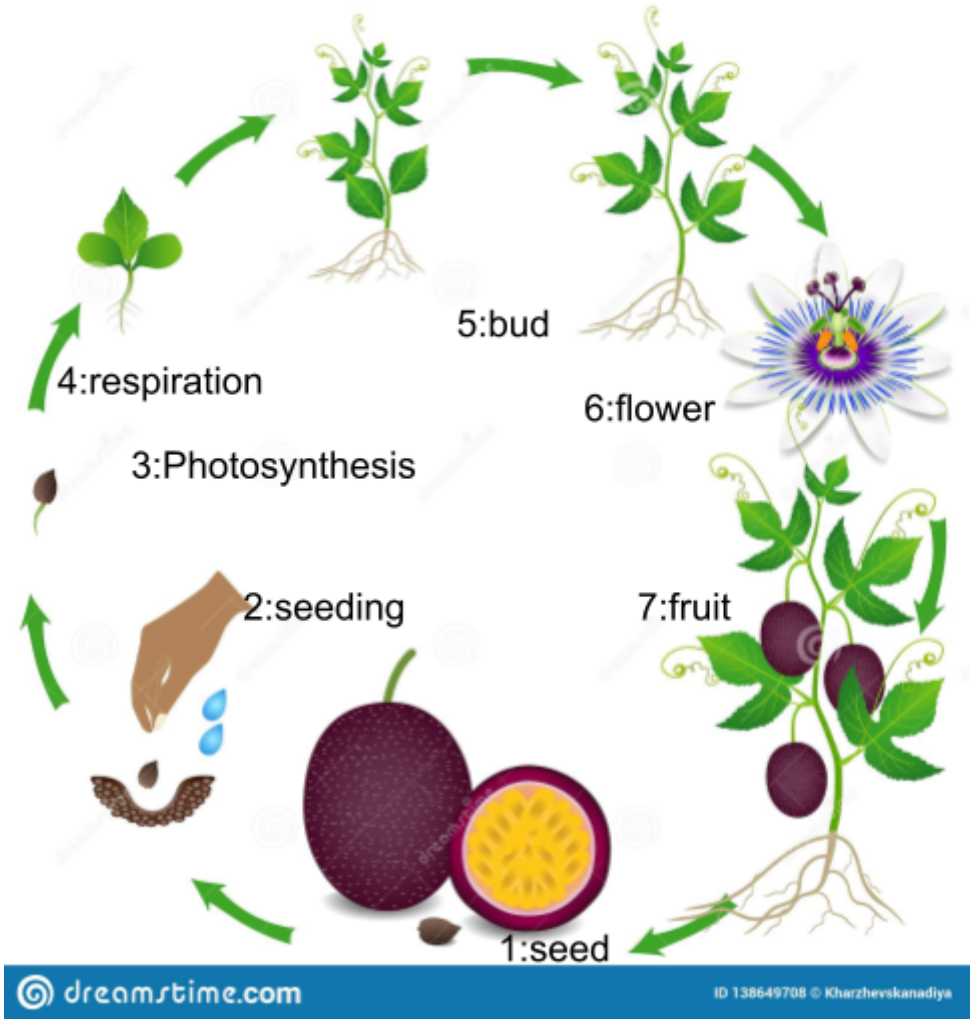
8b. Biennial

There are no passion fruits that follow this process of the biennial, which is that they do the complete cycle, it sets in the winter, and then flowers set fruit, and dies at the end of the second year.(Mifflin, 2012)

8c. Perennial

It may grow, flower, and set fruit in its first year & repeat the pattern for many years after, but equally may take a number of years to grow to flowering size e.g. P. membranacea. Some Passiflora die back each winter & regrow new stems from the roots, plants that can do this are described as herbaceous e.g. P. incarnata. Others as they mature produce more permanent woody stems but still look vine-like, & a very few have become trees e.g. A plant that can live for 3 or more years.(Mifflin, 2012)

Figure 3:



(Nadiia Havryliuk Khorzhevska, 2020)

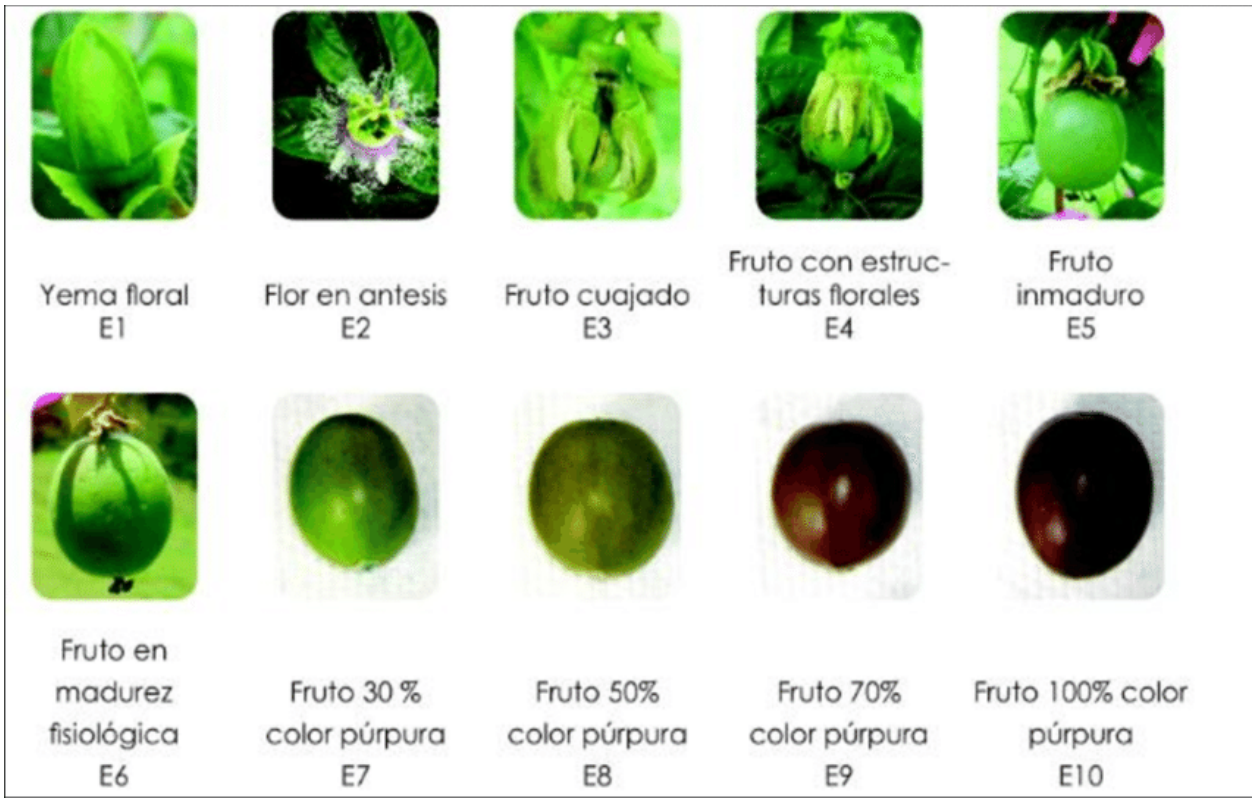
3.2.1 Phenology

DAP(days after planting)

In the principal growth stage 1, we can identify/see the secondary stages corresponding to
The development of the third leaf can be seen on day 6 DAP, along with the appearance of the fifth leaf at 10 DAP, until obtaining nine true leaves on 17 DAP. Afterwards, the development of new leaves continued, and we are likely to distinguish the aspect of the first tendril. During its development, lateral shoots begin to appear in the basal portion, below and over the knot with the first tendril/sprout. A cylindrical stem appear which is finely pubescent(as in puberty), it has a greenish color,in addition they also have striated, herbaceous and woody color towards the base,and it has up to 12 cm in diameter (Ocampo et al.,2015a). At 23 DAP, the main stem reached an average of 37.03 cm. Starting at 30 DAP, the plants increased the growth rate, and at 88 DAP, it reached a maximum length of 455 cm, with a total of 68 nodes, presenting an

emission rate of 2.8 nodes per week and an R2 of 0.91. Schwartz (2013)(one of the scientist who performed the experiments and searching) stated that the phenological stages are good indicators of plant development rates, and, according to Angulo (2003), this behavior can be calculated with the period that lapses from node appearance to the appearance of the next node. The branches can reach up to 30 m in length, with knots and internodes that form a lower bud, two linear, stipulated provisions (orange), a leaf, and a tendril that provide plant support for the plant (Ocampo et al., 2015a). According to the typical behavior of passionflower crops, the growth of lateral shoots is successive, meaning vegetative primary branches. (Ocampo et al., 2020)

Figure 4:



Phenological stages of purple passion fruit (Manual Calendar on Phenology and Physiology of Growth and Development of the Gulupa fruit (Passiflora edulis Sims), National University of Colombia). (Sassine, n.d.)

3.3 Reproductive biology

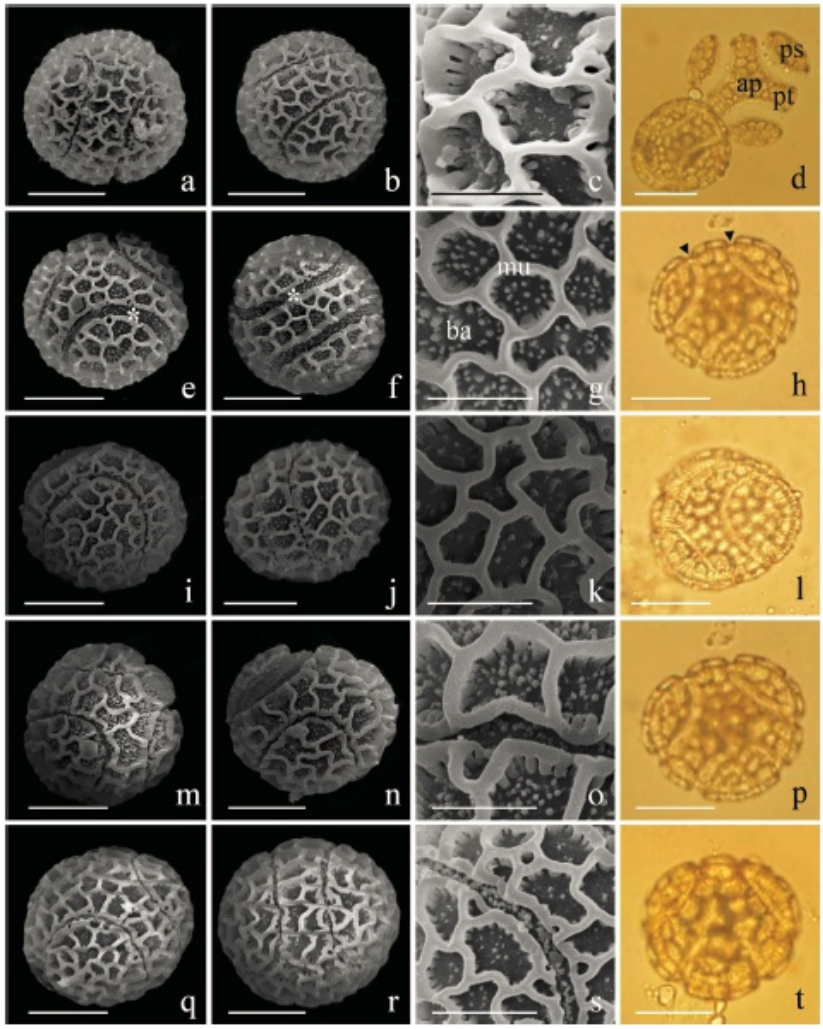
3.3.1 Pollen

Passiflora edulis pollen grains in relation to the type of aperture, they are 6-colporoidate (Presting 1965), 3-zonoporate (Desai & Thorne 1974), Gemini colpate (Spirlet 1965), 6-colpate (Dettke & Santos 2009) and 6-syncopate (Evaldt *et al.* 2011). In passion fruit (P. edulis f. flavicarpa) the pollen viability tests results showed that it can remain feasible for up to 24 hours

after anthesis, with percentages between 50% and 75% (Souza et al., 2004). The morphometric data used for determining the shape and size of the *Passiflora edulis* f. *flavicarpa* and *P. setacea* pollen grains can be seen in figure 5-6. The palynological analysis for the studied Passifloraceae species, through the use of an optical microscope, revealed the presence of large size pollen grains, varying in size from 44.50 µm to 75.00 µm. The pollen grains from the *P. edulis* f. *flavicarpa* and *P. setacea* species are isopolar and oblate spheroidal. (Soares et al., 2013)

Pollen grains:

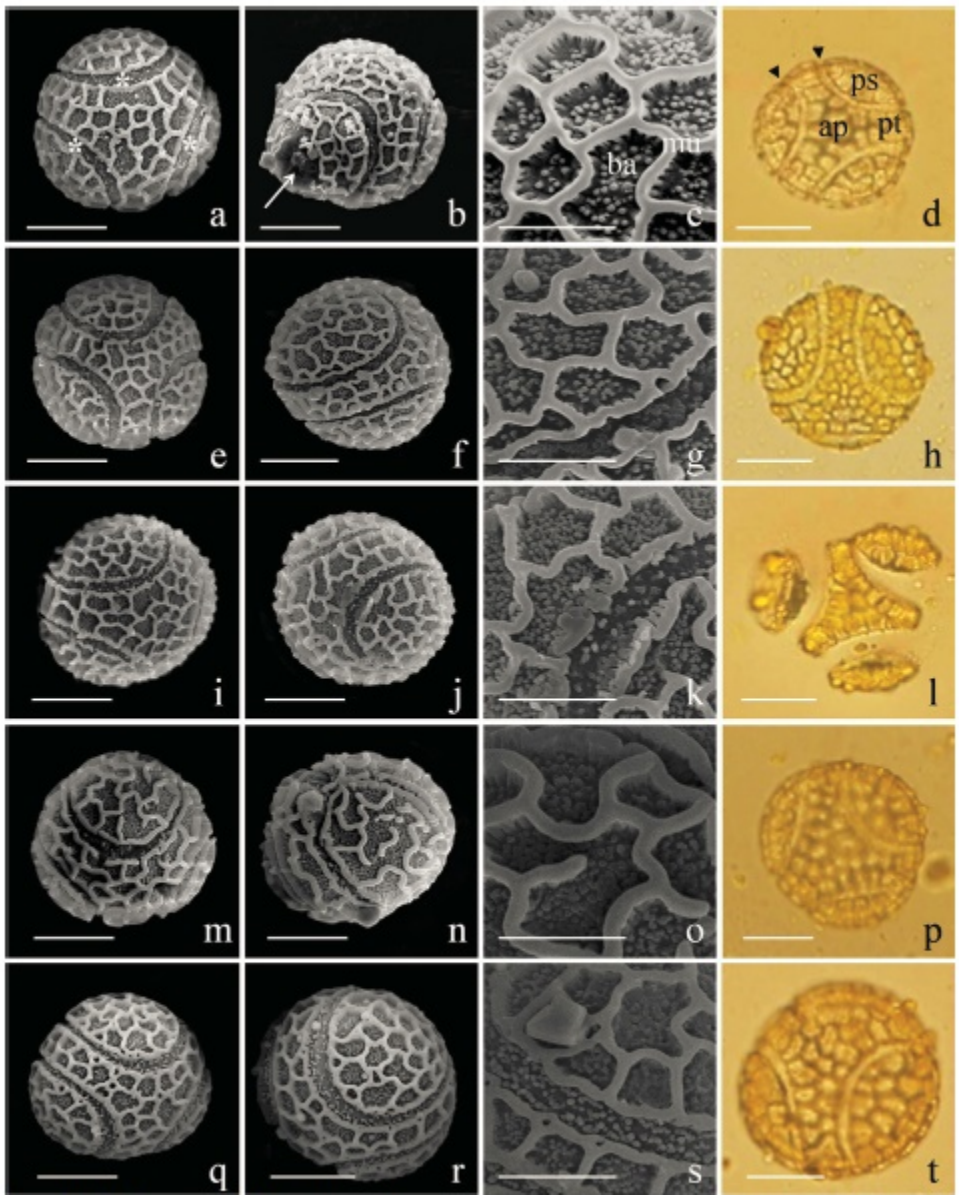
Figure 5:



This figure shows the passion fruit pollen grains in a scanning electron microscope. From i-l we can see a BGP of 330. From e-h we can see a BGP 222. From q-t we can see a BGP of 340. BGP can be seen in a,b,e,f,i,jm,q,r and the SEM overview c,g,k,o,s.

Pollen grains:

Figure 6:



We can see the same as the last figure, but the BGP and the SEM changes. In this one when a see from e-h a BGP of 237. From i-l a BGP 238. From m-p we can see a BGP of 249, from q-t a BGP of 273. And the c,g,k,o,s are the same overview.

3.3.2 Sexuality

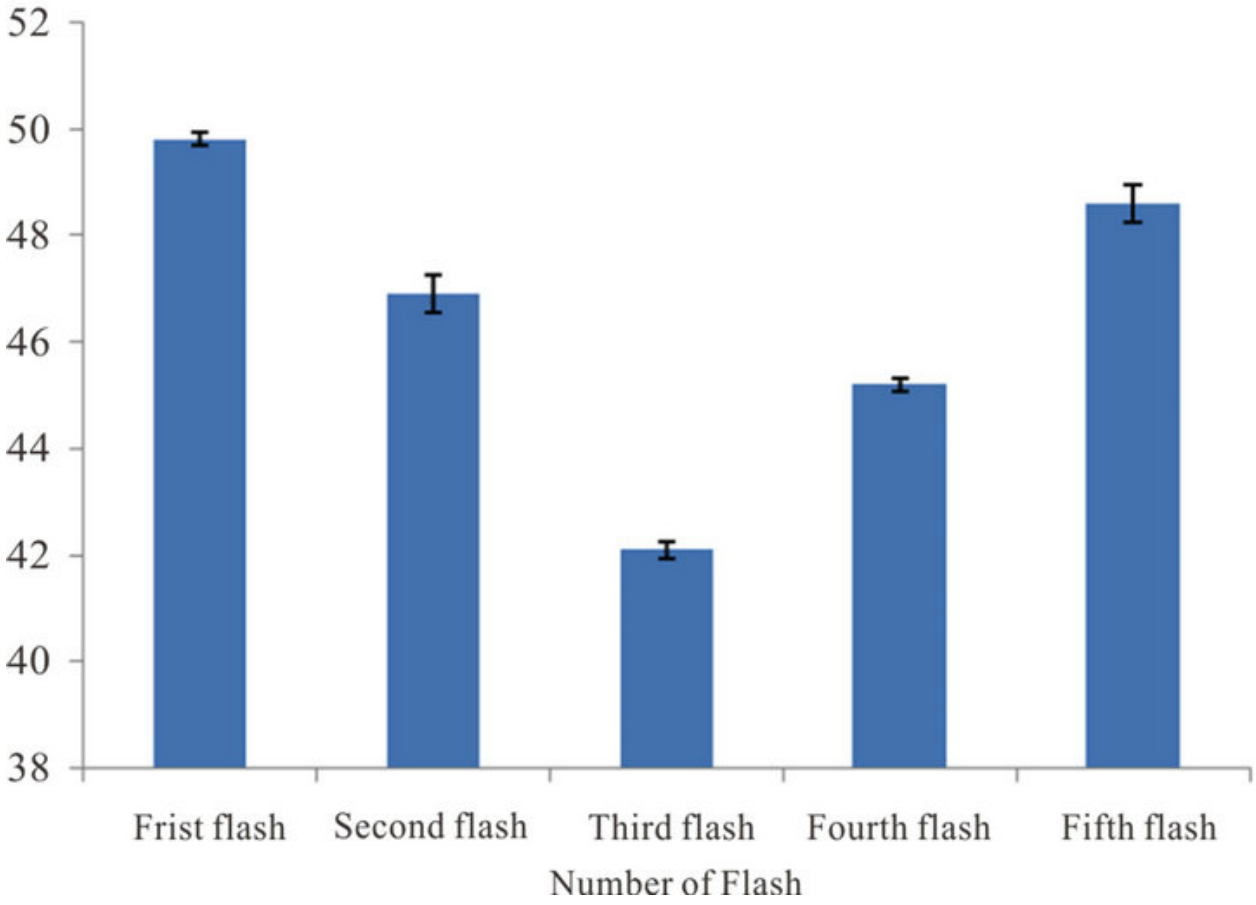
The passion fruit is self-fertile due to the flowers being structured so that the anthers are placed below the stigmas. Plants can be either self-compatible or self-incompatible. The purple passion fruit is mostly self-incompatible; however, selected varieties and hybrids may show signs of

partial self-incompatibility and should not be planted in large blocks of a single variety. On the other hand, the yellow passion fruit is almost entirely self-incompatible and it needs cross-pollination with another cultivar to set seeds and fruit.(Keogh,et al, 2010). Though the passion flowers are hermaphrodite, they are self-sterile and self-incompatible which lead to poor fruit set(Das et al., 2013)

3.3.3 Anthesis

However, in other species such as *P. edulis f. flavicarpa* (passion fruit) anthesis starts after 12:00 hours in most production areas (Souza et al., 2004). Results revealed that plants required minimum days (42 days) from flower anthesis to full maturity during third flash. Days to maturity from anthesis was observed to be enhanced. On the other hand, maturity of fruit was noticed to be delayed during first and fifth flashes of passion fruit. During the third flash, hot and humid weather as well as the longest day-length prevailed that might be the cause of enhancement of fruit maturity. Plants required a minimum period of day from anthesis to full maturity at third flash, compared with other flashes. Plants produced the longest fruit by natural pollination followed by hand pollination during the third flash.(Das et al., 2013)

Figure 7.



Effect of different flashes on days to fruit maturity from anthesis (days) of passion fruit.

3.3.4 Pollination and potential pollinators

The pollen is heavy and sticky; this is why the wind pollination is ineffective, pollen transfer must occur via pollinating insects or manual hand pollination where the amount of pollinators insects are insufficient.(*Passionfruit « Bee Aware*, n.d.) Honey bees and carpenter bees are the principal pollinators of passion fruit; when abundant, the carpenter bee is the most efficient pollinator due to its foraging behavior and larger size. Carpenter bees, which can be found in New South Wales, Queensland, Western Australia, the Northern Territory, and South Australia, have also been found to be much more efficient pollinators of passion fruit overseas in the Philippines and in Sao Paulo. The bad news is that the carpenter bees are not a strong enough population or are non-existent in some areas, which means that they can be extinct and that will be a very bad thing for the passion fruit because it will be a strong pollinator. Honey bees can be established in strong colonies almost anywhere and are still able to pollinate reasonably effectively.(Keogh,et al, 2010) The passion flower usually opens around midday, which is generally the warmest time of day, until the end of the afternoon. During this period pollinators collect nectar, transfer pollen from one flower to another. The effective pollination occurs in the period after the style curves completely

Flashes	Self-pollination		Open-pollination		Hand-pollination		Mean
	L	B	L	B	L	B	L
First	3.19 ± 0.22	3.10 ± 0.29	4.25 ± 0.37	3.20 ± 0.43	3.36 ± 0.27	3.15 ± 0.26	3.60
Second	3.85 ± 0.26	3.12 ± 0.26	5.25 ± 0.34	3.18 ± 0.40	3.95 ± 0.20	3.17 ± 0.21	4.35
Third	4.16 ± 0.26	3.10 ± 0.16	5.91 ± 0.24	3.25 ± 0.46	4.72 ± 0.28	3.16 ± 0.25	4.93
Fourth	4.03 ± 0.35	3.13 ± 0.29	5.37 ± 0.30	3.16 ± 0.35	4.39 ± 0.30	3.20 ± 0.25	4.60
Fifth	3.79 ± 0.33	3.11 ± 0.31	4.76 ± 0.40	3.16 ± .46	3.80 ± 0.30	3.15 ± 0.30	4.12
Mean	3.80	3.11	5.11	3.19	4.04	3.17	4.32

Table 1. Effect of pollination methods on fruits length and diameter of passion fruit at different flashes on maturity (cm).

Flashes	Fruit set %	Fruit per plant	Fresh weight of individual fruit (g)
First flash	15.38 b	8b	21b
Second flash	18.66 ab	25a	31a
Third flash	20.00 a	28a	34a
Fourth flash	17.24 ab	25a	32a
Fifth flash	7.41 c	2c	23b

Mean followed by same letter in the column are statistically similar

Table 2. Yield of passion fruit per plant by natural pollination.

3.3.5 Fruit development and seed set

Fruit setting behavior is an important criterion for plant breeders in the process of development of a variety. The development of variety has been associated with yield and fruit quality. (Rokaya et al., 2016). The agro-ecological conditions mainly of hill tract regions of Bangladesh are amiable for passion fruit cultivation. (Das et al., 2013). Passion fruits in Bangladesh are grown popularly in home gardens for its lucrative color of flower and flavor and tasty yellow juice. Though the fruit setting behavior of passion fruit has been studied in detail in other countries, very little work has been done in Bangladesh [16,17](Fu et al., 2014). Due to above-mentioned natural constraints, pollination and fruit set of passion fruit is hampered. Considering the above facts, the present study was undertaken to find a suitable pollination method for successful fruit setting

3.3.5.1 Ovule Development

Passion fruit can develop as many as 350 seeds and unless at least 100 ovules develop into seeds then the fruit is likely to be hollow, light in weight, and have little juice. (Keogh,et al 9 Aug 2010).

3.4.1 Ecophysiology

3.4.1.1 Germination

Determination of pollen viability can occur through the use of direct methods such as the inducement of *in vitro* germination (Acar & Kakani 2010; Alcaraz *et al.* 2011; Sorkheh *et al.* 2011). This in vitro germination is the process of embryo of a seed in a lab, this is providing a favorable condition for the growth and living of the seed. However, *in vitro* germination of pollen method is used less for viability testing and for genetic breeding programs (Satish & Ravikumar 2010) I*n vivo* germination (Fakhim *et al.* 2011) or other, indirect methods based on cytological parameters, such as pollen staining (Beyhan & Serdar 2008; Abdelgadir *et al.* 2012).

4.0 PROPAGATION AND MANAGEMENT.

4.1 Natural Regeneration

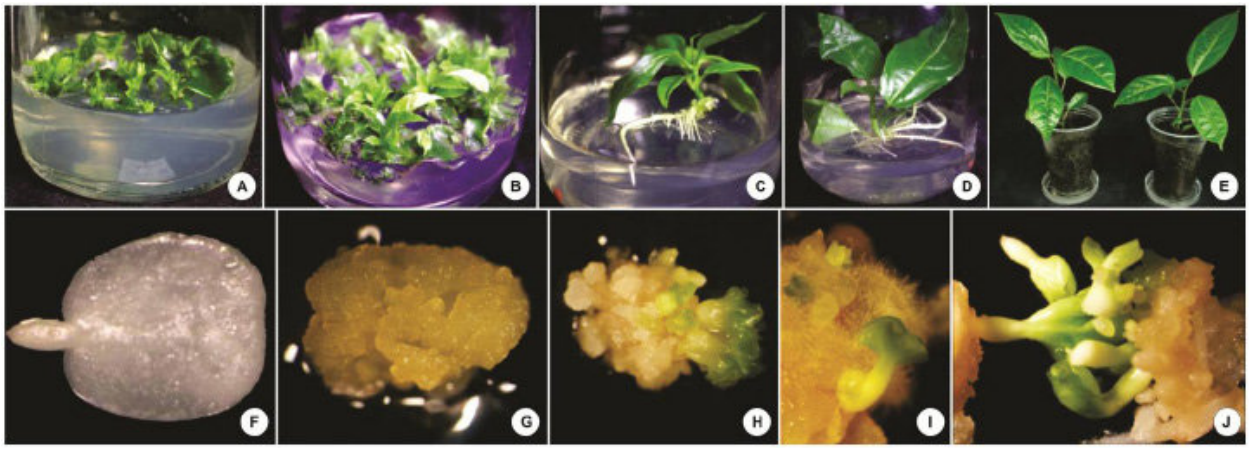
Passion fruit can have asexual reproduction and sexual reproduction, both of these are necessary and used many times.

In the case of sexual reproduction, several species of Passiflora present problems with seed germination. Aspects related to dormancy, genetic and physiological quality of the seeds directly influence graft quality to be used in the production system. As for asexual reproduction, the key factors include the genetic and physiologic quality of parent plants, different reproduction methods, types of substrates, and treatment with vegetable regulators to improve rooting and success in graft production.

4.2.1 Asexual:

The main advantage of this method is the possibility of cloning mother plants so that we can take out the best parts of the plant and make better passion fruit. When you have to consider facts about the plant such as sourness, sweetness, and other wild spices of passion fruit. And also when considering the clonal selection of plants with higher productivity, bigger fruits, and higher resistance to diseases selected to produce seedlings, asexual propagation might suggest significant gains in productivity and higher orchard uniformity (JUNQUEIRA et al., 2006). However, most of the passion fruits species show self-incompatibility so to establish an orchard via asexual propagation, it is necessary to use propagation materials from different plants to allow a cross-fecundation and therefore the set of owner and fruit production. (Faleiro et al., 2019)

Figure 8:



Tissue cultures in Passiflora edulis through adventitious organogenesis (A-E) by using cotyledonary explants and in Passiflora cincinnata through somatic embryogenesis (F-J) from zygotic embryos.(Faleiro, 2019)

4.2.2 Sexual:

The several advantages of this method include a simple seedling production process, shorter formation time, less demand for labor and infrastructure in the orchard, simpler logistics concerning seeds commercialization and transportation, and the possibility to produce seedlings free from phytoestrogens that are not transmitted by seeds, mainly the virus that cause serious problems for passion fruit growers. Another important point for the process of obtaining plants from seeds is the guarantee that it will produce plants genetically distinct in the orchard, avoiding issues like a low set of power and fruits and pulp production. (Faleiro et al., 2019)

4.2 Nursery Propagation

You can use a seed of passion fruit to grow another passion fruit. The steps are easy.

1. Choose your seed

Choose a ripe passion fruit with a slightly crinkled rind from the grocery store, halve it, and extract its seeds. The riper your passion fruit, the more likely the seeds are to germinate. Wash any fruit pulp from your seed and dry them with a paper towel. (MasterClass Staff, 2022)

2. Prepare your seed

When your seed is roughly 4 meters high then repot your seed in a larger pot, dig but be careful with the roots, you have to water it immediately. After roughly six weeks, your passion fruit plant should have a good central vine—about eight inches in height—and will be ready to plant in the garden against a trellis. Prepare your seeds. To improve the chances that your seeds will

sprout, rub them between a sheet of sandpaper and soak overnight for 12 hours. (Masterclass Staff, 2022)

3. Germinate your seeds.

To start the germination process, bury your seed in a container filled with a small amount of soil or seed-raising mix about an inch deep. Sow your seed just below the surface and water it to keep the soil moist. You can also use seaweed solution to get help your seeds sprout more quickly(Masterclass Staff, 2022)

4. Water your seeds.

Water your seed regularly to keep the soil moist, but do not saturate it. (Masterclass Staff, 2022)

5. Wait until the seed sprouts.

Regularly water your seed until it sprouts. Some seeds germinate within two to three weeks, and some as long as four. Other seeds will take up to four months to sprout, so be patient.(Masterclass Staff, 2022)

6. Re-pot your seedling.

When your seedling is roughly 4 inches high, re-pot your plant in a larger pot, around 6-8 inches in diameter. Gently dig the seedling free, taking care to protect the root system, and place in a fresh potting mix in the larger pot, watering immediately. Provide your plant with a climbing support, so its vines can begin to grow. After roughly six weeks, your passion fruit plant should have a good central vine—about eight inches in height—and will be ready to plant in the garden against a trellis.(Masterclass Staff, 2022)

7. Prepare your soil.

Enrich your soil by combining it with fertilizer or mulch, and test the pH to make sure that it is between 6.5 and 7.5. Loosen the soil to make sure that it is draining properly.(Masterclass Staff, 2022)

8. Plant your vine.

Dig a large hole in your garden that is rough, twice the size of the plant's root ball. Remove the vine from its original container, taking care to protect the root system. Bury the roots with fresh potting mix and fertilizer and water immediately.(Masterclass Staff, 2022)

9. Care for your plant.

Your passion fruit plant can take 18 months to 2 years to fruit and flower, and your plant will require regular maintenance. Water your plant regularly, taking care to keep the soil loose and well-draining to prevent root rot. Prune any tendrils that are wilting. (Masterclass Staff, 2022)

10. Harvest your fruit

Harvest your fruit. Once your passion fruit vine begins to flower and fruit, leave the fruit to fully ripen so that the color becomes vibrant, and the rind starts to wrinkle. At that point, you can either pick the fruit or let it fall to the ground. It is now ready to eat. (Masterclass Staff, 2022)

4.2.1 Vegetative Propagation

The vegetation propagation has been developed for cutting in the passion fruit industry, this helps in the obtainment of a uniform orchard with superior clones (RUGGIERO; MARTINS, 1987; MATSUMOTO; SÃO JOSÉ, 1989). In the cutting process, the use of a part of the branch with three to four buds is recommended (TORRES et al., 1975). The best cutting time is the beginning of the spring (RUGGIERO; MARTINS, 1987). In the cutting process, the use of an intermediary part of the branch with three to four buds is recommended (TORRES et al., 1975). The best cutting time is the beginning of the shooting spring (RUGGIERO; MARTINS, 1987). This research aimed to study the potential of propagation of Passiflora actinia by semi-hardwood cuttings and the effect of IBA (indolebutyric acid) and ethanol in this process. The vegetative propagation of P. actinia can be accomplished by semi-hardwood cuttings with two leaves without using IBA or ethanol. (Koch et al., 2004)

4.3 Planting

The best time to plant passion fruit is in spring. You have to prepare the soil first, by incorporating compost and chicken manure to an area around one to two meters wide. A hole is twice as wide and deep. Put sugarcane, bark chips, or pea straw around the base. They require regular watering, especially when it is young and why it is flowering and fruiting. (Williamson, 2021)

4.4 Management

When it comes to passion fruit management, it is different for yellow and purple passion fruit.
It starts with grafting purple passion fruit scion onto yellow passion. This step is crucial because purple passion fruit varieties happen to be highly susceptible to a fungal disease known as fusarium wilt. This process helps the plant become (Mogeni, 2018):

- Hardy,
- Drought tolerant,
- Vigorous,
- Resistant to fusarium wilt,
- And highly productive

This is because the good traits of the yellow passion fruit are passed to the purple passion fruit.

Routine management of a passion fruit farm comprises the following practices(Mogeni, 2018):

- Trellising the passion vine
- Maintaining Soil fertility
- Managing Pests
- Keeping the orchard clean
- Regular watering
- Managing Nutrient deficiencies
- Passion fruit fertilizer requirements.

How To Manage the Passion Plant During the Vegetative Stage.

In this phase, the plant multiplies, producing side shoots and vines in preparation for flowering and fruiting. At this stage, horticulture experts discourage the use of fertilizers rich in nitrogen. Trellising is vital to managing passion fruit To maximize passion fruit production; you ensure that you have one main stem that provides three main branches. You will also need to apply hormones at 5-6 months to stimulate flowering. (Mogeni, 2018)

How To Manage Passion Plant During the Flowering Stage

The flowering stage is the most sensitive stage in a passion fruit plant. Any water and nutrient deficiencies will lead to flower abortion and eventual low yields. Likewise, any pest attack will lead to reduced production. At this stage, you will need to apply high levels of potassium fertilizer and micronutrient fertilizers. You will also continue to use appropriate fungicides and insecticides to prevent damage to flowers. The plant will need regular watering.(Mogeni, 2018)

Managing Passion Fruit During The Fruiting Stage

The plant will need regular watering and pest management. You will also need to protect your maturing fruits from animals like monkeys, birds, squirrels, and people who are likely to pick your mature fruits and lead to losses.(Mogeni, 2018)

4.4.1 Tending.

The tending of the yellow passion fruit is:(Mogeni, 2018)

1. Germinate the seed in a nursery, then transplant in polythene tubs or trays filled with soil.
2. Let the seedling grow until they reach a height of 15-20 cm
3. Transplant the 15-20 cm long seedlings to the open field.
4. Maintain them until they reach maturity.
5. Once they start flowering, you supply them with the right nutrients so that the passion fruits don't abort flowers.
6. Once the fruits form, give the plants the right nutrients so that the fruits become big, juicy, and VERY sweet.
7. As you do all the above steps, you ensure the plants are irrigated regularly. Protected from pests and diseases. Given sufficient nutrients in the form of manure and fertilizer.

It is totally different from the purple passion fruit.

Chapter 5: Market and Uses

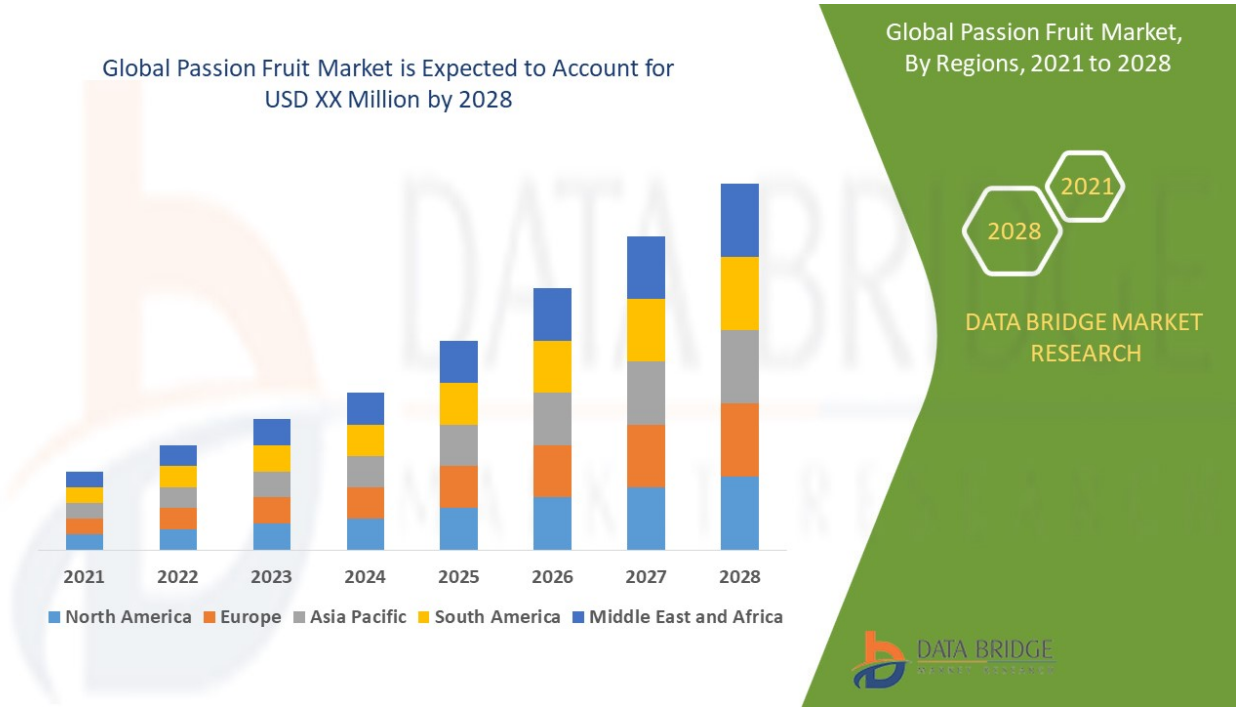
5.1 Markets

The global passion fruit market was valued at a price of $464.57 million in 2019. It is expected to reach $668.83 million by 2027. The market is segmented into North America, Asian Pacific, South America, the Middle East, and Africa. Europe is the one that holds the most passion fruit in the world, followed by South America and North America. Due to the competition among the key players in exports, the markets had grown. The rising demand for organic passion fruit has also helped the market growth. But during the pandemic, the markets had decreased because people had started buying canned food instead of fresh food. (ReportLinker, 2020)

In Colombia, the exports of passion fruit can reach a profit of $39.000.000 per hectare, during the three production years, and the price of coal is $4.200 per quality kilo. Not everything is easy for the farmers that plant passion fruit, due to a good deal of sickness that the passion fruit has, due to this the cropping areas have decreased, and the export demand is greater than the current offer. In 2017, according to the Agricultural-Livestock Sector Strategic Communication and Information Network (Agronet, for its Spanish acronym) data, the Province of Cundinamarca cropping areas were reduced by 86% due to the high incidence of Fusarium sp., which produces chlorosis, leaf wilting, fruit neck rotting and viruses such as scab disease, which produces wart-like lesions on fruits or oil-spot disease, whose effect is greater in the rainy season and especially impacts leaves.(Plazas, 2020)

“Farmers were enduring the consequences of the lack of genetic diversity of gulupa in Colombia, as far back during the nineties when they started to grow this crop, they carried it out in very few greenhouses producing very similar or homogenous crops which were then selected due to fruit yield and quality, narrowing the genetic base even more”, explained Universidad Nacional de Colombia (UNal) Sciences-Biology Ph.D., Nora Rodríguez Castillo.(Plazas, 2020)

Figure 9:



(*Passion Fruit Market – Global Industry Trends and Forecast to 2028 | Data Bridge Market Research*, n.d.)

This shows the increase of the passion fruit market by 2028 in USD millions.

Seasonal Availability

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
California	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	
Florida	☑	☑			☑	☑	☑	☑				☑
Hawaii	☑					☑	☑	☑	☑	☑	☑	☑
Australia	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Brazil	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Colombia	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
India			☑	☑	☑			☑	☑	☑	☑	☑
Peru	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
South Africa	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

References: Agricultural Research Council South Africa, Australian Passion Fruit, California Grown, Purdue University College of Agriculture, University of Florida/IFAS Extension, University of Hawaii Cooperative Extension.

("Passion Fruit – Produce Blue Book," n.d.)

Figure 10:This shows the moths that in each part of the world they are available in.

5.2 Uses

5.2.1 Edible use

It's low in calories and high in nutrients, fiber, and antioxidants. The edible uses of passion fruit can vary depending on where it is eaten. You can eat the pulp, and the seed of the passion fruit. You can use the pulp of the passion fruit to make juice, first you have to pass the pulp through a fine strainer or cheesecloth. Furthermore, you can also make nectar, this is made with the entire passion fruit, not only the pulp. A passion fruit coulis(purée) can also be made with passion fruit, to do this you have to do passion fruit nectar but without the rind. Mix the pulp with sugar for five minutes and strain the mix, you all do this while boiling. You can also do passion fruit purée. In addition to boiling passion fruit pulp, lemon, and sugar, you'll need to boil the outer shells and purée their inner flesh(Passion Fruit, 2019). You can make cakes, sorbets, smoothies, margaritas, popsicles and much more.

5.2.1 Medical uses

Passion fruit can reduce cardiovascular rsikssusch as systolic blood pressure, fasting blood glucose in people with 2 types of diabetes. Purple passion fruit may be an effective alternative treatment for adults with asthma.(Passion Fruit, 2019) passion fruit is filled with vitamin C, which lowers your chance of getting colds and certain types of cancer. Vitamin A is in the passion fruit pulp and the seeds, it has 8% of the vitamin you need every day, and it is good for your eyes, cell reproduction, and immunity. (Bonvissuto, 2020)Fiber and nutrients are also present in passion fruit. Fiber helps you keep full longer, lower your cholesterol, and your risk of diabetes, heart diseases, and certain types of cancer. Nutrients give calcium, magnesium, phosphorus, potassium, and folate. Kidneys, nerves, muscles, and heart rhythm are helped in a big ways.(Bonvissuto, 2020)

You can not eat passion fruit if you are allergic to latex. "Passion fruit pulp also contains a toxin called cyanogenic glycoside. This chemical can cause cyanide poisoning in high amounts. It's highest in very young, unripe fruits. Once the fruit is ripe, it's safe to eat."(Bonvissuto, 2020)

5.3 Other uses

Passion fruit can also be used for skin and hair. The vitamins that are has been great for anti-agingThe antioxidants mixed with riboflavin and carotene can help the skin retain moisture and improve your blood flow, this helps you look younger to prevent aging and wrinkles, the vitamin B2 and Vitamin B6 can help you with the circulation of your scalp and this help have a healthier hair. ("Skin Care Benefits of Passion Fruit," 2018)

It is a rich source of antioxidants like vitamin A, vitamin C, Vitamin B2 and Vitamin 6 and also a number of minerals like copper and potassium. These nutrients altogether support the growth of healthy and lustrous hair. (“Skin Care Benefits of Passion Fruit,” 2018)

How To Use:

Passion fruit contains vitamin A which encourages healthy skin cell production and keeps the skin firm and healthy. Protects against sun damage by lessening the skin’s sensitivity to the sun. Strengthens the skin barrier to protect against bacteria, pollutants and infection. Stimulates collagen production, reduces the appearance of fine lines and wrinkles.When it comes to acne, it unclogs pores, reduces inflammation and increases skin cell exfoliation.(“Skin Care Benefits of Passion Fruit,” 2018)

Passion fruit can help reduce stress, anxiety, as well as insomnia.
Pregnancy is helped by eating passion fruit.Growth and development of the fetus. Bone development of the baby keeps them healthy. It helps the mother's joint pain(Saanvi, 2019).

Passion fruit side effects
Passion fruit can have sedative effects and it can not be beneficial if it is combined with other drugs. When mixed with alcohol it can reduce your reflex action. Do not take aspirin because it can increase the effect of the drug. (Saanvi, 2019)

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