Fragaria Vesca L.

Agricultural Science Monograph

Manuela Ramirez

Dr Wojciech Waliszewski

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Chapter 1: Importance

Fragaria vesca L. is one of the various types of strawberries of the genus *Fragaria.* It grows in high latitudes and it's importance comes from the benefits of both the fruit and its leaves. Additionally, since it grows in rural areas it serves as food for animals that live around. This monograph presents the different aspects of this fruit, from its composition to it's production. The Ecology chapter talks about how it originated in Europe during the 1300s, alongside with the distribution, geology and fossil record. Chapter 3 presents the fruit’s biology, component, and productivity. Chapter 4 talks about seed propagation and how the Fragaria can be planted. In addition it presents the different pests and diseases. The different types include fungal, bacterial, and insect pests. Lastly, Chapter 5 includes a table with the overall information of the production of the strawberry and it's uses which can be medicinal or edible.

Chapter 2 Ecology of *Fragaria Vesca* L.

2. Ecology

Fragaria vesca L. is commonly known as the woodland strawberry. It is part of the genus Fragaria (Figure 1, below) (ITIS report 2019), which consists of 4 other species, *Fragaria x ananassa, Fragaria x bringhurstii, Fragaria x chiloensis, Fragaria x virginiana* (ITIS report 2019) and belongs to the Rosaceae family (Darrow 1966). They are octoploids, meaning they have eight times more chromosomes than the normal haploid. The*y are derived from the F. chiloensis and F. Virginia which are typically known for as being the F. x ananassa.*

2.1: Affinity

Kingdom: Eukaryota

División: Plantae

Class: Dicotyledonae

Order: Rosales

Family: Rosaceae

Genus: *Fragaria*

Species: *vesca*

Figure 1. Taxonomy of Fragaria vesca L.
(ITIS report 2019)

Direct children:

Table 1:

Fragaria x ananassa
Fragaria x bringhurstii
Fragaria x chiloensis
Fragaria x vesca L.
Fragaria x virginiana

(ITIS report 2019)

2.2: Fossil Record

The *Fragaria* genus have "last shared a common ancestor between 1.0 and 4.1 million years ago" and these are the only evidence of any fossil record found in relation to *Fragaria* (Matthews and Ovenden, 1990; Töpel et al., 2012). However, there was a discovery of a single achene, (Figure 2, below) this discovery was collected from Prince Patrick Island in Canada, however, the specimen is "not currently discoverable" (M. Coyne, Canada Centre for Mapping and Earth Observation, Ottawa, ON, personal communication).

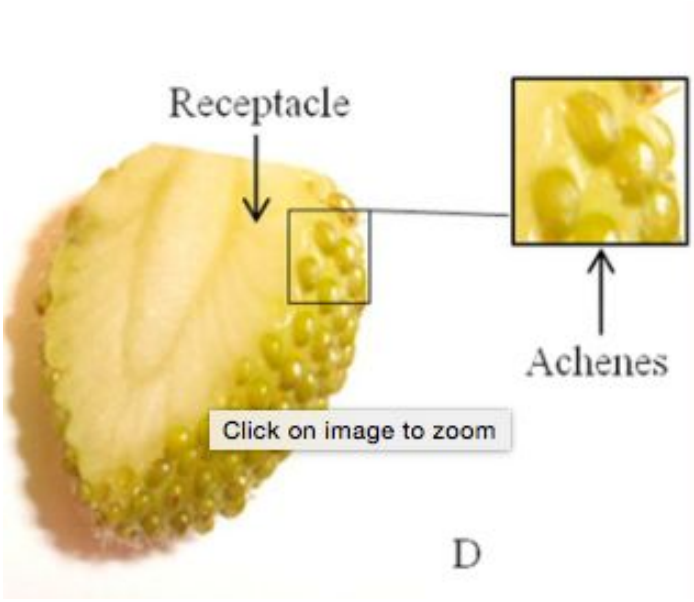

Figure 2. Achene: The seeds that surround the strawberry's skin
(Härtl, K., Denton, A., Franz-Oberdorf, K., Hoffmann, T., Spornraft, M., Usadel, B., & Schwab, W.,2017).

2.3 Origins

Fragaria vesca is a perennial clonal plant that originated during the roman and greek eras, however, this is not completely confirmed since *F. vesca* was not part of the important agricultural goods. *Fragaria vesca* started being cultivated in the 1300s in Europe specifically in France, where it was mostly cultivated for the flower it gave rather than the actual fruit because of its beauty (Darrow 1966). The royals started planting them in their own gardens due to the high admiration they had for them. In the 1500s the plant started being recognized as one of the main ones for garden planting, the *F. vesca* had been transplanted from the woods to the garden (Darrow 1966).

Figure 3

Figure 4

-Figure 3: The flower the plant produces which was highly appreciated by royalty in the 1300s. (Candide, 2019)
- Figure 4: Woodland strawberries planted in a garden (Candide, 2019)

2.4 Present distribution

Fragaria vesca is located in the eastern north hemisphere in different forests of high altitudes. Of all the species from the genus, the *F. vesca* is the most common worldwide, present in Europe, North America, North Africa, and Asia (Figure 7). As we can see these are northern locations which mean they need to be cultivated in northern areas which are colder. However, they are still

present in Southern latitudes like, Mexico, South America, Australia, New Zealand and South Africa (Figure 5 and 6) in some mountains due to their high elevation (Darrow 1966).

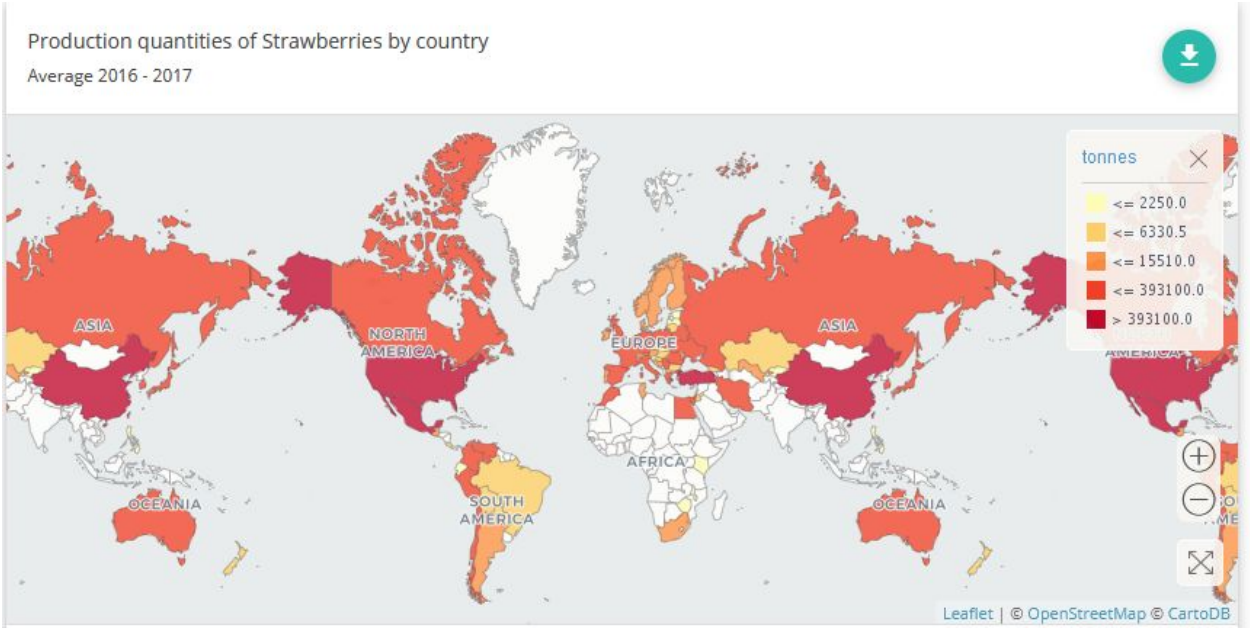

Figure 5: As seen they are also cultivated in regions of Asia, Australia, and New Zealand with their respective tonnes

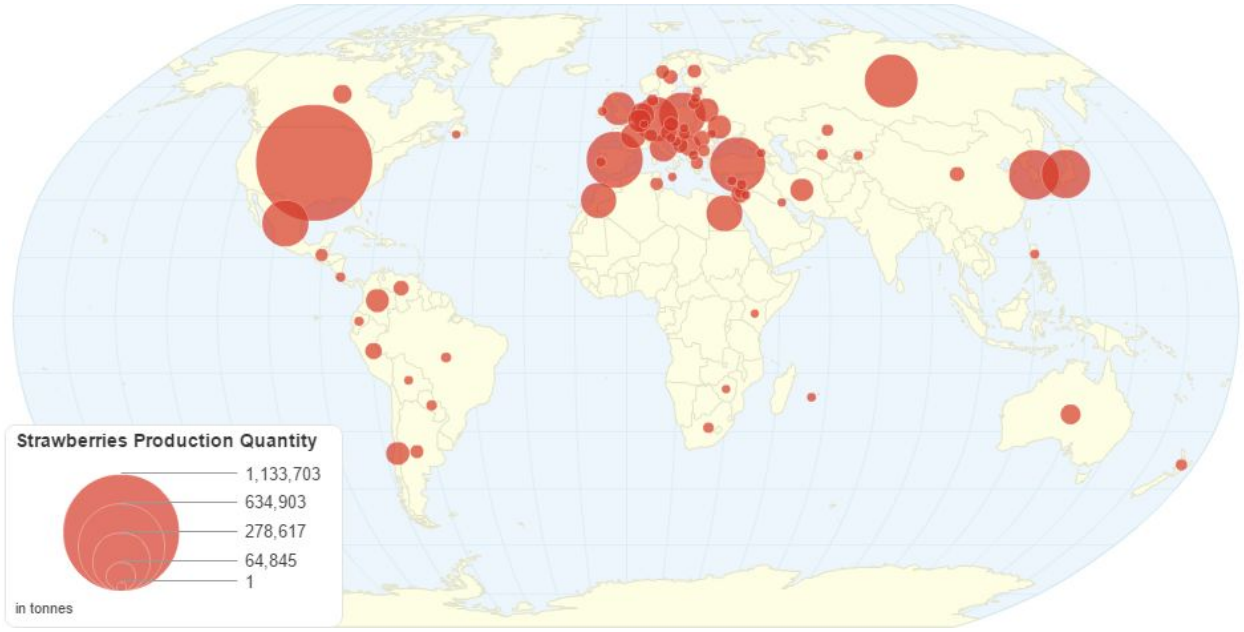

Figure 6: As seen they are also cultivated in southern latitudes ChartsBin.(10, January 2020). Strawberry production quantity by country<http://chartsbin.com/view/43720>.

Figure 7: As seen in figure 5, *Vesca* is mostly cultivated in the northern hemisphere (Hilmarsson et al., 2017)

2.5 Elevation & Climate

Usually planted in hardwood forests, woodlands, cedar swamps, swamps, and damp ledges (Darrow 1966) it grows in temperate regions worldwide, usually at high altitudes, as seen in Table 2. The temperature has to be from about 15°C to 22°C . Strawberries can also be grown in semi-tropical places, some of which include Japan, Colombia, India, and Australia which have a hard climate. Due to their genetic variability, they are able to adapt themselves to its environment and the most important factors for their growth are the temperature and daily light period. Furthermore, high permanent light intensity is essential for the growth of the plant, northern varieties usually grow little during the winter meaning they need good light to grow (Darrow 1966). In Figure 4 we can observe the elevation they are grown in at different parts of North America (Munger 2006).

Table 2: Chart of elevation where woodland strawberry is raised in western North America (Munger, 2006)

Location	Elevation (feet)	Elevation (meters)
East-central and southeastern Arizona	7,000 to 9,500	2,100-2,900
Southeastern Arizona	>9,200	2,800
Southern Arizona	7,900 to 8,000	2,400
California	100 to 6,500	30-2,000
Sierra Nevada Range, California	<6,000	1,800
Colorado	5,000 to 9,500	1,500-2,900
Near Crested Butte, Colorado	8,500 to 12,500	2,600-3,800
West-central Idaho	5,000 to 7,800	1,500-2,400
New Mexico	6,500 to 10,000	2,000-3,000
Utah	6,000 to 10,500	1,800-3,200
Uinta Basin, Utah	7,000 to 10,500	2,100-3,200
Cascade and Olympic Mountains, Washington	up to 4,000	1,200
Northwestern Wyoming	7,900	2,400
Intermountain West	5,900 to 7,900	1800-2400
Yellowstone National Park	6,000 to 7,600	1,800-2,300
Baja California	"higher foothills to about" 8,200	2,500

2.6: Soil & Geology

Fragaria Vesca is very receptive to what soil they ate to grow in. In an experiment, it was found that "from 6 different types of soils, the *Fragaria Vesca* prefers to grow in the soils that were of higher quality" (Waters & Watson, 2015) This means they know which soil nutrients are the best to grow in, however, they are easily adapted to other environments like patchy ones due to the large stolons they have. The type of soil they mostly grow at is clay, loam or sand and the soil moisture must be moist (Candide, 2019).

-Figure 6: Vesca, planted in their natural habitat (Candide, 2019)

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Chapter 3 Biology of *Fragaria vesca L.*

3. Biology

3.1 Chromosome Complement

The Fragaria genus in its most basic form has a chromosome number of " (x=7), and four main fertility groups are recognized: the diploids (2n=2x=14) which include the model species for the genus, *F. vesca*; the tetraploids (2n=4x=28)". More specifically, the *F. Vesca* is a "Diploid (2n=2x=14)" (Shulaev et al., 2011). According to Yarnell, in Genetic and Cytological Studies on Fragaria, there are different diploids depending on the type of *F.vesca* and its varieties, bracteata, californica, americana, rosea, and mexicana (Yarnell, 1931). Through the breeding of *F. vesca* and other species triploids, pentaploids, hexaploids, heptaploids, octaploids and decaploids have been able to be produced (Darrow 1966).

3.2 Life Cycles & Phenology

Fragaria vesca has a short reproductive cycle of about 14-15 weeks (Shulaev et al, 2011). They have a very long flowering period of 2-3 weeks which has allowed botanists to examine them more. When they grow, they form a cluster of a lot of fruit. Over time the plant loses strength due to the large amount of fruit and flowers produced (Shulaev et al., 2011).

3.2.1 Flower Production

The flower production occurs in a short seed to seed cycle where white small parted flowers are formed. They are about 1.25cm to 2.00cm and are organized into small clusters. The flowers that are cultivated in wild areas are much smaller, being 1 to 2 cm, and the color is more reddish. (Shulaev et al., 2011). The plant is spread through stolons (Figure 4) and each of them has about five to eleven flowers that are placed above the leaves in rosette form (Munger 2006). Stolons

which are also called runners, are the strings that come from the roots to spread the plant (Stolon | Definition of Stolon by Lexico, n.d.).

Figure 1: Vesca flowers, white color and small size (*Amazon.com: Alpine Strawberry Baron Solemacher seeds—Fragaria vesca: Garden & Outdoor*, n.d.)

3.2.2 Fruit Development

Due to its large geographical expansion it is evident that *F. Vesca* is able to adapt to different environments and conditions which allows them to expand widely (Heide and Sonstenby, 2007). The fruit has a yellow or red color, is highly aromatic and is hemispherical with pulpy flesh (Darrow 1966). It has a short seed to fruit period of 3-5 months (Shulze et al., 2012).

Figure 2: Fragaria vesca in its final stage, the red colored fruits are the ones ready for collecting (*Amazon.com: Alpine Strawberry Baron Solemacher seeds—Fragaria vesca: Garden & Outdoor*, n.d.)

3.3 Productivity and Biology

3.3.1 Pollination

The *F. vesca* flowers are insect-pollinated and 160 seeds are produced per fruit which are later distributed by animals (Shulze et al., 2012). The flower structure opens itself to have unrestricted access to nectaries and pollen (Ostler, & Harper, 1978). Although the flowers are also self pollinated, pollinators are also needed. These are animals like bees, that pollinate the flowers which helps with the growth and development of the fruit.

Figure 3: Vesca flowers, white color and small size (*Wild strawberries Seeds (Fragaria vesca)*, n.d.)

3.3.2 Sexuality and Reproduction

Fragaria vesca has a clonal reproduction that forms through the nodes that grow on the runners (see Figure 4 below). This reproduction takes place after flowering between summer and autumn. The clones that are connected, could potentially receive resources from the main parental plant, this connection can maintain for even months. This connection allows for the plant to maintain strongly in heterogeneous environments (Shulze et al., 2012). The plant has a breeding system that is self compatible meaning the reproduction becomes easier (Hancock 1999).

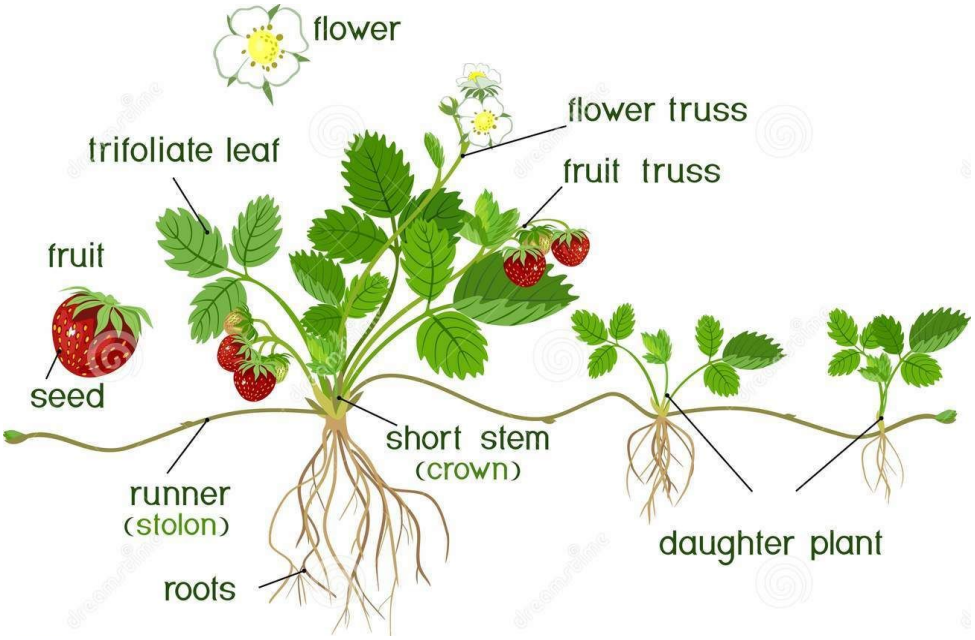

Figure 4: These are the different stolons/stems from where the plant spreads and reproduces itself (*Morphology Of Garden Strawberry Plant Stock Vector - Illustration of flower, white*, n.d.)

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Chapter 4 Propagation & Management

4.1 Propagation

The propagation works first with the seed going through a germination process, this happens because it is harder to plant a strawberry plant from the seed than from the runners themselves. So in this process the seeds should be placed in a freezer for 2-4 weeks. After this they can be placed in the soil and start germination (*Strawberry | Diseases and Pests, Description, Uses, Propagation*, n.d.).

The runners which are the stolons that make the plant spread, also propagate (Figure 1 below). They can be removed, relocated, or kept so the plant keeps spreading. To plant the runners is the same process than planting from the seed just prepare a bed with the desired space (*Strawberry | Diseases and Pests, Description, Uses, Propagation*, n.d.).

Figure 1: These are the runners from where the plant spreads and reproduces itself *(Strawberry | Diseases and Pests, Description, Uses, Propagation, n.d.).*

4.2 Planting

The seeds should be placed in a depth of 6 mm in a soil that's moist so they can go through the germination process for 2-3 weeks (*Strawberry | Diseases and Pests, Description, Uses, Propagation*, n.d.). This type of strawberry since it grows in cool weather, it will respond better to soil that is damp and it will grow faster if planted during spring or fall season. Until there are at least 2 leaves grown the plant can then be placed in a different pot (Figure 2 below)(*How to grow Alpine Strawberries • Lovely Greens*, 2018).

Figure 2: In the pot is the moist soil with the leaves ready to be moved onto a different surface (*How to grow Alpine Strawberries • Lovely Greens*, 2018).

After that, make sure they are placed somewhere they can grow freely since they need around 6-12 inches of space. This kind does not need a lot of maintenance since it grows easily and freely, therefore, it's just about placing it in a place where it can catch some sun and maintaining the soil damp. The stolons will start forming which makes different *fragaria* plants which can be easily transplanted (Tilley, 2019).

To plant the strawberry transplants, one has to do it 30-60cm apart from each other and allow 90-120cm, between the rows of the plant. The crown of the plant which is the part where the leaves start to grow out from, should be placed at the surface of the soil. One year after planting, the fruits can start being harvested (Bordelon, 2001).

Figure 3: Here the plant is starting to show some big progress and the fruit is starting to be seen *(Strawberry | Diseases and Pests, Description, Uses, Propagation, n.d.)*.

4.3 Management

After one year, the produce can start being harvested, this is because the energy of the plant is focused on the vegetive growth before this time. The plant will reach a large volume so the person can choose to start removing runners and cultivating it elsewhere. There is a limited amount of runners that should be kept since a lot of them cause the plant to stop producing fruit, therefore large quantities of runners are like weeds. It is important for weeds to be constantly removed so hoeing might be required. The less weeds there are, the more fruits will be produced. The soil has to be moist enough to aid growth of the plant this means it should receive 2.5-3.8cm of water per week. In times of not enough rain it’s important to keep watering so the plant can maintain its formation. In December when plants are dormant a 2 inch layer of Mulch (Figure 4 seen below) which is a layer of leaves or other organic material to help the soil conserve it's moisture and reduce the weed production. Then in spring the mulch should be placed in the rows so the plants can still be protected but with space to grow (Bordelon, 2001).

Figure 4: As seen mulch is placed besides the plant so the soil is moist enough so the plant grows *(Damrosch, 2011)*

4.4. Pest Disease and Control

For a full and in depth visual look at the multitude of pests and diseases of *F.vesca* the author suggests the reader visit the following link to Plant Village - Strawberry (PlantVillage, n.d). where more detailed information can be found regarding pests and diseases. The following diseases and pests are the most common examples of the pests and diseases of *F. vesca.*

4.4.1 Bacterial Disease:

4.4.1.1 Angular leaf spot (*Xanthomonas fragariae)* (figure 5 below).

This disease makes the leaves have some lesions that are colored dark brown and green. The bacteria is able to survive for long periods especially in crop debris and overwintering plants. The only management there is to stop it is to rotate the crops and don't do overhead irrigation (PlantVillage, n.d).

Figure 5: Leaves are starting to die by the bacteria when this one starts forming large spots. (PlantVillage, n.d).

4.4.2 Fungal disease:

4.4.2.1 Anthracnose (*Colletotrichum fragariae*, gloeosporoides, and acutatum)

This fungal disease (Figure 6) causes the leaves to get light brown lesions however these do not kill the leaves. It also causes lesions on stems and runners which cause the plant to collapse or lose it's form. Additionally, this disease also affects the flowers the plant produces and kills them. This causes the fruit to rot and one can tell since they develop brown spots that show the fruit is essentially dead. Lastly, the fungus is able to live for up to 9 months in soil and the only way of stopping it is to fumigate or solarize the soil (PlantVillage, n.d).

Figure 6: The fungus makes the fruit get some brown spots which makes them get rotten. (PlantVillage, n.d).

4.4.2.2 Gray mould (Botrytis fruit rot)

This fungal disease makes the fruit's shape to change and deforms them, additionally the gray mold takes over making it rotten (Figure 7 below). Therefore the fruit ends up dried and dead. This disease usually takes over when there's periods of high humidity and moderate temperatures. For the disease to go away all leaves or fruit that is infected should get removed and fungicides should be applied especially in the places where leafs are the driest (PlantVillage, n.d).

Figure 7: In the figure the gray mold is observed covering the whole fruit and the runners therefore it's killing the plant (PlantVillage, n.d)

4.4.3 Pests: Insects and Mites

4.4.3.1 Strawberry Aphid (*Chaetosiphon fragaefolii)*

These insects are of color green or yellow and usually place themselves in the stem or leaves of the plant. If there's a lot of insects, leaves will start turning yellow and making the leaves rot. These insects extract a substance called honeydew which causes the plant to lose its nutrients by creating a sooty mold which is when leaves get really large dark spots (PlantVillage, n.d)

Figure 8: As seen the Aphids are on the leave and cause the yellow dots. In the second picture we can see the sooty mold which are the black dots in the leaves (PlantVillage, n.d).

Figure 9: In this picture one cant see the aphids but we can see the sooty mold which are the black dots in the leaves and are the trace they leave. *(Aphids—Strawberries—Ontario CropIPM, n.d.)*

4.4.3.2 Weevils (Strawberry root weevil) - *Otiorhynchus ovatus*

The Strawberry root weevil *(Figure 10 below)* is an insect that makes cuts in the leaves and turns them into a dark color. This insect varies in color, from dark to light brown. The attack is usually sporadic but can really affect the plant in a negative way. To avoid this insect the beds should be weed free, and the plant should preferably be placed away from other berry plants. Lastly, pesticides that contain pyrethroids can help to stop the propagation of the weevils (PlantVillage, n.d).

Figure 10: In the picture the large insect is shown.

(Strawberry | Diseases and Pests, Description, Uses, Propagation, n.d.).

4.4.3.3 Mites - Strawberry spider mite- *Tetranychus turkestani*

The mites get in the leaves and are not easily visible. They make the leaves turn into a yellowish color which makes the leaves lose strength and fall. They usually like to work more in dusty conditions so plants with not a lot of water tend to be more affected. To control this pest it is important to keep the leaves wet so the mites don't reproduce but if they keep attacking the person should apply an insecticidal soap since some insecticides may kill some of the nutrients the plant has to defend itself, so they get more attacked (PlantVillage n.d).

Figure 11: In the picture we can see the large number of mites in the leaf causing lesions so it can ultimately fall. PlantVillage (n.d).

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Chapter 5 Markets and Uses

5.1 Markets

The tables below show the top 10 countries that have the largest value in tonnes of import, export, and the largest quantity of import and export. The regions with the most predominant producers are Europe and North America. An important distinction is how on table 1 and 3 the top exporters are from Europe, North America and North Africa. In contrast with the importers from table 2 and 4 which are only from Europe and North America.

5.1.1 Table 1: Top 10 Export countries for strawberries (quantity):
Chart adapted from FAOSTAT (http://www.fao.org/faostat/en/#data/QC)

Export Quantity	Tonnes
Spain	304314
United States	146385
Mexico	126157
Netherlands	59585
Belgium	47935
Belarus	28367
Lithuania	25590
Greece	25504
Egypt	23649
Morocco	19437

5.1.2 Table 2: Top 10 countries for importing strawberries in 2017:
Chart adapted from FAOSTAT (http://www.fao.org/faostat/en/#data/QC)

Import Quantity	Tonnes
United States	166576
Canada	110487
Germany	108407
France	73132
United Kingdom of Great Britain	53226
Russian Federation	47672
Belgium	37732
Italy	32350
Belarus	30986
Netherlands	28298

5.1.3 Table 3: Import Value of strawberries top 10 countries in 2017:
Chart adapted from FAOSTAT (http://www.fao.org/faostat/en/#data/QC)

Import Value	$1000 US
United States	642573
Canada	350903
Germany	276834
France	219975
United Kingdom of Great Britain	184412
Russian Federation	113895
Belgium	94399
Italy	77614
Belarus	71283
Netherlands	62202

5.1.4 Table 4: Export Value of strawberries top 10 countries in 2017:
Chart adapted from FAOSTAT (http://www.fao.org/faostat/en/#data/QC)

Export Value	$1000 US
Spain	663428
United States	473481
Mexico	428307
Netherlands	285437
Belgium	183514
Egypt	90003
Morocco	51118
Germany	43741
Italy	43014
Republic of Korea	42983

5.2 Uses

5.2.1 Medicinal Use

The strawberry and their leaves serve for different purposes as they are diuretic, laxative, tonic, and astringent. The fruit can be used to relieve sunburnt skin, a fever, chilblains and with treatment of the rheumatic gout. Since the fruit contains salicylic acid, it helps with the treatment of damaged livers or kidneys. The leaves are the most used for medicinal purposes since they are used to make herbal teas which helps for treatment of diarrhoea. Additionally, it can be used to treat open sores, chronic dysentery, and throat gargle. Lastly, the roots have also medicinal uses since they are diuretic and astringent and also used in the treatment of throat gargle (Cham & Schltdl, n.d.).

Figure 1: The different parts of the fragaria (leaves roots and fruit).
(*Fragaria Vesca - Wikiwand*, n.d.)

5.2.2 Edible Use

The fruit can be eaten raw or cooked, it's flavor is sweet and juicy. They are good for people that suffer from anemia since they are rich in iron and potassium. The leaves can also be eaten raw or cooked and they are used as an addition for salads. Lastly, the leaves when dried can be used to make teas (Cham & Schltdl, n.d.).

Table 5: Chemical composition of Strawberry fruit

Nutritional Info

Carbs	**5 g**	Sodium	2 mg
Dietary Fiber	1 g	Potassium	160 mg
Sugar	5 g	Cholesterol	0 mg
Fat	**0 g**	Vitamin A	0 %
Saturated	0 g	Vitamin C	90 %
Polyunsaturated	0 g	Calcium	4 %
Monounsaturated	0 g	Iron	5 %
Trans	0 g	Percentages are based on a diet of 2000 calories a day.	
Protein	**0 g**		

(*Calorie Chart, Nutrition Facts, Calories in Food | MyFitnessPal | MyFitnessPal.Com*, n.d.)

5.2.3 Other Uses

Other uses are for skin care creams since they help tone, and soothe the skin. Lastly, they are good as teeth whiteners since their properties allow them to remove stains from teeths and whiten them (Cham & Schltdl, n.d.).

Figure 2: From the fruit teeth whiteners and creams can be made (*Woodland Strawberry (Fragaria Vesca) Is A Plant That Grows Naturally.. Stock Photo, Picture And Royalty Free Image. Image 22695890.*, n.d.)

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