Reference:

Apple, Heather; Strawberry Planting Systems; Lifted May 12, 2016 from http:// www.canadiangardening.com/how-to/gardening- re-sources/add-a-strawberry-patch-to-your-garden/ a/1731/3

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STRAWBERRY PRODUCTION GUIDE

BIOLOGY

The cultivated strawberry is a hybrid plant between two American species, *Fragaria chiloensis* of western North and South America and *Fragaria virginiana* of eastern North America. The botanical name of the common cultivated strawberry is *Fragaria* × *ananassa*. The hybridization of the two species occurred around 1850 in France and hundreds of varieties have been selected and named since then.

Several cultivated forms of strawberry are grouped as June bearing, everbearing, and day-neutral. The main distinguishing feature of these different types is the time and manner in which they flower.

- June-bearing are harvested in early summer, late May through June. They initiate flower buds during the short days and develops runner on the long warm days of summer.

- Everbearing types bear in both July and late August through September with lower production in between.

- The day-neutral varieties produce flowers and fruits during summer. High temperatures favor vegetative development over flowering, thus flowering and fruiting after periods of high temperatures may be reduced.

SITE SELECTION

Sites for planting strawberries should be in areas where there is adequate air and water drainage. Strawberries grows best in well-drained, clay-loam and loamy soils with pH ranging from 5.5 to 6.5. These soils types have high moisture holding capacity that favors optimum growth. Water-logged and sandy soils do not favor the growth thus, limiting the yield of strawberries.

Avoid planting sites that are previously planted with Solanaceous crops (tomato, potato, pepper, eggplant) unless they can be fumigated.

GRADE	DIAMETER RANGE (mm)
XL	32 and above
L	26-31
M	20-25
S	14-19
Reject/ cull	13 and below

Transport & Marketing Fresh Berries

During transport, berries are packed in plastic or woven bamboo trays with 300 grams capacity lines with thin cellophane sheets and then planed in cartons properly sectioned by card boards.

Berries transported in baskets should be limited to 18 kilos per container or lighter and lined with newspapers to avoid damages caused by compressions.

Processing and Utilization of Berries

Strawberries are highly perishable because of their high moisture content. When left at room temperature for more than 24 hours, the fruits over-ripen making them unpalatable for fresh consumption. Although overripe berries maybe used for processing, this practice is discourages as it results to low quality processed products.

Strawberries not sold nor processed at harvest should be stored under low temperature or partially processed to prevent further deterioration.

In fresh forms, strawberries are prepared as salads, shakes & juices. Traditionally, they are processed into jams, preserves, wines and candies.

HARVESTING

Harvest Indices

Strawberry may be ready for harvest when the fruits have attained any of these maturity levels:

- **Full Ripe** – The fruit surface is reddish all over. This is suitable for intermediate fresh consumption or for processing.
- **Three-fourth Ripe** – Suitable for nearby and long distance markets.

Harvesting Time

It is best to harvest at the later part of the day (3:00pm). Storage life of berries will be longer (1/2 to 1 day more) due to photosynthates accumulation when harvested. In addition, fruit cell turgidity may have been reduced at this time of the day.

Harvesting Technique

Picking is done by holding the fruit at its peduncle and cutting it with the thumb nail, leaving the fruit with 0.5 -1.0cm peduncle. The fruits should be picked every two days if sold as fresh market fruit, and 2-3 days, if intended for processing.

Packaging and Grading

Harvested berries are placed in woven bamboo trays or baskets of various weight capacities. Harvesting containers range from 1 to 3 kilos while ideal transport containers in bulk range from 8 to 18 kilo capacities. Strawberries packed in baskets containing more than 18 kilos run the risk of damaging the fruits due to compression impact sustained at transport.

Berries are graded and sorted according to the following categories: extra-large (XL), large (L), medium (m), small (S) and reject/cull (Lab-ayon, 1992). Small damaged berries are classified as “culls”. Local jam makers process these into jam, jelly and wine.

Soils previously planted to Solanaceous crops may contain Verticillium wilt, a persistent fungal organism in the soil. If these sites must be used for planting, soil fumigation or planting of verticillium-resistant varieties is suggested.

Avoid sites recently planted with sod because they may contain white grub, which are injurious to strawberry roots.

CLIMATIC REQUIREMENTS

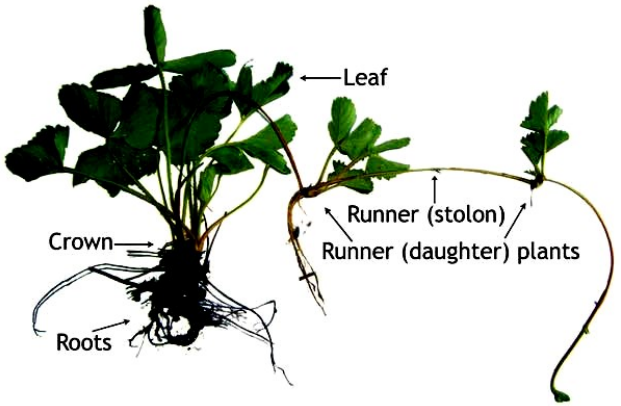
Strawberry grows and yields best at temperature ranging from 14 to 23ºC (57-73ºF). Temperatures higher than 23ºC may reduce flower development in most strawberry cultivars

For most strawberry cultivars, a day length of more than 10-11 hours, accompanied by low temperature may favor flowering, fruit set and development. Longer day lengths with warm temperature generally occur in months of April to mid-September, this favors vegetative growth of strawberry.

PLANTING AND TRAINING

Planting of strawberries depends upon the growing location. Planting is done from June to July on rain fed hillsides while in valley floors prone to flooding, planting may be done in the later part of August to September.

Strawberry parts used for planting are suckers and runners. Runners are however, preferred because they give higher yield.



Strawberries are commonly grown in the matted or space-matted row production system.

- Matted row system – the mother plants are simply allowed to form runners and spread until a matted row of plants is formed.
- Spaced-matted row – the runners are spaced to achieve more controlled of plant density. Plants are maintained in rows by cultivation between rows.

In both the matted row and spaced-matted row systems, the original mother plants are planted 18 to 36 inches apart in rows 36 to 48 inches apart.

Many growers practice a combination of the matted and spaced-matted row systems, spacing runners to fill in areas where mother plants die and keeping runners trained in the rows.

Optimum plant density is six or seven plants per square foot for most varieties. Plants grown on heavy soils may benefit from slightly raised 3 to 5 inch beds to allow for better root development. Plants grown on raised beds, however, have higher water requirements.

In planting, see to it that the plants are planted with the crown set neither too high nor too low. Planting too high exposes roots to the wind and plants die or are poor in performance while too deep planting may cause the crown to rot.

Prior to planting, a soil test can be done to determine nutrient needs. Apply other nutrients as recommended by the soil test results. Plants will flower soon after planting, but remove those flowers to promote good plant development and bed establishment.

Too Deep Too Shallow Correct

as they go to tie the leaflets together. Other species of leafrollers also feed on the plant, but none of them usually cause significant damage.

https://www.freshfruitportal.com/news/2019/03/13/the-biocontrol-brief-how-to-control-two-spotted-spider-mites-in-strawberry-production/

***Strawberry Mites* (*Tetranychus urticae* and *Steneotarsonemus pallidus*)**

The two-spotted spider mite and the cyclamen mite can wreak havoc on strawberry plants. The spider mites damage leaf surfaces in order to feed on sap, while the cyclamen mites feed on new, unfolding leaves and blossoms. Both will cause leaf death and drop, and the cyclamen mite causes distorted fruits.

https://www.flickr.com/photos/anitamgeorge/9542465223

Slugs (*Agriolimax* and *Arion* species)

Slugs will create deep holes into strawberries and leave slime trails over the strawberry plant. The damaged strawberries will begin to decay quickly.

PRUNING

Leaf Pruning. This is done if the leaves have overdeveloped, causing shading of the leaves.

Leaf pruning is necessary to enhance flowering at the same time clean old leaves that have outlived their usefulness and are only respiring and do not contribute to fruit development. Plant inhibitors that accumulated in the old leaves may suppress plant growth and flower development.

Flower Truss Pruning. This is the removal of fruit trusses that have already bore fruit and harvested. Truss pruning must be done to allow room for the development of new trusses and prevent the crowding out of new fruits.

are most commonly affected. The fungus causes infections that manifest as soft, rapidly-growing spots that are light brown in color. The fruit will dry out, darken, and become covered with a dust-like, powdery layer of fungus spores, which gives the gray appearance.

https://www.gardeningknowhow.com/edible/fruits/strawberry/strawberry-verticillium-wilt-controlt.htm

<u>Verticillium Wilt of the Strawberry Plant</u>

Verticillium wilt is caused by a very common soil fungus called *Verticillium alboatrum*. For new strawberry plantings, symptoms usually manifest as new runners are being produced. Older plantings are usually affected just before harvest. Affected strawberry plants will show different symptoms depending on the cultivar, and affected plants must be tested for definitive diagnosis. Symptoms are not easily distinguished from other strawberry plant root diseases. Once established, the fungus will likely survive for 25 years or more.

http://www.omafra.gov.on.ca/IPM/english/strawberries/ insects/white-grubs.html

<u>White Grubs</u> (*Phyllophaga*)

White grubs range from 1/2 to 1 inch and eventually become the large May or June beetles (also called “June bugs”). Grubs burrow into the soil before taking beetle form. Consequently, the grubs can damage the roots of strawberry plants.

<u>Strawberry Leafrollers</u> (Ancylis comptana fragariae)

The adult moths emerge in April or May to lay their eggs on the strawberry plant, usually on the underside of the leaflets. The translucent eggs then hatch and the larvae feed on the epidermis of the leaves, secreting silk threads

https://content.ces.ncsu.edu/leafrollers-in-strawberries

VARIETIES

- Choose a variety that is resistant, adapted to local condition, high yielding, of good eating quality & accepted in the market
- Choose good quality runners from tissue cultured mother plants.

Some of the varieties are:

CULTIVAR	CHARACTERISTICS
Sweet Charlie	Developed in Florida, Sweet Charlie is an early sweet variety. The plant is medium in size, vigorous, and disease-resistant. It is consistent favorate of the farmers due to its adaptability in the locality.
Strawberry festival	Distinguished by the numerous runners it produces in the fruiting field, the long pedicels attached to its fruit, and the production of fruit that are flavorful, firm fleshed, deep red on the outside, bright red on the inside, conically shaped, and have large, showy calyces.
Missionary	Fruits are dry-red and almost heart-shaped although they have somewhat rounded stylar end, prominently protruding seed and firm flesh with sour taste but aromatic
Whitney	It is a late-fruiting, everbearing light-colored, day-neutral cultivar. The plant is very vigorous and produces multiple crowns. Where it has been tested, it is competitive with the important cultivars grown in the area, although it performs better in slightly warmer areas.
‘Winter Dawn’,	Resistance to Colletotrichum crown rot (caused by *C. gloeosporioides*); ability to produce large fruit on a relatively small plant.
Toyonoka	Plant is short but sturdy. Leaf blade is wide and medium thick. It is less prolific in runner production as compared with other cultivars. Fruit is large, almost heart-shaped; flesh is firm, juicy, sweet & aromatic.

IRRIGATION

Irrigation maximizes plant growth and yield by ensuring an adequate moisture supply at all times. Fertilizers and pesticides may be applied through the irrigation system.

Sprinkler or overhead irrigation is commonly used on strawberries. Other forms of irrigation are drip irrigation, flooding, over-head bucket system and rubber hose sprinkling. Generally, a plant should receive at least 1 inch of water per week during the growing season, either from rainfall or through irrigation.

In areas with abundant water supply, the use of sub-surface irrigation applied twice a month or at two-week interval during the peak of the dry season is sufficient for longer fruiting period and better quality fruits. Sub-surface irrigation can also control some soil -borne insects such as grubs, ants, cutworms and mole crickets.

FERTILIZATION

Fertilizer application should be based on result of soil test information and petiole and leaf analysis. Strawberries require nitrogen fertilizer application every year beginning the year of planting.

Excessive and unnecessary fertilization may harm the plants and alter soil structure. Too much nitrogen delays flower development and fruit maturity as well as reduces fruit by softening the berries. Applying too much fertilizer will result to excessive leaf

usually between 1/8 and 1/4 inches in diameter and most easily seen on the leaves. However, the petioles, stolons, fruit stalks (pedicels), and strawberry caps (calyxes), and ripe strawberries can also be infected. The center of the spots eventually become almost white with tan or gray. The parts of the strawberry plant affected by this disease are the young, succulent ones.

https://content.ces.ncsu.edu/phomopsis-leaf-blight-of-strawberry

Strawberry Plant Leaf Blight

The fungus *Dendrophoma obscurans* (also known as *Phomopsis obscurans*) causes leaf blight, and it typically does its damage after harvest. One to six enlarging, elliptical or angular blemishes will develop on the leaflets and growing up to one inch in width. The spots begin with a reddish-purple color. As they enlarge, they develop a dark brown center that is surrounded by a lighter brown area with a purplish border. This fungus almost exclusively attacks weaker, and slow-growing plants. *Dendrophoma obscurans* can also cause a spreading, pink, soft rot at the stem end of a strawberry.

https://www.gardenmanage.com/statuses/1000149512.html

Strawberry Gray Mold

If a strawberry plant is infected by gray mold, fruit production is likely to be particularly devastated (expect 80-90% loss of both flowers and strawberries). It is caused by the fungus *Botrytis cinerea*, and wreaks havoc during rainy and cloudy periods just before or during harvest. Strawberries touching dirt, another infected or rotting strawberry, or dead leaves in dense foliage

WEED CONTROL

Competition from weeds for light, water, and nutrients reduces plant establishment, plant density, fruit size, and flower bud initiation. The strawberry is a relatively shallow-rooted plant it cannot achieve high yields when competing with deeper-rooted and more competitive weed species. Presence of weeds in the planting makes picking difficult.

There are methods of weed control, such as:

- Mechanical Method: hand weeding is done twice a month (every 15 days) for the first two months. After mulching, weeding is occasionally done depending upon the growth and density of weeds.
- Cultural Method: this includes placement of mulch during or just after planting depending on the material used. Black polyethylene mulch is placed at planting time while cogon grass, rice straws are placed just after planting. This is the most economical and efficient weed control method.
- Chemical Method: In selecting and using herbicides, improper use of herbicides have potential damage to strawberry plants. Read the label carefully before using a product, and calibrate the herbicide spray to apply the proper amount of product per acre.

PEST AND DISEASE MANAGEMENT

There are quite a few diseases that affect strawberry plants. The strawberry plant's leaves, roots, and fruit are all susceptible to a variety of diseases, depending on the resistance of the strawberry plant cultivar. This is a summary of the most common strawberry plant diseases:

pinterest.com

Strawberry Plant Leaf Spot

Caused by the fungus *Mycosphaerella fragariae* and manifests as dark purple to reddish-purple spots. The round spots are

growth and poor production of flower stalks. In addition, applying fertilizer on wet strawberry plants can result in phytotoxicity, and no fertilizer particles should remain lodged on the plants.

Recommended Fertilization Scheme

FERTILIZER	RATE/HA (tons)	APPLICATION METHOD	APPLICATION TIME
INORGANIC			
Triple 14	20 bags (140-140-140) (N-P-K)	Side dressing (split applica-tion)	-First at 2 months after transplanting -Four months after transplanting
Muriate of Pot-ash	3 bags (90 kgs)	Side dressing	2 months after trans-planting
Urea	4 bags (120 kgs)	Side dressing	1 month after transplant-ing
ORGANIC			
Cow/ carabao manure (dry)	18	basal	2 weeks before trans-planting
Chicken dung	6	basal	1-2 weeks before trans-planting
Compost (farm wastes)	6	basal	1 week before trans-planting

**use any of the three (3) organic fertilizers*

LIMING

Lime maybe applied and mixed thoroughly into the soil at least 2-3 weeks before planting. To determine the soil pH, a farmer may have his soil samples tested in soil laboratories.

Recommended liming rate table for soils with average organic matter content and 6.0 pH

pH	AVERAGE AMOUNT OF THE GROUND LIMESTONE ($CaCO_2$) IN (t/ha) NEEDED TO BRING SOILS OF AVERAGE ORGANIC MATTER CONTENT TO pH 6.0*				
	Sandy	Sandy Loam	Loam	Silt & Clay Loam	Clay
(1)	(2)	(30	(4)	(5)	(6)
4	2.0	3.5	4.5	6.0	7.5
4.5	1.5	2.5	3.2	4.2	5.2
5.0	1.0	1.5	2.0	2.5	3.0

- Average organic matter content:
  - Cultivated soils: 2.5to 3%
  - Uncultivated soils: 5% and up

Source: The Philippine Recommends for Soil fertility Management. PCARRD, Los Baños, Laguna

MULCHING

Mulching has several advantages:

- Minimizes water evaporation and loss of newly applied fertilizer and soil nutrients
- Minimizes weeds
- Keeps berries clean
- Prevents plants and berries from soil splattering during heavy rains
- Regulates soil temperature. It makes soil temperature stable on the bed surface

Locally available mulching materials are rice straws, cogon, and dried pine needles. Black polyethylene may also be used as mulch. Using black polyethylene plastic is advantageous for early ripening and longer harvest season. Plastic mulch is recommended for areas with available water for flood irrigation.

Mulch should be 2cm thick for grasses like cogon, rice straws and dried pine needles. Thicker mulch may deflect or shield the plant root zones from utilizing natural precipitation and applied irrigation.

Polyethylene can be used to cover the plot shoulders and canals while grass mulch covers the plant root zones.

Renovation

Renovation of strawberry plantings controls plant density, maintains plants in manageable beds, and selectively removes older

plants. After the first growing season, most strawberry plantings become overcrowded and the plant population becomes too high because of the perennial growth habit and prolific runnering.

Overcrowding reduces quality and yield. Fruit size, quality, and yield decrease when the plant population becomes overcrowded. Only six or seven plants per square foot are needed for best yields. Disease problems also increase when plantings become too dense, making foliage and fruit slow to dry after rains and more difficult to adequately spray.

It is important to renovate as soon as possible, within 7 to 14 days, after the last picking to ensure that plants recover and have plenty of time to establish new runner plants. Earliest rooted runner plants normally develop the largest number of flower buds for next year's harvest.