

**Reference:**

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# GOOD AGRICULTURAL PRACTICE: **STRAWBERRY** **PRODUCTION**



## 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.



## Worker's health, safety and welfare

Employers and workers must have appropriate knowledge and proper training on their areas of responsibility that are relevant to good agricultural practice. Based on the area of responsibility of the workers, appropriate knowledge or training should be available on the following areas:

- vehicles, equipment and tool operation;
- accident and emergency procedures;
- safe use of chemicals;
- personal hygiene; and
- proper handling of produce.

New workers should be oriented about the risks associated with health and safety when starting at the worksite. In case living quarters are provided by an employer, the structure must be suitable for human habitation and contain basic services and facilities.



## **Buildings and Structures**

Building and structures used for production, packing, handling and storage of produce should be designed and constructed according to building standards and maintained to minimize the risk of contaminating the produce. There should be a separate designated packing area, where the produce is handled, packed and stored, away from oil, grease and machineries. Sewage, waste disposal and drainage systems are constructed to minimize the risk of contaminating the production site and water supply.



## **Animals, Pest and Disease Control**

Domestic and farm animals are excluded from the production site, and from areas where produce is harvested, packed and stored. Measures should be taken to prevent the introduction of pests and diseases within the cultivation, handling, packing and storage areas. Baits and traps used for pest control should be positioned and maintained in strategic areas to minimize the risk of contaminating the produce, packing containers and other handling materials.



## **Farm Sanitation**

Measures should be taken in order to ensure that the production area is free from possible sources of contamination. Cleaning and sanitation procedures should be prepared and followed. Appropriate cleaning and sanitation chemicals are selected to minimize the risk of these chemicals causing contamination of produce.



## **SITE SELECTION**

The Site for strawberry production should be suitable for agricultural site for food production. It should conform to countries environmental legislation. For establishing new sites, conducting a risk assessment should be considered. If found that the site has potential hazard, the site should be further evaluated through analysis and characterization of the contaminant.

Sites 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. 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.

## **CLIMATIC REQUIREMENTS**

Strawberry grows and yields best at temperature ranging from 14 to 23°C (57-73°F). Temperatures higher than 23°C 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

Aside from yield quantity and quality as basic considerations, varieties to be grown should be selected based on market requirements, grower preference and adaptability to the locality. Other considerations may include soil type and nutrient levels, water availability, prevailing temperatures and humidity, insect pest population dynamics, and presence of inocula of major pathogens. Sourcing and/or procurement of planting materials from the Accredited Plant Nursery Operators are encouraged.

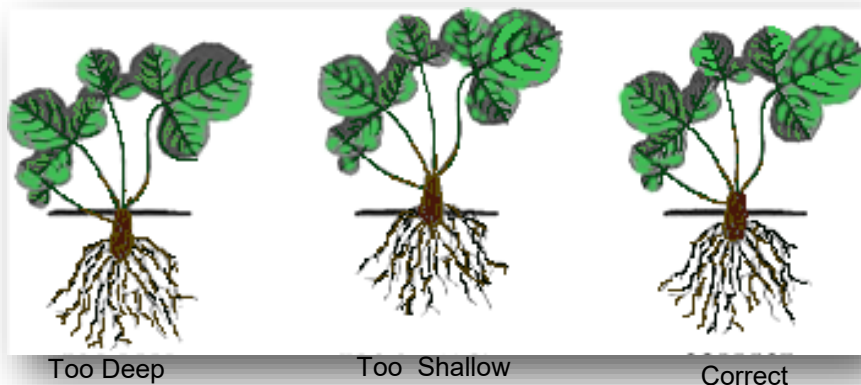
Planting of strawberries depends upon the growing location. Planting is done from June to July on rain fed hillsides while in valley floors prone to flooding, planting may be done in the later part of August to September.

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.



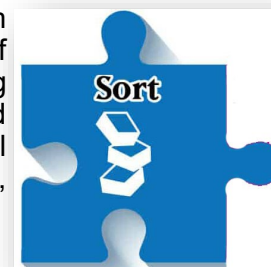
## Workers' health, safety and welfare

A record of personnel orientation training on personal hygiene practices, risks associated with and health safety, and programs relevant to good agricultural practices should be kept. Indicate that the required instructions or training program are in place and copies of attendance certificates or a signed list of workers who attended the training course(s) must be compiled.

## PERSONAL HYGIENE AND FARM SANITATION

### Personal Hygiene

Farm workers should comply with farm hygiene regulations such as observance of personal cleanliness and appropriate clothing (i.e. hand washing, wearing of jewelry and fingernail length and cleaning, etc) and personal behavior (i.e. no smoking, spitting, eating, chewing, etc).



Fixed or mobile toilets and hand washing facilities should be available and accessible to the workers and should be properly maintained in good hygienic condition. These should be located in an appropriate area.

### Equipment, containers and materials

Containers used for harvesting, handling and packing produce must never be used for hauling or storing agricultural chemicals, lubricants, oil, cleaning chemicals, plant or other debris, tools. Equipment, reusable harvesting containers, harvesting tools that comes in contact with fresh fruits are made of non-toxic materials, easily cleaned and disinfected. Implements and the farm vehicle should be regularly maintained. Equipment, containers and materials should be stored in a separate area away from chemicals, fertilizers and soil additives storage areas. Measures should be taken to minimize contamination from pests.



## DOCUMENTATION AND RECORDS

### Site history and management

In case of new sites, a record should be kept for all potential hazards identified during the assessment. Whenever remedial action is required to manage the risk, a record should be kept on the action taken and the results thereof. If multiple production areas in a site, the name or code of each production area should be indicated in all documents and recorded.



### Planting material

Whenever a planting material is produced within the farm or from non-accredited farm sources, chemical used for treatment and purpose of the treatment should be documented. On the other hand, in case the planting materials are procured from accredited nurseries, the name and specifics of the cultivar, the name of the supplier, and the date of procurement should be record.

### Fertilizers and Crop protection

A record of fertilizers, soil additives and chemicals obtained should be kept with the following specifics: source, product name, and date and quantity obtained.

After each application, it should be recorded, detailing the following: date, name of the product or material used, treatment location, application rate, application method, and operator name.

Records of maintenance and calibration activities for agricultural chemical sprayers should be kept. Maintain and update regularly the record of procurement, inventory and utilization.

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.

### Some of the common varieties:

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 favorite 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 <i>Colletotrichum</i> crown rot (caused by <i>C. gloeosporioides</i> ); 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.

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.

## **IRRIGATION**

### **Source of irrigation water**

Risk of chemical or biological contamination of produce from the water used for irrigation should be assessed. Moreover, the proximity of water sources on possible sources of contamination (e.g. near the dumping site, near septic tanks, etc.) should be considered during assessment.

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.

### **Suitability of water quality for agricultural production**

Irrigation use is based on crop water requirements, water availability, soil moisture levels, and consideration of environmental impact on and off the site. Water used for agricultural purposes should be of suitable quality for its intended use.

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.



## **Transport & Marketing Fresh Berries**

All field-packed produce must be covered during transport in order to prevent contamination. Produce should be transported separately from goods that are potential sources of chemical contamination and causes of biological and physical hazards. Moreover, mixing of non-compatible produce during transport should be avoided. When farm vehicle used for transporting harvested produce are also used for other purposes, it should be cleaned prior to hauling to avoid contamination of the produce.

During transport, berries are packed in plastic or woven bamboo trays with 300 grams capacity lined 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.



Strawberries are 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**

Produce should be graded and packed according to market requirements. When packing of fresh fruits is done in the field, contaminated containers or bins exposed to the sources of contaminants should be avoided.



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.

<b>GRADE</b>	<b>Average Fruit Weight (g)</b>	<b>DIAMETER RANGE (mm) ("Lab-ayon, 1992")</b>
XL	>20	32 and above
L	15-20	26-31
M	8-14	20-25
S	6-7	14-19
Reject/ cull		13 and below

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**

To optimize nutrient use and minimize nutrient losses, the farm should apply fertilizers based on the quantitative information on soil nutrient based on soil analysis. Only duly registered fertilizers under the FPA should be used.

Fertilizers and soil additives should be judiciously selected to minimize the risk of contamination of produce, particularly with the heavy metals. 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.

### **Recommended Fertilization Scheme**

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

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

## Organic fertilizer

Composting areas should be separated from the crop production area and from drinking and farm water sources. Undecomposed (untreated) organic materials must not be applied because the presence of potential contaminants. Organic fertilizer materials should be treated prior to application.

## 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 <sub>2</sub> ) 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)	(3)	(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

## HARVESTING

Practices that are critical to managing produce safety and quality during production, harvesting and postharvest handling are identified for the crop grown. Appropriate harvesting technique should be employed in harvesting to optimize the quality and other desired characteristics of produce during harvest or postharvest phases.

### 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

Harvesting time should be done in accordance to commodity requirements. Harvesting under the rain should be avoided. Those that are unfit for human consumption should be segregated and also those which cannot be made safe by further processing should be disposed properly to avoid contamination of the uncontaminated produce.



## 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.



## 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
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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 running.



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.

## CROP PROTECTION

### Choice of crop protection products

Crop protection measures should be appropriate for the control of pests. Use agricultural chemicals that are registered for the cultivation of strawberry and procured from licensed suppliers and approved by the FPA in the country where the crop is grown and in the country where the produce is intended to be traded. The use of such agricultural chemicals must be in accordance with the approved label instructions for the intended purpose/s.

### Application of crop protection products

The person responsible for application should be technically competent. He should possess the relevant trainings and experience, education or preferably be duly accredited as such by a competent authority (e.g. FPA). The Integrated Pesticide Management (IPM) principles and techniques should be used whenever possible to minimize the use of pesticides. A rotation strategy for chemical application and other crop protection measures should be employed to avoid the development of pest resistance.



### White Grubs (*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.



[www.plantwise.org](http://www.plantwise.org)

### Strawberry Leafrollers (*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 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://content.ces.ncsu.edu/leafrollers-in-strawberries>

### 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.



[www.strawberryplant.org](http://www.strawberryplant.org)

### 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.



www.videohive.net

### Strawberry Gray Mold

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 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.



www.gardenmanage.com

### Verticillium Wilt of the Strawberry Plant

It is caused by 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.



www.en.wikipedia.com

### Safety and Welfare of Authorized Worker/s during Application

Authorized farm workers should be trained on the proper handling and application of crop protection products. There should always be an available first aid kits to treat the applicators in cases if injury and those that have been accidentally contaminated with chemicals prior to medical attention/ hospital treatment.. Authorized workers who are directly handling and applying chemicals should undergo periodic/ annual medical check-up to ensure their health and welfare.

### Storage of crop protection products

The storage facility should be located and constructed to minimize the risk of contaminating produce and should be equipped with emergency facilities in the event of a chemical spill, fire and other natural or man-made calamities .It should comply with all the appropriate national or local regulations. It must have a non-absorbent shelves such as metal or rigid plastic material to minimize the problem of contamination due to spillage.

Crop protection products should be stored in its original container with legible labels and should be stored in a well-lighted, sound and secure structure, with access limited to the authorized personnel only. Proper segregation in the storage of crop protection products should be observed.

### Disposal of crop protection products

Empty chemical containers should not be re-used/for food and drink related purposes. and should be safely secured until these are disposed. Empty containers should be rinsed three (3) times prior to disposal .Tank washings should be disposed appropriately to avoid contamination of the produce and minimize the risk of environmental harm within and outside the site.

## 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

This is a summary of the most common strawberry plant diseases:

### Strawberry Plant Leaf Spot

Caused by the fungus *Mycosphaerella fragariae* and manifests as dark purple to reddish-purple spots. The round spots are 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* 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. It can also cause a spreading, pink, soft rot at the stem end of a strawberry.



[www.strawberrypant.org](http://www.strawberrypant.org)