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*Commercial
Strawberry
Production
In Minnesota*

Minnesota Extension Service
University of Minnesota

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Commercial Strawberry Production In Minnesota

Strawberries are successfully grown on a commercial scale throughout much of Minnesota. Commercial production in the state has increased since 1978 and is expected to continue to expand as Minnesota growers take an increasing share of the local market.

Strawberries are adaptable to the wide range of climatic conditions present in the state. However, you will need to consider other factors as well, such as topography, soil, establishment costs, labor supply, marketing facilities, shipping costs, and water availability, in planning a commercial strawberry operation.

Variety Selection

Strawberries suited for Minnesota are of two major types, Junebearing and day-neutral. The essential difference between Junebearing and day-neutral strawberry cultivars is the day-length conditions under which they initiate flower buds.

Junebearing strawberry cultivars initiate flower buds in the fall of the year prior to fruiting when the day is relatively short, about 12 hours. Day-neutral cultivars can initiate flower buds under any day length—even the long 16 to 17 hour days in midsummer in Minnesota. Flower buds continue to develop as long as temperatures are not too high or too low.

Junebearing plants produce fruit from early June through late July and are generally overwintered. The day-neutral strawberry produces fruit from June until the first killing frost, providing the option of growing strawberries as an annual crop.

Whether you choose Junebearing or day-neutral varieties, it's important to select varieties adapted to the local climate. New varieties are introduced each year; however, they are not all suitable for Minnesota soils and climatic conditions. Plant new varieties with little or no local performance record on a small scale initially, and limit the number of varieties to as few as you need to meet market requirements (for example, a pick-your-own operation may need several varieties to extend the harvest season). Qualities to look for in addition to local adaptability are: productivity, season of maturity, berry size, firmness, flavor, freezing ability, color, and disease resistance. Tables 1 and 2 list some varieties recommended for Minnesota growers.

Site Selection and Preparation

Proximity to the intended market must be considered when choosing a site. A pick-your-own operation must consider population density or proximity and existing production in the area. A wholesale grower must consider transportation costs.

Strawberries require full sunlight. The strawberry field should be fairly level with a 2 to 3 percent slope to allow good air circulation and to minimize soil erosion. Cold air will move to low areas, creating frost pockets and damaging flowers during the spring blossoming period. A southern exposure will result in an earlier bloom, while a northern exposure will delay flowering (an ad-

vantage in an area of late spring frosts). The site should be near a source of irrigation water.

Strawberries grow well on many different soil types. A well-drained soil is needed to maintain plant vigor and reduce disease problems. Very light and heavy soils are not as desirable as a well-drained loam or sandy loam soil. Avoid muck or peat soils in low-lying sites because they have greater potential for frost injury.

The previous crop history of a site also must be considered. To reduce the chance of Verticillium wilt disease, wait three years before planting strawberries in a field where potatoes, tomatoes, peppers, or raspberries were grown previously.

A green manure crop before planting will add organic matter to the soil and help maintain desirable soil physical properties. Sow green manure crops such as rape (12.3 lb seed/A), Camelina (4.5 lb/A), rye (63 lb/A), or oats (60.5 lb/A) between April 10 and May 4. Soybean and foxtail millet (75 lb/A and 18 lb/A), soybeans and Japanese millet (75 lb/A and 19 lb/A), and proso millet (38 lb/A) can also be used. Well-rotted barnyard manure worked into the soil also will help improve soil physical properties and fertility.

Test soil fertility and acidity (pH) before planting. Strawberries prefer a slightly acid soil (pH 5.3 to 6.5). If the pH is less than 5.3 you will need to add lime. Follow

Table 1. Characteristics of Junebearing strawberries in Minnesota.

Cultivar	Yield Potential	Hardiness	Vigor	Fruit Size	Attractiveness	Firmness	Texture	Flavor
<u>early season</u>								
Crimson King	high	excel.	high	large	v. good	fair	v. good	fair
Earliglow	mod.	fair	mod.	medium	excel.	excel.	excel.	excel.
Veegem	mod.	good	mod.	medium	good	good	good	good
Veestar	mod-high	good	high	medium	good	good	good	good
<u>early midseason</u>								
Honeyoye	high	v. good	high	med-large	good	v. good	good	good
Redcoat	high	v. good	high	medium	good	good	good	fair
Scott	mod.	fair	mod.	large	excel.	excel.	good	fair
Trumpeter	mod-high	v. good	high	medium	fair	fair	good	good
<u>Late midseason</u>								
Kent	high	v. good	mod-high	large	v. good	v. good	v. good	good
<u>Late season</u>								
Sparkle	high	v. good	high	medium	fair	good	good	good
Micmac	mod-high	good	mod.	med-large	excel.	v. good	v. good	v. good
Bounty	mod-high	good	mod.	medium	good	good	v. good	good
Canoga	mod.	fair	low	large	v. good	excel.	good	good

Table 2. Characteristics of day-neutral strawberry cultivars in Minnesota.

Cultivar	Yield potential	Hardiness	Vigor	Fruit size	Attractiveness	Firmness	Texture	Flavor	Comments
Aptos	mod.	v. good	v. low	medium	medium	excel.	fair	fair	
Brighton	mod.	fair	mod.	large	fair	v. good	fair	fair	very susc. to fruit rots
Burlington	not adequately tested								
Fern	mod-high	good	low	medium	good	excel.	v. good	good	
Hecker	high	good	mod.	medium	good	v. good	good	fair	
Sakuma	not adequately tested								
Selva	low-mod	poor	high	v. large	excel.	excel.	fair	poor	sensitive to alkaline soils
Tribute	high	v. good	mod.	med-large	good	v. good	v. good	good	resistant to Red Stele Root Rot
Tristar	mod.	v. good	mod.	medium	v. good	v. good	v. good	v. good	resistant to Red Stele Root Rot
Ft. Laramie	high	excel.	high	large	good	poor	fair	fair	very susc. to Powdery Mildew
Ogallala	mod-high	excel.	high	small	fair	poor	good	good	

soil test recommendations for rates of lime to apply. Incorporate the lime thoroughly at least one year prior to planting. Fertilizer suggestions are provided in Tables 3 and 4.

Weed Control

A weed eradication program one year prior to planting is recommended if perennial weeds are a problem. Herbicides, mechanical control methods, and a green manure smother crop can be used effectively. Consult herbicide labels to avoid potential carry-over problems for the new strawberry planting. Preplant harrowing of a prepared field will reduce weed populations.

Herbicidal weed control may be unnecessary in day-neutral plantings if a plastic mulch is applied before or shortly after planting. A herbicide may be used to control the first flush of weeds if a straw mulch is used. When the strawberry plants are established, their shade should suppress further weed growth within the rows.

More information on weed control is presented in AG-FS-1131, *Weed Control in Commercially Grown Strawberries*.

Planting Stock

Use quality planting stock that is free from insects, viruses, and other disease problems. Purchase plants from a reputable nursery (contact the Minnesota Department of Agriculture for a listing of local firms). The plants may be either dormant or spring-dug. Dormant plants can be stored for a few weeks before planting, but spring-dug plants must be planted as soon as possible af-

ter arrival. Store the plants in a cool, fairly humid, enclosed area until planted. Trim the roots to 4 to 5 inches immediately before planting.

Planting

Plant strawberries in early spring to ensure good runner plant development for increased productivity the following season. Fall planting is not recommended due to greater problems with weed control and the cost of winter mulch. The number of plants needed per acre depends upon the spacing system used (Table 5). Choose a system which provides high productivity while allowing pickers and equipment to move easily through the field.

The main planting system used for Junebearing cultivars is the matted row. Set the plants 1½ to 2½ feet apart in rows spaced 3 to 4 feet apart. Let the runners develop until the row is 1 to 1½ feet wide. This system allows for easier weed control, easier harvest, less fruit rot, and fewer foliage diseases than other systems.

Table 3. Fertilizer suggestions for Junebearing strawberries.

NITROGEN ^a		
	Application Rate (lb N/A)	Timing
Establishment year	40-80	20-40 lb N/A at or before planting and 20-40 in August during runner production
Bearing years ^b	40-80	Immediately after renovation

^aUse lower rates if soil is medium-high in organic matter. Use higher rates if soil is low in organic matter.

^b20 lb N/A applied in the spring is suggested for sandy soils.

PHOSPHORUS^a

Soil Test Phosphorus (lb/A)	Application Rate (lb P ₂ O ₅ /A)
0-20	100
21-40	50
40 +	0

^aApply and incorporate before planting. If needed during bearing years, apply immediately after renovation.

POTASSIUM^a

Soil Test Potassium (lb/a)	Application Rate (lb K ₂ O/A)
0-100	200
101-200	100
200 +	0

^aApply and incorporate before planting. If needed during bearing years, apply immediately after renovation.

Table 4. Fertilizer suggestions for day-neutral strawberries.

NITROGEN ^a		
	Application Rate (lb N/A)	Timing
First year	60-150	15-40 lb N/A every 3 to 4 weeks after planting
Subsequent years	60-150	

^aUse lower rates if soil is medium-high in organic matter. Use higher rates if soil is low in organic matter.

PHOSPHORUS^a

Soil Test Phosphorus (lb/A)	Application Rate (lb P ₂ O ₅ /A)
0-20	100
21-40	50
40 +	25

^aApply and incorporate before planting. If needed in subsequent years apply in the spring.

POTASSIUM^a

Soil Test Potassium (lb/A)	Application Rate (lb K ₂ O/A)
0-100	200
101-200	100
200-300	50
300 +	0

^aApply and incorporate before planting. If needed in subsequent years apply in the spring.

Table 5. Number of plants required per acre at various spacings.

In row	PLANT SPACING (feet)		Plants per acre
	Between rows		
1-½	3		9,680*
1-½	3-½		8,296
1-½	4		7,260
2	3		7,260
2	3-½		6,223
2	4		5,445
2-½	3		5,810
2-½	3-½		4,980
2-½	4		4,356

*Calculated by multiplying plant spacing in the row by spacing between rows and dividing into 43,560.

Plant day-neutral cultivars in the same way or, if suitable equipment is available, on a 6- to 8-inch raised bed. The raised bed provides higher spring soil temperatures and better drainage, allowing faster establishment and earlier cropping.

Plant day-neutral cultivars in single rows 3 feet apart with plants 6 to 9 inches apart in the row, or double or triple rows 8 to 12 inches apart with plants 8 to 12 inches apart within the rows. (Multiple rows are usually more productive than single rows.) Leave 18 to 24 inches between each series of double or triple rows to allow for movement of pickers and equipment.

New Planting Care

Junebearing strawberry plants should be encouraged to form runners and not flowers during the first year for a larger plant. Therefore, remove all flower clusters until July 1.

The plants are shallow-rooted (most of the root system is in the top three to six inches of soil) and so require large quantities of water. Irrigate immediately after planting and during dry periods while plants are being established. The beds should receive a minimum of one inch of water per week during the growing season. Proper irrigation will improve fruit quality and yields.

Effective weed control during the first season will reduce the number of weeds the following year and increase fruit yields.

Nitrogen, phosphorus, potassium, and other soil nutrients are required for vigorous crown and runner development. Soil tests will identify the nutrient needs (see Table 3 and 4). Generally phosphorus, potassium, and part of the nitrogen should be applied at or before planting. Apply nitrogen again in August during runner plant production.

Keep in mind, however, that strawberry growers tend to overemphasize the importance of fertilizers and underestimate the importance of water. Yields are more frequently reduced from lack of water, poor soil drainage, and poor soil physical properties than from a lack of fertilizer.

Mulching

Mulching is necessary in Junebearing varieties to protect flower buds from temperatures below 15° F and to protect crowns from heaving damage. Apply a three- to five-inch layer of straw mulch after a few hard frosts, usually in late October or early November. Try to use a mulch that is free of weed and grain seed. Remove all but a thin layer of the mulch in the spring when new leaf growth begins and before foliage starts to turn yellow. Place excess mulch between rows to help control weeds, conserve moisture, and maintain clean fruit.

For day-neutral varieties, apply a 1- to 2-inch straw mulch shortly after planting to keep the berries clean, conserve water, and control weeds. Plastic mulches also may be applied either before or after planting. Black plastic will help warm the soil and encourage growth; in warmer areas, white plastic may be suitable to avoid high soil temperatures in midsummer.

Care of Junebearing Cultivars

The spring care of Junebearing cultivars begins with mulch removal about April 20 to May 1. Apply herbicide within a few days of mulch removal if you did not use a fall herbicide application. Begin insecticide sprays 7 to 10 days after mulch removal and apply again just before flowering begins and while the fruit is developing. Apply fungicide sprays to prevent fruit rots at the bud stage and repeat at 7- to 10-day intervals or within 48 hours after rainfall up until harvest. Irrigation is necessary for vigorous runner production and fruit development; the plants should receive about one inch of water per week. Shallow cultivation is effective for weed control and must be started early in the season. If herbicides are not used, cultivate every 10 days to two weeks.

Renovate existing production beds after harvest. The beds should be largely free from perennial weed infestations for a successful renovation.

Begin renovation by applying a broadleaf herbicide such as 2,4-D amine after harvest and before August 1. About a week later, mow the leaves down without injuring the crowns. Till between rows to leave a row center 8 to 12 inches wide.

Do not apply nitrogen before harvest unless plant vigor is poor since it will promote too much vegetative growth and reduce fruit quality. Spring nitrogen applications are usually beneficial on coarse-textured soils (sands, loamy sands, sandy loams) that are low in organic matter. At most, 20 lb/A nitrogen should be applied. A fertilizer application immediately after renovation is beneficial (Table 3). Refer to Table 6 for weed control guidelines. A fall herbicide application can be made about October 15. Lay down straw mulch in late October or early November before temperatures drop below 20°F.

Table 6 summarizes the timing of activities in a commercial Junebearing strawberry operation.

Rotation

Junebearing cultivars are perennials, but they become less productive after several years. Replace the plants every three to five years to maintain high quality fruit and yields and to reduce problems with weeds, insects, and diseases. A detailed cost and productivity analysis should be performed to determine whether existing strawberry beds should be renovated or the old plants discarded and the entire field replanted with new plants. Continuous cropping of strawberries on the same site may be possible where disease, insect, and weed control practices are adequate.

Care of Day-Neutral Cultivars

Table 7 provides a timetable for day-neutral plantings. Remove flowers from day-neutral plants for four to six weeks after planting to encourage vegetative growth. When plants have developed five or six expanded leaves, they may be allowed to flower.

Runner removal is not necessary, especially on cultivars such as Fern and Aptos which produce few runners, but

may be desirable through the first six or eight weeks of the season to encourage greater productivity.

The day-neutral strawberry has high demand for certain nutrients because it is fruiting throughout the season while also trying to grow vegetatively. Fertilizer suggestions are provided in Table 4. Base phosphorus and potassium application on soil test results. Nitrogen should be split into four to six applications at intervals throughout the season. Soil test and foliar analysis can be used to determine whether micronutrient applications are necessary.



Carrying Over Day-Neutral Plantings

Although day-neutral strawberries do not seem to be as productive during the second year, some growers may wish to carry a planting over. Irrigation, fertilizer application, and pest control during the second year are simi-

Table 6: Timetable for growing Junebearing strawberries.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FIRST SEASON												
obtain nursery catalogs	_____											
Plan project	_____											
Order plants		_____										
Prepare site				_____								
Fertilize NPK				_____								
Set plants					_____							
Control weeds					_____	_____	_____	_____	_____	_____	_____	_____
Water as needed					_____	_____	_____	_____	_____	_____	_____	_____
Remove flowers					_____	_____	_____	_____	_____	_____	_____	_____
Control pests-as needed				_____	_____	_____	_____	_____	_____	_____	_____	_____
Sidedress nitrogen							_____					
Obtain mulch										_____	_____	
Apply mulch											_____	_____
SECOND SEASON												
Remove mulch			_____									
Control pests				_____	_____	_____	_____	_____	_____	_____	_____	_____
Water as needed				_____	_____	_____	_____	_____	_____	_____	_____	_____
Harvest berries					_____	_____	_____	_____	_____	_____	_____	_____
Renovate and Fertilize NPK							_____					
Mulch											_____	_____

Table 7. Timetable for annual cropping of day-neutral strawberries.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Obtain nursery catalogs	_____									
Plan project	_____									
Order plants		_____								
Prepare site			_____							
Set plants				_____						
Control weeds				_____	_____	_____	_____	_____	_____	_____
Apply mulch				_____	_____	_____	_____	_____	_____	_____
Remove flowers					_____	_____	_____	_____	_____	_____
Remove runners					_____	_____	_____	_____	_____	_____
Irrigate				_____	_____	_____	_____	_____	_____	_____
Fertilize			-----	-----	-----	-----	-----	-----	-----	-----
Control pests				_____	_____	_____	_____	_____	_____	_____
Harvest berries								_____	_____	_____

lar to the first year. Spring frost protection may be necessary. Additional straw mulch may be needed during the middle of the summer as the old mulch decomposes. Additional herbicide applications may be needed during the fall of the first year (just prior to mulching) or during the early spring of the second year.

Frost Protection, Irrigation, and Cooling

Sprinkler irrigation is crucial to prevent frost damage in Junebearing varieties after the mulch is removed in early spring. Irrigate whenever the air temperature drops below 34° F. Apply 0.1 inch of water per hour with one sprinkler head revolution per minute. Sprinkler irrigation should protect flowers and developing fruit down to 20° F.

Spring frost protection is unnecessary during the planting year in day-neutral strawberries because the flowers are usually removed until the danger of frost is past. Frost protection may, however, be desired in the fall to extend the harvest season.

Day-neutral strawberries require more careful irrigation and water management than Junebearing strawberries, especially on raised beds. During the summer apply 0.75 to 1.5 inches of water per week depending on the weather, soil type, and effectiveness of mulch in preventing evaporation. Use trickle irrigation with plastic mulch to ensure sufficient water in the root zone. Overhead irrigation may be used with straw or other organic mulches. Fertilizer can be applied through the irrigation system. Higher levels of certain nutrients such as nitrogen may be needed if trickle irrigation is used because of increased leaching through the soil profile.

An overhead irrigation system running at a low rate during hot weather (above 82° + to 85° F) can improve flowering and fruiting in day-neutral plants. Turn the water off early in the day to allow the foliage and fruit to dry and avoid disease infection.

Insect and Disease Control

Strawberries are affected by several diseases that vary widely in their occurrence and severity; you must be able to recognize common strawberry insect and disease problems in order to treat them quickly and effectively. A *Compendium of Strawberry Diseases* is available at reasonable cost from the American Phytopathological Society (3340 Pilot Knob Rd., St. Paul, MN 55121) to help you identify diseases. Prevention is the best way to hold disease and insect problems in check. The use of good cultural practices, varieties adapted to the area, and disease-free stock will help reduce insect and disease problems.

You must time pesticide applications and harvests to observe clearance times stated on the pesticide label. Failure to observe clearance times can result in illegal levels of pesticide residues in the fruit and can expose harvesters or customers to unnecessary risks.

For further information about strawberry diseases or insect pests see: AG-FS-1148, *Strawberry Diseases*, and AG-FS-1134, *Commercial Strawberry Pest Control Guide*.

Harvest

Proper picking, grading, and packing are as essential as good cultural practices to success.

The harvest frequency and duration depend on weather conditions, varieties, soil factors, and cultural practices. Strawberries are almost entirely hand picked.

As a general rule for wholesale operations, six to nine pickers are needed for each acre. Pickers must be instructed by a competent foreman about proper picking (to prevent plant injury), fruit handling, and sorting (grading) in the field.

The berries must be picked at the proper stage of ripeness (maturity). Harvest only those berries that are red. Berries still showing white should be left for the next picking. The fruit is usually harvested every other day unless hot weather makes daily picking necessary.

Quickly place harvested berries in a cool, shady location such as a temporary field shed. Store the berries preferably at 32° F to 35° F and at a 90 to 95 percent relative humidity. Enrichment of the storage atmosphere with carbon dioxide to a 10 to 40 percent level using dry ice will extend the storage life somewhat. Under these conditions berries should remain salable for five to seven days and losses during shipping, storage, and marketing will be reduced.

Pint or quart containers are usually filled in the picking fields and covered with plastic film or rigid plastic domes before shipping. The strawberries are then shipped in fiberboard trays which hold twelve one-pint baskets to prevent damage. An attractive package with the fruit visible will bring premium prices.

Pick-Your-Own Enterprise

Pick-your-own (PYO) strawberry farms are the most popular method of direct marketing in Minnesota. PYO farms began when harvesting labor became scarce and increasingly expensive. The advantages of PYO farms include no harvest labor and transportation costs, improved quality, increased product availability for consumers, and reduced packing costs. Disadvantages are long hours including weekends (you work when customers can come to your farm), difficult customers, liability costs, parking areas, and damage to plants and equipment.

Pick-your-own operations require attention to certain factors for successful harvest and marketing including: sufficient quantity of high quality fruit, proximity to population centers, convenient parking area off the highway, and effective advertising notifying customers of berry availability.

When planning a PYO farm, be sure that you:

- provide clear instructions for pickers;
- make sure containers are available before the customers arrive;
- advertise your product;
- make sure your insurance will cover your liability;
- be extremely careful with reentry times for all pesticides;
- organize your checkout so it runs smoothly.

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