

Strawberry Production in Kentucky

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This publication discusses the matted row system of strawberry production only. The annual plasticulture strawberry production system is still considered experimental under Kentucky conditions.

Strawberry acreage has decreased in Kentucky over the last 10 years, which provides excellent marketing opportunities for new growers. Most strawberries grown in Kentucky are sold on a pick-your-own basis. However, the demand for already-picked berries is increasing because many two-income families no longer have time to pick strawberries. Strawberry plantings are spread across the state, with higher concentrations close to population centers.

Planning

What Is Your Market Potential?

Before starting a strawberry planting or expanding existing acreage, you should determine the strawberry market potential in your area. Roughly 350 to 400 pick-your-own customers are needed to harvest one acre of strawberries. The effective marketing area is a 20- to 25-mile radius surrounding the operation. About 85 percent of your customers will live within 10 miles. An area population of 2,500 people supports one acre of pick-your-own strawberries. Customers who visit an operation for picked strawberries usually buy small quantities but return frequently.

Strawberries can be profitable and fit in well with tobacco, vegetable, and other fruit production, providing the first source of income in early spring. Strawberry production gives farmers an excellent opportunity to grow another high-income-per-acre crop.

Labor requirements for strawberry production compare favorably to those for tobacco. The returns from labor and management for strawberry production can be nearly as high as for tobacco and even greater for growers who produce high yields.

As production goes up, total cost per acre usually goes up too, but cost of production per quart goes down. You need to produce at least 5,000 quarts per acre to break even in a retail market. Successful growers consistently produce 9,000 to 15,000 quarts per acre. Highest returns come with good production, but more importantly, with good marketing practices.

Requirements for Commercial Production

- **Pay attention to detail, and be timely in your operations.** Be on time and correct when you prepare soil, fertilize, order plants, plant, weed, de-bloom, pick, and perform other operations. Neglecting any of these can drastically cut yields and potential profits.
- **Market outlets must be adequate.** Growing a good crop of berries is a waste if you can't sell them. Fortunately, very few areas of Kentucky are overplanted with strawberries.
- **Labor supply is essential.** Obviously, plant only the number of plants you can care for and harvest with the available labor supply. In a pick-your-own operation, you use consumers as picking labor.
- **A variety of soils may be used.** Best crops are produced on a deep, sandy loam soil well supplied with organic matter. Other soil types can be satisfactory if handled correctly. For instance, a clay soil produces good crops if it is prepared to drain well and has added organic matter in the form of animal or green manures (preferably both).
- **Site is important.** To reduce the chance of spring frost damage, establish your plot on ground higher than the immediate surrounding area. This promotes good surface water and air drainage. Cold air, like water, flows downhill and collects in low places. So don't plant strawberries in a low place where frost might kill the flower buds in spring or injure the plants in winter.
 Good internal soil drainage is also important. Strawberry roots will not tolerate water-soaked soil for long. In addition, wet soil helps spread certain diseases such as red stele.
- **Optimum soil moisture is vital.** Many commercial growers increase profits with tile drainage and irrigation to keep soil just moist enough. Most use sprinklers for irrigating because they also can help prevent frost and freezing injury. To help prevent frost injury, water is applied using overhead sprinklers to the berries. This maintains the flowers and berries at temperatures just below freezing. Due to the heat generated as the water freezes, the crop is protected.

Selecting Cultivars

For local sales, both roadside stands and pick-your-own, the fruit should have good size, an attractive appearance, and good quality. The cultivars you choose can strongly affect your success. Many cultivars are regional in adaptation, doing well in one area of the United States but not in another. Therefore, select cultivars adapted to local soil and climate conditions. Check with neighboring farms to determine what varieties are popular and in demand. Make trial plantings of new cultivars on your farm to see how they perform before you do large plantings. Table 1 lists cultivars recommended for Kentucky. Earliglow and Allstar have dominated most new plantings the last 10 years, partly because they are resistant to red stele disease and have excellent fruit quality.

Selecting Good Plants

Make every effort to obtain good plants. You should order from a dependable plant source that you know sells virus-free plants. Place your order early, usually the fall before planting, so that you will receive the cultivars and quality you want. Much of the planting's future usefulness is affected by the condition of the mother plants. They should be vigorous and disease-free, with an extensive and healthy root system. Plants with light-colored, fibrous roots are healthy, while those with dark or spotted roots with few fibrous roots may be diseased or unhealthy. Old plants have roots that are almost black.

Just about all nurseries now handle plants that are dug in the fall and stored at a temperature near 32°F throughout winter to make earlier shipment possible. Properly stored plants are usually better than freshly dug ones because stored plants are dormant when set and do not experience as great a shock as freshly dug plants that have started growing. Dormant plants are particularly useful for late spring planting.

Order plants in the fall for spring delivery since strawberries are planted in early spring in Kentucky. Make the order as soon as possible after you get the new catalogs, and

ask for shipment early enough to guarantee arrival before the earliest possible planting date in March or early April. By ordering early, you have a better chance of receiving your full order and getting better plants. If you order too early, you will have to hold them and run the risk of freeze damage.

When the Plants Arrive

Plants often arrive from the nursery at a time inconvenient for planting. If they will be set within a day or two, you may not need to heel them in (that is, to cover them temporarily with soil before setting them permanently). Open the package and inspect for disease, insects, and general condition. Check the order for correct cultivar and number. The plants are usually tied in bunches of 25 with the name label in each bunch. Report serious drying out, heating, disease, or other problems at once. Then put the plants in a cool, sheltered place, and keep the roots moist.

If the plants cannot be set for several days, keep them in cold storage just above 32°F or heeled in. *Do not store strawberry plants in the same cooler with fruit because fruit and some vegetables give off ethylene gas that inhibits strawberry plant growth.*

For heeling in:

- Select a well-drained area protected from the sun and wind.
- Dig V-shaped trenches about 6 inches deep.
- Open the bunches and distribute the plants—one deep—along the trench so that plants lean on either side of the trench.
- Cover the roots with fine, moist soil, and firm well. The crowns should be just above ground as in planting.
- Water the plants well after heeling in unless the ground is quite moist.

Table 1. Recommended strawberry cultivars for Kentucky.

Cultivar	Season	Resistance to: ¹					Productiveness ²	Size ³	Freezer Rating ²	Firmness ⁴
		Red Stele	Leaf Spot	Leaf Scorch	Verticillium Wilt	Powdery Mildew				
June-Bearing Cultivars										
Delmarvel	early	R	R	R	R	—	VG	VL	VG	F
Earliglow	early	R	S	R	R	S	VG	M	VG	VF
Redchief	midseason	R	R	R	R	S	VG	L	VG	F
Honeoye	midseason	S	R	R	S	—	VG	VL	VG	F
Allstar	med. late	R	R	R	S	R	VG	L	G	VF
Jewel	med. late	S	R	R	S	—	G	VL	VG	F
New Cultivars for Trial										
Evangeline	early	S	—	—	—	R	VG	M	—	F
Mesabi	early	R	R	R	R	—	VG	L	VG	MF
Darselect	midseason	—	T	T	—	—	VG	L	—	F
Ovation	midseason	—	—	—	—	—	G	L	VG	F
Primetime	midseason	R	R	R	R	—	VG	VL	VG	MF
Mira	med. late	R	S	S	—	R	VG	L	G	F
Latestar	late	R	R	R	R	—	G	S-M	G	F

¹ R = resistant, S = susceptible, T = tolerant, — = unknown.

² G = good, VG = very good.

³ S = small, M = medium, L = large, VL = very large.

⁴ F = firm, MF = medium firm.

Preparing the Soil

Success of the crop depends largely on the soil in which the plants grow. Therefore, prepare the soil properly for production of a large and profitable crop. Consider the following important factors: rotation, plowing, fumigating, and fertilizing.

Rotation

A good rotation plan is critical for long-term production. If strawberries are grown on the same land year after year, disease and insect problems are so magnified that they ruin profitable production. Rotations also help control weeds, add organic matter, and improve the soil's physical properties. Strawberries are rather shallow-rooted and require a soil that holds moisture. Green manure crops furnish much of the needed organic matter.

A cultivated crop like corn is desirable to precede strawberries because the weed problem is reduced and the soil is left in good physical condition. Use a nonpersistent herbicide on the preceding crop. Do not grow potatoes, tobacco, peppers, eggplants, or tomatoes preceding strawberries because they can increase the level of the *Verticillium* wilt population in the soil that could kill or severely injure the strawberry plants. Rotations should include a legume like clover, alfalfa, cowpeas, or vetch with rye. Plow the legume under, then follow it with corn or another cultivated crop before planting strawberries. If the field is not too weedy, however, strawberries may be planted immediately.

Land that has been in sod should be plowed and cultivated for at least two years before planting strawberries. Doing so helps eliminate white grubs that build up in sod and damage strawberries if not controlled. At present, no effective chemical control exists for grubs in strawberries.

Plowing

Plow in the fall (except where the slope is so great that plowing would cause excessive erosion) because strawberries should be planted as early as possible in the spring (March or early April), when the soil is often too wet for plowing. On fall-plowed land, alternate freezing and thawing during winter puts the soil in excellent physical condition. It may need only to be smoothed with a harrow to prepare it for planting. In addition, fall-plowed ground absorbs a lot of moisture during the winter that is available later for strawberry plants.

To prepare soil in the spring, disc and harrow the fall-plowed ground. The fertilizer may be broadcast and disced in, or it may be drilled. If the soil is too loose, roll it before planting. If berries are to be planted on ground likely to be wet, you might want to plant on ridges. To do so, throw up small ridges with a lister plow.

Fumigating

Fumigate only if you must plant on land with extreme pest populations. Such situations include cases where strawberries must be replanted into an area where they were grown within the last four years; fields in which tomatoes, peppers, tobacco, potatoes, or eggplants have been planted within two years; or where extreme weed populations make growing strawberries difficult.

Methyl bromide has been used in the past but has become very expensive and is being phased out. Vapam (Metam sodium) is a less effective fumigant and controls mostly weeds. Methyl bromide must be injected into the ground to achieve effective pathogen control. Cover methyl bromide-treated areas with a plastic tarp to seal the fumigant in. Seal Vapam-treated land with a culti-packer and overhead irrigation or a plastic tarp. These compounds are usually applied by custom applicators, but you can apply them yourself if you have the equipment and know what you are doing.

For best results, plow the land 8 to 10 inches deep, and work it to remove all clods. All plant debris such as cornstalks, weeds, and straw should be well decomposed, and the soil temperature should be between 60° and 80°F at a 6-inch depth. The soil should have a fairly high level of soil moisture before fumigation but not be too wet to be worked. September is usually the best time to fumigate. Under ideal conditions, some fumigants may require only a seven-day waiting period between fumigation and planting; however, the waiting period may be as long as two months depending on the soil type, temperature, and fumigant used.

Fertilizing

Barnyard manures are among the best fertilizers for strawberries. Apply 10 to 20 tons per acre before plowing in the fall preceding a spring planting. The manure decomposes and furnishes the much-needed nutrients—nitrogen, phosphorus, and potash. Ten tons of manure equals about 1,000 pounds of 10-5-10 in nutrients. Manure is low in phosphorus, so if the soil is also low in this nutrient, add some superphosphate. Manure also adds organic matter and thus improves the soil's physical structure and water-holding capacity.

Strawberries need about the same nutrient level as many other crops. Test your soil, and fertilize before planting, using recommendations in Cooperative Extension publication AGR-1, *Lime and Fertilizer Recommendations*, available in county Extension offices. Apply commercial fertilizers in the spring before planting, according to your soil test results. For established plantings, tissue analysis is the best way to determine fertility needs. For a tissue analysis, sample leaves between July 15 and August 15. Contact your county Extension office for information on available laboratories that conduct tissue analysis, as well as proper sample collection and preparation instructions.

Planting

Early spring is the best time to plant strawberries in Kentucky. Fall planting is not advised because the plants are injured by heaving (alternate freezing and thawing). Plant as early as the ground can be worked in March or early April so the plants can be established and make runners before hot, dry weather comes. Plants formed from early runners produce several times more fruit than those formed from later ones. If planting is delayed until late April or May, dry weather often slows the formation of runner plants until fall, and late-formed plants are low producers.

Planting distances in Kentucky vary. Both cultivar vigor and type of equipment influence plant spacing. Most growers prefer a standard row spacing to accommodate their equipment. The most common spacing is 3.5 feet between rows and 2.5 feet between plants in the row. The following table shows the number of plants needed per acre at different planting distances.

Width of Rows	Distance in Rows	No. of Plants/A
4 ft	2 ft	5,445
4 ft	2.5 ft	4,356
3.5 ft	2 ft	6,223
3.5 ft	2.5 ft	4,978

Prune plants before setting. Remove large, diseased, or yellow leaves to reduce moisture loss through transpiration and avoid infection of your site with diseases carried on the foliage. If roots are too long, cut them back; this helps in machine planting. Place the bundles of plants on a board, and cut the roots off with a sharp knife so the remaining roots are 5 to 6 inches long.

Correct planting helps plants resume growth quickly. Keep roots moist at all times during planting by keeping them in a pail partly filled with water or by keeping damp peat moss, sawdust, burlap, or other similar material over them until planted.

For hand setting, use a dibble, trowel, or spade. Be sure to leave the midportion of the crown exactly at ground level. If it is too deep or too shallow, the plant will be smothered and may even die (see Figure 1). Spread the roots out (not doubled up), and firm the soil around them. A spade is handy for rapid setting. Press it into the soil to about half its length. Move it back



Figure 1. Correct planting pays. The plant at left is not planted deep enough and will be injured by drying out. The one at right is planted too deep and will not grow well. The center plant is properly planted, with the crown at ground level. It will start growth quickly and form runners early.

and forth slightly to make a V-shaped opening. Insert the strawberry plant with the roots fanned out, putting the crown at the surface of the ground. Insert the spade a short distance from the plant, and push the soil against the plant's roots to anchor it. Firm the soil around the plant with your foot.

Machine setting practiced by most large growers is faster than hand planting but has several disadvantages. It is difficult to get the plants at the proper depth with the roots spread out as they should be. Someone should follow the transplanting machine to firm the soil around the plants and to reset those improperly set. Special "strawberry fingers" available for the machine improve its performance. Machine setting is also improved if the soil has been worked up well and is free of clods.

Post-Planting Care

Cultivating

Cultivate the soil frequently to control weeds and keep it loose so runners can root easily. Loose soil absorbs moisture more readily. Cultivating too deep or too close to the plants can destroy many roots and greatly delay rooting and runner formation, especially in dry weather. A certain amount of hand hoeing is necessary to remove weeds the cultivator or herbicide missed. While hoeing, pull the runners into the row, and space them to some extent. Putting a small amount of soil on the runner holds it in place and helps it get established.

After the row is filled with plants, attach rolling coulters to the cultivator in front of the shovels on a tractor to cut out excessive runner plants during cultivation. This method destroys late-formed, unproductive plants. Early in the season, before the rolling coulters are attached, the shovels push the runners back into the row.

Controlling Weeds

Chemical weed control is a standard practice with strawberry growers. Several herbicides now on the market are excellent when used properly. Recommended crop protection chemicals and rates are listed in Cooperative Extension publication ID-94, *Midwest Commercial Small Fruit and Grape Spray Guide*, available in county Extension offices.

When using chemicals for weed control, observe all safety precautions listed on the label by the manufacturer or mentioned in Extension publications. Using low pressure (about 30 psi), spray the material over the row using at least 30 gallons of water per acre. Thorough coverage of the ground is vital. Know the volume of spray per acre that your equipment delivers. (Determine it by first spraying a measured area with water.) If plants are established and you want to selectively spray the land between the rows only, then you must determine the amount of herbicide needed based on the area actually sprayed, not the area of the whole planting.

Removing Blooms

Bloom removal is necessary the first season. Plants bloom a short time after setting, but if you let the fruit develop, the plants will be seriously delayed in sending out runners. It is important that new runner plants be formed as early as possible. The blooms are borne on fruiting stalks; when they have grown out sufficiently, most blooms can be removed by pinching off the entire fruiting stalk (Figure 2). Going over the planting two times should be enough for bloom removal.



Figure 2. Removing flowers the first season helps the plant make vigorous vegetative growth. Pinch off the entire fruiting stalk. (Drawing courtesy USDA).

Irrigating

Irrigation especially benefits strawberry plants, since they have relatively shallow root systems. Thus, at critical drought periods during the first year, irrigation may ensure a large crop the following spring. The additional water will stimulate more runner plants, which will have larger crowns and develop more and stronger fruit buds. Irrigation in the fall when it is dry helps increase flower number and fruit size the next spring. One or two irrigations the next spring, while the fruit is developing and maturing, generally increase berry quality and size and may even save the crop if a drought occurs.

Irrigation especially helps renovate older plantings and protects flowers from frost injury.

Trickle irrigation is satisfactory for strawberry production, but it does not provide frost protection.

Mulching

Strawberry plants must have winter protection with a mulch of straw or other material. Unmulched plants can be seriously damaged by frost heaving, and cold weather can hurt crowns. Injury from heaving breaks off the fine roots and, while not apparent, can reduce yields significantly.

A mulch serves many purposes. It retards growth during early spring, protecting blooms from spring frosts. It also helps reduce weed growth, conserves moisture, makes picking more pleasant, and keeps fruit clean.

Wheat straw is the preferred mulch material for strawberries, although oat and rye straw will also work well. Leaf mulch tends to pack too much, sawdust may tie up nitrogen, hays usually contain large amounts of weed seed, and pine needles are not plentiful. If weed- and grain-free straw is not available, straw should be piled loosely near the planting in early fall so that weed and grain seeds may germinate and freeze, thus reducing weed problems in spring. If baled straw is used, distribute bales over the field in early fall, and clip the ties so that rain will wet the straw and seeds will germinate and freeze.

Apply mulch when the temperature is expected to reach about 20°F and the strawberry leaves are beginning to change from green to gray. In Kentucky, this is usually in December



Figure 3. Applying mulch by machine in large fields.



Figure 4. Properly mulched planting.

(Figure 3). Don't wait too late, since temperatures of 12° to 18°F can injure plants and reduce bloom. In addition, frozen bales are hard to spread. Apply about 1.5 to 2 tons per acre by hand, manure spreader, or mulching machine (Figure 4). Machines are also available that spread large, round bales. Some growers have spread straw by hand by unrolling the straw from large, round bales off the bale spear.

Many growers produce their own mulching material. Allow the grain crop to head, and mow it before the grain forms; then cure and stack it until needed. Thickly planted sudangrass also produces a good mulch for strawberries. However, it must be run through a hay conditioner at cutting as it dries very slowly. One-half acre should produce enough mulching material for one acre of strawberries.

Don't hurry mulch removal in the spring so strawberry fruit buds stay protected. Unmulched plants usually bloom early and frequently are killed by spring frosts. Remove the mulch when plants have started new growth and the new leaves are slightly yellow. If the mulch is heavy enough to retard growth, then rake part of it to the middle of the rows. The plants will grow through the remaining mulch. Leaving the mulch over the plants too late in the spring substantially reduces yields. If a killing frost is expected, raking the straw back over the plants can provide protection.

Protecting from Frosts

Late spring frosts can seriously reduce strawberry profits. Cultivars that mature early also bloom early and are prone to frost injury because flower buds lose their hardiness as they develop (Table 2). Further, the first flowers to open produce the largest fruit. So, if 5 to 7 percent of the first flowers are lost, the total crop will be reduced by 10 to 15 percent.

Table 2. Critical temperatures for strawberry buds, flowers, and fruit.

Developmental Stage*			
Emerg ed Buds	Closed Buds	Open Flowers	Small Green Fruit
10°F	22-27°F	30°F	28°F

* Duration of temperature for damage can be 20 minutes to two hours depending on wind, humidity, and cultivar.

Overhead sprinkler irrigation, the cheapest way to protect flowers from spring frost injury, is economically justified. It works because as the water freezes it releases its heat and maintains the flower temperature at 32°F, even when the air temperature drops below freezing. However, wind counteracts this effect because it evaporates the water and causes cooling. Thus, as the wind increases, you need to put more water on the flower to achieve the same degree of protection (see Table 3).

Table 3. Inches of water/acre/hour to apply for protection for various air temperatures and wind speeds.

Air Temp. (°F) at Canopy Level	Wind Speed (mph) at Crop Height				
	0-1	2-4	5-8	10-12	18-22
27°	0.10	0.10	0.10	0.10	0.2
24°	0.10	0.16	0.30	0.40	0.8
20°	0.16	0.30	0.60	0.80	—
18°	0.20	0.40	0.70	—	—

Source: Martsoff and Gerber, Penn. State University.

Sprinklers specifically designed for frost protection (for example, Standard-Angle Wobbler #6 Nozzle 0.11 inches/acre/hour) are preferred because they do not tend to ice up but provide uniform coverage. Apply 0.10 to 0.20 inches of water/acre/hour. On lighter, sandier soils, you can use sprinklers with higher application rates. Sprinklers are usually set on a 30- by 30-foot spacing.

Start sprinkling when the air temperature reaches 34°F in the plant canopy, and continue until all ice on the blossoms melts the next morning. Space sprinklers to assure thorough coverage under severe conditions. Plants should be sprinkled at least once per minute. Under windy conditions, walk the planting, and unclog sprinklers that freeze up.

Before the frost season, be sure the sprinkling system functions properly and back-up parts are on hand. Calibrate and check temperature alarms and thermometers. A thermometer may be calibrated by placing it in a rapidly stirred water-crushed ice mixture. After about one minute, the thermometer should read 32°F. If it does not, note how far it is off, and remember to make this adjustment when reading this thermometer.

Pollination

Strawberry flowers must be pollinated to set fruit. Insects provide a portion of this pollination. Poorly pollinated fruit are malformed and reduced in size. A single strong colony of bees is enough to pollinate one acre of strawberries. Move bees into the field before first bloom, and remove them as soon as bloom is finished to avoid injuring colonies with pesticides. If pesticide application is necessary during this period, we recommend you spray at dusk when bees will be back in the hive.

Pests

Strawberries are subject to several insects and diseases. Cooperative Extension publication ID-94 contains the latest strawberry pest control recommendations for commercial growers, and ID-21, *Disease and Insect Control Program for Home-Grown Fruit in Kentucky*, contains recommendations for the home grower.

Harvesting and Marketing

Harvesting the crop is the important phase of strawberry growing. Harvesting is your ultimate goal and must be performed correctly for maximum profit. The harvesting season generally begins in May and lasts two or three weeks. Berries generally ripen 28 to 30 days after first bloom. A large increase in production usually occurs within the first four to six days. Because berries ripen rapidly, pick them every other day. Most cultivars under normal growing conditions produce six to seven pickings.

The pick-your-own method has become the most important way of marketing strawberries in Kentucky. Strawberry acreage in many states has dwindled because the consuming public no longer has time to engage in pick-your-own activities. Local sales of fresh-picked strawberries have potential for growers near population centers. Over a period of years, you can develop a clientele radius of 10 to 30 miles. Adequate labor to handle picking is critical. The average pick-your-own customers in Georgia, Illinois, and Ohio picked 8, 11, and 23 pounds of strawberries per visit, respectively.

Most Kentucky growers sell by volume rather than weight, but some have switched to selling by the pound. One quart of strawberries weighs about 1.4 pounds. Selling by weight has several advantages—primarily, eliminating complaints about over- and under-filled containers. Pick-your-own berries are usually priced slightly below those in local supermarkets. Some growers have set their pick-your-own price only slightly lower than their already-picked price. This reflects the fact that in a pick-your-own situation, many berries are consumed in the field, and many are stepped on. It costs about twice as much for paid pickers to harvest a field after it has been picked by pick-your-own pickers.

Roadside stand operations have developed rapidly and offer possibilities for growers located near population centers. In considering a roadside stand, realize most sales will be local and repeat rather than from tourists passing through. Large quantities usually cannot be handled in this way, but

a roadside stand may be very helpful when associated with a pick-your-own operation.

If strawberries are harvested to sell, you need enough pickers to harvest the crop by noon, while the fruit are still relatively cool. An average picker can harvest about 12 to 15 pounds of berries, or about 10 quarts per hour. Hired pickers generally are paid on a piecework basis and receive 20 to 25 percent of the selling price. It takes about six pickers to harvest one acre of strawberries (10,000 pounds) over the entire season.

Harvest strawberries with their caps on, handle them carefully to avoid bruising, and put them in shallow containers. Harvest only berries that are fully colored and at their peak of flavor since quality will not improve after harvest. Keep berries clean, and protect them from the sun.

Since strawberries have a high rate of respiration, cold storage can substantially extend their storage life. If berries are held for only a few hours, a temperature of 45°F is cold enough. It is best to sell berries within 24 hours of harvesting them. If they are kept longer than a day, however, store them at 33° to 35°F with 90 to 95 percent relative humidity. At this temperature, firm berries store for two to four days and remain in good condition. Berries also can be stored at 30°F for up to seven days and will be attractive if allowed to warm up at room temperature for six hours.

Use the following four-pronged marketing strategy to increase pick-your-own sales:

- Produce high-quality fruit.
- Advertise to inform consumers about availability. One technique that works well is to have customers fill out postcards with their names and addresses. Drop these cards in the mail the next year to let them know when the strawberries are ready for harvest.
- Encourage pickers who don't process their fruit for storage to do so by having Extension bulletins with recipes and information on processing available at your market.
- Price your fruit just below the local supermarket so customers get a sense of price savings and satisfaction.

Renovation and After-Harvest Care of the Field

Most commercial fields in Kentucky are fruited for two or more years. The success of the second and subsequent fruiting depends largely on the condition and care of the planting after harvest in late June. The second year's production can be almost as good as the first if the field is properly cared for and relatively free of weeds, insects, and diseases. Remember that labor-hours per acre the second year are considerably less than the first year.

The following 10-point renovation program will maximize profits and yields and prolong the life of the planting.

- 1. Determine if the planting is worth renovating.** Examine each field at the end of harvest. Some plantings may be in such poor condition that they should be plowed under after the first season. But if the planting is in a vigorous condition and has a well-developed fruiting row with

at least a 70 percent stand and no serious weed, insect, or disease problems, it is generally advisable to keep it a second year and possibly even a third, fourth, or fifth year.

- 2. Apply 2,4-D (amine) and Sinbar at renovation for weed control.** Assess the broadleaf weeds in the field immediately after harvest. The whole renovation process should be completed as soon as possible. If there are a number of broadleaf weeds, apply the herbicide 2,4-D (amine form) no later than July 15 to selectively remove broadleaf weeds. Sinbar is labeled for broadleaf and grass control and can also be applied after post-harvest renovation and before new growth begins in midsummer.
- 3. Mow four to five days after 2,4-D application if needed.** It takes four to five days for the 2,4-D to work. If you mow too soon after 2,4-D application, you may not get broadleaf weed control. *Mow only if the strawberries have a considerable amount of foliage injury symptoms or if the herbicide Sinbar is used.* Mow off the strawberry plant tops, being careful not to damage the crown portion of the plants.
- 4. Fertilize with 50 to 60 pounds of actual nitrogen per acre plus phosphorus and potassium if a soil test shows you need them.** Nitrogen is needed to stimulate new growth and aid in decomposing leaves and mulch material. Fifty to 60 pounds of actual nitrogen is equivalent to 150 to 180 pounds of ammonium nitrate per acre. If phosphorus and potash are low, apply a complete fertilizer based on a soil test.
Strawberry foliage is susceptible to fertilizer burn, so apply fertilizer when the foliage is dry. Some growers hang a piece of canvas behind the fertilizer applicator to brush the fertilizer from the foliage. Others apply fertilizer with a fertilizer buggy and then subsoil and cultivate to remove the fertilizer from the foliage.
- 5. Subsoil to reduce soil compaction.** Heavy foot traffic and machinery often compact the soil 5 to 6 inches down. Subsoiling to a depth of 14 to 18 inches between rows greatly increases water penetration and improves plant performance. This is often done with a one- or two-shank subsoiler pulled behind a 40- to 50-horsepower tractor. Subsoiling is most beneficial when soil is dry.
- 6. Reduce rows to 8 to 10 inches wide.** Reduce row width with a light plow or rototiller to 8 to 10 inches wide, using the wider spacing when irrigation is not available. Growers often remove half of one side of the row to remove as many old plants as possible. Recent research indicates maximum yields are achieved when the row is 12 inches wide at harvest. This row width gives maximum light penetration. A rototiller is effective at thoroughly tearing up the row middles and incorporating the leaves and mulch. If the mulch is too heavy, part of it may be raked off and removed before incorporation.

Mother plants maintain a high level of production if one-half inch of soil is thrown over the crowns at this time. Doing so lets new roots form higher on the crowns and rejuvenates old plants. This practice induces the old plant to quickly produce daughter plants, which, if formed

early enough, develop multiple crowns and promote the highest yields. Too much soil can bury the crown and inhibit development.

- 7. Thin plants to 5 to 6 inches apart within the row.** Strawberries, like any crop, do best when spaced properly. To produce the highest yields of quality fruit, ideal spacing is six plants per square foot. Crowding causes smaller and lower quality fruit because of increased competition for nutrients, light, and water. Some cultivars are more likely to need thinning than others. Hand thinning, however, is time consuming and probably unprofitable under Kentucky conditions.

Some growers have found it satisfactory to pull a harrow with the teeth pointed back across the rows. The harrow teeth uproot weak old plants that are not well established and leave large healthy plants that have extensive root systems. Other growers plow or destroy the middle of the row or use a flail mower to thin out the planting. Plantings on ridges are hard to thin.

- 8. Cultivate to remove weeds.** This is the time to remove competing weeds from the planting. Most herbicides cleared for bearing strawberries have only preemergence activity. A cultivation made several days after narrowing the rows helps remove weeds that have re-rooted.
- 9. Apply a preemergence herbicide.** This is a critical step. If you apply the herbicide properly, you can save considerable time, labor, and money in weed control. Consult Extension publication ID-94 for specific recommendations.
- 10. Irrigate to activate the herbicide and promote plant growth.** Irrigation at this time, particularly if the season is dry, is especially helpful in providing nutrients for the plants and stimulating new growth. Irrigation or rainfall is necessary to move the herbicide into the soil and activate it. In a sandy soil, 25 percent of the strawberry plant roots are in the top 3 inches of soil and 50 percent are in the top 6 inches.

Following renovation, examine the planting weekly and control insects, diseases, and weeds as needed.

Fall Nitrogen

Frequently strawberries may benefit from an application of a nitrogen fertilizer in late August. Several studies show that where moisture and temperature are not limiting factors, the number of flower clusters, number of flowers, and size of berries depend on the nutritional conditions within the plant during the preceding late summer, fall, and winter and are virtually independent of soil fertility during spring and at the time of fruiting. Nitrogen-starved plants will set as many flowers per plant as those with adequate nitrogen if a nitrogen application is made at least three weeks before fruit buds form in the fall.

Other tests show that nitrogen applied in the fall has little effect on yield. This inconsistency between studies results from wide differences in soil types and varietal response. Thus, making a general recommendation is impossible. Strawberry plants that are small with light yellowish-green leaves or that show a reddening of the leaves and petioles are likely to be deficient in nitrogen. For this condition, apply about 120 to 150 pounds of ammonium nitrate or its equivalent in other nitrogen fertilizers August 15 through September 1. Usually, the nitrogen applied at renovation is adequate.

Apply fertilizer when the plants are dry, and brush it off the plants immediately; otherwise, serious foliage burn will result.

Spring Nitrogen

Do not apply nitrogen during spring of the fruiting year; to do so can seriously cut yields and reduce fruit firmness. On bearing plantings, apply nitrogen only at renovation and in the fall if it is needed.

Day-Neutral Strawberries

Day-neutral strawberries can initiate flower buds under any day length. Flower buds continue to form as long as the temperature is not too hot or too cold. The fruit quality of day neutrals does not equal that of the better June bearers. Presently, day-neutral strawberries should only be considered for home use or on a trial basis for commercial production. Hot weather has tended to limit fruit set and reduce fruit firmness and berry size for summer and fall production in Kentucky. The use of site selection, mulch, and timely irrigations to lower soil and air temperatures might lead to higher fall yields and larger-sized berries. First-full-year production records of 10,000 to 18,000 quarts per acre have been obtained at experimental sites in Kentucky. Supplemental irrigation is essential.

Ground Preparation

Apply manure if available and plow the ground, preferably in fall. Prepare a good bed and set plants in early spring.

Planting

Plant the crown flush with the soil surface in a hole big enough for roots to be fanned out. Firm the soil around the roots, and water the plants in.

Planting Distance

Set plants in rows with the plants spaced 2 feet apart. Rows should be 4 feet apart. Allow a matted row to develop that is 10 to 14 inches wide. Fertilize with 50 to 60 pounds per acre of nitrogen plus the recommended phosphorus and potassium before establishing the planting. During the second year, 25 to 50 pounds of nitrogen per acre can be applied following spring harvest (mid- to late June). If weeds or leaf spot diseases are problems at this time, renovate as you would for June bearers.

Culture

- Cultivate approximately one month after planting.
- During the first two months after planting, pinch off the flowers. This allows day neutrals to direct their energies into root growth and runner production. After that time, let the plants flower and produce berries for a fall crop.
- Mulch with 1 to 1.5 inches of any kind of sawdust or straw about one month after planting. Mulch not only helps keep out weeds but also helps keep the soil cooler and encourages fall fruit development. However, make sure that you don't smother the plants with too much sawdust, as it hardens after it gets wet.
- Hand weed as necessary.
- Irrigation is critical. Irrigate often with a medium amount of water. Light irrigations during the early afternoon on hot summer days (temperatures above 85°F) may help fruit bud development and berry size.

If moisture is adequate and soil and air temperatures near the plants can be kept below 85°F, you can easily get yields of 4,000 to 6,000 pounds per acre during the first fall. Spring yields the next year will average 15,000 to 20,000 pounds per acre. Initial berry size for Tristar and Tribute, 0.40 and 0.30 ounces respectively, are slightly less than the 0.55 ounces of Redchief harvested at the same time (Table 4).

Size of Plot

If moisture conditions are favorable, 25 to 50 plants should furnish enough fruit during late August, September, and part of October (or until frost) for the average-sized family. This plot requires a minimum area of 35 to 70 square feet.

Labor Requirements

Day-neutral strawberries require more labor than June-bearing cultivars since the harvest extends over a longer period. Daily yields are also lower than those of June-bearing strawberries.

Table 4. Recommended day-neutral or ever-bearing strawberry cultivars for Kentucky.

Cultivar	Season	Resistance to: ¹					Productiveness	Size	Freezer Rating	Firmness
		Red Stele	Leaf Spot	Leaf Scorch	Verticillium Wilt	Powdery Mildew				
Tristar	early	R	R	R	R	R	G	small-medium	G	firm
Tribute	midseason	VR	R	R	R	R	G	medium	G	firm

¹ Resistance ratings: R = resistant, MR = moderately resistant, VR = very resistant, S = susceptible, VS = very susceptible, T = tolerant, — = unknown, G = good.

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