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By

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Growing Strawberries in Minnesota

E. M. Hunt

STRAWBERRIES are one of the most prized fruits used in Minnesota homes. Compared with other fruits, they are a short-time crop, the everbearing type often bearing fruit within 3 to 4 months from the planting date.

Although home plantings have been successful in most parts of Minnesota, nearness to market, soils and sites, and the supply of labor should be considered before plantings for commercial production are established. In considering all these together, often a disadvantage is outweighed by other advantages. For example, low production costs resulting from fertile soil, efficient labor, or inexpensive irrigation facilities may enable a grower to operate successfully even though the berries must be transported a hundred miles or more to market.

Strawberries require intensive care but are well adapted to many systems of culture and many types of soil. Successful production depends a great deal on the yield and quality of fruit; these in turn depend considerably on the intensity of culture. Although complete figures for the state are not available, it is estimated that the average yield per acre is approximately 1,500 to 2,000 quarts. With proper attention to planting site, soil, varieties, and culture, this yield can be materially increased.

Yields of 3,000 quarts per acre might be considered satisfactory. However, it is not uncommon for growers using the best soils and intensive methods to obtain yields as high as 6,000 quarts per acre.

Whether one is to grow strawberries for home use or for commercial purposes, the most satisfaction and profit will be realized when high yields are obtained. The principles and practices that, to a large extent, determine yields are the same in both cases.

Planting Location Important

The planting site for the home strawberry patch often depends upon available space in the garden and convenience to the house. However, if a choice is possible, considerable attention should be given to the selection of the site.

Select ground which is sufficiently level to avoid severe washing and yet has enough slope to insure ample air and water drainage. A slope which has a fall of approximately 2 feet per 100 feet is satisfactory.

The root system of a strawberry plant is fibrous and shallow, most of the roots occurring in the top 6 inches of soil. Because of its restricted area, the root system requires a readily available water supply, yet considerable damage will result if the soil becomes waterlogged.

During the winter months surface drainage is important because there is danger of injury to the plant crowns if

water stands for any appreciable time or if ice sheets form.

Plantings that are elevated slightly above the surrounding country often escape frost damage which would be serious on lower land. Lowland sites are somewhat dangerous, especially for early flowering varieties, because of the draining-in of cold air from surrounding country. In spite of frost danger, strawberries are sometimes grown on flat lowlands, the higher expected yields on rich moist soil somewhat compensating for the danger of losing the early crop.

If early ripening is desired choose a southern slope. Although earlier, it will be warmer and drier and will perhaps need irrigation if yields are to be kept up. For late varieties in which the lateness of the blossoms avoids some danger of frost injury, a northern exposure or a well-drained bottom-land site may be used. The cooler, more moist site should be more productive.

No One Ideal Soil

Strawberries can be grown on almost any soil that is reasonably fertile, retains moisture, and is well drained. There is no one ideal soil as the requirements of varieties and localities differ. However, a fertile sandy loam has many advantages. It is easy to work, does not bake, and retains moisture well. Clay soils are usually more fertile and retain moisture better, but they are often poorly drained and tend to bake unless handled carefully.

Sandy soils, unless well prepared by heavy applications of some form of organic matter, are usually the least desirable as they have neither the moisture nor the fertility to produce satisfactory yields.

Well Fitted Ground

Essential for Strawberries

Unlike most other fruit crops, strawberries are a short time investment, because they seldom occupy the ground for more than three years. For this reason, the ground should be well fitted for strawberries before planting rather than attempting to build up the soil after the planting is established.

The soil conditions required for strawberries are: good structure, abundant moisture, and a readily available supply of plant food. These conditions are mainly dependent on the amount of organic matter or humus in the soil.

A soil which works easily and which does not "puddle" or bake is said to have good structure. The organic matter, or humus, which gives the soil this structural quality also acts as a sponge to regulate the moisture supply. Such a soil enables the plants to meet the tremendous demand for water while the fruit is developing. Finally, the soil is dependent mainly on the organic content for its fertility. Due to bacterial action, the humus slowly breaks down, creating chemical conditions which release food.

Since important requirements for strawberry growing are fulfilled by the presence of large quantities of organic matter, any soil lacking in this material should be built up by the use of green manure crops or farm manures before plantings are established.

Strawberries Fit in Rotations

For several reasons strawberries should not remain on the same ground more than three years. Weeds and in-

sect and disease pests must be controlled, and a high humus content must be maintained. Since strawberries are a short-time fruit crop, they fit in well with a rotation.

Strawberries usually should follow corn, potatoes, or a similar cleanly cultivated vegetable crop. The best rotation will depend largely on the soil and the adaptability of the various crops to it. A common rotation is clover two years, potatoes or sweet corn one year, strawberries two or three years, followed by grain and clover.

If a definite rotation is not followed, the organic content of the soil can be built up by applications of barnyard manure or by plowing under green manure crops such as rye, soybeans, or buckwheat. To obtain the greatest possible amount of organic matter, the green manure crop should be allowed to make considerable growth but should be plowed under in early fall.

Manure Is Ideal Fertilizer

Nitrogen is one of the most needed food materials for strawberry growing. Farm manures contain much nitrogen along with other essential elements and a large amount of organic material. Applied on sandy soils they increase the water holding capacity and on clay soils they improve the texture and prevent stickiness and baking. These qualities make manures ideal general-purpose fertilizers. If manure is well decomposed it may be applied to land the season the planting is established. In this case, it should be applied to the plowed ground in the spring and worked into the soil by disking or harrowing before the plants are set. Coarse strawy manure or manure which may contain weed seeds should be applied only to soil in preparation for the crop preceding the strawberries.

Two vegetable crops, heavily manured, followed by strawberries, is a good short rotation if longer rotations including clover or green manure crops are not practical.

The usual application rate for manure is from 10 to 20 tons per acre, depending on the type of manure and the condition of the soil. Poultry manures should be used at the rate of only 5 to 10 tons per acre as they are very concentrated and may damage the plants if applied at a heavier rate.

Commercial Fertilizers

Definite recommendations for the use of commercial fertilizers cannot be made as results are extremely variable depending on soil type, previous treatment, and other factors. Soil which has been maintained with a high humus content either through the use of manures or green manure crops will probably give little response to additional chemical fertilizers. In some cases, however, the food elements—nitrogen, phosphorus, and potash—may be seriously lacking. In such instances commercial fertilizers may be used profitably.

Nitrogen is the food element most apt to be deficient. Slow growth coupled with light green leaves later turning reddish are the usual growth symptoms of nitrogen deficiency.

Similar symptoms from other causes are common. If nitrogen deficiency symptoms appear and are not obviously the result of drouth, disease, or insect pests, applications of a readily available nitrogen fertilizer will be beneficial. A readily or quickly available fertilizer is one whose benefits or results are available soon after it has been applied.

Deficiencies of phosphorus and potash are less common. The symptoms

are not easily detected, and applications of these elements are usually made only after soil analysis or test plots have shown a definite need for them.

Fertilizers, such as superphosphate, which become available to the plants rather slowly, are usually applied broadcast, and worked into the soil by disking or harrowing before planting. Quickly available nitrogen fertilizers such as ammonium sulphate and sodium nitrate will be used more efficiently if applied as a side dressing after the plants are established. They may be placed in shallow furrows made with a cultivator or hoe on each side of the row, 5 or 6 inches away from the plants.

Care must be taken to avoid actual contact of the fertilizer with any part of the plant or severe injury may occur.

Time of Application—Commercial nitrogen fertilizers will usually produce the best results when applied early in the year the plants are grown, that is, the year previous to fruiting. Fruit bud formation in June-bearing varieties takes place during the early fall and is dependent mainly on a vigorous plant growth and adequate food reserves. Nitrogen applications during the spring of the fruiting year give little or no increase in yield and may delay ripening.

Phosphorus and potash in commercial fertilizers will be of most value if applied the year previous to setting the strawberry plants.

General Recommendations—If commercial fertilizers are needed, the following applications are suggested for use on a trial basis:

SUPERPHOSPHATE—Apply 500 pounds per acre in the spring when preparing the ground for planting; omit if a simi-

lar application has been made to a previous crop in the rotation.

MURIATE OF POTASH—Usually needed only on light sandy soils. Apply 100 pounds per acre when preparing the soil for planting.

AMMONIUM SULPHATE—Apply 200 pounds per acre ($1\frac{1}{2}$ to 2 pounds per 100 feet of row) as a side dressing two weeks after the plants are set in the spring. Repeat this treatment about August 1.

Mixed Fertilizers

If a fertilizer containing the three food elements, nitrogen, phosphate, and potash, is desired, 4-8-6 fertilizer may be applied 1,000 pounds per acre (approximately 10 pounds per 100 feet of row).

Apply in a similar manner and at the same dates suggested for ammonium sulphate. The nitrogen in such a fertilizer will be used within a short time, but it is doubtful if the phosphorus and potash will benefit the plants until the following year unless applied very early in the season.

Lime Seldom Necessary

The use of lime in preparing land for strawberries is seldom necessary. Experimental work and observations of strawberry soils in many states show that strawberries are highly tolerant of acid and will grow well on neutral or slightly alkaline soils. Soils which are suitable for most other agricultural crops in respect to acid reaction will be satisfactory. On extremely acid soils some other crop in the rotation such as clover may benefit from the application of lime. In this case it will be best to apply it preceding the crop for which it is intended.

Productive Stands..

Depend on Grower's Care

In plantings of June-bearing strawberries one whole year is required to prepare the planting for the one or two crops which follow. If the enterprise is to be profitable, close attention must be paid to every detail that will insure a good stand of producing plants for the crop year.

Plant Strawberries in Early Spring

In Minnesota early spring is the best time to set strawberry plants. If possible, begin preparation of the ground the previous fall so that it will be in condition for planting at the earliest possible date in the spring.

Considerably lower vigor and plant-making ability, as compared with early set plantings, has been observed in fields in which the planting date was delayed as little as two weeks.

Summer or fall planting is not recommended. Plants set during the summer usually produce a poor stand of runner plants. Most of these are formed too late to produce fruit buds for a satisfactory crop the following year.

Fall set plantings do not have sufficient time to produce runner plants in the fall, and, therefore, no crop can be expected the following spring. The fact that fall set plants are already in the ground in the spring may enable them to take advantage of early spring growing weather. This advantage is probably offset by the danger of winter injury and the cost of two mulchings before a crop is harvested.

Prepare Soil Thoroughly

Thorough preparation of the soil is essential for strawberry planting. Land which has been in sod or which has lain idle will benefit from the growing of cleanly cultivated crops one or two years before planting strawberries. This allows sufficient time for rough organic matter to break down and decreases the number of grubs and other insects. Where danger of erosion does not prevent the practice, fall plowing is preferable. Light soils can be suitably handled by early spring plowing. Double disk and harrow before planting in the spring. Plank or roll ground which is very loose. This will make marking the rows for planting easier and will insure good contact between soil and roots.

Choose Healthy Plants

Plant only well developed healthy plants that were formed from runners early the previous season. Discard plants which have woody, blackened crowns as they are either old plants or have been injured. They will not be vigorous in either case. The roots should be vigorous and 3 to 5 inches long. They should have a fresh appearance and should be white or straw color.

If home grown plants are used, dig the whole width of the row. Discard the old plants with woody crowns obtained from the center and the small late-formed runner plants from the outer edges. Be careful to dig deep enough to avoid pulling off the bottom portion of the roots.

When plants are purchased, patronize a reputable nurseryman who can be depended upon to furnish well-grown plants true to variety name. Order early and specify that the plants be



FIG. 1. CHOOSE GOOD PLANTS

(Left) Old plant with woody, dark crown and dark roots. (Right) Young plant with light crown and vigorous roots.

delivered at the earliest possible planting date for your locality.

A local nurseryman can usually give the best service because he knows conditions in your locality and requires shorter transportation time for delivery.

Care Before Planting

One of the advantages of using home grown stock is the short time required from digging to resetting. A common cause of failure is improper handling of planting stock received from nurseries. As soon as the plants arrive, unpack and examine them. If possible plant them immediately. If the roots are cool and moist, the plants may be stored for one to two days in a cool place, such as a vegetable cellar. If the plants are warm or dry when unpacked, soak the roots for an hour in water. Then if they cannot be planted immediately, open the bunches and heel in. For this operation select a shady location where the soil is moist but well drained. Open a "V" shape

trench about 6 inches deep. Line the single plants against one side of the trench with the roots well spread, the crowns level with the top. Replace the soil firmly against the roots to prevent drying. Avoid covering the top of the crowns, or they may rot. If the soil is dry, it may be watered occasionally, care being taken not to wash soil over the crowns.

If Possible, Set Plants Directly

When properly heeled in, plants may be kept in good condition for two weeks or longer. Nevertheless, heeling in should be considered as merely a temporary planting, and the sooner the plants can be moved to the permanent field, the greater will be their chance to succeed. Proper heeling in of strawberries involves considerable labor. If possible, have the ground prepared and set the plants in the field directly when they arrive.

Training Systems...

Determined by Planting

Matted Row System.—In Minnesota, June-bearing varieties are planted almost entirely in the matted row. The recommended spacing for rows for horse cultivation is 4 feet, with the plants 20 to 30 inches apart in the rows. Variations are sometimes made depending on the soil and the tendency of the variety to produce runners.

The runner plants are allowed to spread in all directions, the width of the row being limited by cultivation. Unless runner restriction through cul-

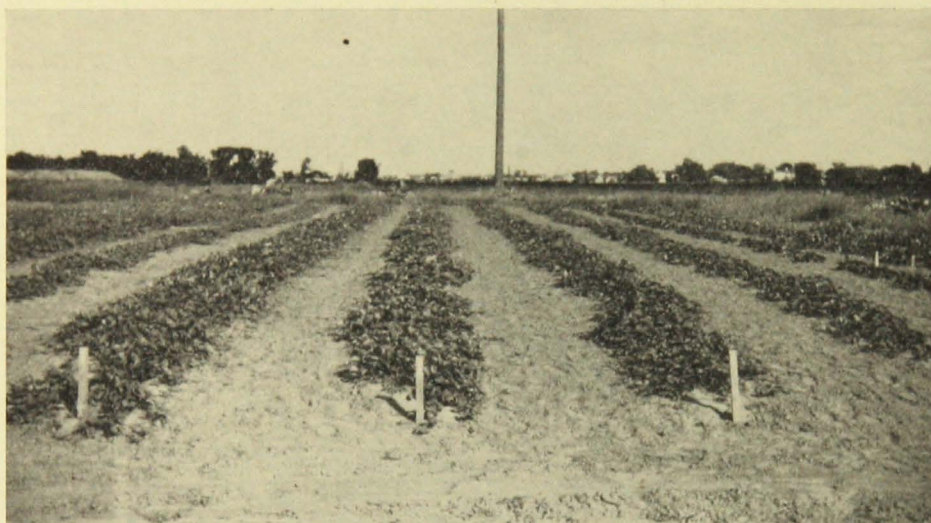


FIG. 2. ONE SEASON'S GROWTH OF MATTED ROW SYSTEM

tivation or other means is rigidly carried out, the runner plants will tend to fill entirely the alleys between the rows. In general a matted row 18 to 20 inches wide is preferable to one wider. Although the wider row may produce a slightly higher yield, there will be many undersized berries. Nearly as much fruit will be produced in the narrower rows, and the fruit produced will be much higher in quality and much easier to pick.

Hill System.—In the hill system all runners are removed as soon as they appear, and the original plants are encouraged to stool out, producing large crowns.

The hill system offers the advantages of cross cultivation, maximum berry size, and ease of picking. Because of the large amount of labor required in maintaining the system, it is seldom used in growing June-bearing varieties but is used extensively with ever-bearers. Amateur home gardeners and commercial growers who practice intense cultivation in order to produce

a fancy product may occasionally use the hill system for June-bearers. A row spacing of 3 to 4 feet and 15 to 18 inches between the plants in the row might be used.

Estimating Needed Plants

To calculate the number of plants needed for a given area, divide the number of square feet in the area by the product obtained when the distance between rows is multiplied by the distance between plants in the row, using feet as the unit of measurement. The number of plants needed for an acre can be calculated by dividing 43,560 (the number of square feet in an acre) by the above product.

For example, the area to be planted measures 26 feet x 100 feet. $26 \times 100 = 2600$ —the number of square feet in the area. The plants are to be set in rows 4 feet apart and spaced 2 feet in the rows. $4 \times 2 = 8$ —the space occupied by each plant. $2600 \div 8 = 325$. Therefore approximately 325 plants are needed to plant the area.

By this method it is seen that nearly twice as many plants are required to plant an acre by the hill system as are needed for the matted row. This is an added expense which should be considered in choosing the culture system.

Trim Plants Carefully

Before planting, remove blossom buds, runner cords, and dead or diseased leaves from the plants. Save only two or three small healthy center leaves. Pruning in this manner will reduce evaporation from the tops giving the plant a better chance of survival until the roots can establish themselves.

If the roots are so long that they interfere with planting, shorten to 4 inches.

Setting the Plants

Be sure the soil has been worked sufficiently to provide a smooth, well-worked surface with the under soil fairly compact. Straight accurate rows give good appearance and facilitate cultivation. Usually the rows are marked, and the distance between plants is estimated in setting the plants. Marking can be done with lines in small plantings; however, for large plantings, a wooden marker of the sled type will save much labor.

If possible, set the plants on a cool cloudy day. Provide a suitable carrier for the plants such as a basket lined with damp moss or a moist sack, or a bucket partially filled with water. Take only a few plants at a time from the heeling-in bed or storage place.

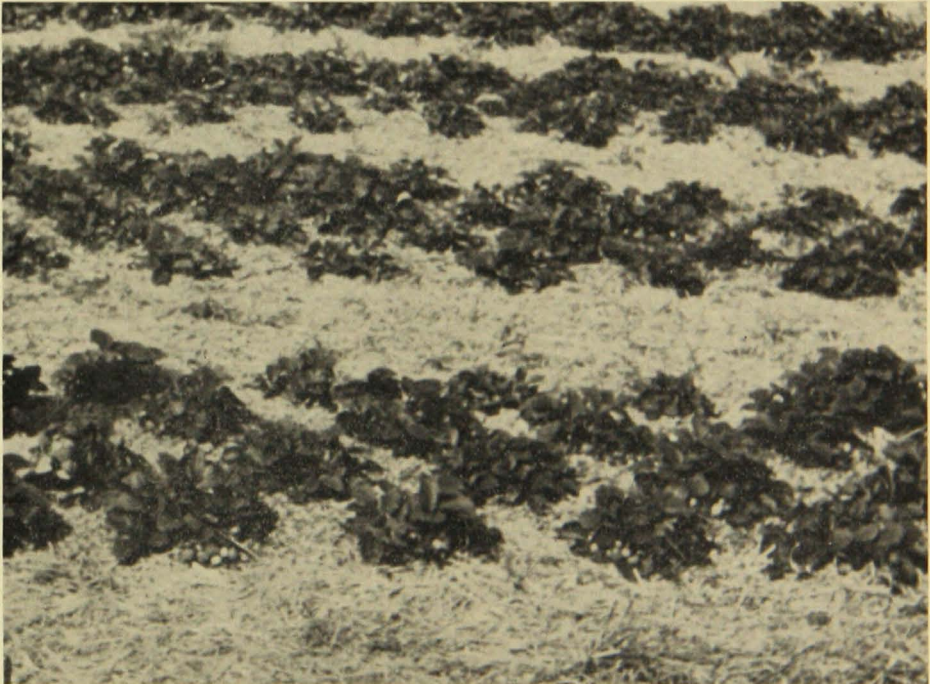


FIG. 3. EVERBEARERS IN MULTIPLE HILL SYSTEM WITH PICKING AISLES BETWEEN

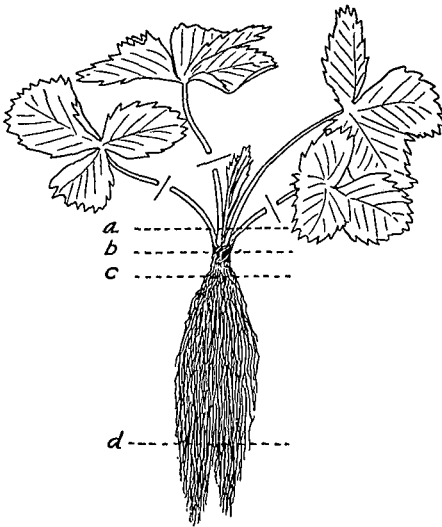


FIG. 4. PLANT SHOWING PRUNING AND DEPTH OF PLANTING

- a. Planted too deep.
- b. Planted correctly.
- c. Planted too shallow.
- d. Pruning of root.

Strawberry roots are susceptible to drying out and should be protected at all times from the sun and wind.

When home grown plants are used to set a small area, a hand trowel is sometimes used to dig the plants in order to carry considerable soil intact with the roots. This method, although practical for only a few plants, insures transplanting with practically no loss from drying out.

Strawberry plants are usually set with a hand dibble or with a spade. Insert the blade of the tool into the soil nearly its full length. By a backward and forward movement make a wedge-shaped opening. Spread the roots of the plant and place in the opening. Remove the spade or dibble and insert again about 3 inches behind the plant. By a forward thrust, force the soil firmly against the roots.

Observe These Points

Two points in setting the plants must be carefully observed: First, the soil must be firmed around the roots so that good contact is made with the soil moisture; and second, the plant must be placed at a depth where the soil surface is level with the center of the plant crown. If the plants are loose or if they are planted too high they will dry out. If planted too deep the crowns will rot.

Good Summer Care

Essential to Large Yields

The strawberry grower's job the first summer is to grow a crop of plants. The stand of plants and their vigor will determine, to a large extent, how well he will be rewarded, not only for this year's work but for next year's work as well. Special attention must be given to cultivation, removal of flowers, and development of a well-spaced system of plants.

Start Cultivation Immediately

Begin cultivation immediately after planting. Cultivate rather deep the first time in order to loosen the ground which has become packed in the planting operations. Subsequent cultivations should be increasingly shallow, the object being merely to keep the ground free from weeds and the surface loose so that runner plants can root. For each successive cultivation the cultivated strip will become narrower due to the rooting of runner plants. When the desired width of row is reached, addi-

tional runner plants must be prevented from rooting. A sharpened disk or "runner cutter" may be attached to the cultivator or may be run along the edge of the rows by hand. In small plantings the surplus runners may also be removed by hand or with a hoe.

If cultivation alone is used to keep the rows at the desired width, there is danger of merely turning the late formed runners back into the row rather than destroying them. This may result in the proper width of a row, but there will be an undesirable crowding of worthless plants along the edges.

Much hand weeding and hoeing among the plants in the row will be necessary in order to remove weeds, keep the soil soft for rooting, and assist in the spacing of plants. Continue shallow cultivation and weeding until late in the fall as the planting must be absolutely free from weeds if best results are to be obtained during the fruiting year.

In the hill system of culture remove all runners during the entire season leaving only the original plants. If the plants are "checked" in at sufficient widths, cross cultivation can be practiced eliminating considerable hand weeding.

Remove Flowers

Many of the plants will produce flower stalks soon after they are set in the field. Remove these, preferably before the flowers have opened. If the flowers were left and the fruit allowed to develop, there would be no appreciable crop. The production of even this small crop, however, would seriously hamper the production of runner plants, generally reduce vigor, and result in a poor crop the following year. Remove flowers from everbearing plants the first year until July first.

Spacing and Thinning Plants

One of the faults of the matted row system arises from the fact that most varieties under normal conditions produce far too many runner plants. This results in the crowding together of many more plants than the soil area can properly support. It is not uncommon to find 20 or more plants per square foot. Best results are usually obtained when the plants are spaced about 6 inches apart or from four to six plants per square foot. Additional plants may be thought of as weeds because they merely compete with the other plants for food, water, and light. A reduced yield of low grade berries results.

Experimental results in several states have shown that proper spacing has increased yields up to 45 per cent. Most of the increase in yield brought about by spacing is due to a higher proportion of large berries which in practical terms means more number one grade fruit and a higher market value.

Although experimental work has demonstrated the desirability of well spaced plants, how far the grower can go in carrying out a definite spacing system is an individual problem. Because of the great amount of labor required, it is doubtful if most growers can afford to keep the plants spaced at the optimum distance. On the other hand, probably no grower can afford to ignore certain practices such as keeping rows reasonably narrow and destroying some of the late formed runners by weeding and hoeing.

Late formed runner plants can economically be prevented from rooting by raking the row with a stiff toothed rake late in September. Large fields may be harrowed with a spike tooth harrow, the teeth slanting back enough to avoid digging out well rooted plants, but dislodging new, poorly rooted plants.

Mulching Needed...

Serves Many Purposes

The value of mulch in keeping the fruit clean would justify its use even if there were no other benefits.

Occasionally winter weather conditions are such that unmulched plantings survive the winter in as good or better condition than mulched plantings. Do not be misled by this occasional occurrence. Most years mulch is needed for winter protection and in addition serves the following purposes:

1. Prevents injury to crowns from severe late fall freezes.
2. Prevents heaving due to alternate freezing and thawing of the ground during the late fall, winter, and early spring.
3. Prevents the plants from drying out during the winter.
4. Prevents too early starting in the spring, which might be followed by frost injury to the blossoms.
5. Makes straw, after adjustment in the spring, available for frost protection in case of late killing frosts.
6. Conserves moisture from the time the plants are uncovered until the berries have been picked.
7. Keeps down weeds.
8. Keeps the berries clean and makes a clean place for pickers to work.

Materials for Mulching

The ideal mulch material should possess the following characteristics:

1. It should be free from weeds or weed seeds.
2. It should spread evenly.
3. It should settle sufficiently to pre-

vent blowing, yet mulch should not pack so that it excludes the air.

4. It should contain a small amount of fine material which can be worked in around the plants.

Wheat straw and short marsh hay are satisfactory mulch from the standpoints listed above. Wheat straw is probably most commonly used. However, some growers prefer marsh hay because it is usually free from weed seeds. Straw, unless old, is also apt to contain some grain which may grow and be troublesome the next spring. Other materials such as oat straw, rye straw, buckwheat, leaves, and shredded cornstalks have been used successfully, but they are usually inferior to wheat straw or marsh hay.

Time of Application

In Minnesota mulch is usually applied during the latter half of October. No definite date can be set because the time of application should be governed by the temperature and previous exposure of the plants to frost rather than by the calendar. Recent experimental work has shown that soil surface temperatures of 20° F. may cause injury. Allowing the ground to freeze before applying the mulch, therefore, is not safe since considerable injury may already have occurred. On the other hand, the experiments show that subsequent resistance to cold is dependent on previous exposure to frosts at a temperature above 20° F. Too early mulching may, therefore, be as undesirable as too late mulching. Apparently mulch should be applied only after the plants have been exposed to several frosts and growth has stopped, but before they have been exposed to temperatures lower than 20° F.

It is obvious, then, that the ideal period for mulch application may be



FIG. 5. REMOVING STRAW MULCH IN THE SPRING

rather short some years and may vary considerably from year to year.

Apply enough mulch to leave a 2-inch layer after settling. This will require approximately 2 tons per acre.

Removing the Mulch

Most growers prefer to leave the mulch on as long as the plants are dormant. Early removal will sometimes encourage the production of early fruit; however, in Minnesota the danger of frost injury to the blossoms is so great that it is usually advisable to hold the plants back as much as possible. As soon as growth starts or there is evidence of slight yellowing of the leaves, the mulch must be removed. Place half or more of the mulch material between the rows and tramp it down. The remainder may be loosened and spread lightly over the tops of the plants. As the leaves grow through,

this will settle to the ground around the plants protecting the fruit from dirt.

No cultivation is necessary in the spring of the fruiting year. If the planting has been properly cared for the previous year, only a few weeds will be present and these may be pulled by hand.

Irrigation Helpful During Dry Weather

A crop of strawberries is seldom harvested without the planting at some time having suffered from lack of water.

Dry weather during planting or runner production may cause a poor stand of plants. During the fruiting season, strawberries require large quantities of water. Lack of water at this time may shorten the picking season and may greatly reduce the grade through the production of many small berries. Some growers find overhead irrigation useful in warding off light frost which might injure blossoms. Because of these benefits, many intensive growers who have an adequate water supply have found irrigation profitable. Others for various reasons do not feel that the cost of installation is justified. The cost per acre for the installation of overhead irrigation varies greatly depending on the water supply, the type of equipment, completeness of coverage, and the size of the field irrigated. Systems have been installed costing from \$50 up to \$350 per acre. Surface and porous hose systems are less expensive to install, but they are usually unsatisfactory except on very small plantings.

Harvest Season....

Brings Many Problems

In Minnesota strawberry harvesting usually begins sometime in mid-June and continues for three to five weeks. The harvesting period will, of course, be somewhat dependent on the variety, section of the state, and the weather conditions.

To the grower of strawberries for home consumption, harvesting and packing problems are of little concern since the product will not compete with that of other growers and will be consumed soon after picking. The commercial grower, while keeping his operating costs reasonable, must produce an attractive product of standard quality which can be depended upon to reach the ultimate consumer in good condition. He must, therefore, give as much consideration to harvesting operations as to the cultural practices which produced the crop. A discussion of marketing problems can be obtained by requesting General Bulletin 332 "Market Outlets for Minnesota Fruits," from the University Farm, Bulletin Room, St. Paul, Minnesota.

Since pickers are likely to be of different ages and abilities, considerable supervision is usually necessary. The foreman must see that picking instructions are carried out, assign rows, check the fruit picked, and attend to many other details.

A large enough crew should be engaged to pick the entire planting every day or at least every two days. Too long a picking interval allows some of the fruit to become too ripe. Overripe berries will not stand shipment. A few

of them may greatly lower the grade of the whole pack.

The rate of pay should be high enough so that the pickers will feel that they can afford to pick clean and separate the culls if necessary.

Pick While Fruit Is Cool

The best time to pick is early in the day while the fruit is cool. However, during the heavy picking season it may be necessary to continue through the warm part of the day. This will not be particularly harmful if the berries are removed immediately to a cool place where there is good circulation of air.

A temporary shed which consists of a roof supported by posts, or a stand or table placed in the shade of a tree where there is good air circulation, will allow berries to cool faster than a cool cellar in which there is poor air circulation.

Berries which will reach the consumer 12 to 24 hours after picking are picked in a full red or nearly red stage. Berries for longer shipment are picked in a slightly less mature stage with considerable white showing.

The fruit should be picked, not pulled or jerked from the stem. Pickers should be trained to pinch the stem between the thumb and forefinger so that the berry is removed intact with the hull and a short piece of stem. Do not allow pickers to hold too many berries in the hand at one time or to drop the fruit carelessly into the boxes. Bruised berries or berries without hulls will not stand up long after picking. For ease of picking and protection of the berries, box carriers are usually provided. These should be of light wood fitted with a convenient handle. They should hold from four to eight quart boxes. (See cover page.)

Grading and Packing

To obtain top prices some grading will be necessary. Ordinarily no grading is done except that the pickers, in the field, place damaged, small, or misshapen berries in separate boxes.

It is usually less costly to do the necessary grading at the time of picking rather than later as a separate operation. The grower can afford to hire only dependable pickers, paying a higher price per quart or paying by the hour if necessary when the condition of the berries is such that extra care is needed. Slightly increased picking cost may save a costly separate grading or may avoid the necessity of selling the whole picking at an unprofitable price because of inferior grade.

Grading is done separately only when the pack coming from the field is very low grade or when the grower finds it profitable to maintain his reputation for selling only a very high grade pack. In this case the fruit is taken to a packing shed where each box is emptied on to a tray for examination. Berries that are under-colored, soft, or damaged in any way are removed, and only high grade fruit is returned to the box and sold in the usual market. The lower grades are usually sold at a reduced price.

A few growers produce a fancy pack by grading and "facing" the boxes. The top layer is selected for uniformity and carefully arranged in rows with the tips all in the same direction. A neat label or band may be placed across the top layer bearing the variety name and the name of the grower.

Strawberry Crates

Both 16- and 24-quart crates are used in Minnesota, the 24-quart crate being more common in the Twin City area.

Ventilated crates having a center deck or partition on which the top layer of boxes rests are recommended. This provides for better air circulation and prevents bruising the lower layer of fruit. The ventilated crate is especially suitable for berries shipped long distances.

In many years when the strawberry crop is heavy a shortage of crates develops. It will be wise to order crates early as manufacturers cannot increase output for sudden heavy demands.

Renewal of Planting

Improves Second Crop

Some growers prefer to harvest only one crop from a planting, plowing it up immediately after harvest. Others find it profitable to retain the planting for a crop the second year. The cost of preparing ground and purchasing and setting plants is thus avoided. If the soil was well prepared before the planting was established; if weeds, diseases, and insects were well controlled; and if a proper renewal procedure is followed, satisfactory results may be expected the second year. It is seldom advisable to keep the planting for a third year.

Undoubtedly many plantings are retained for a second fruiting which should have been plowed out, the low yield of small unattractive berries being much inferior to the first crop. The decision to fruit a planting the second time should be made only if the plants are in a healthy vigorous condition and a thorough job of renovating can be done. If the soil is extremely dry, it will not work properly. Also the plants

will be slow to recover from the operation and probably will not produce vigorous growth in time to form sufficient fruit buds for next year's crop.

As soon as the spring crop is harvested, remove the excess mulch from between the rows. If the mulch is in good condition, it may be saved and used again in the fall. Finely broken up portions of the mulch may be left on the field to be incorporated into the soil. Mow the planting with a scythe or mowing machine cutting as close as possible to the ground without injuring

the plant crowns. Rake the plant tops from the field and burn, the object being to destroy leaf spot organisms which might otherwise overwinter on the old leaves. With the aid of a heavy cultivator or plow, narrow the rows to 8 inches. Cultivate the aisles until they are level and free from weeds. By hoeing or hand weeding, space the remaining plants in the row approximately 12 inches apart. Save only strong runner plants, destroying the old plants with woody crowns and the late formed small runner plants.

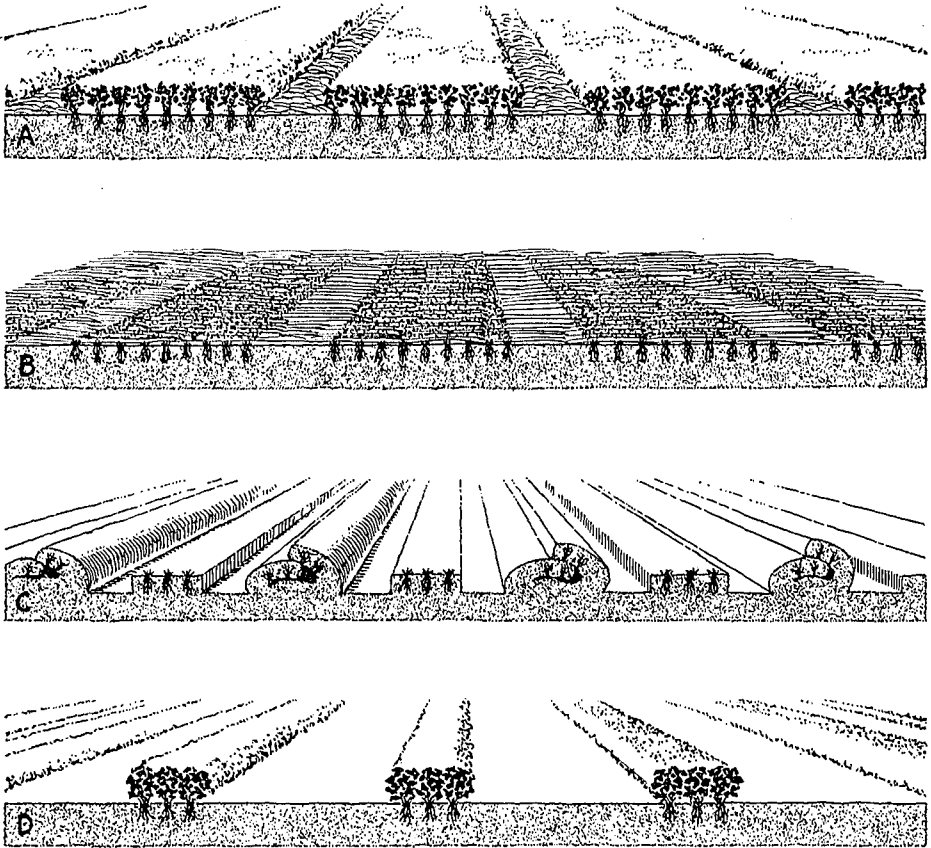


FIG. 6. RENOVATION OF OLD STRAWBERRY BED

- (a) Rows and mulch before renewal.
- (b) Tops cut and burned with most of mulch.
- (c) Plowing under strip from each side of row.
- (d) Healthy new foliage.

Care Remainder of Season

To insure a satisfactory yield the following spring a heavy stand of vigorous plants must be grown before fall. This will require care similar to that given the planting the first year.

Vigor may be increased by the application of fertilizer. Immediately after narrowing the rows apply a dressing of well rotted manure or ammonium sulphate at the rate of 200 pounds per acre and cultivate into the soil. If preferred, the ammonium sulphate may be drilled along the row or placed by hand near the plants at the rate of 1 to 2 pounds per 100 feet of row. Continue regular cultivation until fall. Hoe or weed the rows several times giving some attention to the spacing and rooting of runner plants. Mulch in the usual manner in the fall.

They require more intensive care than June-bearing varieties. They require fertile soil and more moisture. Irrigation is desirable since fruit is produced during the heat of the summer and during the fall when there may be dry weather.

Planting Systems

The hill system is usually used for everbearers as it is more adaptable to the required intensive culture than the matted row. Rows are usually 3 to 4 feet apart with the hills 15 to 18 inches apart in the rows. Many variations are employed such as close set double or triple rows with picking aisles between the groups of multiple rows.

If the variety is a prolific plant maker, the matted row system with a spacing of 4 feet by 24 inches is sometimes used.

Everbearers

Suited to Home Gardens

Everbearing varieties differ from the standard or June bearers in that they bear fruit almost continuously throughout the summer and fall instead of maturing the entire crop within a three- to five-week period in the spring.

Because of this distribution of fruit over the season, everbearers are especially desirable for home gardens. The fact that plants set in the spring may bear a crop the following fall makes them particularly attractive to the home grower. Although everbearers are grown commercially in special situations, they are not as important as the June-bearing varieties.

General Culture

Everbearers require essentially the same care as June-bearing varieties. Set the plants early in the spring because they are expected to bear the same fall. Remove all blossoms until July 1. Under normal conditions fruit will be produced continuously from August until freezing weather. Apply mulch around the plants at the beginning of the fruiting season to keep the berries clean. Cultivate the soil thoroughly until this time. Mulch the same as for June-bearing varieties.

Care the Second Season

Profitable crops are sometimes produced the second year although the berries are usually smaller than those obtained from the first crop. After producing a fall crop, everbearers cannot be expected to bear a crop the fol-

lowing spring which will compare with that of June-bearing varieties. Although saving everbearers in the hill system for a second fall crop is not recommended, some fruit may be obtained if a fertilizer dressing is applied after the spring crop, and the plants are kept well cultivated until fall. If the matted row is used, narrow the rows and thin out the plants in the crowded parts. Do not mow the tops unless they are badly infected with leaf spot. It is seldom advisable to save everbearers after the second fall crop.

Suitable Varieties..

Vary With Local Conditions

Strawberry varieties vary considerably in performance under different local conditions. Descriptions should not be taken too literally since actual trial of the variety on the soil is the only proof of its suitability to those specific conditions. As a general rule, it will be best to plant those varieties which are already being grown successfully in your locality. Also it will be best to plant as few varieties as possible and still meet your requirements for home use or market. New varieties constantly are being offered for sale. Although some of these merit trial, they should be planted only on a trial basis until they have shown their superiority over proved varieties.

Some varieties are poor pollen makers and must be interplanted with other pollen-producing varieties in order to bear fruit.

Varieties whose flowers do not produce sufficient pollen are said to be "imperfect" or "pistillate." Those

which have sufficient pollen are called "perfect" or "staminate." In planting a pistillate variety, every third or fourth row must be planted to a staminate variety which will mature its blossoms at the same time.

Fortunately, few imperfect varieties are now offered for sale, and none appear on the list of varieties recommended except Minn. No. 1192 which is recommended for trial only.

June-Bearing

Beaver.—Early, good color, very firm. Widely used as a shipping berry because of the fruit's firmness and the plant's productivity. Quality fair but not as high as Premier and Dunlap.

Catskill.—Midseason, large, slightly rough, good quality berry. Plants very vigorous and upright. One of the newer New York varieties meriting trial in Minnesota.

Dunlap.—Until recently it was the most widely planted June bearer in Minnesota. Early, medium-size, good-quality berries. Plant hardy—productive and a good plant maker.

Premier.—Probably the most popular June bearer at the present time. Ripens very early. Productive and hardy—a fair to good plant maker. Berry bright red, fairly firm, good quality.

Everbearing

Gem.—Berry large, light red, slightly rough, fair quality. Attractive because of its size and bright color. Plants very vigorous and productive—sets runners well. A dependable new variety.

Mastodon.—Berry large, fair to good color, soft, fair to good quality. Plant

hardy, very vigorous, productive in some areas. Seems to perform best in northern fruit districts.

Progressive.—Berry medium size, good quality, heavy plant maker. Sets a heavy crop, but the berries do not hold their size under adverse conditions. Until recently was the most dependable and popular everbearer.

Wayzata.—Berry size medium, holds size well through the season. Medium firm, productive, very high quality. Attractive, medium red color. Under some growing conditions it is a very poor plant maker.

Insects and Diseases

Controlled by Good Culture

Several insect and disease pests are found in Minnesota. Ordinarily proper cultural practices make the use of systematic control measures for specific pests unnecessary in small home plantings. However, many commercial growers find a regular pest control program necessary for best results. Such a program is outlined in Extension Folder 69, "Pest Control Program for Fruits in Minnesota," which may be obtained from the Bulletin Office, University Farm, St. Paul. When unusual pests are encountered, it is suggested that latest recommendations for control be requested from the divisions of Plant Pathology and Entomology at University Farm, St. Paul.

Strawberry Insects

White Grub.—The white grub is the most troublesome and injurious enemy

of strawberry plants in Minnesota. The adult is commonly known as the June beetle; it is brown and almost an inch long. The larva, which does the damage, is the whitish worm commonly known as the grubworm or white grub. The grubs destroy the strawberry roots by feeding on them. The damage is usually most noticeable in newly set patches because of the small number of plants, but the injury may be equally serious in older fields.

Control must start two years before the plants are set. The plants should not be set on land that has been in sod for some time. Since sweet clover and alfalfa fields are infected only slightly, soils on which they have grown recently can be used with little danger. During egg laying, the adults feed at night on foliage of shade trees, particularly oaks, willows, and poplars. Avoid fields close to such plantings.

Strawberry Leaf Roller.—Strawberry leaf roller does its damage in the larva stage when it is a slender, active caterpillar about $\frac{1}{2}$ inch long. The adult female, a small brown moth, deposits the eggs near the base of the midrib of the leaf. After hatching, the larva spins a small web, drawing the two halves of the leaf together, and feeds on the inner surface. There are from one to three complete generations in a season. After the leaf is so folded, spraying is useless. Pyrethrum dusts are sometimes effective in this situation. Since pyrethrum is nonpoisonous to man, it may be applied when the berries are ripening if necessary.

The spray control is $1\frac{1}{2}$ pounds of arsenate of lead to 50 gallons of water applied on the leaves before folding has begun. Subsequent applications should be made as new foliage develops in the spring. If there is more than one generation, later sprayings may be

necessary. Mowing and burning of the foliage at renewal time is very helpful in the control of leaf roller.

Strawberry Weevil.—The strawberry weevil is a small beetle that lays its eggs in the blossom bud. After depositing the egg, the female girdles the stem so that it either falls to the ground or hangs loosely by the tissue. The injury from this insect may be very severe, at times resulting in the loss of as high as 90 per cent of the crop. The adult winters over in trash, most frequently in grassy or weedy plots that are frequently found along fence rows and at the edges of a field.

The best control measure is a short rotation in which only one or two crops are taken from a bed of June-bearing varieties, and where the old beds are plowed up immediately after picking the last crop. Locations adjoining woodlots, waste lands, or overgrown fence rows should be avoided, and new plantings should be made far from the old ones. If there is a light infestation and plants are being sprayed with a fungicide for disease control, an addition of one pound of arsenate of lead to 50 gallons of liquid will kill many of these pests. Most effective control will be obtained through proper rotation and avoiding the use of fields close to trash or growth that might provide a place for winter hibernation of the adult weevils.

Ground Beetles and Crickets.—These insects commonly do severe damage to ripened fruits in the field. Should the damage become serious, various poison baits are frequently effective.

Strawberry Diseases

Leaf Spot.—This disease is caused by a fungus. The spots appearing on the leaves are first reddish or purple. As the infected area gradually dies, the spots enlarge and appear brown and dry. Some varieties of strawberries, particularly Dunlap and Progressive, are more susceptible than others in Minnesota.

To control the disease, set out only healthy plants and spray them early in the season with 4-4-50 Bordeaux mixture. If the disease has been troublesome in previous years a second application of Bordeaux mixture on the new foliage is recommended. Careful mowing and burning of all foliage when the field is renewed sometimes gives sufficient control.

Virus Diseases.—Strawberry plants are subject to a number of virus diseases, which cause stunting, yellowing, and other abnormalities. It is impossible to maintain a patch in satisfactory vigor or production when the plants are infected with these diseases. Although they are not generally prevalent in Minnesota, any plants that become infected with them are a hazard to the whole planting. Once the planting is infected no spray or other treatment will be effective.

Buying only clean, certified plants is the best safeguard. State Nursery Inspection Service in Minnesota is particularly rigid in its inspection for these diseases. Only plants that have been properly certified as to freedom from dangerous diseases and insects should be used to establish plantings.

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