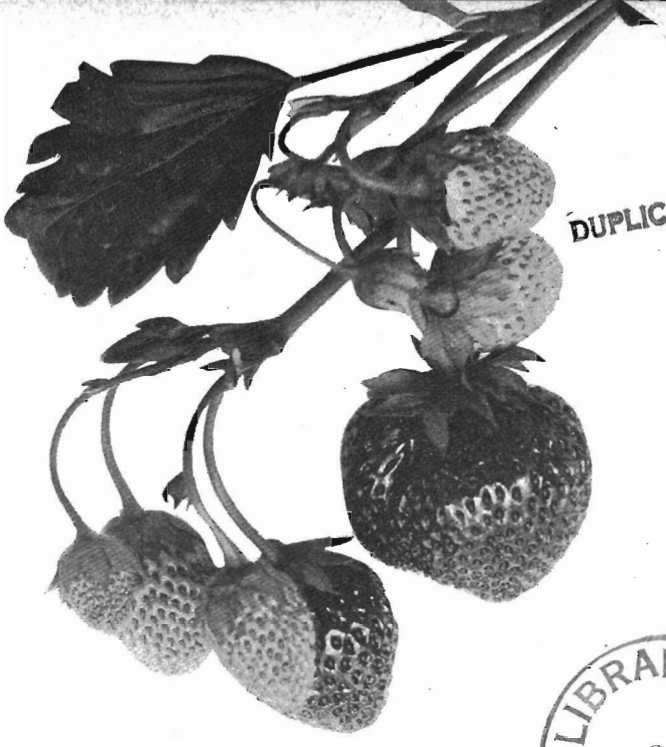

STRAWBERRY PRODUCTION IN OREGON

G. F. WALDO and HENRY HARTMAN

Oregon State System of Higher Education
Agricultural Experiment Station
Oregon State College
Corvallis

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Cover illustration—

Cluster of ripening berries.

FOREWORD

During the latter part of the war and especially during the postwar period thus far, there has been an increasing demand on the part of Oregon growers or prospective growers for information on the production of small fruits. This demand has stemmed from the present high prices being paid for these fruits and the fact that parts of western Oregon are exceptionally well suited for their production.

The peak production of small fruits in Oregon was reached in 1941 when more than 25,000 acres were in plantings, and a production of approximately 83,000,000 pounds was obtained. Acreage and production fell rapidly during the next three years, however, dropping to about 16,500 acres and 48,000,000 pounds production in 1944. The production of these crops is definitely on the increase again with many former producers reestablishing their old plantings and many new ones entering the industry.

In order to help answer the many questions that will confront these growers, this bulletin and two others, Station Bulletin 443, *Raspberry Culture in Oregon* and Station Bulletin 441, *Culture of Trailing Berries in Oregon*, have been prepared.

Wm. A. Schoenfeld

Dean and Director

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Strawberry Production in Oregon*

By

G. F. WALDO and HENRY HARTMAN†

STRAWBERRY PRODUCTION in Oregon has been a major horticultural enterprise for the past fifty years. During the prewar decade, Oregon was exceeded by only California and Louisiana in the production of this fruit. Although the state's strawberry acreage has fluctuated from year to year, approximately 11,000 acres were grown annually between 1930 and 1939. The acreage decreased considerably at the beginning of the war, but is on the increase again in the postwar period.

Since the advent of the frozen pack method of preserving fruit, the Willamette Valley has become the center of Oregon's strawberry production. Marion, Washington, Clackamas, and Multnomah counties are the leading producing areas. Other Willamette Valley counties, together with Umatilla, Douglas, Jackson, and Columbia counties, account for most of the remainder of the state's commercial production.

Commercial strawberry growing in Oregon is no longer a simple undertaking. Its success requires adherence to numerous details and technical procedures. While some of these may appear to be trivial, they are in reality of considerable importance for successful operation. For the most part the strawberry crop has to be processed and must meet the requirements of markets beyond the state's boundaries. This necessitates close cooperation between the growers and those who prepare the product for sale.

Numerous details must be considered

High yields of fruit must be obtained if Oregon producers are to compete successfully with those closer to the consuming areas of the East. Yields of at least 3 to 4 tons per acre must be obtained to be profitable under normal price levels. Many recent plantings have been lower yielding than this, as well as shorter lived than formerly.

* This publication is based largely on the results of investigations conducted jointly by the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture and the Oregon Agricultural Experiment Station.

The authors express appreciation to Mr. R. M. Alexander for his assistance in the preparation of this bulletin.

† George F. Waldo, Pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, and Henry Hartman, Horticulturist and Head, Department of Horticulture, Oregon Agricultural Experiment Station.

This situation merits the serious attention of all who are interested in the future of the strawberry industry in Oregon.

Several factors are contributory to low yields and to the comparatively short life of plantings. Insect pests and diseases are known to be causal factors. Impoverished soil plays a part, as well as failure to observe certain basic principles of plant culture. This bulletin places particular emphasis on factors that are known to affect yields and longevity of the plantings.

LOCATION OF STRAWBERRY PLANTINGS

One of the first things a grower must take into consideration prior to establishing a strawberry planting is the question of how and where to market his crop. If the berries are to be marketed in the fresh form, proximity to the consuming market is imperative. If they are grown for processing, as about 85 per cent of Oregon's production is, the plantings should be located close to the processing plants.

The concentration of plantings near the marketing outlets has certain disadvantages, however. The main one of these is the increase in disease and insect pest problems when plantings are made close or adjacent to each other. *In order to reduce this hazard, every attempt should be made by the growers in an area to disperse their plantings as much as possible.* This procedure will require planning on the part of individual producers, but it is imperative if a district is to remain permanently in the strawberry business.

Close plantings have hazards

Certain locations should not be used for strawberry planting for various reasons. The following are usually considered undesirable sites:

1. Steep slopes.
2. Depressions or ravines subject to frost.
3. Poorly drained areas, which encourage destructive root diseases.

SOIL FACTORS FOR STRAWBERRY PLANTINGS

The best yields of strawberries are obtained on fertile, well-drained soils which have a high moisture holding capacity and good depth (Figure 1). Strawberries thrive on a fairly wide range of soil types if properly drained. Certain varieties do better on certain types of soil, however. Narcissa and Corvallis prefer sandy river-bottom soils of Chehalis and Newberg series, while Redheart does better on Mel-

Wide range of soil types used

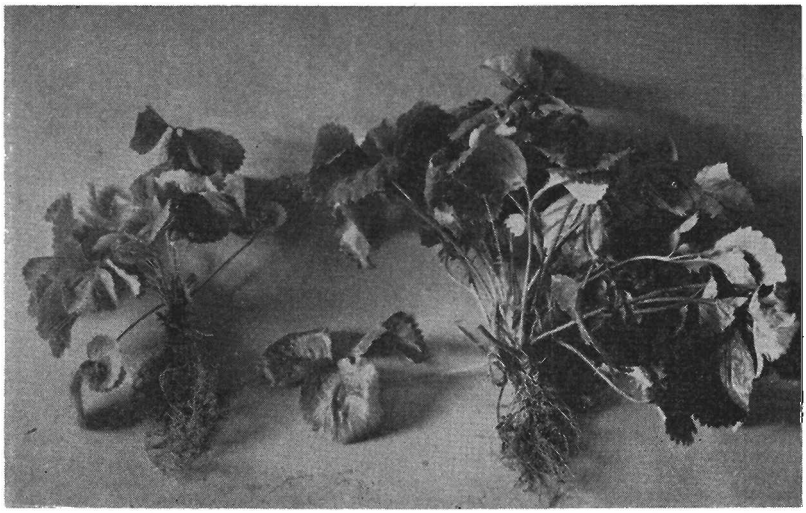

Figure 1. Deep soils produce better strawberries. Marshall grown on, *left*, soil of 6-inch depth, and, *right*, soil of 18-inch depth. A shallow soil does not hold sufficient moisture to mature the crop in the dry summer months.

bourne and other deep red-hill soils. The Marshall succeeds best on Willamette and the red soils of the Melbourne, Olympic, and Aiken series.

Strawberry growers have long been aware that the best crops of this fruit are usually obtained on newly cleared land. Such land, however, is seldom available now, and plantings have to be made on areas that have been cropped for some time. Often the soil has lost much of its fertility, and its physical properties have been impaired. In such cases, drastic preparatory treatment is often necessary if high yields are to follow. While it is possible to add some fertility after the planting is established, most of the soil building must be accomplished prior to planting.

Depleted soils need restoring

Building and managing the soil

The preparatory soil treatment for strawberries usually involves the use of organic matter, which is supplied by applications of manure or crop refuse or by plowing under cover crops (Figure 2). This organic matter that is incorporated into the soil is really its "life blood." It provides fertility, maintains the physical properties of soils, promotes the development of beneficial soil organisms, and increases water-holding capacity.

Depleted soils are usually restored quickly through the use of barnyard manure. Manure, although likely to be low in phosphorus, contains practically all of the other food elements required by plants.

Manure aids several ways

In addition to the fertilizing effect of manure, soil structure is also improved by its application. Heavy soils are made more workable and the water-holding capacity of light soils is increased. As a preparatory treatment for strawberry land, barnyard manure applied at the rate of 20 to 30 tons per acre (or 5 to 10 tons of poultry manure) is highly recommended. The addition of superphosphate or a similar phosphorus fertilizer to the manure will make it a more complete nutritive material.

When strawberry plants are to be set out in the spring, it is considered best to apply the manure the previous fall. A cover crop is usually planted after the manure has been incorporated into the soil and turned under prior to planting in the spring.

While not usually the equal of manure in fertilizer value, certain crop refuses, such as straw, damaged hay, or pea vines, are valuable as soil builders. They provide some fertility as well as improve the physical conditions of the soil. They can be incorporated into

Figure 2. Plowing under a heavy crop of a grain and legume combination supplies organic matter to depleted soils on which strawberries are to be grown.

Figure 3. A cover crop of rye has been incorporated into the soil of this young strawberry planting. This is an excellent method of maintaining the soil organic matter.

the soil in liberal amounts but should be fairly well decomposed at the time the strawberry plants are set out. The addition of a nitrogen fertilizer, such as ammonium sulphate or ammonium nitrate, aids materially in the decomposition of such refuse and greatly increases its value as a fertilizing material.

Since manure and crop refuse are not usually available in sufficient quantity, cover crops are the principal means of adding organic matter to the soil (Figure 3). When cover crops are grown as a preparatory soil treatment, the object should be to grow as much organic matter as possible in a short time and to return all of it to the soil. In the case of badly depleted land, it may be necessary to repeat the cover crop treatment over two or three seasons.

Cover crops add organic matter

The cover crops most commonly used in western Oregon are legumes, such as vetch or Austrian field peas, sown in combination with rye, oats, or barley. Legumes are highly desirable in that they add nitrogen to the soil. Some growers have found it to advantage to use such crops as turnips or mustard in their cover crop program.

Under Willamette Valley conditions, cover crops are usually sown in late summer or early fall and are turned under in the spring before they become too coarse or woody. Some growers increase the amount of organic matter produced by following the regular cover crop with another crop that makes some growth during the summer. Sudan grass is an example of such a crop.

The growth of cover crops is usually stimulated by applications of certain commercial fertilizers. Such fertilization usually results

in a greater bulk of organic matter. Most of the fertilizer so applied is not lost to subsequent crops that may be grown on the land, but is incorporated in the organic matter of the cover crop and becomes available as the organic matter decomposes. Fertilizers that are high in nitrogen and phosphorus are particularly beneficial to cover crops of the grain-legume combination, and under some conditions sulphur and potash are beneficial also. The fertilizer requirements for cover crops vary somewhat with the soil type and with the locality. As an example of this, Chehalis and Newberg soil types have been found to be lacking in sulphur. Because of the variation in requirements of different soil types, growers should follow local recommendations.

Fertilizers help with cover crops

In order to maintain the fertility and structure of the soil and help reduce the hazard of insect pests and diseases, *a system of crop rotation should be established* and followed. Many strawberry diseases, of which black root rot and red core (stele) are typical examples, have few practical control measures other than the use of a crop rotation system that reduces the number of the harmful organisms in the soil. This is accomplished by giving the land a rest of at least 4 to 5 years between strawberry plantings, during which time green manure crops are plowed under and cash crops other than strawberries or cane fruits are grown. Station Circular of Information 392, *Strawberry Root Rot and a Plan of Crop Rotation for Its Control,* gives additional information on this subject.

Crop rotation is essential

Preparing the soil for planting

Strawberry plants frequently die or make poor growth because the soil is not properly prepared at the time of planting. Soil in which strawberries are to be set should be prepared much as it is for other cultivated crops. Plowing should be deep so that refuse or cover crops will be turned under properly and should be followed by fairly deep disking to remove all large air pockets. Rollers or soil packers may be used to advantage with some soils, but these should be followed by light harrowing to leave the upper two inches of soil in a loose condition.

Plowing when the ground is too wet or too dry should be avoided as it leaves the soil lumpy or cloddy. Such soil makes poor contact with the plant roots and dries out quickly at the surface.

SELECTING VARIETIES FOR PLANTING

Strawberry varieties are exacting in their environmental requirements. Because a variety succeeds in a certain area is no assurance

that it will succeed elsewhere. As a rule, the varieties that thrive in the eastern part of the United States are not suited to western Oregon but may do well in the eastern part of the state.

Old varieties tend to go out and new ones take their place. Varieties such as Wilson, Clark Seedling, Gold Dollar, and Magoon were widely grown in Oregon at one time but are seldom seen now. Marshall is the variety most commonly grown for processing and is also popular in the fresh market. Other varieties in western Oregon are the Redheart, Corvallis, and Narcissa which are grown for local markets, for processing, and for home use.

Standard varieties

The list of varieties well adapted to western Oregon is small, and to date none of the varieties introduced has met all of the requirements. Marshall is a superior variety in its fruit qualities but is susceptible to certain diseases which often make serious inroads upon it. The United States Department of Agriculture and the Oregon Agricultural Experiment Station, through their joint efforts, are attempting to develop new disease resistant varieties. Some of these varieties show promise, but, as yet, none have been tested sufficiently to warrant their recommendation. Descriptions of some of the better varieties for Oregon follow.

BLAKEMORE—origin, Maryland, 1923—is the principal variety now grown in the United States as a whole, but it is not suited to western Oregon conditions. It grows vigorously in some parts of eastern Oregon, although it has been criticized because it produces too many runners. Despite the fact that its fruit is quite desirable for freezing in the preserving trade, it is a little too acid to be popular as a fresh berry. The fruit is medium to large in size, somewhat blunt in shape and has a brilliant red color. It is an early ripening berry.

BRIGHTMORE—origin, Oregon, 1933—was introduced in 1942. It is a vigorous, productive variety introduced because it is especially well suited for freezing for the preserve industry. The plants seem to be resistant to the crinkle and yellows virus diseases but are susceptible to the red core (stele) root disease. The berries ripen early —about the same time as the Marshall. They are medium and uniform in size, conic to long conic in shape, lighter red in color than the Marshall, and very glossy with a firm flesh.

CORVALLIS—origin, Oregon, 1921—was introduced in 1930. With irrigation, this variety does well in the southern part of the Willamette Valley but is less successful in the northern portion. It

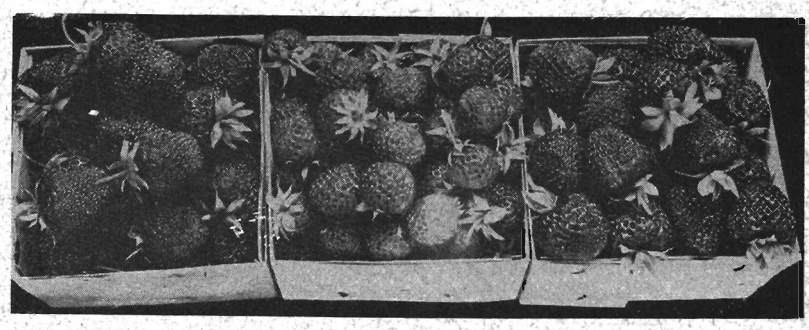

Figure 4. Corvallis strawberry, *right*, compared with its two parents, Marshall, *left*, and Ettersburg 121, *center*. The Corvallis is well adapted for canning or freezing and for the local market.

is quite vigorous when moisture is abundant and forms large plants under the square system of planting. It is medium to late in season. Its fruit is medium in size, roundish conic in shape, fairly dark red in color, and has a pleasing subacid flavor (Figure 4). The variety is suitable for canning or freezing and for local fresh markets. It is susceptible to virus and root diseases.

DORSETT—origin, Maryland, 1923—has done well in some localities but is not generally adapted to western Oregon. It does fairly well in eastern Oregon but is subject to frost injury. It is classed as an early variety. Its fruit is large, long conic in shape, and has a bright red color with a mildly subacid flavor. It is rated high on the fresh market as it has excellent dessert qualities. It is very good for freezing also.

ETTERSBURG 121—origin, California, 1907—was grown extensively on the heavy soils of the Willamette Valley during the years when strawberries were canned in large amounts. As canning gave way to freezing, the variety became less popular. Its vigor and productivity have declined within recent years. Although susceptible to virus diseases, the symptoms are less pronounced with this variety than they are with some others. It is also susceptible to root diseases. The fruit of Ettersburg 121 is small to medium in size, firm in texture, and has a mild subacid flavor. It is classed as a late maturing variety.

FAIRFAX—origin, Maryland, 1923—does well in some parts of eastern Oregon, but it does not generally succeed in the western portion of the state. The fruit of Fairfax is large in size, blunt conic in form, very firm in texture, and has a dark red color. It has a mild

subacid flavor and excellent dessert quality. Its season is medium early.

IMPROVED CLARK (ULRICH)—origin, Oregon, 1920—has superseded Clark's Seedling. It has been grown only in Hood River Valley. It is an excellent canning and shipping berry but produces only moderate yields. The fruit is medium in size, round to conic in shape, and bright red in color. It has prominent straw-colored seeds. It is a midseason variety.

MARSHALL—origin, Massachusetts, 1890—is sometimes known under other names such as Oregon, Banner, Oregon Plum, Pacific, and Dewey. It is the standard by which all other varieties are now judged in Oregon. Most of the frozen pack of Oregon strawberries is of this variety, and it is well adapted to other uses. Marshall is very susceptible to virus diseases but rather resistant to root diseases. Its successful culture depends upon disease-free planting stock. It is an early midseason variety. The fruit is large in size, round conic in shape although somewhat irregular, rather soft in texture, deep crimson in color, and has excellent flavor.

NARCISSA—origin, Maryland, 1923—is not well adapted to canning or freezing, but is grown to a limited extent as a fresh local market berry. In the Willamette Valley it does best when grown under irrigation on fertile river-bottom soil. It is a very early ripening variety. The fruit is medium in size, blunt conic in shape, rather soft in texture, and has an attractive crimson color and fine flavor.

PREMIER OR HOWARD 17—origin, Massachusetts—was introduced as Howard 17 in 1918. This variety is not adapted to western Oregon but is grown in some parts of eastern Oregon largely because of its hardiness and early season. The fruit is medium to large in size, long conic in shape, relatively soft in texture, and has a mild and pleasing flavor.

REDHEART—origin, Maryland, 1923—is grown to some extent in the Willamette Valley for canning and freezing. When well grown, it is quite desirable for these purposes. In some localities the variety appears to be short-lived. When grown on the soils that are not well drained, it is susceptible to root diseases. It has performed well in some of the coastal areas. The fruit is large in size, conic but somewhat irregular in shape, firm in texture, and has a deep color of both skin and flesh. It is subacid in flavor and ripens during midseason.

WRAY RED—origin, Washington—was introduced in 1932. This berry has been grown to some extent in eastern Oregon mainly

because of its heavy yields. As the fruit is quite soft, it is not adapted for shipping. Since the berries are borne in short clusters, they lie on the ground where they are subject to decay. It is early in season, bears large to very large fruit, is bright dark red in color, and has good dessert quality.

Everbearing varieties

Everbearing strawberries are those that bear fruit during the summer and fall as well as in the spring. These are now being grown for home use and for local fresh markets. The culture of these strawberries is essentially the same as for other varieties, but since they fruit throughout the season, special attention must be given to moisture and fertility. They require a very fertile soil, and irrigation is necessary in most cases.

With the everbearing strawberries, it is essential that a large plant be obtained as quickly as possible. The young plants should be set out early in the spring, and all blossoms should be removed until about July 1. Excessive blooming and fruiting after planting seriously retards growth.

It is considered best to replant these varieties each spring. Old plants usually produce a good early crop in the spring of the second year; so they should not be removed until after this crop has been harvested. Good vigorous plants from which the blossoms were removed for some time during the second spring may continue to bear fairly well throughout the second summer.

Some varieties, particularly Rockhill, produce only a small number of runners so it is often necessary to propagate them by dividing old plants. When this is done, the crowns of old plants are pulled apart so that each division has at least 4 to 6 good roots. Divisions so made are then ready for setting in the garden or permanent planting.

Descriptions of some of the everbearing varieties now grown in Oregon are as follows:

GEM is vigorous and productive in most parts of the state. Its fruit is large and attractive, but it is only fair in quality. Because of its good yields and fine appearance, the variety is quite popular.

MASTODON is probably the most vigorous and most productive of the everbearing strawberries. It produces many runner plants which bear fruit in late summer. Its fruit is very large and attractive but like Gem, is only fair in quality.

PROGRESSIVE or CHAMPION is well adapted to central Oregon and at one time was very popular in that region. Its fruit is somewhat small in size and lacking in attractiveness.

ROCKHILL or WAZATA has the best dessert quality of any of the everbearing varieties and is, therefore, quite popular for home gardens. Its berries are large and attractive, and it yields well. This variety, however, is more difficult to grow than the others. It requires an especially fertile soil and abundant moisture in summer. The fact that it usually has to be propagated by division is a handicap to its culture on a large scale.

STREAMLINER, a recent introduction, originated in eastern Oregon where it seems to be well adapted. Many plantings are now being made in western Oregon, but its general adaptability to this area has not been fully determined. Plants are vigorous, produce runners freely, and start bearing early. Its flavor is excellent.

ESTABLISHING THE PLANTING

The success of a strawberry planting depends a great deal upon how well it is established. When plant mortality is high during the first season, yields are likely to be low during the entire life of the field. Replants set the following year are handicapped, as the soil cannot be thoroughly prepared for them.

Spring planting recommended

Spring planting is usually best for strawberries. The plants should be set out as soon as the ground can be properly worked. If planting is delayed until late spring or summer, severe losses may be incurred from the hot, dry weather. Fall planting is sometimes practiced, but there are some serious objections to this procedure. Fully mature runner plants are seldom available at this season unless they have been irrigated. There is some danger, too, that the plants will not be thoroughly established before winter, and any heaving that may result from alternate freezing and thawing may be injurious to them. Another important objection to fall planting is that on many soils weeds and grass are a greater problem than they are with spring plantings. When plants can be obtained and irrigation is available, it is possible to plant during August and early September and thus obtain a small crop of fruit during the following season.

Planting systems to use

The various types of strawberry planting systems used in Oregon are discussed in the following paragraphs along with the more important factors to be considered in connection with each.

INDIVIDUAL HILL SYSTEM is the one most commonly used in non-irrigated plantings. The rows are 3 to 4 feet apart with the plants

set from 15 to 24 inches apart in the rows, depending on how vigorous the plants are likely to be. Runners are kept off, and the original plants are maintained as individuals. From 6,000 to 10,000 plants per acre are needed in this system depending on how far apart the rows and plants are.

SQUARE (HILL) SYSTEM is one type of the individual hill system. The plants are set in a square formation—from 3 to 3½ feet apart (Figure 5). This system is used with especially vigorous varieties or when ordinary varieties are expected to produce quite large plants. This system permits cultivation in two directions, thus reducing hand labor. Low yields may result, however, if all the plants are not fruitful. This system requires from 4,000 to 5,000 plants per acre.

SPACED ROW SYSTEM may be used to advantage when abundant moisture is available (Figure 6). This method of planting is a modification of what is commonly known as the matted row system. The rows are set from 4 to 5 feet apart with the plants from 2 to 3 feet or more apart in the row. A certain number of runner plants are then allowed to become established around the mother plants so that ultimately the plants are from 7 to 10 inches apart. After the plants are so spaced, all additional runners are cut off. The row plantings

Figure 5. Varieties that make large single plants are often grown on a square (hill) system to permit cultivation in two directions.

Figure 6. Marshall strawberries planted in spaced row system and following the contour of the ground to prevent erosion. The spaced row planting system produces high yields on fertile soil with irrigation.

may be permitted to attain a width of 20 to 30 inches (Figure 7). A medium sized plant, which has been found to be the most productive of flowers and fruit in relation to its size, is developed with this method of planting. Some of the highest yields have been obtained with this system.

The chief limitation of this planting method is that a considerable amount of hoeing and hand weeding is necessary to keep weeds down and runners removed after the full-sized plant has been obtained. This system can be established with a minimum number of plants, the number varying from 2,500 to 5,000 depending on the spacing of plants and rows.

MATTED ROW SYSTEM, as the name implies, permits runner plants to become established closely together so that the rows become a continuous planting. The original planting plan may be the same with this system as with the spaced row system, except that the rows are generally spaced farther apart. This system can also be established with a relatively small number of plants. If the plants are set 3 feet apart in 4-foot rows, 3,630 plants will be needed per acre. It may be desirable to set the plants closer together, however, if conditions are not favorable for rapid spreading by runners.

This system has certain limitations. Usually the berries are smaller than those produced by using other systems, and more hand weeding has to be done. This method of planting should be used

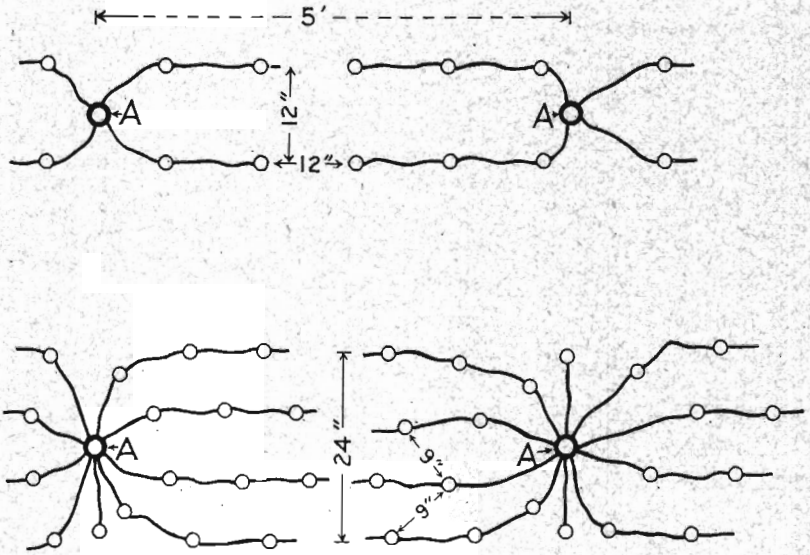

Figure 7. Diagram showing, *above*, how a 12-inch-wide and, *below*, a 24-inch-wide spaced row are developed. A=Mother plants, O=Runner plants.

only where irrigation is available or where the rainfall is heavy. With adequate moisture and soil fertility, however, this system can be used and can be expected to give very high yields.

NARROW MATTED ROW SYSTEM is a modification of the matted row system made by limiting the width of the matted row to from 12 to 18 inches. This system can be best put into effect by using sharp disks attached to cultivating implements to cut all runners between the rows. Attachments to cultivating implements may also be used to push the runners back closer to the row and throw soil on them so they can take root again. Hoeing out of plants by hand may be practiced also when the plants become too thick in the center of the row.

Handling and storage of planting stock

Selection of plants vital to success

Proper handling of the plants prior to planting and during the planting operation has much to do with the success of a strawberry field. First of all, plants that are free from injurious insects and diseases should be obtained. If the latter are introduced, the result is almost certain to be a short-lived planting with low yields of poor quality fruit. Control measures may be taken, but these increase the cost of pro-

duction and may not always be entirely effective. In addition to this, only plants that were produced during the preceding summer and fall should be used. Older plants usually make poor growth and are often infested with the larvae of the crown borer, which may become a serious menace.

The plants should be dug while they are in a dormant condition. In western Oregon, this means that they must be dug during the winter—not later than early March. No soil should be left on the roots at the time of digging. Root weevil is often carried by soil left on the roots. Soil should not be removed by washing, unless a continuous stream of water is used, since washing in a tub tends to spread red core (stele) and other root destroying diseases.

Dig plants in winter months

While plants are usually dug during winter, it is seldom possible to set them out at that time, so storage must be provided. Cold storage at a constant temperature of 32° F. is satisfactory if the plants are dormant. Plants dug after spring growth has started are very often injured by heating or molding or injured by cold at temperatures below 32° F. Dormant plants in storage will keep in good condition for 6 to 8 weeks. The plants packed in moist moss do not require watering while they are in cold storage.

Keep dormant plants in storage

When cold storage is not available, the plants can be held back for a short period by heeling them in out of doors, preferably on the north side of a building. If this practice is followed, the bundles should be broken open and the plants scattered along a shallow trench. Soil should then be firmed about the roots, but the tops should not be covered.

Setting out young plants

While the essentials of strawberry planting are simple, it is important that certain details be observed. The plants must not be allowed to dry out during the planting operation. It is best to plant during periods of cool or moist weather. Planting during periods of high temperatures and low humidity or planting in dry ground are frequent causes of poor stands. If planting has to be done during hot and dry weather, it is best to remove all large leaves from the plants.

The plants should be set so that the crown (the place where the leaves are attached) is level with the surface of the ground (Figure 8). The roots should be spread out and the soil thoroughly packed around them. No air spaces should be left as these cause the roots to dry out.

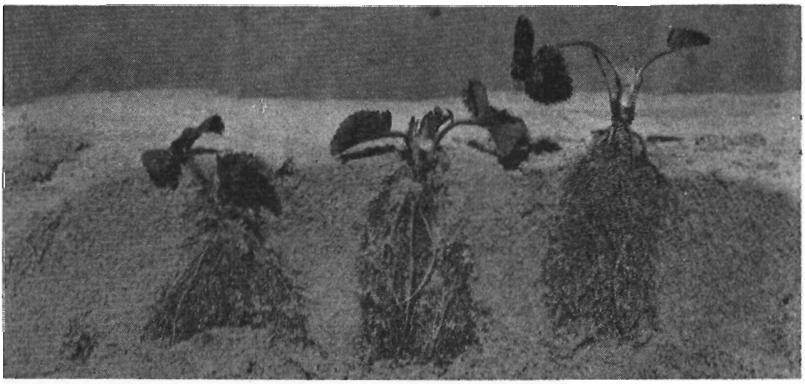

Figure 8. Depth of planting is important. The center plant shows the proper planting depth. The right one is too shallow, while the left one is too deep.

Various implements are used to make the holes to put the strawberry plants in. Those commonly used are a trowel, a hoe, a small shovel, or even a pointed stick. Sometimes the plants are set in a shallow trench or furrow. Planting machines are commonly used when large acreages are to be put in. When the machine is used, however, precautions must be taken to insure proper planting depth and packing of the soil around the roots of the young plant.

CARE OF ESTABLISHED PLANTINGS

The care of established strawberry plantings involves care of the soil, insect and disease control, runner control, weed eradication, and irrigation. These operations have much to do with the productive life of a planting. When a planting has been well established and receives good care, it should last for 4 or 5 years and should produce 3 or 4 good crops. Most plantings, however, seldom produce more than two crops, due to infestation of insect pests and diseases and depletion of soil fertility.

Care of the soil

As the strawberry is a shallow-rooted plant, it is easily injured by deep tillage. While tillage is necessary in strawberry fields, it should be done primarily to control weeds that compete for moisture and plant food, and to break up surface crusts that form after rains or irrigations. Deep cultivation destroys the feeding roots of the strawberry which spread out from the plants just beneath the surface of the soil. When

Deep cultivation causes injury

these roots are cut, plants become stunted for lack of moisture and soil nutrients. In general, frequent cultivation in summer is seldom necessary. However, some hand weeding is always necessary to keep down weeds within the rows.

Fertilizer trials in established strawberry fields have given varying results, particularly on nonirrigated lands. In some cases, beneficial results have been obtained from applications of fertilizers on certain soils, while in other areas practically no beneficial results have been noted. Because of this situation, growers are advised to follow the fertilizer recommendations made for their particular local conditions by their county agricultural agent.

Fertilizer trials give varying results

Studies have shown that strawberry fruit buds begin to be formed during the late summer and early fall. Marshall, Redheart, and Narcissa were found to start fruit bud formation in September in western Oregon. The Ettersburg 121 starts developing buds in late October or November and the Corvallis some time between these periods. Obviously, the plants should be in a good growing condition at the time these buds are developing. Applications of fertilizers made between the last of July and the first of September should be beneficial, particularly when moisture at the time of application is sufficient to make the fertilizers available.

Preparation for winter

Grass and weeds are a serious problem in strawberry production in western Oregon. Since the seeds of some obnoxious plants germinate freely in the fall and continue growth throughout the winter, cultivation and weeding should continue as long as it is possible to work the soil in autumn. Late fall tillage goes a long way in solving the weed problem.

Winter mulching has been used in some strawberry-producing areas but is not practiced in western Oregon. In sections where freezing is severe or where the soil remains frozen for long periods, a mulch of straw or hay is often necessary to prevent winter injury and serious loss of plantings. This mulch should be put on immediately before temperatures in the field drop to as low as 18° F., or before the first hard freeze occurs in the fall. The mulch should be from 2 to 6 inches in depth after settling, depending on how severe the winter weather is expected to be. The mulch should be removed from above the plants as soon as growth starts in the spring, but may be left between the rows for some time or even permanently.

Mulch used in cold areas

Removal of tops after harvest

The practice of topping or removing the foliage after harvest is still in use but is less popular than it was at one time. Investigations have shown that this practice is quite effective in the control of crown moth (crown borer). Although the tests were somewhat inconclusive, they showed that yields are not usually reduced as a result of this practice. In some of the experimental tests slight increases in yields were obtained by topping.

Topping method of crown moth control

To be effective all foliage must be removed soon after harvest. If topping is delayed, injury to the plant may result from lack of a large leaf area during the period of fruit bud formation. Except for the control of the crown moth, the practice of topping is usually not practical; however, some growers believe that later cultivation and control of weeds and runners is made easier by its use. When control of the crown moth is desired, a few plants or portions of certain rows of plants are left untopped. The moths will be driven to these and will deposit their eggs on the foliage. If these plants are destroyed in late summer, a large portion of the infestation is thus removed.

Runner control

Runner cutting, a necessary operation to successful strawberry production, varies in method with the planting system. In the case of the individual hill system, all runners are generally removed at intervals of 2 to 4 weeks during the period from June 15 to November 1. When the spaced row method of planting is used, runner plants are permitted to root until the desired number of plants is obtained. Some spacing of runners is necessary to insure a uniform distribution of plants within the row. Runners, in this case, can be held in place by placing one or two clods on the runner string.

Control differs with planting system

Runners should be cut and not pulled from the plants. A sharp hoe or some other cutting implement may be used for this purpose.

Irrigation

Irrigation is a standard practice with strawberry growers in southern and eastern Oregon (Figure 9). The furrow method of applying the water is commonly used in these areas. Irrigation is practiced to some extent in the Willamette Valley, particularly in the southern part of the region. The major portion of the acreage in the valley, however, is nonirrigated, since in many cases water is not available at the present time.

Figure 9. Irrigating spring-set strawberries near The Dalles. This furrow method of irrigation is the most widely used system in eastern Oregon.

Investigations, as well as practical experience, have shown that irrigation of strawberries pays in some parts of the Willamette Valley during dry seasons. In experiments at Corvallis from 1929 to 1935 comparisons were made of the yields and returns from irrigated and nonirrigated fields of berries. The Marshall, Narcissa, and Corvallis varieties showed an increase in yield and net profit each year, but the Ettersburg 121 did not. The irrigated berries were from 25 to 100 per cent larger in size than the nonirrigated, and an average gain in yield of 91.5 per cent was obtained.

Yield increased by irrigation

When soil moisture is deficient, irrigation during harvest prolongs the season and increases the size of the fruit. Irrigation in the dry season of the summer months stimulates growth so that the plants are in better condition to produce the following year. The crop in the spring is correlated closely with the number of leaves on the plants in the previous fall. Every effort should be made to produce large vigorous plants by the end of the fall growing season. Irrigation is one of the most effective means of obtaining large plants.

Irrigation helps produce large plants

Both the furrow and the sprinkler method of irrigation are in use in the state. Considering topography and the soil types on which strawberries are usually grown, especially in the Willamette Valley, the sprinkler method appears to be the most practical system to use.

HARVESTING STRAWBERRIES

Strawberries in Oregon usually begin to ripen during the latter part of May and continue ripening throughout the month of June. Some late varieties, however, may continue to ripen for a week or ten days into July. The nature of the season has considerable effect on the time of ripening and on the length of the harvest season. Time of ripening also varies considerably in the different areas of the state.

Time of ripening varies with variety

The fruit of the strawberry, like that of most berries, does not improve in quality after picking. The sugar content does not increase, and acidity tends to remain at a constant level. It is essential, therefore, that the fruit be fully ripe at the time of picking.

Berries of all types are softer in texture when they are warm than when they are cool, and if picking and hauling can be done during the cool part of the day, less mechanical injury is likely to occur. As strawberries are subject to decay soon after harvest, they should be handled promptly. As little time as possible should elapse between the time of picking and the time of processing or utilization. Decay is aggravated if the fruit is moist or wet when picked. Decay is also more severe in fruit that has been bruised or punctured. Cold storage retards decay when the fruit cannot be utilized quickly.

Poor handling increases decay

Growers should not attempt to harvest a crop of strawberries without a packing or assembly shed (Figure 10). This should be conveniently located so that it is accessible to all parts of the planting and should be well ventilated so that it can be kept cool. With large plantings more than one shed is often desirable. The fruit is brought to the shed as it is picked and kept there during the assembly period.

The success of harvesting operations depends greatly upon how well the picking crew is trained and organized. When a large number of pickers is employed, an experienced foreman is necessary. Pickers must be taught how to judge maturity and how to pick and handle the fruit without injury. Pickers are usually paid on a weight basis, so it is necessary to keep a record of the amounts picked by each person. From 6 to 10 pickers are needed for each acre of berries during the height of the season.

Picking must be organized

Berries for local fresh markets are usually picked with the hulls

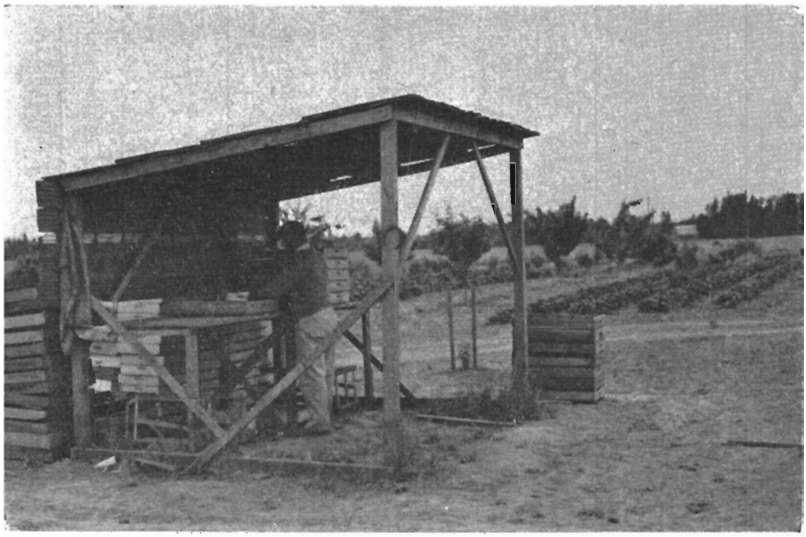

Figure 10. A typical Oregon berry packing or assembly shed. Some type of shed is necessary for proper handling of the berries.

and stems attached in 12-ounce boxes called hallocks. The hallocks are then assembled into crates of 12 or 24 units. Each picker should be provided with a carrier. The most convenient carrier holds from 8 to 12 hallocks (Figure 11). When the berries are being harvested for processing, they are usually picked with the hulls and stems removed. The containers for the berries to be processed are generally furnished by the processing plants receiving the fruit.

STRAWBERRY PLANT PRODUCTION

The prevalence of certain strawberry diseases in Oregon makes it essential that a large volume of disease-free planting stock be available for new plantings each year. The demand for these plants comes from neighboring states as well as from Oregon growers. A system of inspection and certification of strawberry plants has been developed by the Oregon Agricultural Extension Service, details of which are given in Oregon Extension Circular 493, *Plan for Producing Strawberry Foundation Planting Stock,* by S. M. Zeller and R. Ralph Clark.

Disease-free plants are in demand each year

Those interested in the production of certified strawberry plants for sale should become thoroughly familiar with the symptoms of strawberry diseases and should know the regulations concerning cer-

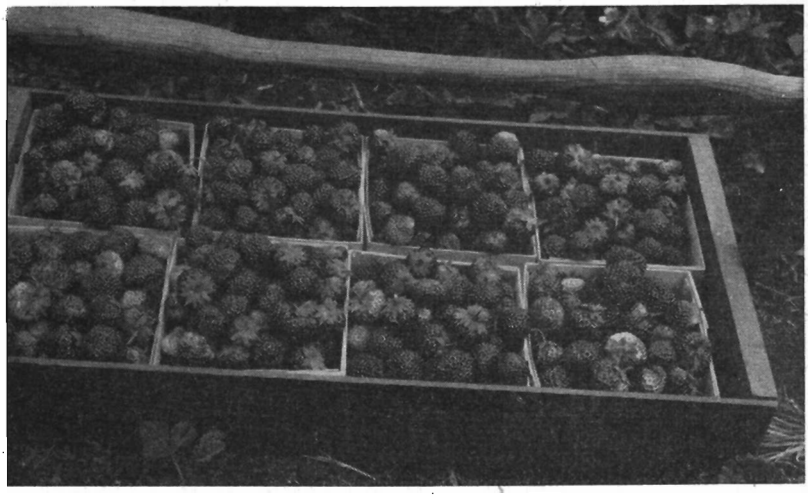

Figure 11. A strawberry carrier holding 8 hallocks. Every picker should be supplied with a carrier.

tification. In addition to this, a grower should be familiar with plant propagation, as well as have a knowledge of strawberry production, to be successful in this phase of the industry.

Isolation essential for clean plants

Isolation of propagation fields is essential if clean plants are to be expected. The mother block must be far removed from all other strawberries. It is best if the nearest plantings are several miles away. The mother block should be isolated from wild strawberries, also, as these may be affected by virus diseases. Only plants free from virus and root diseases and from insect pests should be used in the mother planting.

To facilitate digging, which is usually done in winter, it is best to grow the plants on light sandy soil. Since luxurious growth is essential, ample moisture and fertility are necessary. Irrigation is highly beneficial in most seasons.

It is best to grow only one variety in a given location. Introduction of other varieties may complicate the disease problem. Since careful watching is necessary, the new grower should begin with a small field, one acre usually being sufficient for the first year. After the initial planting is established and the grower is sure of his planting stock and his technique, the enterprise can be enlarged. It is usually best to set out a new mother block each year. Blocks from which plants have been dug may be allowed to fruit, but the crop from such blocks is generally small.

Frequent and systematic roguing or removal of diseased mother plants, beginning early in the summer, is necessary to the production of clean strawberry plants. Plants that show any symptoms of virus disease should be removed, together with all of their runners. Roguing must be done throughout the growing season.

Diseased plants must be rouged

STRAWBERRIES FOR THE HOME GARDEN

Strawberries are well adapted to the home garden. They can often be grown under conditions that are not feasible for other fruits, and they lend themselves to a wide variety of uses. By growing several varieties, including some of the everbearing ones, the fruit can be available over an extended period.

The cultural practices employed by commercial growers can generally be followed in the home garden. The home gardener, however, has more latitude than the commercial grower. He can choose varieties that are to his individual liking and can often provide better conditions of soil fertility and moisture.

The home gardener should not make his planting too large. A small planting that receives proper care will produce more fruit than a large one that receives only superficial attention. From fifty to two hundred plants are sufficient for the average family.

INSECTS AND DISEASES

This bulletin deals with insects and diseases only as they affect certain cultural practices. For detailed information on the names, symptoms, and control of the insects and diseases of strawberries, the reader is referred to Oregon Agricultural Experiment Station Bulletin 419, *Insect Pests and Diseases of the Strawberry in Oregon*, by S. M. Zeller and Joe Schuh. Growers are urged to obtain copies of this bulletin from their local county agent or by writing *Clerical Exchange, Oregon State College, Corvallis, Oregon.*