

481

1) COLORADO

BULLETIN 481

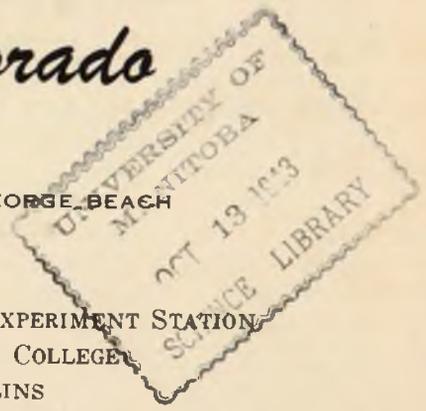
SEPTEMBER 1943

2) AGRICULTURAL EXPERIMENT STATION

Strawberry Production in Colorado

L. R. BRYANT AND GEORGE BEACH

COLORADO AGRICULTURAL EXPERIMENT STATION
COLORADO STATE COLLEGE
FORT COLLINS



Colorado State College

COLORADO AGRICULTURAL EXPERIMENT STATION

Fort Collins, Colorado

STATE BOARD OF AGRICULTURE

LEON S. McCANDLESS, President	Craig
CHARLES W. LILLEY, Vice President	Virginia Dale
GEORGE McCLAVE	McClave
ROBERT ROEMER	Fort Collins
J. W. GOSS	Pueblo
R. F. ROCKWELL	Paonia
W. I. GIFFORD	Hesperus
REX EATON	Eaton

Ex-officio	}	GOVERNOR JOHN C. VIVIAN
		PRESIDENT ROY M. GREEN

EXPERIMENT STATION OFFICERS

ROY M. GREEN, M.S., D.Sc.	President
HOMER J. HENNEY, M.S.	Director
JAMES R. MILLER	Secretary
MARVIN J. RUSSELL, A.B.	Editor
SADIE I. COOLEY, B.S.	Chief Clerk

AGRICULTURAL DIVISION SECTION CHIEFS

ALVIN KEZER, A. M.	Agronomy
R. C. TOM, M.S.	Animal Investigations
L. W. DURRELL, Ph.D.	Botany and Plant Pathology
J. W. TOBISKA, M.A.	Chemistry
CHARLES R. JONES, Ph.D.	Entomology
INGA M. K. ALLISON, S.M.	Home Economics
A. M. BINKLEY, M.S.	Horticulture
FLOYD CROSS, D.V.M.	Pathology and Bacteriology
†H. S. WILGUS, Jr., Ph.D.	Poultry
E. W. NELSON, A.M.	Range and Pasture Management
R. T. BURDICK, M.S. (Acting)	Rural Economics and Sociology
BRUCE J. THORNTON, M.S.	Seed Laboratory

ENGINEERING DIVISION SECTION CHIEFS

*N. A. CHRISTENSEN, Ph.D.	Chairman
*N. A. CHRISTENSEN, Ph.D.	Civil Engineering
J. T. STRATE, M.S.	Mechanical Engineering

HORTICULTURE STAFF

A. M. BINKLEY, M.S.	Horticulturist
LOUIS R. BRYANT, Ph.D.	Associate Horticulturist
JOHN G. McLEAN, Ph.D.	Associate Horticulturist
‡GEORGE A. BEACH, M.S.	Assistant Horticulturist
WALTER C. SPARKS, M.S.	Assistant in Horticulture

*On leave

‡On military leave

591
1939
42-1000
10-5

Strawberry Production in Colorado

L. R. BRYANT AND GEORGE BEACH¹

Strawberries are grown for home use over most of Colorado, but commercial production is found primarily in the area around Denver.

Location of Plantings

Two factors govern the desirability of a location for strawberry growing: site and type of soil. Strawberries are especially subject to injury from frosts, and since elevations which provide for air movement will give protection, this is a factor to be considered in selecting a planting site. Low lands where late spring frosts are common should be avoided.

The direction of the slope also will affect a location. Southern slopes warm up earlier in the spring and will often produce earlier-maturing fruit, but the earlier blooming of plants on this slope may increase the amount of injury from late frosts. Northern and eastern slopes ordinarily retard spring growth, and although the ripening of the fruit is thus delayed, the danger of frost injury is minimized. Where spring frost is a hazard, northern or eastern slopes are preferable.

Strawberries are grown on many types of soil, but deep sandy or gravelly loam is best. Heavy soils are much less desirable, and growing plants on this type of soil is frequently unprofitable. A serious strawberry disease, the red stele root rot, is much more prevalent on heavy soils, especially if drainage is poor. Any good garden soil should produce strawberries. If manure is to be added, better results usually are obtained if the manure is applied in the spring or fall the year before the strawberries are set.

Since under Colorado conditions irrigation is essential, land for strawberries should be such that irrigation water can be applied efficiently and easily. In some instances this may mean grading the land before the plants are set.

Varieties

There are two types of strawberries, the single-crop or June-fruiting varieties which mature their fruit in a 3- or 4-week period, and the everbearing varieties which fruit more or less continuously through the summer and fall. Most of the important commercial varieties are in the single-crop type since few of the everbearing sorts produce sufficient fruit at any one time to be commercially profitable except on some specialty markets.

¹Bryant, associate horticulturist, Beach, assistant horticulturist (on military leave), Colorado Agricultural Experiment Station.

However, everbearing varieties do have a definite place in the production of berries for home use.

In recent tests at Fort Collins Aroma has been the most productive single-crop variety, with Catskill and Corvallis following in the order named. In the everbearing types, Gem and Mastodon have been the most successful.

ESTABLISHING THE PLANTING

Soil Preparation

Soil for strawberries should be weed-free and in the best possible condition to encourage the early rooting of runners. For this reason it is desirable for strawberries to follow a cultivated crop. Freshly broken sod is not desirable because of damage which may be caused by white grubs the first year after breaking the sod.

Barnyard manure is often applied to cultivated crops the year before strawberries are to be set, applications ranging between 10 and 30 tons per acre. This method and turning under green manures are desirable ways of building up the soil organic-matter content and fertility.

The land should be fall plowed whenever soil erosion through the winter will not be a problem. The following spring the ground should be worked down to provide a fine surface on which to plant.

Time to Set the Plants

Under Colorado conditions best results will follow spring planting. The plants should be set just as soon as the ground can be prepared, usually by the early part of April. Plants set as soon as the ground is in condition for planting become established readily and runner formation starts early. The first runners set each season are always the most productive.

Fall is a poor time to set strawberry plants in Colorado, even though they are of good planting size, because they will produce only small runner plants. Some runners may become firmly rooted but they will not be productive.

Plants to Use

Satisfactory results can be obtained only when vigorous plants not more than 1 year old are used. They should be free from diseases and insects, and the root systems should be large and well developed. The crowns and roots of young plants are light brown while those of old plants are dark brown.

Spacing of Plants

Common commercial practice is to space the rows about 3½ feet apart and the plants from 18 inches to 2 feet apart in the

rows. Varieties such as the Mastodon which do not develop many runners may profitably be set closer, while varieties such as Fairfax and Dunlap which set large numbers of runners may be spaced farther apart.

Setting the Plants

In planting, the roots should be spread out well. The ground should be pulled in over the roots and then tamped firmly around the plants. Strawberry plants must be set at just the right depth so that the crown is at the same level as it was before the plant was dug (see fig. 1). Plants that are set too shallow or too deep and those that are not in firm contact with the soil cannot do well.

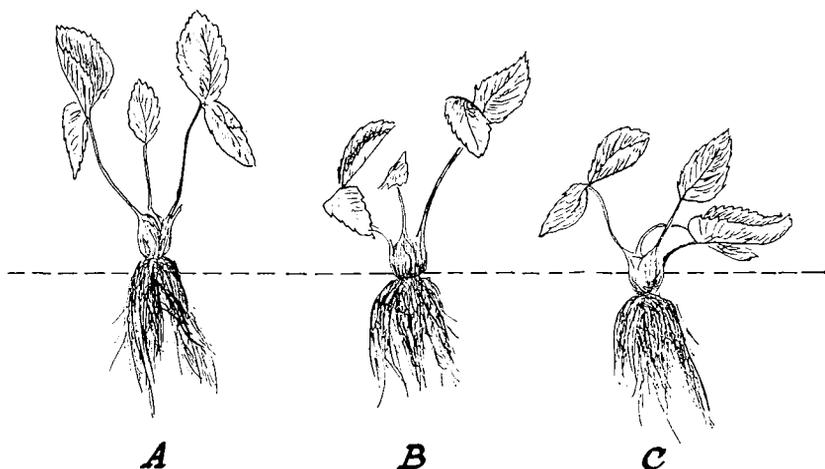


Figure 1.—Correct and incorrect planting depths. Plant B has been set to the proper depth. Plant A is set too shallow and plant C too deep.

HANDLING AFTER PLANTING

Removal of Blossoms

All blossoms should be removed from the plants during the first year after setting. Allowing them to set fruit will prevent the development of the most vigorous and productive plants.

Training

The matted-row system of training in which runner plants are allowed to set at random is the method most frequently used. When there is less than 5 to 7 inches between plants in an established row, yields and quality decrease. Experience has shown that production is enhanced by keeping rows narrow, that is from 12 to 15 inches in width, or by spacing the plants to these distances by hand.

Cultivation

Frequent shallow cultivations should start soon after planting and should continue until mid-August or later. Cultivations should always be in the same direction to avoid pulling out runner plants.

Cultivation during the second and succeeding seasons usually does not start until after the fruit is picked unless weeds are unusually bad. Leaving part of the mulch in the field usually should make cultivation unnecessary until harvesting is over.

Irrigation

In Colorado, where irrigation is necessary, water must be applied frequently. Strawberry plants are relatively shallow-rooted, and competition between plants for water often is great. On light soils during the bearing season irrigation may be required every 4 to 6 days or even at shorter intervals. One common practice at harvest time is to irrigate between every other row so that there will be dry ground between alternate rows for the pickers. At the next irrigation the alternate row-middles will be watered.

Harvesting

Strawberries usually are marketed in quart boxes in crates holding from 16 to 24 or more boxes. Early berries often are sold in pints. For commercial sales a supply of crates and boxes should be on hand when the fruit is ready to pick. Only fresh, clean packages should be used. Each picker should be provided with a carrier to use in the field.

Pickers must be carefully supervised. They must be taught to pick the fruit with stems in place and to handle the berries with care. Strawberries are easily damaged by the handling incidental to grading so they are often marketed just as the pickers put them in the boxes. If the pickers are required to put only good-sized, firm berries in the boxes while picking, grading may not be necessary. Picked fruit must be protected from the sun.

Six pickers usually can care for an acre, going over it every 1 to 3 days. Assignment of pickers to numbered rows makes supervision easier. A row up to 2 feet in width can be picked clean with little reaching when a picker works both sides.

Berries that are fully colored but not soft will stand a 12-hour shipment. For 24-hour shipment they should be picked three-fourths red in color.

CARE OF THE PLANTS AFTER HARVEST

Returns from strawberry plantings are in direct proportion to the care the plantings are given. Consequently completion of harvest should not mean neglect of the planting from then on. Irrigation should be continued as necessary and cultivation should not stop until the middle of August or a little later.

Removal of Mulch

After harvest the remaining mulch should be removed and burned. If foliage diseases are present it may be desirable to mow the old foliage and remove it with the mulch. Some growers burn over such a patch, but plants are likely to be damaged unless the burning is done on a windy day when the leaves and mulch are dry but the ground is moist. However, if the plants are vigorous and healthy, mowing is of but questionable value, and it is usually better merely to rake and remove the mulch and leaves.

Renewing the Planting

The length of time a strawberry bed will be profitable depends primarily on its condition after harvest. Grower experience has shown that it is seldom worth-while to attempt to harvest more than two commercial crops from one planting.

If a second crop (third year of planting) is to be harvested the planting should be renewed, and the best time to do this is as soon after harvest as possible. After the excess mulch material has been removed and the planting cleaned up, the surplus plants should be thinned out. Thinning should be done so as to leave the greatest possible number of vigorous young plants. In small home plantings this may be done with a hoe. On larger plantings where horse- or power-drawn tools are available, one of the best methods is to turn under one side of the row. If a plow is used, one or two furrows should be plowed from one side so that only a narrow row of young plants, from 6 to 12 inches wide, is left. Then the plowed ground should be worked down at once and the plant thinning completed with a hoe. Plants should not be left closer than 5 to 7 inches apart each way.

Mulching

Winter mulch is applied to strawberries in northern areas as a protection against winter injury. Most commercial strawberry varieties are not sufficiently resistant to low temperatures to go unprotected through the average Colorado winter without injury to the plants. A layer of straw 2 or 3 inches deep over the tops of the plants is usually sufficient, and 3 or 4 tons of straw should mulch an acre. The mulch should be on before the first hard freeze.

In the spring when growth starts, the mulch should be forked off the tops of the plants but left between the plants and between the rows where it helps keep the fruit clean, conserves moisture, and checks weed growth. Excessive amounts of mulch should be removed from the planting. Mulch delays early growth and thus helps prevent early bloom which is likely to be frosted.

DISEASES AND INSECTS

Unlike trees and bush fruits in which the tops increase in size and live over several years, strawberries are renewed from the ground up each year. By removing and destroying the old mulch after harvest, the grower may rid the patch of many pests. If only one or two crops are harvested from one planting and the plants are then turned under, other crops can occupy the land for several years before replanting to strawberries. If such a rotation is followed, insects and diseases seldom will be troublesome. The more important strawberry diseases and insects are discussed on the following pages.

DISEASES OF STRAWBERRIES²

General Control Measures

In general to prevent strawberry diseases or to reduce losses where they occur:

1. Plant healthy plants in soil in which strawberries have not been previously grown. Never plant diseased plants. If it can possibly be avoided, never plant strawberries in soil where strawberry diseases have occurred.
2. Select sites which have *good drainage*. Avoid low spots.
3. Avoid overhead watering. Do not overirrigate or irrigate too often.
4. Where leaf spots occur spray with 4-4-50 Bordeaux mixture at 10-day intervals.
5. When berries are picked cull all moldy or rotten berries to aid in preventing transit or market losses.
6. Avoid bruising berries.
7. Where fruit rots occur keep berries at a temperature below 50° F. in transit.

The more prevalent strawberry diseases in Colorado are:

Leaf Spot

Leaf spot is caused by a fungus *Mycosphaerella fragariae*. This disease is characterized by the appearance of circular spots on the leaves. On the under surface of the leaf the spots are light brown or bluish in color $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter. On the upper side of the leaf the spots are at first purplish, but as the tissue

²By W. A. Kreutzer, Botany and Plant Pathology Section, Colorado Agricultural Experiment Station.

within the spot dies, the color changes to gray to almost white surrounded by a purplish border. Fruit stalks, leaf petioles, and caps are frequently infected.

CONTROL.—Remove diseased leaves from plants prior to planting. Avoid overhead sprinkling and excessive irrigation. If the disease is serious spray with 4-4-50 Bordeaux mixture at 10-day intervals. The varieties Aroma, Fairfax, and Rockhill are resistant. Catskill is slightly susceptible.

Fruit Rots

There are numerous fruit rots of strawberries occurring in the field, in transit and in the markets. One of the most serious of these diseases is known as "leak." Leak is caused by the black bread mold *Rhizopus nigricans*. Affected berries become soft, collapse and lose a great deal of juice. The mold can frequently be seen growing on such diseased berries. Leak is a disease characteristically found in transit and on the markets.

CONTROL.—Handle the berries carefully to avoid bruising. Where the disease is prevalent, keep the temperature below 50° F., if possible.

Root Diseases

There are at least two distinct types of strawberry root troubles. One is known as "black root" and the other as "red stele."

Black root may result from a number of causes. Chief among these causes are alkaline soil, winter injury, and several types of fungi. The disease is characterized by a dark brown or black rot of the roots which results in dying of the leaves and eventual death of the plant.

CONTROL.—If the disease is caused primarily by fungi, systematic crop rotation is recommended. Winter injury can largely be prevented by mulching with straw in the late fall. Planting strawberries on well-drained sites is also a good preventive practice.

Red stele is caused by the fungus *Phytophthora fragariae*. The disease is aggravated by poorly drained soil and overirrigation. Diseased plants are stunted and the older leaves wilt and die. The causal fungus attacks the roots, entering the woody part or the stele. Affected roots die, and when split open the woody portions of such roots reveal a brown-red to dark red discoloration. The above-ground portions of the plant are markedly stunted and the outer leaves die. Eventually the diseased plants die.

CONTROL.—Plant healthy plants. Plant in a well-drained soil. Avoid low sites and poorly drained soil. Avoid overirrigation. Use a 3 to 4 year crop rotation.

STRAWBERRY PESTS³

Strawberry Pests	Description and injury	Control recommendations
Ground beetles <i>Harpalus caliginosus</i> Fab.	Sometimes the seeds on ripening berries are eaten off by black ground beetles, about 1 inch in length. This insect in the larval stage is beneficial, feeding on other insects. Adults are usually predaceous, but sometimes feed on seeds and become destructive to ripening strawberries. Beetles are active at night and are seen in the day time only when disturbed. Development is slow and usually only one generation occurs a year.	Beetles may injure crop before their presence is known. Dusting heavily with pyrethrum dust, containing 0.2 or 0.3 percent pyrethrins gives good control. About 50 pounds of this dust are needed to cover an acre.
Leaf roller <i>Ancylis comptana</i> Frolich	Small greenish-yellow caterpillars rolling the strawberry leaves and feeding within. Heavily infested plants have a whitish appearance. Small grayish moths, ¼ inch long, with wavy brown wing bands, may be seen from April to September. Winter as larvae in silken shelters under trash, and as pupae in silken cocoons in folded leaves. Two or three generations a year.	Spray with lead arsenate, 3 pounds in 100 gallons of water, or dust with 1 pound of calcium arsenate or cryolite in 5 pounds of dusting sulfur. Dust or spray just before plants bloom. Two or three applications of dust or spray at 10-day intervals may be necessary. Insect population reduced by mowing and burning over shortly after the fruit is picked.
Millipedes <i>Orthomorpha gracilis</i> Koch	Hard shelled, many-legged animals, up to 1 inch in length, crawling over ground or underneath shelter. Bodies brownish or pink-brown color. Active when disturbed, but move slowly. Most abundant where the soil is damp. Eggs deposited in the ground in clusters, hatching about 3 weeks. Young millipedes at first have only 3 pairs of legs. They grow slowly with one generation a year.	Bait made from sliced potatoes dusted with paris green and placed where millipedes occur is usually effective. Poison-bran bait, as used for cutworms, placed in small piles under plants, is fairly effective. Clean up dead leaves and mulch that provides moist living quarters.

Strawberry Pests	Description and injury	Control recommendations
<p>Red Spider Mites <i>Tetranychus tetarius</i> Linn.</p>	<p>Leaves spotted and dying, with minute specks and some silk on the underside, among which small 6- and 8-legged greenish or reddish mites crawl and feed. Winter as adults under rubbish which offers suitable protection and on weeds that retain green foliage through the winter. Eggs are deposited on the under surface of the leaves and hatch in about 7 days. Newly hatched mites resemble the adults. Mature in about 3 weeks. Several generations a year.</p>	<p>Mites reduced in numbers by destruction of their winter host plants. Dusting sulfur applied to under side of leaves gives good control. Wettable sulfur, 1 pound to 20 gallons of water, or liquid lime-sulfur 1 gallon to 40 gallons water, will check them. Repeat the application of dust or spray in a week. Organic thiocyanates, such as Lethane and Loro, are quite effective, as are summer oil emulsions at strengths of 1 or 2 percent oil.</p>
<p>Root Aphid <i>Aphis forbesi</i> Weed</p>	<p>Plants attacked lack vigor, and fruits often fail to mature. Roots of the injured plant are covered with a bluish-green aphid. Aphid of same color on leaves in early spring. The aphids winter as black, shining eggs attached to the leaves and stems of plants. The eggs hatch in early spring and dark green aphids feed on the new leaves. Small brown ants usually care for the aphids and carry them to the strawberry roots where they feed, sucking out the plant juices. A number of generations occur each year.</p>	<p>No effective control measure is known. Deep fall plowing and deep cultivation in the spring aids in discouraging the ants. Set aphid-free plants. Nicotine sulfate, 1 part to 600 parts water, will kill the aphids wet by the solution. Saturating the soil around the plants with carbon disulphid emulsion, 0.35 percent, will reduce the number of aphids.</p>
<p>Root Weevil <i>Brachyrhinus ovatus</i> (L.)</p>	<p>Plants are eaten off close to the ground by a curved-bodied grub 1/5 inch long, with a light brown head. Grubs most abundant in late spring and again in late summer. Black beetles, about 1/6 inch long with blunt snout, cluster around bases of plants. Winter in larval and adult stages under surface litter and in old strawberry crowns. Eggs deposited in crowns and roots of plants. Two generations a year.</p>	<p>Dust or spray with calcium arsenate early in the spring. Destroy old beds promptly after the last picking. A bait composed of sodium fluosilicate, 5 pounds, with bran or shorts, 50 pounds, and chopped raisins, prunes, or dried apples, 50 pounds, has given good control when a teaspoonful of bait is placed in crowns at 1-foot intervals, using about 50 pounds on an acre. Two treatments may be required.</p>

Strawberry Pests	Description and injury	Control recommendations
Slugs <i>Agriolomax agrestis</i> L.	Soft, gray or gray and brown spotted, slimy snails up to 4 inches long are found in damp places. A sticky secretion from the body forms a dry, shining trail where the animals have crawled. Active at night, feeding on many different kinds of plants. Overwinters in protected places where it is damp. Egg masses held together by a sticky secretion laid in the soil. Eggs hatch in about a month. The young resemble the adults except for size. Develop slowly and may live for a year or more.	Trapping under small pieces of board and hand picking fairly effective. Bait composed of small pieces of boiled potato dusted with arsenic has given fair control. Poison-bran bait containing metaldehyde, placed in small piles, has given good results. It may be necessary to rebait the area once or twice at about 1-week intervals.
Weevil <i>Anthonomus signatus</i> Say	Buds and newly formed fruits dry up on a severed or partly severed stem. A small reddish-brown snout beetle, $\frac{1}{8}$ inch long, makes bud punctures in which eggs are inserted. A small, legless grub feeds within the dried-up bud. Beetles hibernate during the winter sheltered under trash, becoming active in the spring about the time plants bloom. Young, legless grubs feed within the dried up bud for about a month. The adults soon emerge, feed for a short time, and seek hibernation quarters, where they remain until the following spring.	Dust with lead arsenate or calcium arsenate or cryolite, 1 part, in sulfur, 4 or 5 parts, using two applications, the first as the plants come into bloom. Poisons should not be used within about 3 weeks of ripening. Thoroughly applying 0.2 percent pyrethrin dust at early blooming period gives good control.
Other insects	The alfalfa webworm, greenhouse white fly, root worms, crown borers, and lygus bugs are sometimes found injuring strawberries.	

*By John L. Hoerner, Entomology Section, Colorado Agricultural Experiment Station.