

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

g 84F

LIBRARY
RECEIVED

★ MAY 20 1933 ★
U. S. Department of Agriculture

U. S. DEPARTMENT OF
AGRICULTURE

FARMERS' BULLETIN No. 1646

May 1933

ASPARAGUS
CULTURE



ASPARAGUS is an important truck crop, both as a fresh vegetable and for canning purposes.

It can be grown under a wide range of soil and climatic conditions, but is not well adapted to some localities in the South where the winters are not severe enough to check the growth and give the plant a dormant period.

Vigorous 1-year-old crowns produce the heaviest yielding plantations. Crowns more than 2 years old should not be used for planting.

A well-cared-for plantation may yield profitable crops for a period of from 15 to 20 years, but it is generally desirable to renew the beds after 8 to 10 years.

In localities where asparagus rust is prevalent, only varieties resistant to the disease should be used for starting a new plantation.

This bulletin is a revision of and supersedes Farmers' Bulletin 829, Asparagus.

Washington, D. C.

Issued November, 1930
Slightly revised May, 1933

ASPARAGUS CULTURE

By ROSS C. THOMPSON, *Associate Horticulturist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page		Page
Importance of the industry.....	1	Profitable productive period.....	14
Climatic and soil requirements.....	1	Harvesting the crop.....	15
Fertilizing before planting.....	2	Preparation for market.....	16
Maintaining fertility.....	4	Grades.....	16
Varieties.....	5	Bunching and tying.....	17
Growing and handling the crowns.....	7	Packages.....	18
Starting the plantation.....	8	Asparagus rust.....	19
Age and size of crowns.....	9	Insect pests.....	22
Planting distances.....	9	Asparagus beetle.....	22
Setting the crowns.....	10	Cutworms.....	23
Cultivation and care.....	10	Garden centipedes.....	24
Length of cutting season.....	13		

IMPORTANCE OF THE INDUSTRY

ASPARAGUS is one of the most valuable of the early vegetables and perhaps the most important of the perennial vegetable crops. It is healthful and palatable, both as a fresh vegetable and as a canned product. Its importance as a market garden, truck, and canning crop is growing, as evidenced by the rapidly increasing acreage being devoted to its production, both for fresh consumption and for canning purposes.

The acreage devoted to the production of asparagus, according to the Bureau of Agricultural Economics, United States Department of Agriculture, increased from 30,500 acres in 1918 to 94,930 acres in 1928, or more than trebled in those 10 years. Approximately half of the acreage is grown for fresh consumption and the remainder for canning.

More than 95 per cent of the asparagus acreage of the country is in six States, and over 50 per cent of the entire acreage is in California alone. New Jersey, South Carolina, Georgia, Illinois, and Maryland follow in the order mentioned. The growing of asparagus for canning purposes is localized, almost wholly, in the Sacramento and San Joaquin River Valleys of California, a small additional amount being produced in New York.

CLIMATIC AND SOIL REQUIREMENTS

Asparagus is cultivated to some extent in nearly all sections of the country. In many places it is found growing wild where the seed has been disseminated by wind, water, birds, and other carriers. Conditions suitable for commercial production are much more limited.

The asparagus plant (*Asparagus officinalis*) is a native of temperate regions and is best adapted to localities where low temperatures prevail during some period of the year. For normal development it is necessary for the plant to have periodic intervals of dormancy. During the growing season, after cutting has stopped, the plant stores up reserve food materials in the roots. During the dormant period important chemical changes take place in the reserve food supply that greatly influence the future development of the plant. Without such periods the plant does not develop properly and the shoots may become less vigorous and more spindling each year. Asparagus culture on a large scale should not be undertaken where climatic conditions are such that the plant continues to grow throughout the year without a dormant period.

Asparagus can be grown on many kinds of soil, but good drainage is essential. The best types of soil for permanent plantations are deep, loose, and light, such as mucks and light sandy loams. The asparagus plant has an extensive root system and for maximum development must have an open, porous soil. Since early spring growth depends on the reserve food stored in the fleshy roots, a soil should be provided that permits unhampered development of the storage roots, which may reach a length of over 10 feet. Where earliness is important, a soil that warms up readily in the spring is essential, for temperature is an important factor in early growth.

Asparagus will thrive on soil having a salt content too high for the culture of most crops. Many growers have believed common salt to be essential to asparagus growing and have applied it to their asparagus beds. The work of a number of investigators indicates that asparagus is benefited by sodium chloride or common salt, but others question its value as a fertilizer or as a soil amendment. It is not used by the larger growers, and good crops of asparagus are produced without it. Unless its need has been proved by experiment, the application of salt to asparagus fields is not advisable.

Although tolerance of the asparagus plant to various salts makes it possible to utilize for its production land that is too alkaline for the growing of other crops, the life of the plantation is likely to be shorter on such land. The shortening of the life of the bed has been noted in California where the soil has become very alkaline from salts in the irrigation water.

FERTILIZING BEFORE PLANTING

The long time that the land is occupied by an asparagus plantation makes it highly desirable that the soil be made fertile and that it be put into the best physical condition possible before the plants are set.

The question of fertilizer practice is a local problem and to a large extent must be determined by local conditions. What has proved to be a good practice in one locality may not be the best procedure in some other where soil and climatic conditions are different. It should be borne in mind that a fertilizer that gives the greatest yield may not return the greatest profit per acre, for

the cost of the fertilizer may be proportionately more than the increase in yield over that with another treatment.

Asparagus thrives best in a soil well supplied with humus. In soils of mineral origin low in organic matter the application of some organic material may be of more importance than the addition of nitrogen, phosphorus, and potassium. Soils of organic origin, like peat and muck, are already well supplied with humus and may need only the addition of one or more of the fertilizing elements to put them in a good state of fertility.

Where organic matter is needed it can best be supplied in the form of animal manure if it can be obtained at a reasonable cost. Such manures are especially desirable in that they add some plant food and also improve the physical condition of the soil by the addition of humus. The present cost of animal manure makes it inadvisable to try to maintain fertility on large plantations by the use of it alone. On the other hand, animal or green manure can not be entirely replaced by commercial fertilizer, unless the soil is already well supplied with organic matter. It is a good practice to supply part of the required materials in the form of manure and part by commercial fertilizer.

Where animal manure is not available, the required organic material can be supplied by turning under a green crop. Some of the leguminous crops, such as cowpeas, soybeans, vetch, or clover, are preferable, as they add some nitrogen to the soil when they are properly inoculated with the nitrogen-fixing bacteria. Where it is impracticable to grow a legume, one of the small-grain crops like rye, wheat, oats, or barley can be used. While the grains do not add nitrogen to the soil as do the legumes, they furnish a large amount of organic material and should be used where legumes can not be grown to advantage.

In turning under any green-manure crop it is essential that it be done while the crop is still green and succulent. This is especially important in the case of nonlegume green-manure crops. Much of the benefit to be derived from the crop is lost if it is allowed to become too mature before being turned under. Mature plant material requires more time to decay and may interfere temporarily with the soil moisture supply which is needed by the asparagus plants. Moreover, too heavy an application of mature plant material may result in a temporary reduction in the available nitrates in the soil.

Where a heavy application of animal or green manure is to be added to the soil it should be turned under the season preceding the setting of the asparagus crowns. A light application of well-decomposed manure may be broadcast and worked into the surface soil. If only a limited supply of manure is available, it can be utilized more economically by being placed in the bottom of the planting furrow than by being broadcast. When thus applied, it should be well rotted and thoroughly incorporated in the soil before the crowns are set.

In addition to manure, an application of commercial fertilizer is usually advisable. In general, the longer the land has been in cultivation the greater is the need for one or more of the fertilizing elements. Soils in the eastern part of the country are more likely to require commercial fertilizer than the western soils. Investigators

in California report little increase in yields from fertilizers tested in the delta region of that State. An application of 1,000 to 1,500 pounds to the acre of a complete fertilizer containing 4 to 5 per cent of nitrogen, 8 to 10 per cent of phosphoric acid, and 6 to 10 per cent of potash can often be used profitably. If applied before the plants are set it should be broadcast and thoroughly mixed with the soil. The application of the commercial fertilizer may be delayed until after the crowns are set. It is applied along the rows and worked into the soil by cultivation.

If a legume rather than a nonlegume is turned under as a green-manure crop, less nitrogen will be required in the commercial fertilizer. Animal manures vary greatly in the percentage of the fertilizing elements they carry. Furthermore, soil origin and climatic conditions influence soil fertility and fertilizer requirements. Such variable factors as these preclude the establishing of a fertilizer practice which would be best under all conditions.

MAINTAINING FERTILITY

Once a plantation has been established, it should be fertilized every year, but the best time to apply fertilizer to an asparagus bed is a debatable question. The first season or two after setting, 1,000 to 1,500 pounds of a complete fertilizer should be broadcast and worked into the soil as early as the soil can be worked, followed by one or two applications of nitrate of soda applied along the rows at the rate of 150 to 200 pounds per acre.

When the plantation has been established long enough to begin harvesting the spears, most of the fertilizer is usually applied just after the cutting season. Asparagus draws most heavily upon the plant food when it is making top growth and storing reserve food in the fleshy roots. Investigations made by the New Jersey Agricultural Experiment Station show that the asparagus plant can utilize nitrates in the spring and during the cutting season. The records of yields for nine years at the Maryland Agricultural Experiment Station showed no consistent difference in the yield of asparagus fertilized at the beginning and that fertilized at the end of each cutting season. Some successful growers apply quick-acting nitrogen fertilizer early in the spring and side dress the rows during the harvesting season, believing that early applications of such nitrates help to maintain production and quality, especially where green asparagus is grown. It is, however, generally considered a better practice to delay the application of most of the fertilizer until after the cutting season, when the plant can make the most efficient use of it.

Where animal manure is available it is a good practice to broadcast at the end of the cutting season as heavy an application as is economical. This should be supplemented with a complete fertilizer containing from 4 to 5 per cent of nitrogen, 6 to 10 per cent of phosphoric acid, and 6 to 10 per cent of potash, applied at the rate of from 1,000 to 1,800 pounds per acre. Many eastern growers are using 4-8-6 and 4-8-7 fertilizers with good results.

In some of the eastern asparagus sections cowpeas and soybeans are being grown as a late cover crop with good results. (Fig. 1.)

The seed of the cover crop is drilled in between the asparagus rows about three weeks after the cutting season, about 5 pecks of seed being used to the acre. The cover crop tends to prevent weed growth and, if the growth is disked in, adds considerable organic matter as well as some nitrogen to the soil. This is a good practice and one likely to become more general with the increasing scarcity of animal manure.

VARIETIES

There are only a few varieties of asparagus, and the varietal differences between some of these are not well defined. The constant mixing of strains in the field, which is due to the male and female flowers being borne on different plants, makes it difficult to obtain seed that will produce plants uniform in type and true to varietal

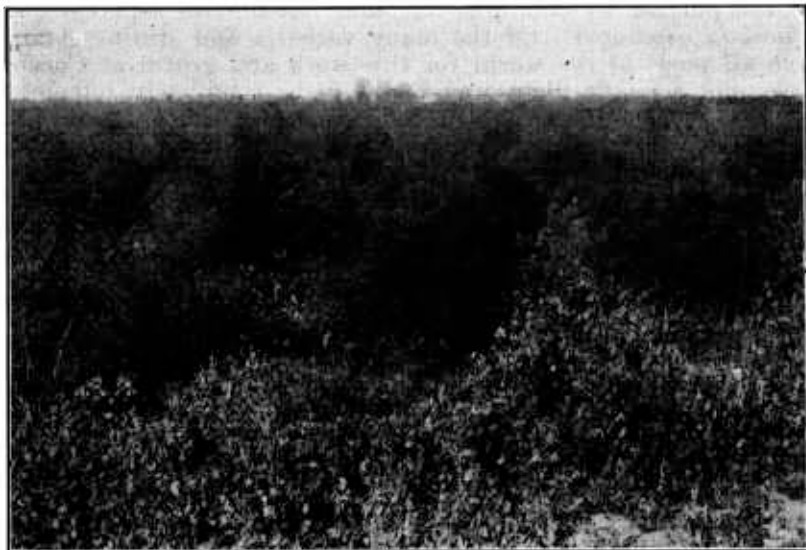


FIGURE 1.—Soybeans grown as a cover crop following the cutting season

characteristics. Since the crowns are propagated almost wholly from seed, wide variation is likely to appear in any lot of crowns unless special effort is made to isolate the seed-producing and pollen-producing plants. Where more than one variety is grown for seed, careless handling of seed stocks soon results in mixture and in varietal differences becoming less distinct.

Because of these facts and the fact that the bed or field to be planted will last for many years, the importance of care in selecting planting stock is apparent.

There are two general types of asparagus based on the color of the spears. The less important group includes such varieties as Conover Colossal and Mammoth White, which produce light-green or whitish spears. The spears of this group are violet or reddish colored before they are exposed to the light and become light green in full light. The more important group includes such varieties

as Palmetto, Argenteuil, and Mary Washington. The tips of the spears before exposure to the light are purplish, and the spears become dark green in sunlight.

The best of the old varieties are Palmetto, Reading Giant, and Argenteuil. The Palmetto and Argenteuil are very similar if not identical. Good strains of Palmetto are somewhat resistant to asparagus rust and are generally productive. The Palmetto was formerly most widely grown, but it is now being largely replaced by Mary Washington.

Among the new varieties and strains are the Mary Washington and Martha Washington. These strains are the result of years of breeding and selection work done by the United States Department of Agriculture in cooperation with the Massachusetts Agricultural Experiment Station and other cooperators throughout the country, for the purpose of obtaining varieties resistant to asparagus rust (*Puccinia asparagi*). Of the many varieties and strains obtained from all parts of the world for this work and grown at Concord, Mass., not a single plant was found to be completely immune to the disease. However, in 1910 a vigorous rust-resistant male plant was isolated from a lot of New American, of unknown origin, which, with a resistant female plant from Reading Giant, procured from Sutton & Sons, Reading, England, gave the progeny from which the first Washington strain was selected. Other rust-resistant female plants were later isolated and used in the crosses, from the progeny of which the present Washington rust-resistant strains were selected. These strains are now the most rust resistant of the varieties in cultivation.

Aside from their rust resistance, the Washington strains are of high commercial quality, fully equal to or superior to the best varieties on the market in earliness, vigor of growth, and size and quality of shoot. They are also more uniform in size, shape, and color than the old standard varieties and are very productive of large spears. These strains have already replaced the older varieties in many asparagus sections and are the more desirable even in sections not subject to rust epidemics. The Martha and Mary strains are very similar, and although the former is more rust resistant, the latter strain is slightly earlier and more vigorous and is resistant enough for practical purposes. It is the more popular and the better for general planting in most asparagus sections.

The demand for seed and roots of these strains, especially of the Mary Washington, for a long time exceeded the supply. Their development and distribution had a marked effect on the asparagus industry. The greatly increased acreages of asparagus planted throughout sections of New Jersey, South Carolina, Georgia, and California during recent years have included a considerable and increasing percentage of these strains.

A number of older varieties have not been mentioned, since most of them are less desirable than the newer strains. In fact, many nurserymen and plant growers now list only the varieties resistant to asparagus rust. In establishing a new plantation it is important to use one of the rust-resistant strains, especially in localities subject to rust epidemics.

GROWING AND HANDLING THE CROWNS

For the home garden or a small planting it is perhaps best to purchase 1-year-old crowns from a reliable nurseryman or plant grower, but where a large acreage is to be planted it may be advisable for the grower to raise his own plants. There are several advantages in growing the crowns rather than in purchasing them, namely, (1) the grower can select his own source of seed; (2) it usually costs less to grow large quantities of crowns than to buy them; (3) special care can be exercised to produce large healthy crowns; (4) selection can be practiced and only the best crowns transplanted; (5) the crowns can be transplanted with less injury from exposure and drying.

The first essential in growing crowns is to obtain good seed of the desired variety. The crossing that occurs in the field, as already mentioned, adds greatly to the difficulty of procuring seed of known quality for planting. Unless special care is exercised in the selection and handling of the seed-bearing and pollen-bearing plants the young seedlings may be somewhat variable. Most asparagus varieties are rather variable at best; hence the importance of good seed of known quality can not be too strongly emphasized.

Close attention must be given the seed bed if good results are to be secured. The soil should be worked until it is free from clods, for germination is likely to be poor in a rough, cloddy soil. A finely pulverized, well-prepared seed bed permits the soil particles to come into close contact with the seed, insuring constant moisture supply and thereby hastening germination.

Asparagus seed is slow to germinate; it often requires from four to six weeks for the plants to appear above ground, the time required depending on soil temperature, moisture, and depth of covering. Asparagus seed absorbs water slowly at temperatures below 70° F.; hence, if dry seed is planted in cold soil several weeks may be required for the seedlings to appear. Investigations conducted by the California Agricultural Experiment Station show that germination of asparagus seed can be hastened by soaking the seed in water, but seed so treated must be handled properly or more loss than gain may result from the practice. It is recommended that it be soaked at a temperature of 85° to 90° for four or five days. Little benefit is derived from a temperature below 75°, or from soaking for a short period. After being soaked, the seed must be dried off and planted at once. Damp seed should not be held in containers when the air is excluded, or long enough after being soaked for rots or molds to develop on the seed. For best results, soaked seed must be planted in moist soil; if it is planted in dry soil the benefit of soaking is lost.

In order that the asparagus seedlings may have as long a season as possible in which to develop large crowns, the seeds should be planted as early in the spring as the soil becomes warm enough for germination. The date of planting must be governed by the location and seasonal conditions. In the Imperial Valley of California the seed is often planted the latter part of January or early in February. In the North seeding is frequently done as late as the latter part of May. The best temperature for the germination of asparagus seed is between 75° and 85° F. Below 70° germination is very slow.

If the germination is known to be good it is advisable to plant the seed thinly. It is better to give the plants enough space at seeding time than to attempt to thin them. Thinning is difficult, and the crowns are hard to separate after digging if grown so close together that the roots are interwoven. Moreover, thin seeding saves expense and reduces the amount of root injury in separating the crowns.

A good planting practice is to seed in rows 24 to 30 inches apart, allowing 3 or 4 inches between plants in the row. The distance will depend largely upon whether the cultivation is to be done by hand or by horse implements. From 5 to 10 pounds of seed is sufficient for one acre.

The depth to plant depends upon the type of soil and moisture conditions. The heavier the soil the shallower the seed should be covered. The chief object in covering seed is to provide proper moisture for germination. The question of uniform moisture during the germinating period should be borne in mind in determining the proper depth to cover the seed. In light peat soil the seed may be covered as deep as 3 inches; in sandy loam $1\frac{1}{2}$ inches is deep enough, provided the soil is sufficiently moist for germination.

Weeds should be kept down, as they draw heavily on soil moisture and in dry weather may deprive the asparagus roots of needed moisture. Cultivation should be shallow, especially so late in the season, to prevent injury to the developing roots.

Before digging the crowns the old tops should be cut and removed so as not to interfere with the digging. A common moldboard plow or a special implement equipped with a U-shaped knife can be used to lift the plants from the nursery row. In digging the crowns care should be exercised to avoid injuring the roots. If the plants are lifted without injuring the tips of the fleshy roots they will continue to elongate after being transplanted. Since the fleshy roots are essential storage organs, it is important that their development be checked as little as possible.

It is best to set the crowns as soon as possible after digging. Where it is necessary to keep the crowns for a period before setting, they should be stored in some dry, protected place at a temperature near 40° F. Extreme drying of the crowns should be avoided. Experiments conducted in California, in which the yields from dried crowns were compared with those from crowns not dried, showed the yields to be greatly reduced by drying. The greatest reduction occurred during the first cutting season, but the injurious effect of drying the roots was apparent the second season.

STARTING THE PLANTATION

In most sections of the country asparagus crowns are set in early spring as soon as the soil can be worked. In some parts of the South and in the Delta and Imperial Valley districts of California, where climatic conditions are favorable, the roots are set late in the fall or during the winter. Fall and winter planting is necessary in some parts of California, as heavy rains interfere with spring planting. Spring planting is preferred in the North because fall-planted roots may be injured by cold before they become established if the

winter is severe. The time to plant the crowns must be governed by local climatic conditions.

AGE AND SIZE OF CROWNS

One-year-old crowns are the most desirable for setting. In some cases the grower may be justified in planting 2-year-old crowns, but those older should never be used. Two-year-old crowns should not be used unless they have been given sufficient space in the nursery row for proper development, and even then the 1-year-old roots are preferable because they result in more productive plantations. Where the crowns are grown very close together, the fleshy roots may be injured in separating them, and severe root injury will materially reduce the yield in years following.

Experiments conducted at the Pennsylvania Agricultural Experiment Station indicate that it is profitable to use only the larger and better crowns. In this work, 1-year-old crowns of Palmetto and Argenteuil were divided into three grades according to the size of the crowns. No weights or measurements of the grades were reported. Records of the returns from each grade were kept for a period of six years. There was no striking difference between the returns from the first two grades, but those from the third grade, consisting of the smaller crowns, fell far below the other two. There was also a very significant difference in favor of the larger crowns in the number of crowns that grew. Other experiments have given similar results, indicating that some system of selection should be practiced and that only the larger crowns having well-developed buds free from disease and severe root injury should be planted.

PLANTING DISTANCES

The soil must be as thoroughly prepared for asparagus as for any other crop. It should be plowed deep and well worked down. Furrows for the crowns should be opened with a lister or some other suitable implement, the depth to depend upon that to which the crowns are to be finally covered. A deeper furrow is required in a loose soil where the crowns are to be finally covered to a depth of 10 to 12 inches than in a heavy soil where they are to be covered only a few inches.

The distance between the rows depends on whether white or green asparagus is to be grown and on the type of cultivation to be practiced. For a small planting or in the home garden the planting distances need not be so wide as for commercial plantings. Less space between rows is required for growing green asparagus than for growing white asparagus. The latter should have the soil ridged over the crowns so that the spears can attain the desired length before reaching the surface. Where ridging is to be practiced, from 6 to 8 feet should be allowed between rows to provide enough soil to form the ridge. Rows of green asparagus should be from 5 to 6 feet apart. The higher the ridge the more soil required and the greater the space between rows. In some sections green asparagus is cut during the early part of the season, and white asparagus is harvested from the same beds the latter part of the cutting season. Where the growing of both green and white asparagus is to be practiced the rows should be far enough apart to allow for ridging.

The distance between plants varies from 8 to 30 inches. In some sections, New England in particular, a method of planting known as the Wilkinson system is practiced. By this plan the crowns are set 8 to 10 inches apart in the row. Close spacing has the advantages of larger yields during the first few years and less loss from skips due to crowns that failed to grow. However, this system has the disadvantage of greater cost in starting the bed, owing to the larger number of crowns required; and the life of the bed is much shorter.

In many of the eastern plantings the plants are set from 18 to 36 inches apart in the row. If the soil is reasonably fertile, 36-inch spacing does not seem advisable, as too wide spacing gives lower yields. A good spacing distance is 24 to 30 inches, the former being recommended in most of the California districts.

SETTING THE CROWNS

When the crowns are placed in the furrow, the roots should be well separated and spread in their natural position. It is a good practice to place a small mound of soil in the trench where the crown is to be placed and to set the crown on the peak, allowing the roots to spread out naturally. Although the careful spreading of the roots is a good practice and should be done in small plantings, generally no attempt is made to spread the roots in very large plantings, as it requires considerable time and labor.

At first it is best to cover the crowns with 2 or 3 inches of soil, increasing the depth as the shoots develop, since too deep covering at the time of planting may cause poor growth or the death of many crowns. The extremely deep planting formerly practiced is no longer advised. Deep planting means a late crop, as the soil is slow to warm up to a sufficient depth to promote rapid growth early in the season. In deep loose soils like peat the final depth of the crowns may be as much as 12 inches, but this is too deep for most soils. The final depth of the soil over the crowns should not exceed 6 to 8 inches in light soils and 4 to 6 inches in heavy soils.

CULTIVATION AND CARE

Cultivation should begin soon after the crowns are planted and should continue throughout the season at intervals frequent enough to keep down weeds. Any stirring of the soil should be shallow, as serious injury to the roots may result from deep cultivation, especially after the root system has become extensive and the crowns have grown near the surface. Filling in the furrow during the season will keep down most of the weeds in the row close to the plants the first year after setting, and little handwork may be necessary. After the first season some hand-hoeing is necessary to keep down weeds near the plants. Any working of the soil close to the crowns during the cutting season must be shallow and carefully done, to avoid injuring the developing spears. Weed control is very important with a perennial crop like asparagus. A year or two of neglect may result in the soil becoming so foul with seeds that weed control may be difficult and expensive.

If white asparagus is to be grown, the rows must be ridged up, covering the crowns with several inches of soil. Implements of two

types used for this purpose are shown in Figures 2 and 3. The soil over the crowns must be deep enough for the spears to attain the desired length before reaching the surface. In order to keep the crowns properly covered it may be necessary to renew the ridges every two weeks or oftener.

If green asparagus is to be grown, a very low ridge or no ridge at all is necessary. The crown of the asparagus plant increases in thickness, thus coming a little nearer the surface each year, so that slight ridging may be necessary for the growing of green asparagus when the crowns have come very close to the surface. Too shallow

covering of the crowns subjects them to excessive heat during hot weather, which causes the tips of the spears to open before they reach the desired length and reduces their market value.



FIGURE 2.—A type of asparagus ridger used to a considerable extent in some asparagus-growing regions for renewing the ridges

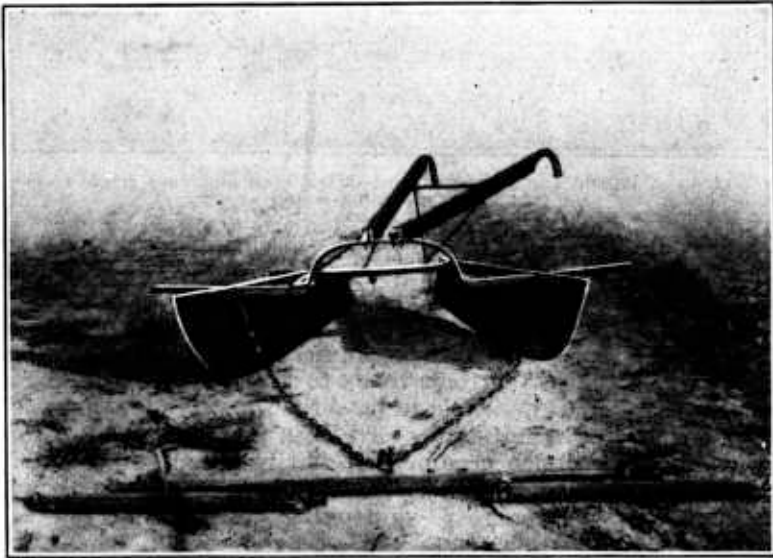


FIGURE 3.—A very satisfactory homemade type of asparagus ridger

At the end of the cutting season the asparagus beds should be thoroughly cultivated, ridges leveled, and the plantation given flat culture for the remainder of the season. The ridges can be plowed

down with a turning plow or with an implement of the type shown in Figure 4. Care must be taken not to disturb the crowns. Any fertilizer to be applied after cutting should be worked into the soil at this cultivation.

The best way to handle the tops which grow up after the cutting season is a debatable question. Some advocate cutting off the tops as soon as the berries begin to mature and either removing or burning them. It is claimed that delay in removing the tops results in scattering the seed, which may become troublesome upon germination.

In parts of the North where winter temperatures are low it is believed to be advisable to allow the tops to remain in the fall, as they afford some winter protection by holding the snow and pre-

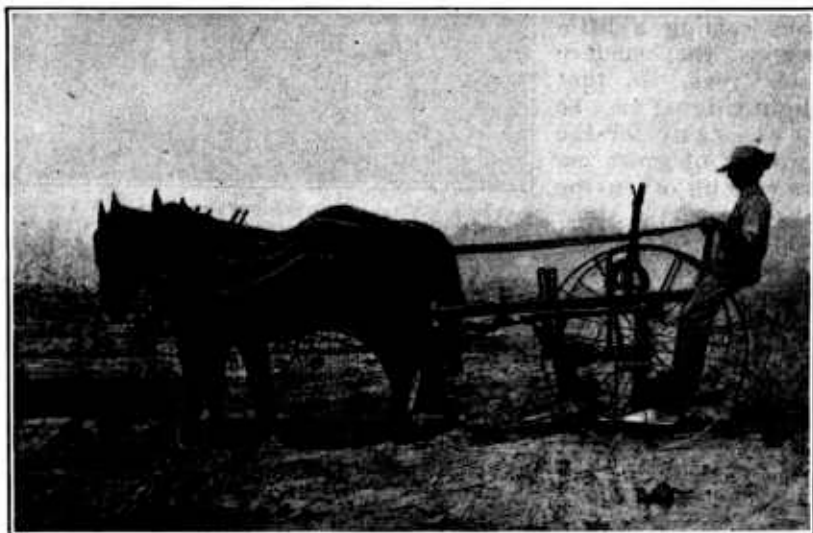


FIGURE 4.—A type of implement used in plowing down asparagus ridges at the end of the cutting season

venting the blowing of the soil. In this case the tops are disked into the soil in the spring.

Removal of the tops too early in the fall is a bad practice. It has been shown that too early removal of the tops stops the transfer of reserve food materials to the fleshy roots. Any decrease in the supply stored in the roots tends to reduce the succeeding crop. For this reason it is desirable to have the tops stand as long as they continue to grow, or until they have been killed by frost. Burning the tops destroys much organic material which might be profitably returned to the soil, provided no serious disease or insect is present; but it has the advantage of destroying diseases and insects that may be present on the stems.

The grower may feel that he must obtain some income before the asparagus becomes productive. Intercropping is often practiced during the first year or two. Low-growing crops like cabbage, lettuce, beans, and peppers can be grown between the rows without

serious injury to the asparagus. However, most successful growers do not intercrop, and it is not recommended as the best practice. Tall-growing or long-season crops should never be grown with asparagus, as the latter may suffer from shading and depleted soil moisture. When intercropping is practiced, one row between the asparagus rows is sufficient.

LENGTH OF CUTTING SEASON

In many asparagus sections harvesting of the spears is delayed until the third season after setting. This has been the general practice throughout most of the eastern and middle-western sections, but many growers are now cutting for a short period the second season. In California it is the general practice to cut for a period of three or four weeks the year following that of planting. It is thought by some that cutting during the year after planting weakens the plants and may reduce the yield in years following. However, many growers who practice harvesting the spears the year following planting are of the opinion that early cutting does not weaken the plants if a good vigorous growth has been made the first year and the cutting period does not exceed 30 days. Moreover, it is their belief that early cutting has the advantage of causing the crowns to spread more widely than they do when no harvesting is done.

The California Agricultural Experiment Station has conducted some investigations on the effect of cutting the spears the first season after setting. The results obtained indicate that the yield and size of the spears are not impaired by harvesting for a short period the year following planting. This is an item of considerable importance, especially to the grower who is pressed for capital. If harvesting can be practiced for even a few weeks during the season following planting without injury to the plants, it will help to defray expenses in bringing the plantation into full production.

Some of the most successful eastern growers are now harvesting spears for a period of three to four weeks the first season and for five to six weeks the second season after planting. Subsequently, the beds are harvested the entire cutting period of from eight to nine weeks. In California the general practice is similar; after the second cutting season, however, harvesting may extend over a much longer period. The long growing season in California makes it possible to cut over a longer period without injuring the crowns than is possible in sections having a short season.

In planning the management of the plantation it must always be remembered that production depends largely on the care given the bed during the previous season. Early spring growth is made very largely from materials stored in the fleshy roots during the preceding season. In order to have a large reserve supply stored in the roots it is necessary to have a healthy vigorous growth of tops during the summer and fall following the cutting period. A long cutting period may deplete this supply and may impair the vitality of the crowns. Furthermore, cutting too late in the season limits the growth of tops and reduces these reserve materials.

When an asparagus bed declines in production and there is a large proportion of small spears, it frequently means that the roots are becoming exhausted. When such a condition develops, it may be beneficial to shorten the length of the cutting period or not cut at all for a season, to allow the plants to recuperate. Allowing the beds to remain uncut for a season is expensive and can be avoided by proper fertilization each year, and the right care and attention during the growing season.

PROFITABLE PRODUCTIVE PERIOD

The establishment of a new asparagus plantation involves considerable labor and expense, hence a few years added to the productive life of the bed may be of significant economic importance. If properly cared for, a plantation may be expected to produce profitable yields over a period of 10 to 15 years. On very fertile soil and with special care a bed may remain profitable for 20 years or more.

The plantation can be expected to increase in production for several years following the setting of the crowns. After reaching the peak, profitable yields may continue under favorable conditions up to the twelfth or fifteenth year, when the yield is likely to decline. It is generally desirable to renew the plantation after 10 or 12 years. The new bed should be started two or three years in advance of plowing up the old one, in order to have it yielding profitably before the old bed is abandoned. On large plantations it may be advisable to renew a part of the field each year until the entire acreage has been replaced by new plantings. It is best not to set the same land to asparagus. If necessity compels its use, it should be planted to some other cultivated crop for a year or two, to rid the soil of the old roots before resetting.

The productive life of the beds depends on climatic conditions, soil texture, soil fertility, planting distances, diseases, insects, and cultural and harvesting methods. While very light soils are ideal for maximum production for several years, the beds are likely to be shorter lived than on heavier soils. The asparagus plant is a heavy feeder, hence profitable production over a long period of years requires heavy fertilization. The system of close planting, as practiced in some localities in New England, tends to shorten the life of the plantation. The average life of a bed so planted is about 10 years. Continued high production requires that the beds be kept free from disease and insects, for any injury interfering with the proper growth of the tops after the cutting season reduces the quantity of reserve materials stored in the fleshy roots and rhizome. The succeeding crop will be reduced as the reserve food supply is curtailed. Improper cultural practices may interfere with crown development and shorten the life of the bed. When the bed has reached the age where the crowns are near the surface, many of the terminal buds may be injured by cultivation. The injury of the large terminal buds on the crown permits the growth of the smaller lateral buds which produce smaller and often spindling shoots. The injury of the crowns by improper cultivation may be partially responsible for the increase in the number of spindling shoots as the

beds become older. Repeated cutting of the tops too early, thereby stopping the manufacture and transfer of food materials from the green tops to the fleshy roots, may reduce the succeeding crops and shorten the profitable life of the plantation.

All these factors and probably many others play a part in limiting the productive life of an asparagus plantation. The grower will be well repaid for special attention to these phases of asparagus culture by increased yields and prolonged life of the beds.

HARVESTING THE CROP

Three kinds of asparagus, relative to the color of the spears, are marketed. The spears may be entirely green, green with white butts, or entirely white. The greatest market demand is for a green product, whereas most of that grown for canning is white. Nearly all the green asparagus is harvested with a small amount of white on the butt end. The entirely green product that is cut at the surface of the ground does not keep as well as that cut with a portion of the shoot underground. Since the part of the stem that was underground is more woody than the stem above ground, it loses moisture less rapidly than the tender green portion and adds to the keeping quality of the spears.

White asparagus is obtained by growing the spears in darkness. This is accomplished by ridging the soil over the crowns and cutting the shoots below the surface as soon as the tips of the spears appear. White asparagus is grown in some localities where the asparagus beetle is prevalent in order to reduce the loss from beetle injury. The injury by the beetle causes the spears to grow crooked, otherwise mars the appearance, and thus destroys their market value. When white asparagus is grown the beetles have little opportunity to do much damage before the spears are cut.

Asparagus shoots grow very rapidly, especially if the temperature is high. If not harvested regularly, the spears soon become too old. Early in the season the shoots may require cutting only every third day. As the season advances, however, and the growth becomes more active it may be necessary on very light warm soil to cut twice a day.

The cutting should be done with a knife made especially for the purpose. For green asparagus 9 to 10 inches is a desirable length, and at least half of the length should be aboveground. The underground portion should not be too long, as the lower end is fibrous and less palatable. In cutting, care must be exercised to avoid injury to the young spears developing underground. The spears should not be cut too close to the crown, as the undeveloped buds on the rhizome may be injured. Knife injury to buds and unharvested shoots causes them to develop into crooked spears. It is a good practice not to cut closer than 2 inches from the crowns.

The proper way to cut without injuring the developing shoots is to place the knife near the shoot to be cut, forcing it straight down to the desired depth before tilting it to make the cut. The knife should not be forced into the ground at an angle, as many young shoots may be injured in this way. By holding the tip of the spear

with one hand the operator can readily tell when the shoot has been severed. Asparagus shoots should not be cut aboveground, leaving a stub. Stubs interfere with harvesting and may injure the hand in using the knife.

PREPARATION FOR MARKET

Asparagus loses its edible quality very rapidly after it is harvested, owing to chemical changes in the spears which reduce the amount of sugar and increase the amount of tough fibrous material. Analyses of the spears at various intervals after cutting show that the reduction in sugar content and increase in fiber take place most rapidly during the first 24 hours after harvesting. This is particularly the case in white asparagus. Although deterioration goes on at all temperatures, it is much slower at temperatures near the freezing point. Because of this rapid loss in quality at high temperatures, it is essential that asparagus be brought in from the field, bunched, packed, and placed in a cool atmosphere as soon as possible after cutting. It is a good practice to protect the spears as much as possible from the sun while harvesting during very warm weather.

If it is necessary to keep asparagus for a time after bunching, the bunches should be stood on end in cold water or on damp moss and held at a low temperature in some place not exposed to air currents. If placed in water and exposed to warm moving air currents the stalks continue to elongate, and changes taking place in the composition of the spears injure their quality. A temperature near freezing reduces these chemical changes to the minimum and maintains the edible qualities of asparagus.

In preparation for market, asparagus stalks are generally carefully graded, trimmed, and tied in bunches weighing from 2 to 2½ pounds. Sometimes the poorer grade and field-run asparagus is packed in crates without grading or bunching. In some localities, the Kennewick district of Washington in particular, some first-grade asparagus is shipped loose in crates without bunching. In some sections of the East asparagus is packed in 1-pound bunches, as some markets prefer the small bunch; or the large bunches are divided into smaller ones by the retailer.

GRADES

The Bureau of Agricultural Economics of the United States Department of Agriculture has outlined grades for asparagus, but since these grades are subject to change from time to time, anyone desiring the latest detailed information on the subject should apply to that bureau at Washington, D. C.

Asparagus may be classified as very small, small, medium, or large, depending upon the diameter of the spears. The following terms are provided for describing the diameter of any lot: Very small, less than one-fourth inch; small, one-fourth to nine-sixteenths inch; medium, nine-sixteenths to three-fourths inch; and large, over three-fourths inch. These measurements must be taken at a point not more than 8½ inches from the tip.

Asparagus may be classified as green if 90 per cent of the spears in any lot are of a green color, covering not less than 4½ inches of

the length of the stalk. The greenness of the stalks is one of the most important single factors influencing sales in markets that demand a green asparagus.

The grading according to the diameter of the spears depends upon the market demand and the quality of the product. California shippers sometimes pack as many as five grades, based on size. Eastern growers usually do not pack more than two or three grades. After trimming, the bunches should be from 8 to 10 inches long.

BUNCHING AND TYING

White asparagus is usually washed. This is done by placing the spears in wire-bottomed trays or baskets and dousing a few times in a vat of water. Unless a considerable amount of soil adheres to the spears green asparagus should not be washed. If it is necessary to remove soil from the butt end, the spears should be doused in a vat of water, butt down, taking care not to wet the tips. The stalks, butt down ward, should be laid on some sloping surface to drain before bunching. Asparagus keeps best if not wet.

Where asparagus is grown in large quantities for commercial purposes it is essential to have a contrivance for holding the stalks while they are being bunched and tied. There are various devices on the market made for this purpose. (Fig. 5.) Some

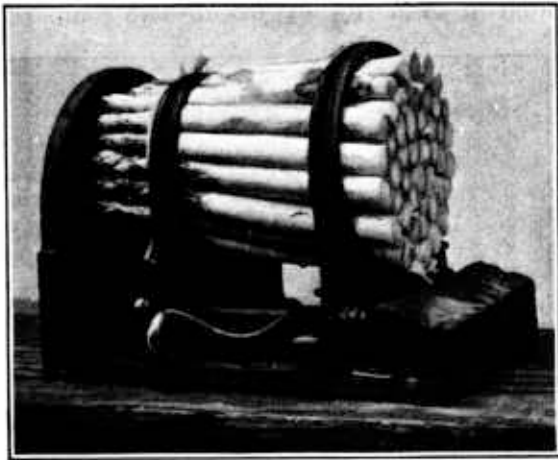


FIGURE 5.—One type of asparagus-bunching device. Note that the spears have been cut to a uniform length

of the large plantations are equipped with machinery that cuts the spears to the desired length; however, most of the trimming is done by hand. A large number of spears can be trimmed at one operation by placing them in a frame which holds all the tips even, and the extra length of stem can then be cut off with a large knife. Where a small bunching machine is used the spears are usually cut to the right length while the bunch is held in the buncher.

The bunches should be tied near each end. Some growers tie only once, at a point near the center; but a single tie makes a very poor bunch, as it permits too much slipping of the spears. Besides making a tighter bunch, the double tying adds to the appearance. Various materials, such as raffia, twine, and tape, are used for tying the bunches. While tying tape is a little more expensive than the other materials, it has much to recommend it. Raffia does not have the neat appearance of tape, and twine is likely to cut the spears if tied very tightly. The tape is available in various colors, and sometimes the several grades are tied each with different-colored tape. How-

ever, only good grades of tape having fast colors should be used, as any coloring of the spears from dye in the tape may impair the market value.

The bunches should be tied as tightly as possible without injuring the stalks, as there is some shrinkage of the spears, especially if they are bunched while very turgid. This shrinkage causes the bunches to become loose.

Many growers and shippers wrap the bunches in parchment paper, leaving a portion of the tip end of the spears extending above the paper, making a neat-appearing bunch. The paper wrapper generally bears the name and address of the grower or shipper. This is a good way to advertise a high-quality product.

PACKAGES

Shipping crates of different types are used in the various sections where asparagus is grown. The most commonly used crate is pyramidal in form (fig. 6), having two compartments each holding six

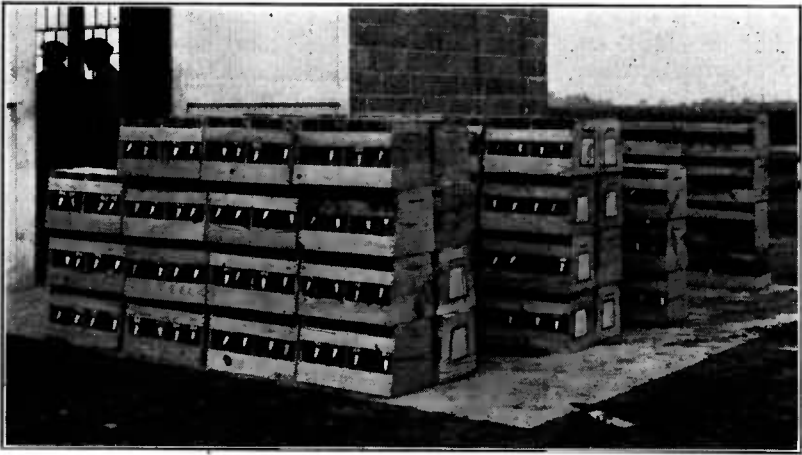


FIGURE 6.—Asparagus packed in crates ready for market. Note the pyramidal shape of the containers

2-pound to 2½-pound bunches. The type of crate most popular in California has two compartments which hold six bunches each. The inside measurements of this crate are approximately 9½ inches wide at the top, 11 inches wide at the bottom, 10½ inches high, and 17¼ inches long. A similar crate is used in Georgia and the Carolinas. This is a very satisfactory shipping container, as the pyramidal shape conforms to the taper of the bunches, preventing their being shifted about in shipment.

New Jersey, Delaware, Maryland, and Pennsylvania have not adopted a standard-size container, but the tendency is toward a dozen-size crate without a center partition. A 2-dozen size crate having an inside measurement of 10½ by 14½ by 17 by 23⅜ inches has been popular in New Jersey. A 32-quart berry crate and a pyramid crate holding 1½ dozen bunches have also been used in this section, but they are all being replaced by the pyramid crate holding a dozen bunches.

The bottoms of the crates are generally lined with paper which is covered with a layer of damp moss. The butts of the bunches are placed on the moss, and when packed in this way and kept at a temperature just about freezing, asparagus will carry a considerable distance and keep for several days without serious loss in quality.

In the early part of the cutting season when the quantity is small and where the product is to be sold in near-by markets, asparagus is shipped either by express or by motor trucks without refrigeration. After the cutting becomes heavy and car-lot shipments begin, most of the asparagus is shipped under refrigeration.

No one factor is of more importance in the selling of a product than its appearance. The grower is usually well repaid for a little effort to make his produce command attention when it goes on the market. Care in grading, bunching, tying, and wrapping should add considerably to the selling qualities of an asparagus crop.

ASPARAGUS RUST¹

Asparagus is subject to a number of diseases, but only one, asparagus rust (*Puccinia asparagi*), is of much economic importance in asparagus production. The occurrence of this disease in North America was first mentioned by Halsted, who reported epidemics of rust on asparagus in New Jersey, Delaware, Long Island, and some parts of New England in 1896. Since then the rust has spread to practically every asparagus-producing section.

The presence of the disease is closely related to environmental conditions. Although the rust is present in most places where asparagus is grown, it is much more destructive in some localities than in others. The rust spores are dependent on moisture for germination, hence lack of moisture retards the spread of the disease. In the semiarid West the rust spreads very slowly, on account of the lack of moisture necessary for the germination of the spores. Severe rust epidemics are most likely to occur in regions of heavy rainfall and in localities subject to heavy dews.

The disease is generally first observed as small reddish-yellow spots on the main stems near the ground and on the very slender branches of the stalks which grow up after the cutting season is over. The red spots are due to numerous spore-bearing pustules on the stem. These pustules burst, liberating great numbers of rust spores which have the appearance of reddish or rust-colored powder. By close examination of the stems the pustules may be found before they become numerous enough to attract attention. The spores liberated from the pustules are rapidly disseminated by the wind, and an entire field may soon become red with rust if sufficient moisture is present.

When the attack is severe the entire plant or the entire field may become brown and appear dead. The disease causes the tiny leaves to fall, and the plants present a naked appearance, as shown in Figure 7. The effect of rust on a field of asparagus is shown in Figure 8. The damage caused by the rust organism is not seen directly in the marketed product. The injury develops after the cutting season and

¹ The section on asparagus rust was originally prepared by J. B. Norton, formerly of the Office of Cotton, Truck, and Forage Crop Disease Investigations, and has been revised by W. W. Gilbert, senior pathologist, of the Office of Horticultural Crops and Diseases.

reduces the succeeding crop by weakening or killing the plants during the summer. It is due largely to the destruction of the tissues which function in the manufacture of food materials for storage in the

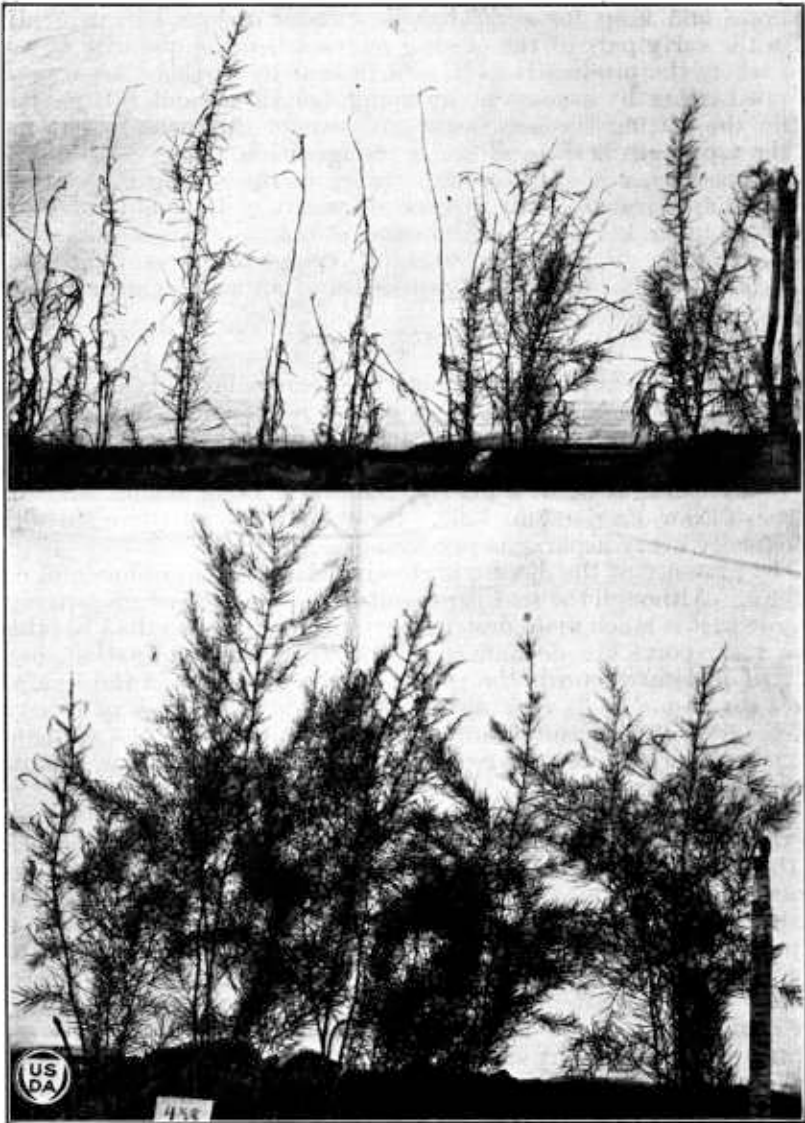


FIGURE 7.—Seedlings of Argenteull asparagus, showing some resistance to rust (above). The new pedigreed Washington asparagus, highly resistant to rust (below). Photographed by J. B. Norton, Concord, Mass., September, 1911

fleshy roots. The removal of the stalks for market during the harvest season is a heavy drain upon the roots. In order that the plant may replenish the reserve food supply for the next season's crop, it must make a vigorous top growth after the harvest season is over. If the

tops are injured by the rust, food manufacture and translocation are checked, and the plants if not killed may go into the winter in a starved condition. As a result, the succeeding crop suffers a reduction in both the number and the size of the shoots produced.

The most satisfactory way to control asparagus rust is to plant varieties known to be resistant to the disease. The most rust-resistant variety of asparagus in cultivation is the Martha Washington. The Mary Washington, while slightly less resistant than the Martha Washington, is sufficiently resistant for planting except where rust attacks are very severe. The Mary Washington has some other qualities, such as earliness and large size, that make it especially desirable for general planting.

However, a certain proportion of the asparagus acreage throughout the country still consists of stocks that are susceptible to rust.

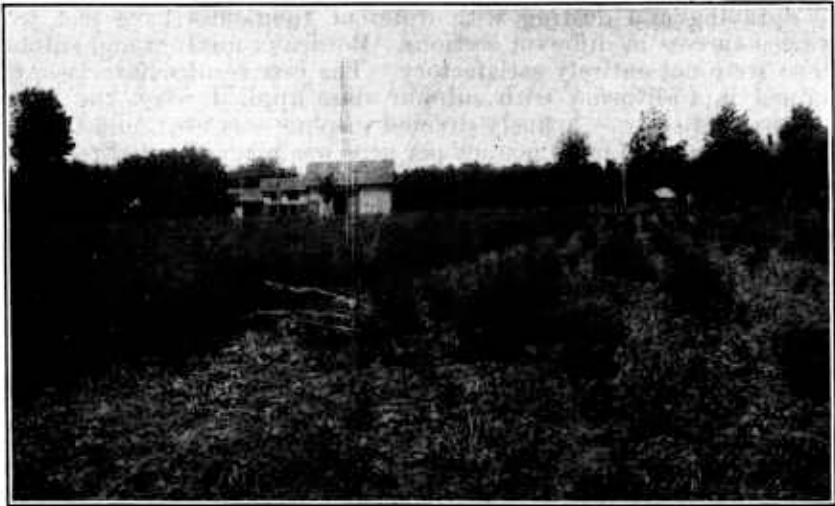


FIGURE 8.—An old asparagus field killed out by rust. The new field of the Reading Giant variety on the left was grown as a breeding field for rust-resistance work

(Fig. 8.) Several years must elapse before these nonresistant stocks will be entirely replaced by rust-resistant strains as their value becomes better understood. Meanwhile, in sections where rust is a factor and it is not practicable to do away with susceptible varieties, all practicable measures should be taken to reduce rust damage.

To this end the most important factor is to keep the rust away from the fields in early summer just as long as possible. Wild asparagus plants growing around the borders of the fields and along fences, hedges, or ditches are the worst enemies of the asparagus growers, because they carry the rust disease over winter and act as sources of infection for near-by fields in the spring. Most epidemics of rust start from asparagus plants in the field that have not been cut up to the close of the infection period of the spring rust, or from infected wild plants near by, usually on the windward side of the infested area, since the spores of the rust fungus are carried

by the wind. For this reason wild plants wherever found should be dug up and burned, small shoots or seedlings should not be allowed to grow up in the field until the end of the cutting season, and new beds when started should be planted with rust-resistant strains or located as far as possible from the cutting beds and on the side opposite the prevailing winds. In the fall the tops should be removed from the 1-year-old beds that are to be cut the next year. This practice will largely reduce the danger of infection from this source.

The removal of the tops from mature beds in the fall is not considered important as a rust-control measure, since repeated tests have shown that the spring stage of the rust fungus does not occur in fields where the tops are left over winter, disked in the spring, and the field kept clean of asparagus until the end of the cutting season.

Spraying and dusting with different fungicides have met with varied success in different sections. Bordeaux mixture and sulphur dust were not entirely satisfactory. The best results have been obtained in California with sulphur dust applied when the plants are wet with dew. A finely divided sulphur was used, and the first application of 25 to 30 pounds per acre was made about three weeks after the close of the cutting season. Another application about a month later should be sufficient under ordinary conditions to hold the rust in check. On newly planted beds or when cutting stops early in the season more than two applications may be necessary.

INSECT PESTS ²

ASPARAGUS BEETLE

The asparagus crop is subject to injury by several pests, but the one of the greatest widespread importance is the asparagus beetle (*Crioceris asparagi* L.). This insect overwinters in the adult or beetle stage under the protection furnished by rubbish and other debris surrounding the cultivated fields. Emerging from overwintering quarters in the early spring, it injures the market product by feeding and depositing eggs upon the young shoots of the asparagus after they appear aboveground. Later in the season both the beetles and immature forms attack the fully developed plant. As previously stated, the eggs are laid in the early spring upon the marketable shoots, but later in the season they are deposited on the leaflets and stems of the upper parts of the mature plant. The small dark-colored larvae or slugs upon hatching from the eggs feed upon the foliage of the plant and in cases of heavy infestations defoliate large areas in a comparatively short time. It requires from 10 days to 2 weeks for the larvae to complete their development. Upon reaching maturity they drop from the plant to the ground and there form small cases or cocoons in which to transform to the pupal stage. After about a week or 10 days in this stage they emerge as adults.

There may be one or more generations during a season, depending upon the climate. During the hot summer months, however, the

² Prepared by W. H. White, entomologist, Division of Truck-Crop Insects, Bureau of Entomology.

insect apparently does not thrive. Most of the damage to the crop is therefore caused in the spring and early summer. The attack upon the asparagus shoots during the early season reduces their market value because of the feeding marks and the presence of numerous small eggs which are difficult to remove. The younger plantings of asparagus are also subject to severe injury during the early part of the year. Later in the season the fully developed plants may receive a setback through defoliation by both larvae and adults.

Control.—No entirely satisfactory method has been developed for the protection of the market product from damage by the asparagus beetle. Keeping the pest in check by the use of arsenicals on the mature plantings and cleaning up the areas about the asparagus fields, however, will serve in a large measure to prevent noticeable losses. In regions comparatively free from rust attack advantage may be taken of the fact that the female beetles prefer to lay their eggs on the full-grown asparagus plants rather than on the shoots. A number of the plants throughout the field, or a row of plants along the edges of the field, may be allowed to develop to serve as trap plants for the adults. As the insects collect on these plants they can be destroyed by any convenient means, such as, in the case of small plantings, knocking the beetles from the plants into a shallow pan containing a small quantity of kerosene, or dusting the plants with an arsenical. One part of calcium arsenate to 10 parts of hydrated lime applied in the form of a dust should give satisfactory results. This treatment can be used on young plantings and later in the season on the fully mature producing fields.

On small plots a hand duster may be used to advantage in applying the material. Large areas can be treated with saddle dust guns, such as are used in dusting cotton, or with traction dusters the nozzles of which are properly adjusted to the crop.

The larvæ readily succumb to treatments with hydrated lime alone. They are also very susceptible to heat, and if they are jarred from the plant during hot periods on to freshly cultivated soil many will die before reaching the plant again.

CUTWORMS

Cutworms (larvæ of moths of the family Noctuidæ) frequently become troublesome in asparagus plantings both by cutting off the shoots and by feeding on the tips of the shoots as they appear above the ground. A suitable poisoned-bran bait, in the following proportions, applied directly to the affected area, is a satisfactory method of controlling these pests:

Dry bran.....	1 peck or 5 pounds.
White arsenic or Paris green.....	¼ pound.
Sirup or molasses.....	1 pint.
Water.....	3 or 4 quarts.

Or, in large quantities:

Dry bran.....	25 pounds.
White arsenic or Paris green.....	1 pound.
Sirup or molasses.....	2 quarts.
Water.....	15 to 20 quarts.

This bait should be prepared as follows:

(1) Thoroughly mix the poison with the bran. This is important. Each particle of bran must carry a little poison in order to get a good kill. When making small quantities, mix the materials in a bucket with a paddle, adding the poison slowly and stirring the bran at the same time. A still more effective way is to mix the poison and bran with the hands; but, since soluble arsenic is absorbed to a slight extent through the skin, there may be some objection to this method. If the hands have any cuts, scratches, or other wounds, do not put them into the bait. When making large quantities mix the poison with the bran on some flat, smooth surface, using a shovel and rake in much the same way as in mixing concrete.

(2) Mix the sirup with the water.

(3) Put the poison bran in a bucket or washtub and gradually add the water-and-sirup solution, stirring slowly all the time. A large quantity of water added at one time will wash the poison from the bran, and an uneven mixture will result.

Caution.—Add only enough liquid to make a crumbly mass. It is a good plan to set aside a little of the mixture of dry bran and arsenic so that if too much water has been used this dry reserve can be added to bring the mixture up to the proper consistency.

Either broadcast the poisoned bait or sow it by hand along the rows. Do this late in the evening so that the bait will not dry out to any great extent before the worms become active. From 10 to 15 pounds of the wet bait per acre is enough for one application. Where the bait is applied directly to the rows the smaller quantity will be sufficient. It may require two or three applications at 2-day intervals to rid the fields of the pests.

GARDEN CENTIPEDES

In certain parts of California a pest known as the garden centipede (*Scutigereilla immaculata* Newp.) has become at times very destructive to large areas of asparagus. This centipede feeds below the surface of the ground on the succulent shoots of the asparagus plant. Considerable work has been done by the University of California on the control of this pest, and F. H. Wymore³ reports that it is most successfully combated by flooding. The ground should be covered with water to a depth of from 1 to 3 feet for a period of three weeks during the latter part of December and the first part of January. Many soil fumigants have been tried in an effort to control this centipede, but no satisfactory chemical method of control has been developed.

³ Biology and Control of the Garden Centipede *Scutigereilla immaculata* (Newport), by F. H. Wymore in Jour. Ent. and Zool. 16 (3): [73]-88, illus.

**ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
WHEN THIS PUBLICATION WAS LAST PRINTED**

<i>Secretary of Agriculture</i>	HENRY A. WALLACE.
<i>Assistant Secretary</i>	REXFORD G. TUGWELL.
<i>Director of Scientific Work</i>	A. F. WOODS.
<i>Director of Extension Work</i>	C. W. WARBURTON.
<i>Director of Personnel and Business Administration.</i>	W. W. STOCKBERGER.
<i>Director of Information</i>	M. S. EISENHOWER.
<i>Solicitor</i>	SETH THOMAS.
<i>Bureau of Agricultural Economics</i>	NILS A. OLSEN, <i>Chief.</i>
<i>Bureau of Agricultural Engineering</i>	S. H. MCCRORY, <i>Chief.</i>
<i>Bureau of Animal Industry</i>	JOHN R. MOHLER, <i>Chief.</i>
<i>Bureau of Biological Survey</i>	PAUL G. REDINGTON, <i>Chief.</i>
<i>Bureau of Chemistry and Soils</i>	H. G. KNIGHT, <i>Chief.</i>
<i>Office of Cooperative Extension Work</i>	C. B. SMITH, <i>Chief.</i>
<i>Bureau of Dairy Industry</i>	O. E. REED, <i>Chief.</i>
<i>Bureau of Entomology</i>	C. L. MARLATT, <i>Chief.</i>
<i>Office of Experiment Stations</i>	JAMES T. JARDINE, <i>Chief.</i>
<i>Food and Drug Administration</i>	WALTER G. CAMPBELL, <i>Chief.</i>
<i>Forest Service</i>	R. Y. STUART, <i>Chief.</i>
<i>Grain Futures Administration</i>	J. W. T. DUVEL, <i>Chief.</i>
<i>Bureau of Home Economics</i>	LOUISE STANLEY, <i>Chief.</i>
<i>Library</i>	CLARIBEL R. BARNETT, <i>Librarian.</i>
<i>Bureau of Plant Industry</i>	WILLIAM A. TAYLOR, <i>Chief.</i>
<i>Bureau of Plant Quarantine</i>	LEE A. STRONG, <i>Chief.</i>
<i>Bureau of Public Roads</i>	THOMAS H. MACDONALD, <i>Chief.</i>
<i>Weather Bureau</i>	CHARLES F. MARVIN, <i>Chief.</i>