

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

It can be grown under a wide range of soil and climatic conditions. Asparagus is not well adapted, however, to sections where the plant is not forced into a period of rest by either low temperature or drought. The crop does not thrive in parts of the humid South where the winter temperatures are not sufficiently low to check growth and give the plant a rest period. In certain sections where the rainfall is very low during the winter, the lower Sacramento Valley of California, for example, asparagus is grown successfully even though the temperatures during this season are too high to force a rest period. In these sections irrigation water is withheld and dormancy is induced by drought.

Where climatic conditions are favorable, asparagus is a satisfactory home-garden crop.

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 15 to 20 years, but it is generally desirable to renew the beds after 10 to 12 years.

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

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ASPARAGUS CULTURE

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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 as a canned or a frozen product and as a fresh vegetable. Its importance as a home-garden, truck, and processing crop is growing, as evidenced by the increasing acreage being used for its production.

The acreage devoted to the commercial production of asparagus, according to the Bureau of Agricultural Economics, United States Department of Agriculture, increased from 115,950 acres in 1934 to 131,910 acres in 1944. Most of the asparagus from the increased acreage during recent years has been used for fresh consumption. The production of asparagus for processing has remained fairly stable at about 45,000 acres. These figures do not include a sizable crop grown on small acreages and sold largely in the local markets.

The States leading in the production of asparagus are California, New Jersey, Washington, Illinois, South Carolina, Michigan, and Pennsylvania, in the order named. Slightly more than one-third of the asparagus eaten fresh is produced in California. The growing of asparagus for canning is localized almost wholly in the Sacramento and San Joaquin Valleys of California. Most of this asparagus is of the white type. Small quantities of green asparagus are canned in some of the eastern producing districts. Asparagus is well adapted to processing by the quick-freeze method, and increasing amounts of it are being processed in this way.

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 scattered by wind, water, birds, and other carriers. Conditions suitable for commercial production are much more limited.

The asparagus plant (*Asparagus officinalis* L.) is a native of temperate regions and is best adapted to sections where either low temperature or drought stops growth of the plant and gives it a rest period. For normal development it is necessary for the asparagus plant to have an annual period of rest.

During the growing season after cutting has been stopped the plant stores up reserve food materials in the roots. During the rest period important chemical changes that greatly influence the future development of the plant take place in the reserve food supply. Commercial asparagus culture should not be undertaken where climatic conditions are such that the plant continues to grow throughout the year. If the plant does not have a rest period the shoots may become less vigorous and more spindling each year. The low yields per acre in the southern producing States may partly reflect the lack of the severe winter temperatures. In Georgia and South Carolina the average yields per acre for the 10-year period 1933-42 were 25 and 39 crates, respectively; whereas for the same period the yields in four Northern States, New Jersey, Pennsylvania, Michigan, and Illinois, were 136, 103, 99, and 89 crates, respectively.

Nutrition, cultural practices, and other factors no doubt contribute to the differences in yield in northern and southern sections, but it seems probable that temperature relations are also involved. In certain sections having mild winter temperatures, asparagus can be grown successfully, for rainfall during the winter is low and the required rest period can be induced by drought. For example, in the Sacramento Valley of California where the winters are mild but rainfall is low, asparagus is given its required rest period by withholding irrigation water.

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

Very light sandy or gravelly soils having a porous subsoil should be avoided. The moisture-holding capacity of such soils is too low for profitable asparagus production. Soils having a gravelly or hardpan subsoil are not desirable either. Many of the commercial asparagus soils of the South have a light sandy topsoil underlain by clay. Heavy soils, while not the best, may be satisfactory for asparagus, if they are not so heavy that they bake. Heavy soils are more difficult to work, and they warm up slowly. Muck and light sandy loams well supplied with organic matter are ideal for asparagus.

Asparagus is found growing naturally on the banks of streams and near salt marshes, where the salt content of the soil is high and the reaction somewhat alkaline. It does well in moist places, if the water table does not come within 4 feet of the surface.

Asparagus will thrive in soils having a salt content too high for many other crop plants but will not tolerate extreme acidity. Soils ranging from slightly acid to slightly alkaline are best for asparagus. Land known to be very acid should be given an application of lime to make the reaction nearly neutral before being planted to asparagus. The tolerance of the asparagus plant to various salts makes it possible to utilize for its production land that is too alkaline for certain crops. However, the yields are likely to be lower and the life of the planting shorter on such land than on land more nearly neutral in reaction.

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 be put into the best physical condition possible before the plants are set. The question of fertilizer practice is a local problem and must be determined largely by local conditions. What has proved to be a good practice in one locality may not be good in some other where soil and climatic conditions are different. Furthermore, 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. This is especially true if high-priced manure is used.

Asparagus thrives best in a soil well supplied with humus. In soils of mineral origin the application of some organic material may be more important than the addition of nitrogen, phosphorus, and potassium. Soils of organic origin like peat and muck, already well supplied with humus, 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 this can be obtained at a reasonable cost. Animal manures are especially desirable because 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, however, to try to maintain fertility on large plantations by the use of it alone. 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 at low cost, 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 cannot be grown to advantage.

In turning under any manure crop attention should be given to its effect on the nitrogen supply in the soil. This applies also when large amounts of coarse, strawy stable manure are used. Such manures, high in woody materials, require large amounts of nitrogen in their decomposition. If these woody materials have not decayed before the planting of a crop, they may cause nitrate starvation. To help keep a supply of nitrogen available it is a good practice to apply 100 to 300 pounds per acre of a high-nitrogen fertilizer, such as nitrate of

soda or sulfate of ammonia, to aid in the decomposition process. Manure crops, especially leguminous ones, turned under while green and succulent decompose more rapidly than woody material and are less likely to cause nitrogen starvation during decomposition.

Where a heavy application is to be made to the soil, animal or green manure 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.

As stated previously, the use of some commercial fertilizer in addition to manure 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 western soils. An application of 1,000 to 2,000 pounds per acre of a complete fertilizer containing 6 to 8 percent of nitrogen, 10 to 15 percent of phosphoric acid, and 6 to 10 percent of potash is often profitable. If applied before the plants are set, the fertilizer should be broadcast and thoroughly mixed with the soil. The application of part of the commercial fertilizer may be delayed until after the crowns are set. This part should be 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 prevent 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 asparagus is a debatable question. The first season or two after the asparagus is set, 1,000 to 1,500 pounds of a complete fertilizer should be broadcast and worked into the soil as early in the spring as the soil can be worked. This should be followed by one or two applications of nitrate of soda or other readily available nitrogen fertilizer along the rows at the rate of 150 to 200 pounds per acre.

When the plantation has been established long enough so that spears are beginning to be harvested, part 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 9 years at the Maryland Agricultural Experiment Station show no consistent difference in the yield of asparagus fertilized at the beginning and that fertilized at the end of each cutting season. More recent investigations made by the South Carolina Agricultural Experiment Station indicate that certain fertilizer formulas such as 10-8-5 and 5-8-5 when used at the rate of 2,000 pounds per acre give

the greatest yields when half is applied before harvest and half after harvest, with a later application of about 150 pounds of nitrate of soda.

Some successful growers apply quick-acting nitrogen fertilizer early in the spring and side-dress the rows during the harvesting season. They believe that early applications of such nitrates help to maintain production and quality, especially where green asparagus is grown. Other equally successful growers apply most of the fertilizer at the end of the cutting season because they believe that the asparagus plant can make more efficient use of it while making top growth and storing reserve food in its roots.

The time and amount of fertilizer to be applied to a producing asparagus field, however, should be determined from local conditions. It is better not to make a heavy application of fertilizer during a period when the soil moisture is likely to be low for some time, as it often is at the end of the cutting season in some nonirrigated sections. With low moisture the plant may not be able to make use of the fertilizer, and in extreme cases injury may result. Under such conditions heavy applications of fertilizer are best made in early spring, when soil moisture is usually more abundant.

It is a good practice to divide the fertilizer used, applying part of it before growth starts in the spring and the remainder at the end of the cutting season. In most cases a balanced fertilizer carrying all three of the important elements nitrogen, phosphorus, and potassium is best. Where a soil is known to be already high in one or more of these elements the formula should be altered to meet the particular needs. Mixed fertilizers carrying 4 to 6 percent of nitrogen, 8 to 12 percent of phosphorus, and 6 to 10 percent of potassium are in general use. The 5-8-7 and 5-10-5 formulas are widely used. Besides the general fertilizer application it is sometimes necessary to use one or two side dressings of a quickly available form of nitrogen such as nitrate of soda or sulfate of ammonia. One application of 200 to 300 pounds or two applications of 150 pounds each are sometimes necessary, especially after periods of prolonged heavy rains, which leach nitrogen from the soil.

Since asparagus thrives best on nearly neutral soils, attention should be given to soil reaction in applying fertilizers. If acid fertilizers are used in large amounts it is necessary to adjust the soil reaction with lime. Asparagus is a heavy feeder on calcium, and many eastern soils require regular applications of lime to maintain the calcium content and proper soil reaction. As much as 1,000 to 2,000 pounds of limestone may be required annually for a period of years until the calcium content becomes fairly high. Many eastern soils are also low in magnesium. Where this element is low a dolomitic lime high in magnesium should be used.

The use of common salt, or sodium chloride, was at one time considered essential for asparagus production. It has been shown that sodium chloride and sodium carbonate may be beneficial on soils low in potassium. Where the potassium content is high or where fertilizers relatively high in potassium are applied, the addition of sodium salts has produced little response. The same stimulation as that obtained from sodium salts can no doubt be more efficiently obtained from potassium. The best growers obtain satisfactory yields without sodium salts, and their use is not generally advisable.

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

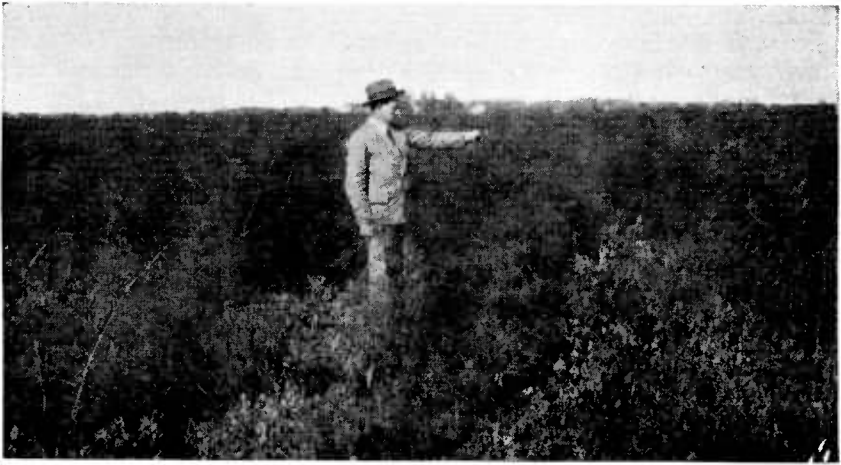


Figure 1.—Soybeans grown as a cover crop after the cutting season for asparagus.

of the cover crop is drilled in between the asparagus rows about 3 weeks after the cutting season, about 5 pecks of seed being used per 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 because the male and female flowers are borne on different plants makes it difficult to obtain seed that will produce plants uniform in type and true to varietal 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 plants from the pollen-producing ones. Where more than one variety is grown for seed, careless handling of seed stocks soon results in mixture and in less distinct varietal differences.

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.

Asparagus varieties are of two general types 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 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 of these varieties are purplish before exposure to the light, and the spears become dark green in sunlight. The product from the light-colored varieties should not be confused with white, or blanched, asparagus as grown for canning (p. 13). Although much of the white canned product is obtained from light-green varieties, additional whiteness is produced by covering the crowns with soil.

The present list of desirable varieties includes Conover Colossal, Palmetto, Reading Giant, Argenteuil, Mary Washington, Martha Washington, and Paradise. Conover Colossal, probably the best of the whitish-speared type, is grown chiefly in California for the white canned product.

Palmetto is probably the best and most widely planted of the older varieties. It is very similar to Argenteuil. Good strains of Palmetto are somewhat resistant to asparagus rust, caused by *Puccinia asparagi* DC., and are generally productive. Reading Giant, an old English variety, and Argenteuil, a French variety, are still grown in some parts of the East, especially in New England.

The older varieties have been largely replaced by the newer rust-resistant Mary Washington and Martha Washington strains. The best and most widely planted is Mary 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. 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 from the disease. However, in 1910 a vigorous rust-resistant male plant was isolated from a lot of crowns of unknown origin. This, 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 these the present Washington rust-resistant strains were selected. These strains are now the most rust-resistant of the varieties in cultivation.

Besides having rust resistance, the Washington strains are of high commercial quality, fully equal to or superior to the best other 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 replaced the older varieties in many asparagus sections and are more desirable even in sections not subject to rust epidemics. The Martha and Mary strains are very similar; the former is more rust-resistant, but the latter 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.

A variety recently introduced as Paradise is reported to be a selection from one of the Washington strains. Although it may be as resistant to rust, it does not appear to be commercially superior to good strains of Mary Washington.

In establishing a new plantation it is important to use one of the rust-resistant varieties, especially in localities subject to rust epidemics. In fact, many nurserymen and plant growers now list only the varieties resistant to asparagus rust.

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 both the seed-bearing and the 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 cannot be too strongly emphasized.

Seed capable of producing high-yielding crowns can be obtained only by the selection of high-yielding parents. High-yielding male and female plants should be selected and isolated in such a way that the selected female plants receive pollen only from the selected males, and not from other sources. Seed obtained from parents selected and protected in this way should produce crowns capable of a much higher average yield than seed from unprotected field-grown parents. The importance of good seed from high-yielding parents cannot be too strongly emphasized in the case of a perennial crop like asparagus. Even a small difference in yield per crown resulting from careful selection of seed stock may mean a great deal of difference in profit over the lifetime of the planting.

Close attention must be given the seedbed if good results are to be obtained. 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 seedbed 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 4 to 6 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 4 or 5 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 from which air is excluded or long enough after being soaked for rots or molds to develop on the seed. For best results soaked seed should 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 seed 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 late in January or early in February. In the North seeding is frequently done late in 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 they are 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. The best spacing can be obtained by planting with a mechanical seeder, which can be adjusted to drop a single seed at regular intervals.

In growing asparagus crowns for field planting it is good practice to plant the seed in rows 24 to 30 inches apart and to drop 10 to 12 seeds per foot of row. The distance required between rows depends largely on whether the cultivation is to be done by hand or by horse- or tractor-drawn implements.

The quantity of seed used for growing enough crowns to plant an acre ranges from 1 to 10 pounds. At the planting distances suggested, 1 to 2 pounds of seed should be enough. Many growers use too much seed.

The depth to plant depends upon the type of soil and the 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 germination period should be borne in mind in determining the proper depth to cover the seed. In light peat the seed may have a 3-inch cover; in sandy loam 1½ inches is enough, provided the soil is sufficiently moist for germination.

Weeds should be kept down, as they draw heavily on needed soil moisture. Cultivation should be shallow, especially late in the season, to prevent injury to the developing roots.

Before the crowns are dug, 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, the roots will continue to elongate after being transplanted. Since the fleshy roots are essentially 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 they are dug. Where it is necessary to keep the crowns for a period before setting them out, they should be stored in some dry, protected place at a temperature near 40° F. Crowns should not be stored in pits, as they may be injured by becoming heated. 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, show 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 still 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, SIZE, AND SEX 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 crowns more than 2 years old 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; 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 the crowns and severe root injury will materially reduce the yield in years following.

Experimental evidence shows that it is profitable to grade asparagus crowns before planting them, on the basis of size and vigor, and to keep only the largest and best developed roots for planting. All small, weak crowns and those having many small buds should be discarded, as they tend to produce a high percentage of unsalable spears. A desirable crown for planting is one having a large, well-developed root system with large buds well distributed over the crown.

Some attention has been given to the relative productivity of male and female plants. Female plants have been shown to produce larger spears than male ones, but male plants produce a greater number of spears, which have a greater total weight than the female. Although male plants may be a little more productive than the female, it is doubtful whether the grower should make much effort to obtain crowns of one sex for planting. As stated previously, 1-year-old crowns are known to be decidedly superior to older crowns; therefore, since it is impossible definitely to determine the sex in most cases until the second season, when flowers and fruits are produced, it seems advisable for the grower to pay particular attention to the selection of large, vigorous 1-year-old roots and leave the matter of sex to chance.

PLANTING DISTANCES

The soil must be as thoroughly prepared for asparagus as for any other crop. It should be plowed deep and worked down well. 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 covered finally. A deeper furrow is required in a loose soil where the crowns are to be covered finally to a depth of 8 to 10 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, 6 to 8 feet should be allowed between rows to provide enough soil to form the ridge. The higher the ridge the more soil required and the greater the space between rows. Rows of green asparagus should be 5 to 6 feet apart. In some sections green asparagus is cut early in the cutting season and the white asparagus is harvested from the same beds late in the season. Where both green and white asparagus are to be grown, the rows should be far enough apart to allow for ridging.

Planting distances vary greatly in different sections and under different soil conditions. Investigations indicate that maximum yields of high-quality spears may be obtained when the crowns are set 18 to 30 inches apart in rows 4 to 8 feet apart. Where the rows are close together the distance between plants in the row should be greater. The recommended distances in California are 18 to 24 inches between plants in rows 6 to 8 feet apart. Closer planting is practiced in some of the eastern sections. In New England the crowns are set 18 to 24 inches apart in rows 4 to 5 feet apart. Too close planting results in a large percentage of small spears. However, very wide spacing may reduce the yield even though the spears are large. Soil fertility and other local conditions must be considered in determining the best planting distances for a given locality.

SETTING THE CROWNS

When the crowns are placed in the furrow, the roots should be well separated and spread in their natural position (fig. 2). It is a good practice to place a small mound of soil in the trench where the crown is to be placed, to set the crown on the peak, and to allow 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.

It is best to cover the crowns with 2 or 3 inches of soil at first and to increase 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 ones.

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 close to the plants the first year after setting, and little hand work 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 seed that weed control may be difficult and expensive.

In recent years calcium cyanamide has been used with more or less success for the control of weeds in asparagus fields. For weed control about 100 pounds of pulverized cyanamide per acre should be applied while the weeds are small. Unless this material is finely pulverized it is not very effective in weed control. Although it kills most broadleaved weeds, it is not recommended for the control of grasses. Calcium cyanamide, which supplies both calcium and nitrogen, is frequently used as a source of these elements in fertilizing asparagus. Where it is used as a fertilizer it may be broadcast at the rate of 300 to 500 pounds per acre and worked into the surface soil before growth starts in the spring. Calcium cyanamide may also be used at the end of the cutting season, in which case the application should not exceed 300 to 400 pounds per acre, especially in dry weather, as injury to the asparagus may result.



Figure 2.—Roots of asparagus properly spread ready for covering with soil.



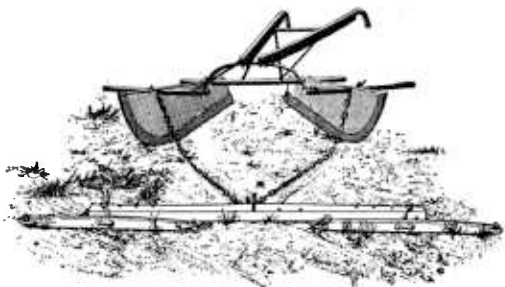
Figure 3.—A type of asparagus ridger used to a considerable extent in some asparagus-growing sections for renewing the ridges.

Calcium cyanamide is poisonous. A dust respirator should be worn by the operator.

If white, or blanched, asparagus is to be grown, the rows must be ridged up to cover the crowns with several inches of soil. Implements of two types used for this purpose are shown in figures 3 and 4. 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 2 weeks or oftener.

If green asparagus is to be grown, a very low ridge or none at all is necessary. The crown of the asparagus plant increases in thickness and thus comes a little nearer the surface each year, so that slight ridging may be necessary when the crowns have come very close to the surface. Too shallow covering of the crowns subjects them to excessive heat during hot weather; this heat causes the tips of the spears to open before they reach the desired length and reduces their market value.

Figure 4.—A very satisfactory home-made type of asparagus ridger.



At the end of the cutting season, the asparagus beds should be thoroughly cultivated, the 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 5. 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 that 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 scattered seed, which may become troublesome upon germination.

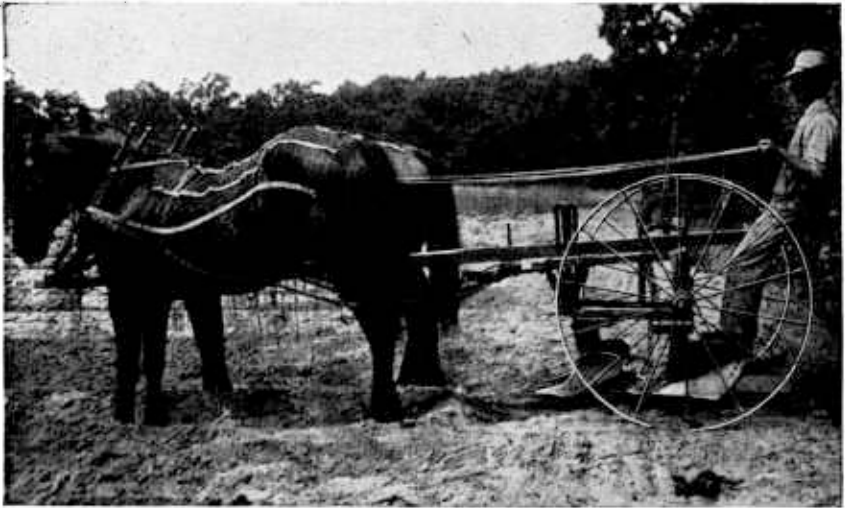


Figure 5.—A type of implement used in plowing down asparagus ridges at the end of the cutting season.

In parts of the North where winter temperatures are low it is believed advisable to allow the tops to remain in the fall, as they afford some winter protection by holding the snow and preventing the blowing of the soil. In this case the tops are disked into the soil in the spring.

Removing 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 let 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 if they are present on the stems. Asparagus stems, being coarse and woody, are difficult to work into the soil. As a general practice it is advisable to collect and burn them.

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 intercropping 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, it should be discontinued when the asparagus comes into full production.

WHEN AND HOW LONG TO HARVEST

The time elapsing between the setting of asparagus crowns and the first harvest of spears and the length of the cutting period vary in different sections of the country. Where the growing season is long and relatively cool, as in California for example, harvesting of spears may start at an earlier age and be continued for a longer period than where the growing season is short. Cutting too soon after planting and too long has been shown to reduce the vitality of the plants, thereby reducing yields in the years following. Except where a long, cool growing season prevails, it is probably a good practice to begin harvesting of spears only after the crowns have had 2 full years of growth after setting and then only for a period of 3 to 5 weeks. The fourth season, and thereafter, the cutting period may be extended to 6 to 8 weeks, or in general to about July 1. In California and other sections having similar climatic conditions a short cutting period of 2 or 3 weeks after the plants have had one full year in the field after setting has shown no injurious effect on yields in years following. In these sections the cutting period for the second year of harvesting may be extended to 6 to 8 weeks, and thereafter, to as much as 12 weeks.

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 the reserve materials.

When an asparagus bed declines in production and there is a large proportion of small spears, it frequently means that the food supply has become exhausted. When such a condition develops it may be beneficial to shorten the cutting season and to give particular attention to fertilization and care during the growing season. However, as the bed grows older, there is always an increasing proportion of small spears, even in highly productive beds.

PROFITABLE PRODUCTIVE PERIOD

The establishment of a new asparagus plantation involves considerable labor and expense; hence adding a few years to the productive life of the bed may be of considerable 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 2 or 3 years in advance of plowing up the old one, in order to have it yielding profitably before the old bed is abandoned. It may be advisable to renew a part of large plantations 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. Although very light soils are ideal for maximum production for several years, the beds are likely to be shorter lived than those on heavier soils. The asparagus plant is a heavy feeder; hence profitable production over a long period of years requires heavy fertilization. Continued high production requires that the beds be kept free from diseases 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 the factors just discussed 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, classified according 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 so 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 part above ground, it loses moisture less rapidly than the tender green portion and adds to the keeping quality of the spears.

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 to cut twice a day if the asparagus is growing on very light warm soil.

The cutting should be done with a knife made especially for the purpose. Green asparagus should be 9 to 10 inches in length, and at least half of the length should be above ground. 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. It is a good practice not to cut closer than 2 inches. Knife injury to buds and unharvested shoots causes them to develop into crooked spears.

The proper way to cut without injuring the developing shoots is to place the knife near the shoot to be cut and to force 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 above ground, so that stubs are left. Stubs interfere with harvesting and may injure the hand using the knife.

PREPARATION FOR MARKET

Asparagus loses its edible quality very rapidly after it is harvested, because chemical changes in the spears reduce the amount of sugar and increase the amount of tough fibrous material. Analysis of the spears at various intervals after cutting shows 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 it is cut. It is good practice to protect the spears from the sun as much as possible when they are harvested 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 (fig. 6) 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 the changes taking place in the composition of the spears injure their quality. A temperature near freezing reduces these chemical changes to the minimum and preserves the edible qualities of asparagus.

In preparation for market, asparagus stalks are generally carefully graded, trimmed, and tied in bunches weighing 2 to 2½ pounds. 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. In some localities some first-grade asparagus is shipped loose in crates. Sometimes the poorer grade and field-run asparagus is packed in crates without grading or bunching.

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

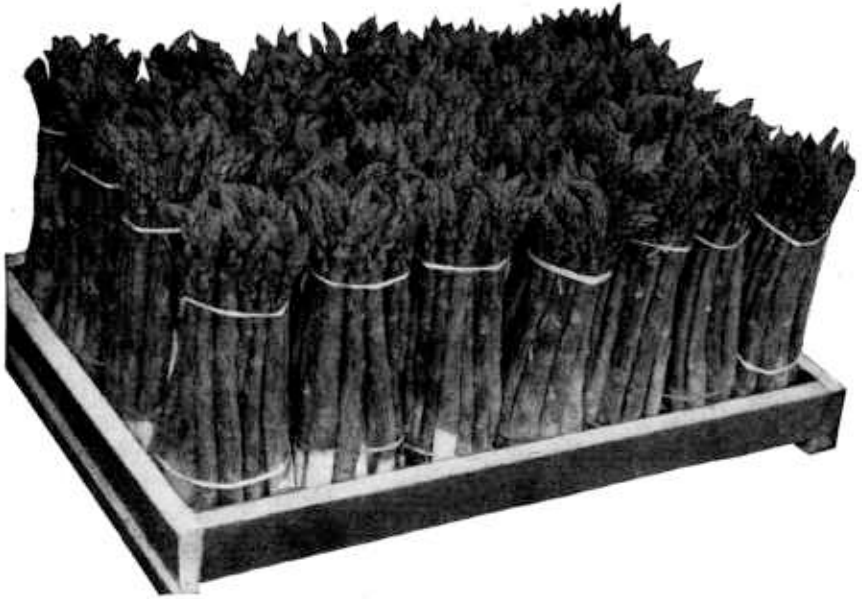


Figure 6.—Bunches of asparagus placed on damp moss in flat to keep them fresh.

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.

GRADING, WASHING, BUNCHING, AND TYING

Grading

The United States Department of Agriculture has established market grades for asparagus. Since these grades are subject to change anyone desiring the latest information on the subject should write to the Production and Marketing Administration, United States Department of Agriculture, Washington 25, D. C.

Asparagus is marketed chiefly under two grades, U. S. No. 1 and U. S. No. 2. Asparagus not meeting the specifications required by these grades is considered as unclassified. The factors used in the grading of asparagus include freshness, length and diameter of the stalk, proportion of the stalk that is green, and the amount of damage due to dirt, diseases, and insect or mechanical injury.

The present specifications classify asparagus on diameter of stalks as follows: Very small, less than $5/16$ inch; small, between $5/16$ and $8/16$ inch; medium, between $8/16$ and $11/16$ inch; large, between $11/16$ and $14/16$ inch; and very large, above $14/16$ inch. Grading according to diameter of spears depends somewhat upon market demand and the quality of the product. The present standards permit the trimmed bunches to vary in length from 7 to $10\frac{1}{2}$ inches.

Washing, 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, with care not to wet the tips. The stalks, butt downward, should be laid on some sloping surface to drain before they are bunched. Asparagus keeps best if it is 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 for this purpose (fig. 7). Some 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 (fig. 6 and cover). 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 tight. The tape is available in various colors, and sometimes the several grades of asparagus are tied each with different-colored tape. However, 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.

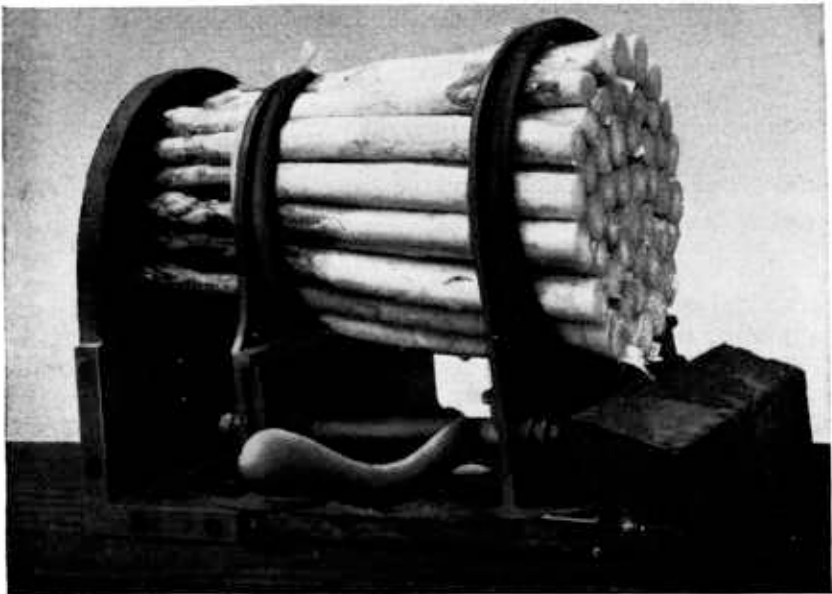


Figure 7.—One type of asparagus-bunching device. Note that the spears have been cut to a uniform length.

The bunches should be tied as tight as possible without injuring the stalks, as there is some shrinkage, 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; such bunches have a neat appearance. 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.

PACKING AND SHIPPING

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. 8) and has two compartments each holding six 2- to 2½-pound bunches. A typical pyramidal crate used in California is 11 inches deep, 9 inches wide at the top and 11 inches wide at the bottom, and 18 inches long. A similar crate is used in Georgia and the Carolinas. The tendency in most States is toward this type of crate. Different States may use pyramidal crates having slightly different dimensions. This is a very satisfactory shipping container, as the

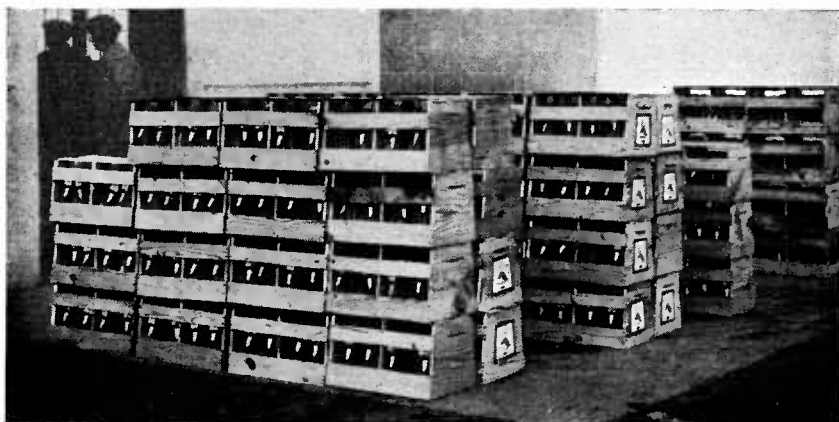


Figure 8.—Asparagus packed in crates ready for market. Note the pyramidal shape of the containers.

pyramidal shape conforms to the taper of the bunches and prevents their being shifted about in shipment.

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. 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 nearby markets, asparagus is shipped either by express or by motortrucks without refrigeration. After the cutting becomes heavy and carlot shipments begin, most of the asparagus is shipped under refrigeration.

ASPARAGUS DISEASES ¹

ASPARAGUS RUST

Asparagus is subject to a number of diseases, but only one, asparagus rust, caused by the fungus *Puccinia asparagi*, is of great economic importance. Rust was first reported from New Jersey, Delaware, Long Island, N. Y., and New England about 50 years ago, and later it appeared in practically all sections where asparagus is grown.

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; therefore lack of moisture retards the spread of the disease. Hence in the semiarid West the rust spreads very slowly, whereas in sections of heavy rainfall and in those subject to heavy dews severe rust epidemics are likely to occur.

The disease is generally first observed as numerous 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 pustules that contain seedlike bodies, or spores, that reproduce the fungus. These pustules burst and liberate 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 scattered by the wind; if sufficient moisture is present they may infect all the plants in the field.

When the attack is severe the entire plant or the entire field may ultimately become brown and appear dead. The disease causes the tiny needlelike branches of the stems to fall, and the plants present a naked appearance, as shown in figure 9, A. The effect of rust on a field of asparagus is shown in figure 10. The damage caused by rust is not seen directly in the marketed product. The injury develops after the cutting season and 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 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 effective way to control asparagus rust is to plant varieties known to be resistant. The most rust-resistant variety of asparagus in cultivation is Martha Washington. Mary Washington, although slightly less resistant than Martha Washington, is sufficiently resistant for planting except where rust attacks are severe. The earliness and large size of Mary Washington make it especially desirable for gen-

¹ Originally prepared by W. W. Gilbert, formerly senior pathologist, and revised by S. P. Doolittle, senior pathologist, Division of Fruit and Vegetable Crops and Diseases.

eral planting. When first introduced, the two Washington varieties generally showed a high resistance to rust, but of late years there have been occasional losses from rust on varieties reported to be either Mary Washington or Martha Washington. It is possible that high rust resistance may not have been maintained in some stocks of these varieties, or possibly there are strains of the rust fungus to which they



Figure 9.—A, Seedlings of Argenteuil asparagus, showing some resistance to rust; B, the highly rust-resistant Washington asparagus.



Figure 10.—An old asparagus field killed out by rust (foreground). The new field of the Reading Giant variety on the left was grown as a breeding field for rust-resistance work.

are not highly resistant. When purchasing either of the Washington varieties, the grower should obtain information regarding the previous performance of the stock with respect to rust resistance.

A certain proportion of the asparagus acreage throughout the country is planted to varieties that are rather susceptible to rust. Where rust is a factor, all practicable measures should be taken to reduce rust damage even when resistant varieties are grown.

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 over winter and act as sources of infection for nearby 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 stage of the rust or from infected wild plants nearby, usually on the windward side of the infested area, since rust spores are carried by the wind. For this reason wild plants wherever found should be dug up and burned, and small shoots or seedlings should not be allowed to grow up in the field until after the cutting season. New beds 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 does not occur in fields where the tops are left over winter, disked in the spring, and kept clean of asparagus until the end of the cutting season.

Spraying and dusting with fungicides have met with varied success in different sections. In the past bordeaux mixture with a resin-fish oil or other sticker has been used to some extent in the East. In California the best results have been obtained with sulfur dust applied when the plants are wet with dew. A finely divided sulfur was used, and the first application of 25 to 30 pounds per acre was made about 3 weeks after the cutting season. Another application made a month

later should be sufficient to hold the rust in check under most conditions. On newly planted beds or where cutting stops early in the season more than two applications may be needed.

Stickers and such poisons as bordeaux mixture must be thoroughly washed from the spears to be used as food.

FUSARIUM WILT

Asparagus shoots affected with fusarium wilt are sometimes wilted and stunted, and they may show a brown discoloration of their surface. These stalks are generally unfit for market, and yields occasionally are considerably reduced by this wilt.

Wilt, which is caused by a fungus (*Fusarium* sp.) occurring in the soil, has been reported from most asparagus-producing sections of the United States. Losses in individual plantings occasionally are severe, but this disease does not occur so commonly as does rust. The only available control measures consist in avoiding further plantings on infested soil and care in procuring healthy planting stock. New plantings should be kept as far as possible from old beds that have shown the disease.

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 above ground. Later in the season both the beetles and immature forms attack the fully developed plant. As previously stated, in the early spring the eggs are laid 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. Upon hatching from the eggs, the small dark-colored larvae, or slugs, feed upon the foliage of the plant and in cases of heavy infestations defoliate large areas in a comparatively short time. It requires 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 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 set-back through defoliation by both larvae and adults.

² Prepared in the Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration.

The beetles and the larvae of the asparagus beetle are controlled at any stage in the growth of the crop by applying a dust mixture containing 0.75 percent of rotenone as soon as the insects are noticed on the plants. All parts of the infested plants should be covered thoroughly with the dust. Applications should be repeated as often as required to control the insect. Ordinarily not more than two applications, about a week apart, are needed for satisfactory control.

CUTWORMS

Cutworms 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. These pests can be controlled readily by the use of the following poisoned bait: 1 peck (or 5 pounds) of dry bran, $\frac{1}{4}$ pound of sodium fluosilicate or paris green, and 3 or 4 quarts of water; or, in large quantities, 25 pounds of dry bran and 1 pound of sodium fluosilicate or paris green with enough water to moisten.

To prepare the bait: (1) Thoroughly mix the poison with the bran. This is important. Each particle of bran must carry a little poison to get a good kill. When making small quantities, mix the bait in a bucket with a paddle, adding the poison slowly and stirring the bran at the same time. When making large quantities, mix the poison with the bran on some flat, smooth surface; use a shovel and rake in much the same way as in mixing concrete. (2) Add the water to the mixture of bran and poison, stirring slowly all the time. Large quantities of water added at one time will wash the poison from the bran and the result will be an uneven mixture.

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 poison so that if too much water is used this dry reserve can be added to bring the mixture up to the proper consistency. Large quantities can be made up in galvanized-iron or wooden washtubs and small quantities in buckets or similar containers.

Either broadcast the poisoned bait or scatter it by hand along the rows or about the base of the plants. Do this late in the evening so that the bait will not dry out before the worms get busy. Since many kinds of cutworms overwinter in the ground and start feeding as soon as the weather becomes favorable in the spring, it is a good plan to broadcast the poisoned bait over the field before the asparagus shoots begin to appear above ground.

Ten to fifteen pounds of the wet bait per acre is enough for one application. Where the bait is applied directly to the rows or hills a smaller quantity is sufficient. It may require two or three applications at 2-day intervals to rid the field of the pests.

A stomach poison for an insect is poisonous also to animals and man. Keep the poison and poisoned-bran bait away from farm animals. Destroy all bait left over, and thoroughly clean all vessels and utensils used.

GARDEN CENTIPEDES

In certain parts of California a pest known as the garden centipede (*Scutigerebella 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 was done by the University of California on the control of this pest, and F. H. Wymore³ reported that it is most successfully combated by flooding. The ground should be covered with water to a depth of 1 to 3 feet for a period of 3 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 Wymore, F. H. Biology and Control of the Garden Centipede *Scutigera im-maculata* (Newport). Jour. Ent. and Zool. 16: [73]-88, illus. 1924.