Bulletin 285 June 1957

CARROTS in ARIZONA

Summary

Varieties of carrots grown for commercial production are few. Most important is Imperator, Long Type. The Goldspike variety is used chiefly for bunching carrots where relatively small tops are desired.

Planting may be done from late July through March in the major production areas. Important planting periods are from late July through September for the fall crop and from early February through March for the spring crop. In the higher elevation districts plant in April or May.

Soils of all types are used. Most ideal soils are the lighter sandy loams that are loose and friable to a depth of 15 to 18 inches.

Irrigation practices vary considerably with soil type. Soil should be kept moist by light irrigations 3 to 4 days apart during the germination and stand establishment period. During root enlargement and maturing period soil should be kept uniformly moist to prevent bulgy-type growth and root cracking. Avoid over-watering in cold weather.

Fertilizer phosphorous and nitrogen are important in carrot production. From 80 to 100 pounds of P_2O_5 and 60 to 80 pounds of nitrogen are generally needed for carrots on most soils. Apply all the phosphate fertilizer and about two-thirds of the nitrogen before planting or as soon as possible after the stand is established. Side dress the remaining nitrogen in one or more applications before roots are lead pencil size.

Weed control is best done with commercial carrot oils applied at 50 gallons per acre when the air temperature is 60 to 80 degrees and will remain in this range for several hours after application. A preplanting irrigation followed by a disking and precision cultivating help keep early weeds under control.

Harvesting in the Salt River Valley begins in mid-November and extends through February. The spring crop harvest is started in late April and extends into June. Roots should be five-eighths of an inch to one inch in diameter when ideal for harvesting.

Packing is done in three ways, as bunched carrots, film packaged roots and in mesh bags that contain 50 pounds of topped carrots.

Insects have not been a serious problem. Nevertheless, the fields should be checked at frequent intervals for tulip bulb aphids, green peach aphids, vegetable weevil, grasshoppers, crickets and yellow-striped army worms.

Diseases that may create a serious problem are root knot nematodes, cottony rot or sclerotiniose and California aster-yellows.

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Carrots In Arizona

By W. D. Pew[1]

In the fresh vegetable industry of Arizona the carrot, *Daucus carota*, ranks among the upper four or five major vegetable crops on an acreage basis. Its exact position of importance over the years cannot be cited because the acreage fluctuates widely from year to year. During the 1954-55 season about 5,300 acres were grown while in the 1955-56 season only about 3,700 acres were used in carrot production. The average acreage for the past ten years is slightly below 6,000 acres.

Arizona's annual acreage of carrots is localized in two principal districts, the Salt River Valley and the Yuma area. A third area which is relatively new, though potentially important, is located in the Eloy district. The Salt River Valley is the leading carrot producing area in the state, although production in the Yuma district sometimes contributes heavily to the total acreage. In the 1951-52 season there were about 3,000 acres planted in the Yuma area, which equalled plantings in the Salt River Valley areas that year. Since this peak year, however, plantings have been markedly reduced in the Yuma district.

Because of their high nutritive value, carrots during the past two decades have increased greatly in nationwide popularity. They are rich in carotene or provitamin A, which is perhaps the chief reason this crop has gained such a position of importance as a human food. The greater diversity of uses of fresh carrots in the American diet, which has been shifting toward the greater use of salads, has also been an important factor in enhancing carrot consumption.

The characteristic freshness and crispness which the consumer associates with Arizona grown carrots has been important in establishing a carrot industry in Arizona. Likewise, these factors have been important in making the carrot a favorable year-round vegetable for the American table.

Arizona growers generally receive highest prices for their carrots because of the normally heavy demand for fall or early winter and spring grown carrots of highest quality. These are the heavy production periods in Arizona. In fact, Arizona's production is rather sharply divided into fall or early winter and spring crops. Approximately 45 per cent

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of the national requirements for spring carrots and 20 per cent of the fall or early winter carrots are grown in, and shipped from, Arizona.

In spite of these favorable conditions every commercial grower should be aware of competition from other areas located closer to the large markets because of the advantage they have in freight costs. The grower must realize that shipments from those areas may markedly influence the market for Arizona carrots.

The consumers' preference for prepackaged carrots has caused a marked change in the marketing of Arizona grown carrots. Until recently the bulk of Arizona carrots were packed and shipped as bunched carrots. This was an advantage to Arizona growers because the consumer could distinguish between the fresh, untopped carrots and the topped and stored eastern and midwestern carrots.

Today over 90 per cent of Arizona's carrots are shipped as topped roots either in polyethylene film (plastic) bags or in 50-pound open mesh bags for repackaging in plastic bags at the receiving market. This change in marketing has one chief disadvantage, since it permits competition from prepackaged eastern and midwestern grown and stored carrots. With the tops removed, there is no natural identifying mark by which the consumer can distinguish between freshly harvested western carrots and stored eastern and midwestern carrots. Thus the only identifying mark for Arizona carrots is the printed label on the prepackaging bag.

SOIL TYPE

Because the carrot is a popular home garden vegetable it has been grown on many of the soil types found in Arizona. However, the most desirable soil for commercial production is a loose, friable, sandy loam. The soil should contain enough clay particles to give it a satisfactory water holding capacity, yet it must have enough sand and fine sand particles uniformly incorporated in it to provide good tilth conditions. Selecting a soil with these characteristics will minimize crusting and packing which often adversely affect carrot root development. Above all, the soil should be loose and friable enough to enable the plant to develop a long, smooth, straight root.

Each soil type must be considered individually, especially from an irrigation and fertility standpoint, because each type responds differently to application of water and fertilizer. In selecting a soil it should be remembered that growth and maturity are much slower on heavy types of soil than on light sandy loam soils. This difference is due chiefly to the cooler temperatures of the heavier soils and the slower change from cool to warm soil temperatures during warm days of the growing season.

VARIETIES

Imperator Long Type

The Imperator Long Type variety is a specially selected and developed bunching-type carrot. Its roots are long, ranging from 9 to 11 inches, and average about five-eighths of an inch to one

inch in diameter when ready to market as bunching or packaging carrots. This variety produces smooth roots that are uniformly tapered from top to tip and have a small, rounded top or collar.

Its skin color is typically a deep orange. This rich color normally extends uniformly through the inner portions of the root. The core of this carrot is small and is slightly darker orange than the outer portions but relatively indistinct. The root is fine grained and of excellent eating and shipping quality. Its tops range from 14 to 16 inches in length, are bright green and are moderately strong. This variety is used for 90 to 95 per cent of the crop grown in Arizona.

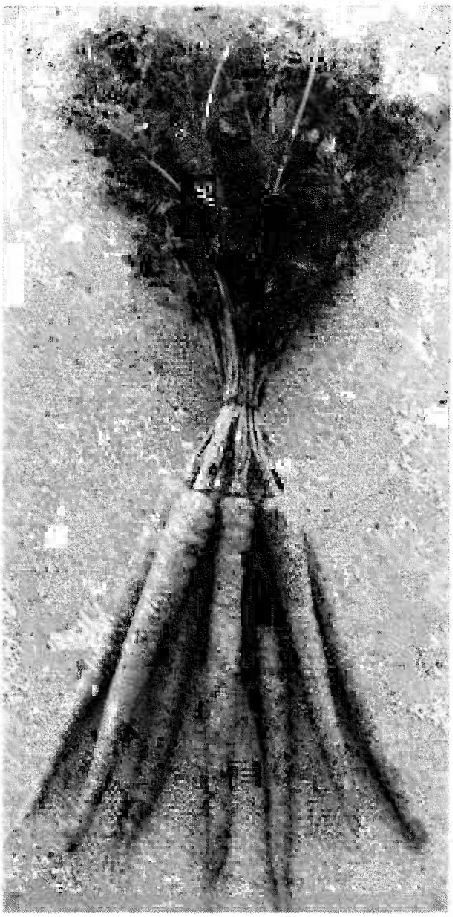

Figure 1.—Typical carrots of the Imperator Long Type variety.

Imperator

The older standard variety, Imperator is very similar to the Imperator Long Type except that it produces a slightly shorter root. The root of this variety is slightly more stubby at the tip than the Imperator Long Type. Roots range from 8 to 9 inches in length with a diameter of five-eighths of an inch to one inch when ideal to harvest for bunching or packaging carrots. The use of this variety is generally limited to very light soils and where extra long roots are not advantageous.

Gold Spike

Gold Spike is a relatively new variety developed to provide a carrot with the shape, quality, and refinement of the Imperator types but with shorter tops. Because of this fact, it is used in Arizona primarily as a bunching carrot under growing conditions where the Imperator types tend to develop larger tops than desired for easy handling and packing. The roots are similar in size, shape, color, and texture to those produced by the Imperator Long Type variety.

Nantes, Danvers Half Long, Chantenay, Oxheart

Nantes, Danvers Half Long, Chantenay and Oxheart varieties are sometimes used in home gardens and some small commercial plantings in the northern counties of the state. However, none of these varieties are recommended for use in the commercial carrot industry.

PLANTING DATES

Unlike many of the vegetable crops grown in Arizona, carrots can be seeded over a long continuous period. Seeding in the Salt River Valley and Eloy district begins about July 25 to August 1 and continues until March. For the Yuma area, planting starts about mid-September and may continue until February. The frequency of seeding should be determined by the grower's capacity to harvest and market the product at the proper stage of maturity.

Although planting can be done throughout this period, heaviest plantings are made from late July through August and September. In Yuma, fall plantings are made in September and October. These plantings represent the fall or early winter crop. For the spring crop in the Salt River Valley, planting is done during February and March. The same varieties indicated previously are used throughout the season.

Generally there is no spring crop planted in the Yuma area. Early planted carrots mature in about 90 to 110 days and therefore are usually ready to harvest during the first two weeks in November. Late fall or winter sown seeds for the spring crop may take from 120 to 130 days, or longer in some cases, to reach market maturity. These general periods of development also vary with soil type.

In the higher elevations of Arizona (3500 feet or above) plantings are made in April and May for harvest in August to October.

PLANTING AND SEED BED PREPARATION

Seed bed preparation and planting follows closely that used for other bedded winter-grown vegetable crops in Arizona.

Because of the rooting habits of this crop and the desirability of producing a high percentage of long, straight, smooth roots, the soil should be plowed or worked 12 to 15 inches deep to allow for unobstructed root extension and development and for good water penetration and aeration. An excessive number of tillage operations is not necessary nor advised in attempting to accomplish these conditions. If a hard pan exists in the upper two feet of soil it should be eliminated by proper plowing, knifing or similar tillage operation. Care should be taken not to destroy the advantages of this type of tillage by an excessive number of diskings or land-planings.

All tillage operations should have one or both of the following aims: (1) To provide for optimum moisture penetration and soil aeration and thus encourage proper root development; (2) To eliminate irregularities in the soil surface so that the bedded area can be uniformly irrigated.

Figure 2.—Applying a pre-planting irrigation by the border method. Note the elevated levees or ridges used to confine the water.

Regardless of tillage methods used, it is very important not to pulverize the top few inches. Pulverizing the surface few inches of the seed bed, regardless of cause, tends to reduce germination and usually results in a poor stand. Seedlings that do survive generally lack vigor and grow poorly.

After the area has been plowed or otherwise broken it should be bordered and a pre-planting flood irrigation applied. This method of irrigation consists of dividing the field into approximately parallel strips separated by specially constructed low levees or borders. The width of land between the levees may vary from 25 to 75 feet or more, depending chiefly upon steepness of land slope. Other factors are topography, soil type and condition and the amount of water available for any given application. The strips extend in the direction of the steepest slope thus providing a minimum of cross-slope.

When irrigating, the water moves as a sheet down the strips and is confined and guided by the levees.

Considerable land grading and leveling is often required to prepare the fields for this method of irrigation. Irrigating in this manner tends to leach the soluble salts down below the active root zone except along the levees.

Another method sometimes used is the corrugation method. However, this procedure is not generally recommended for the pre-planting irrigation because such a treatment permits soluble salts to be accumulated on the ridges. Then when the soil is subsequently worked and bedded-up the salt remains in the seed bed area.

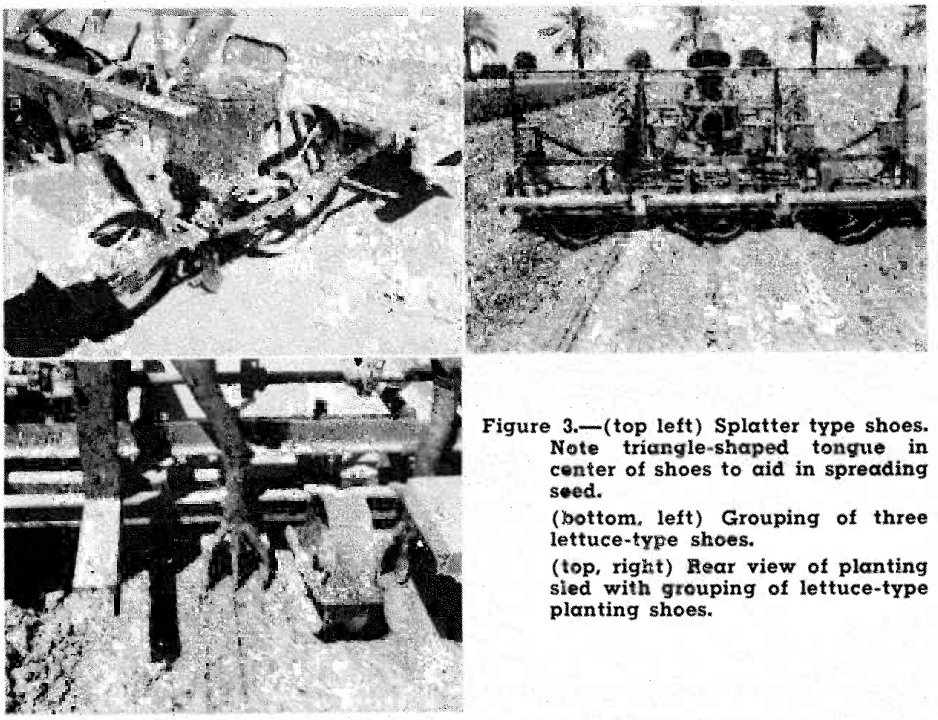

Figure 3.—(top left) Splatter type shoes. Note triangle-shaped tongue in center of shoes to aid in spreading seed.

(bottom, left) Grouping of three lettuce-type shoes.

(top, right) Rear view of planting sled with grouping of lettuce-type planting shoes.

The corrugation method consists of running a continuous series of parallel small ridges and shallow furrows across the field. The width between adjacent ridges or furrows varies from 12 to 24 inches. The height of the ridges measured from the bottom of the furrows is generally 4 to 8 inches.

When irrigating, the water moves down the furrows and is confined by the ridges to either side of each furrow. Moistening of the ridges is done through the "subbing" action of the water in adjacent furrows.

Following the pre-planting irrigation, the borders are removed when sufficiently dry to work and the land is given one or not more than two diskings to dry and air out the upper six inches of soil. After the soil has had time to air out, a light float or drag is applied, being drawn at an angle different from that to be used in planting.

Because it is the underground portion of the plant that is marketed and since the market demands a long, straight, smooth carrot root, every effort should be made in soil preparation and cultural practices to insure roots of this type. Listing or furrowing-out is the next land preparation operation, followed by seeding in a dry soil with a lettuce-type sled or planter. The packer wheel of the individual planting unit is employed where the 2½-3½-inch "splatter-type" shoes are used.

A newer and perhaps more desirable method of seeding com-

mercial carrot fields involves use of groupings of "lettuce-type" shoes. A grouping of three "lettuce-type" shoes are arranged side by side and are used to seed one side of the bed. When this equipment is used the packer wheel should not be attached and used in planting. Using this method each bed contains six distinct seed rows — two groups of three each. The rows or seed lines within each group are about 1½ to 2 inches apart. This method aids in a more uniform distribution and placement of seeds, thereby reducing the number of twisted and misshapen roots. After planting, the field is ready for the germination irrigation.

The most nearly ideal seed depth for planting carrot seeds is between 1/8 to 3/8 inches. In the case of the "splatter-type" shoe, the depth of the seeds falling in the center of the seed band should be about 3/8-inch and grading upward to 1/8-inch on the outer edges of the seed row.

Carrot seeds germinate slower than many other vegetables and also produce relatively weak seedlings. The seedlings become stronger and gain vigor when the first true leaves appear. Seeds usually begin to germinate in from 7 to 10 days and the stand should be established in 10 days to two weeks.

SEED AND PLANTING RATES

Carrot seed is sold commercially under several classifications: unsized, sized—medium or large —and pelleted. (These are listed with the least expensive type first and progressing toward the more expensive ones.) In deciding which type of seed to use one should consider the advantages or disadvantages of each; also, the cost differential should be taken into consideration.

The chief disadvantage in using unsized seed is the difficulty in getting uniform planting. Conversely, the chief advantage in using sized seed, regardless of the particular graded size, is that greater uniformity can be achieved in planting. Pelleted seeds occasionally are used but

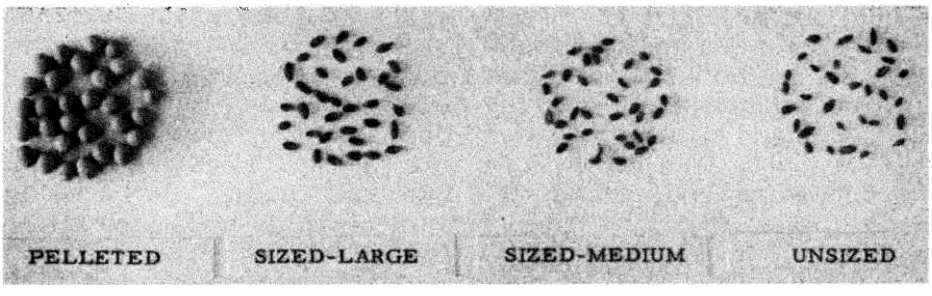

Figure 4.—Seeds of the several carrot seed classifications used in commercial production.

their use is not a general practice. Pelleted seed is used for precision planting.

Rates used in planting generally vary slightly, depending on the season or period in which they are planted. For all except pelleted seed, the rate for early fall planting will range from 2¾ to 3¼ pounds per acre. Because of difference in seed size there are fewer seeds per pound of sized large seed than seeds of the other unpelleted groups. It may be wise to increase the rate of the sized large seed to a range of 3 to 3½ pounds per acre. When using pelleted seed with a 20-to-1 pelleting ratio, the planting rate will range between 50 to 60 pounds (seed plus pelleting material) per acre. This rate would be 2½ to 3 pounds of actual seed per acre.

SPACING

To determine the best row widths, the grower should consider first the available equipment necessary to plant and grow the crop. In any case the beds should be no closer than 36 inches or farther apart than 42 inches. The 40-inch width is most popular.

Plant spacing within the row should average ¾ inch to one inch between plants. Since hand thinning is not practiced, all planting rates should be carefully calculated and planters regulated so this spacing can be obtained from direct seeding methods. Individual plant spacing is more of a problem in the medium to heavy loam soils than in light sandy soils because heavier soils resist shifting as the roots are developing and enlarging. If carrots are sown too thick, a high percentage will be unmarketable when mature because of misshapen and twisted roots characteristic of such planting.

IRRIGATION

A pre-planting irrigation is important in carrot production for at least three reasons: (1) To supply the sub-surface soil with ample moisture; (2) To germinate and sprout weed seeds which can be destroyed during the subsequent disking operations before the crop is seeded; (3) To leach the soluble salts below the bed zone.

The duration of the "germination" irrigation — the irrigation following the planting operation — will vary, depending chiefly on such factors as soil type, bed height and width, time of application, length of run, slope, and season. However, generally speaking, it should be of such duration as to allow the beds to become "blacked" — soaked through.

Where short runs (1/8 mile rows) are used on acceptable soils and where proper planting procedures have been followed, an 18- to 24-hour run should be long enough for the first irrigation. A second irrigation usually will be necessary in three or four days following the first application to keep the bed surface moist and soft during the seedling emergence period. Irrigations from this point should continue at fairly frequent intervals (7 to 10 days apart) until the plants are well established.

After plants have been established, the periods between irrigations may be lengthened to three or even four weeks when cool temperatures and slow drying conditions prevail. Develop an irrigation schedule based on the plant needs and not by a given number of days. The medium or heavier type soils that become very hard when dry should never be allowed to reach this condition but should be kept moist and soft so the roots can develop properly. On all soil types irrigations should continue up to harvest time to keep plants growing rapidly and the roots turgid and tender through the harvesting period.

To help prevent poor color development over-watering should be avoided, especially during prolonged cool periods when the carrots are sizing and maturing. Likewise, prolonged periods of cold weather when soil temperatures are below 50° tend to cause the carrots to develop a paler color than typical for the variety.

Improper timing of irrigations when the carrot roots are enlarging often causes deformed or irregularly shaped roots. Allowing the plants at this stage to stress for water with a subsequent period of adequate water will cause bulgy-type growth and root cracking.

FERTILIZATION

In fertilizing carrots, phosphate fertilizers generally are used in equal or greater amounts than nitrogen fertilizers. This is especially true where a carrot crop follows closely a vegetable crop that has received heavy applications of nitrogen fertilizer late in the growing season. However, of these two fertilizer materials nitrogen will produce the quickest and most pronounced effect on the carrot crop. In spite of this response one should be cautioned not to over-fertilize carrots with nitrogen because it often causes them to produce more tops than are desirable. This is very important on naturally fertile soils or where a large nitrogen fertilizer residue is present.

Because of the rooting and plant growth habits of this crop and because the "spiking" cultivation practice limits root extension, the fertilizer program must be tailored to the particular field and crop. Sometimes more frequent applications of fertilizer are suggested than for many vegetable crops because of the cultivation practice and type of root growth. In any event the quantity and kind of fertilizer materials needed will depend largely on soil type, previous cropping history, residual fertilizer, and several other factors. A total of 60 to 80 pounds of actual nitrogen per acre is suggested as ample to produce an excellent crop of carrots.

In the pre-planting application where both nitrogen and phosphates are used, 40 to 60 pounds of actual nitrogen, and 80 to 100 pounds of P_2O_5 per acre should be applied. If pre-planting fertilizers are used, they should be worked into the soil or applied in the pre-planting irrigation prior to listing or furrowing-out for planting. If pre-planting fertilizers are not used, the amounts in-

dicated above should be side-dressed shortly after a stand is established. One to three additional light applications of nitrogen may be needed as the crop is growing. Side-dressing with dry fertilizer materials or making an injection, ribboning or water application of agricultural ammonia or liquid nitrogen may be used.

The choice of the type or source of nitrogen fertilizer appears to make little difference in growth or end product, provided each is correctly applied. However, the use of sodium nitrate should be avoided because of the added sodium. The presence of excessive sodium is the cause of many of our soil structure and salt accumulation difficulties. Each side-dressing application will require from 15 to 20 pounds of actual nitrogen. The last application should be made when the roots are about the size of a pencil and are beginning to enlarge rapidly.

When dry-type fertilizers are side-dressed, they should be placed two to three inches to the furrow side of the row and just deep enough for the soil to cover the fertilizer. If the field is level and properly planted, an easy and effective way to apply nitrogen is in the irrigation water. Here again the grower may select and use any one of the commonly available, readily soluble dry forms, liquid or gaseous types, taking care to meter the materials into the water accurately and uniformly.

For soils known to be very low in phosphorous, an application of 100 to 150 pounds of P_2O_5 per acre is recommended. Phosphates should be applied early in the growing season, either as a preplanting application or as a side-dressing immediately after a stand is established. It is not wise to use phosphate fertilizer as the only fertilizer material in producing a crop of carrots except on naturally fertile soils or where high residual nitrogen from previous crops is present.

To date there is no experimental evidence to show that potash fertilization is necessary to produce an excellent yield of quality carrots in the major producing areas of Arizona. Most carrot soils have enough of this element (nutrient) to more than meet the plant requirements. Consequently this fertilizer material is not ordinarily recommended in the fertilizer program for carrot production.

CULTIVATION

The recommended practice in cultivating carrots is to loosen the sub-surface soil, on both the bed and furrow side of the carrot plants as an aid in promoting long, straight, smooth roots. This type of cultivation is unique with carrots alone. Special cultivator teeth or shanks known as "carrot spikes" are commonly used for this purpose. The depth of the spikes, and the closeness of these spikes to the carrot plants during cultivation will depend on the age and size of the carrots and condition of the soil. Early spikings may be done three to four inches from the plants and two

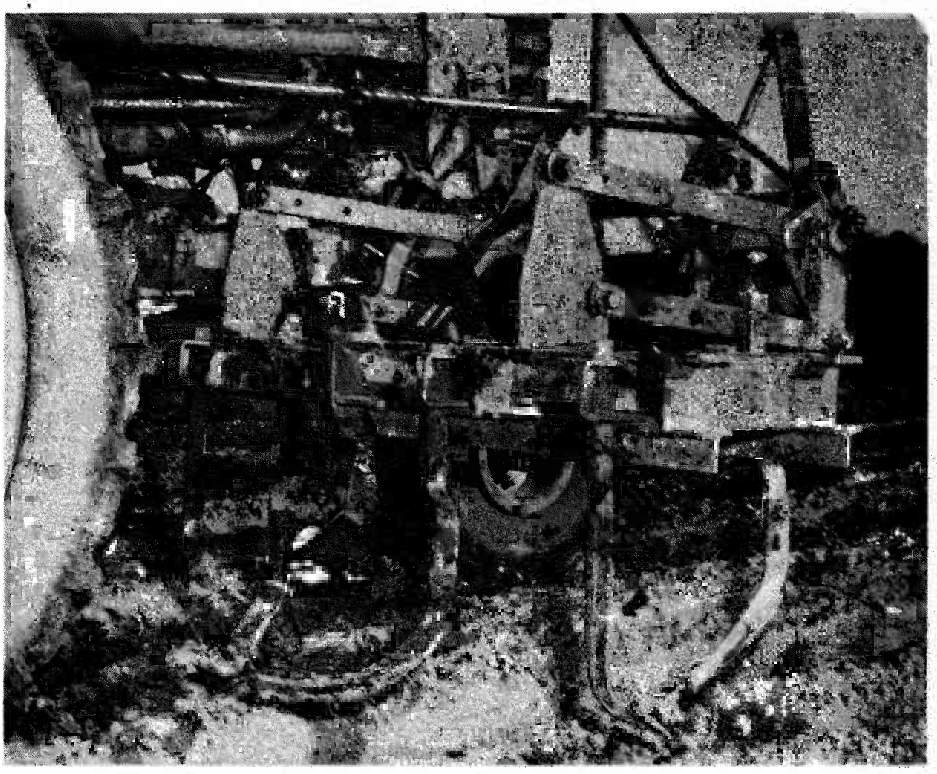

Figure 5.—View of the front end of a tractor equipped with special cultivator teeth or shanks and furrow knives used in carrot production. The straight, sharp-edged shanks with the forward curved points (see arrow) are referred to as "carrot spikes."

to three inches deep, while later ones are usually applied to the center of the beds, using one spike and placing it six to eight inches deep. Only the conventional cultivation is used in the furrows to loosen the soil compacted by the tractor wheels. Under no circumstances should one "spike" cultivate so close to the plant or so deep that the plants are lifted or shaken loose in the process.

In addition to the value of cultivating carrots as described above, cultivation may be necessary to:

1. **Control weeds.**
2. **Mulch area to facilitate proper side dressing with commercial fertilizers.**
3. **Loosen the bedded area as an aid in water penetration and to allow for proper root development.**
4. **Allow for soil aeration.**

Excessive cultivations are time consuming and expensive. Therefore, cultivate only when there is a good reason for doing so. Above all, do not cultivate when fields are wet.

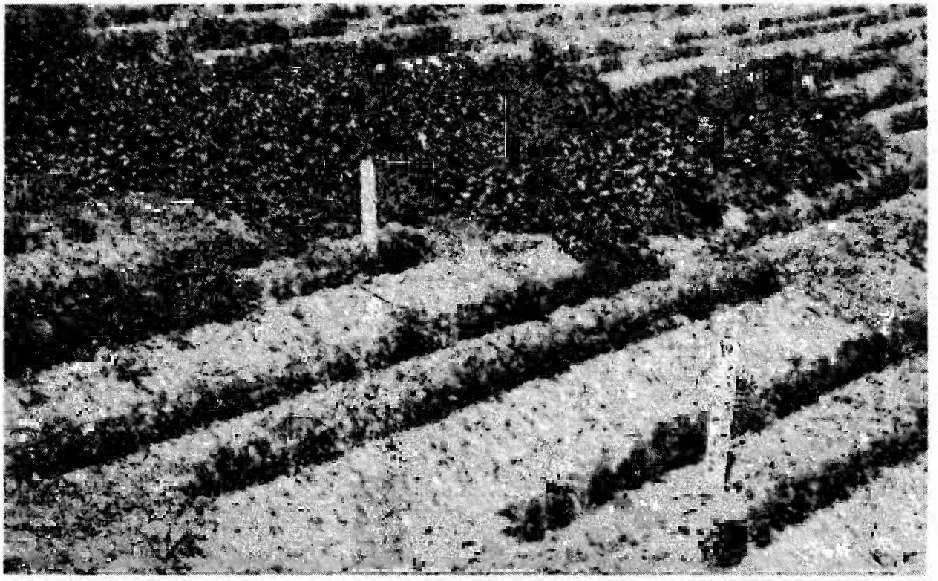

Figure 6.—Good and poor weed control. Plot in foreground shows "clean" rows of carrots that were sprayed properly for excellent weed control. Plot in background shows weed-choked rows where no control measures were used.

WEED CONTROL

Of the many vegetable crops grown commercially in Arizona, carrots stand out as the crop which is most ideally adapted to economical and effective chemical weed control measures. The use of proper fractions of oil, applied correctly, has been found to provide excellent weed control without injury to the young carrots. In spite of this adaptability to such chemical weeding, the grower should select areas as free from weeds as possible on which to grow carrots.

Likewise, there is no substitute for careful and proper cultural management and the use of a pre-planting irrigation and subsequent disking to control early weeds and to minimize later weed control problems. Evenly spaced beds that are uniformly high, with uniform spacing of the seed rows on the beds, allows for close, precision cultivation. Careful and efficient mechanical cultivation will go a long way in eliminating or minimizing much of the costly hand weeding often necessary.

Three factors appear to be of utmost importance in determining the toxic (killing) value of an oil spray weedicide. **These factors are: Rate of application, types of fractions[2] of oil, and air temperature when applied.**

[2]The fraction referred to is the "high-flash" (Stoddard solvent-type) cleaning solvent. This is a specific oil fraction. There are several other similar oil fractions, such as: stove oil, kerosene, fuel oil and low-flash cleaning solvent. NONE of these are recommended for weed control in carrots.

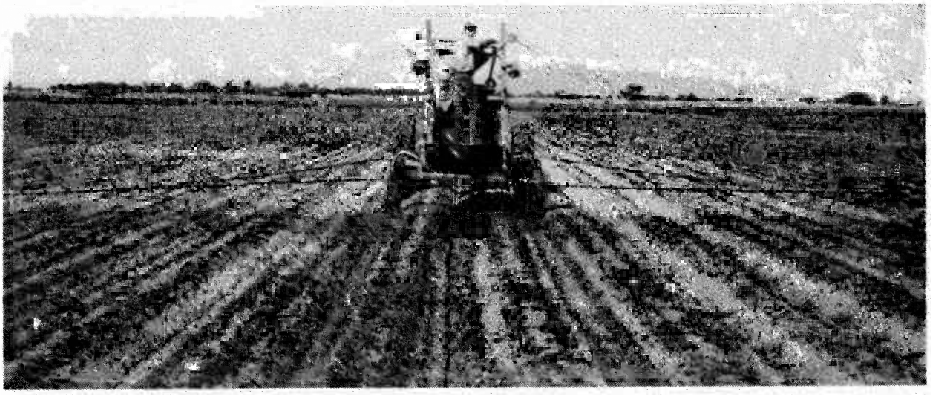

Figure 7.—View of commercial sprayer equipment applying carrot oil for weed control.

It is recommended that a commercial carrot oil be used at the rate of 50 gallons per acre except where weed populations are heavy. In such cases, increase the rate to 75 gallons per acre. Commercial weed oils rather than stove oils are recommended for most satisfactory results. Application should be made when the air temperature is between 60 to 80° F. and will remain in this range for several hours after application. This will usually mean the oil should be applied in late afternoon, evening, or at night. Oils should be applied to cover the entire land area (bed and furrow). Use 20 to 30 pounds pressure at the nozzle. The fan-type nozzles are suggested. At the time of application the carrot seedlings should be in the two to four true leaf stage. Carrots larger than this are likely to take on an oil taste which persists in the roots even after harvest.

HARVESTING

Digging and harvesting carrots normally begins in mid-November and continues into June. A break in this period occurs during March and most of April corresponding to the period when seeding is not usually done. If more than one seeding is made, plantings should be timed so that each crop can be harvested when it reaches optimum market maturity. Harvesting in the higher elevation areas is done in the period of August to October.

To facilitate pulling the carrots, special tractor mounted heavy duty knifelike blades are used to lift the plants. After the lifting operation, crews of hand laborers complete the pulling job, sort, bunch and tie the carrots into the desirable bunch size. An average bunch will weigh from 1⅛ to 1¼ pounds. The number of carrots per bunch

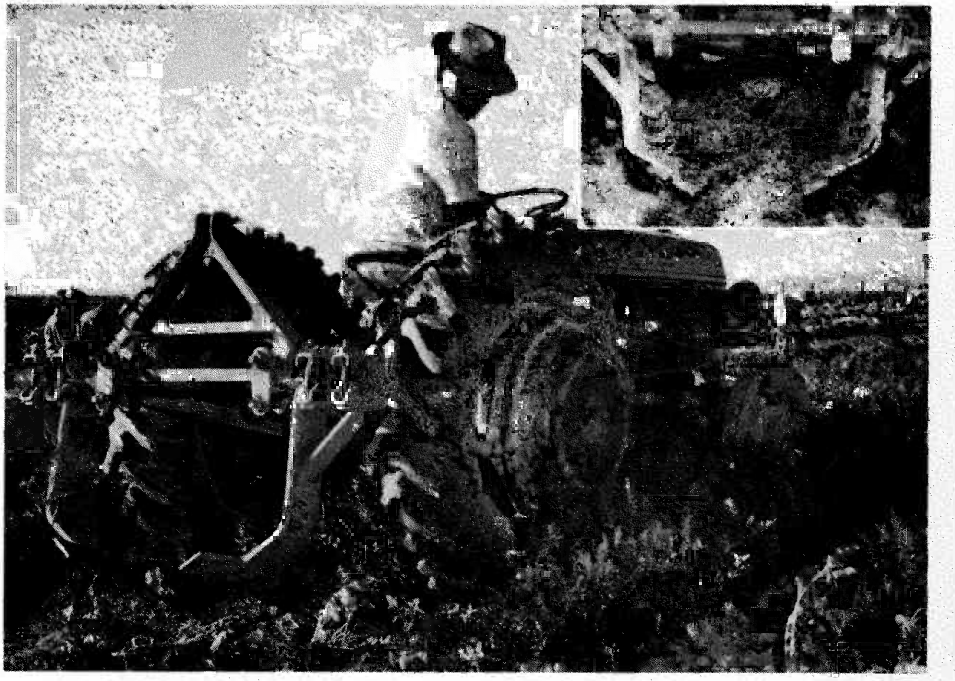

Figure 8.—View of tractor equipped with special heavy duty knifelike blades used to lift carrot plants. Inset at top right shows close up view of lifting blades.

Figure 9.—Freshly dug carrots being tied in 1 1/8-1¼ pound bunches.

Figure 10.—Bunched and washed carrots being packed in wooden crates for shipment.

usually ranges from five to seven, depending on the size of individual roots. These individual bunches are then tied in groups of 10 bunches each. Carrot bunches thus prepared are transported to the packing sheds for washing, packing, icing, and loading into refrigerator railroad cars or trucks. Each crate is approximately 20½" x 18¼" in size and holds 60 (5 dozen) bunches of carrots.

Today over 90 per cent of the Arizona grown carrots are topped and packaged in polyethylene film bags or in 50-pound bags to be packaged in plastic bags at the receiving market. Carrots packaged in polyethylene film bags are attractive to the consumer and such packages are well adapted to the modern self-serving merchandising methods.

There are several variations in the prepackaging process but the following will suffice as a rather typical example:

Carrots dug for prepackaging are topped by hand in the field, loaded onto trucks, and/or trailers and hauled to the packing sheds. At the packing house they are unloaded onto a conveyor belt that carries them through one or two washing operations.

The washed carrots continue to travel on the conveyor belt through the grading line where they are placed in polyethylene film bags by hand laborers. Then they are replaced on the conveyor belt and sent to other workers who tie or seal the packages. Before the bags are sealed, occasional bags are taken at random from the line and weighed as a constant check to insure that each contains a minimum of one pound of carrots. Tying may be done with tape, ties — fine wires laminated between two ribbons of paper — rubber bands or similar items. The tied plastic bags are packed in crates. Each crate contains 48 one-pound packages. The filled crates are lidded and loaded into refrigerator cars ready for icing and shipment.

Sometimes topped, packaging-sized carrots are shipped in mesh bags that contain approximately 50 pounds. On arrival at the terminal market, these carrots are packaged in polyethylene film bags. A disadvantage in this

Figure 11.—Topped carrots being packaged in polyethylene bags.

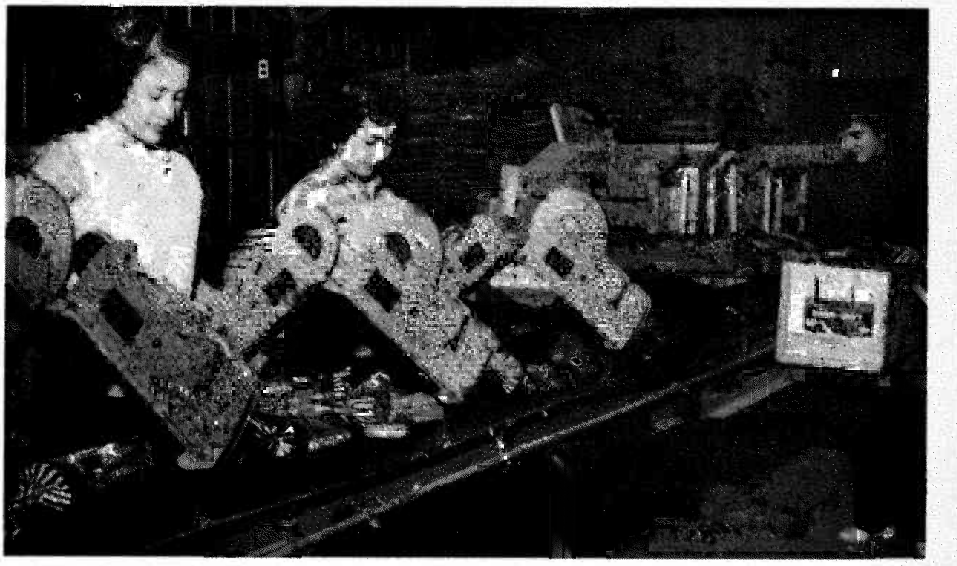

Figure 12.—Filled bags being tied and packed in wire-bound crates for shipment.

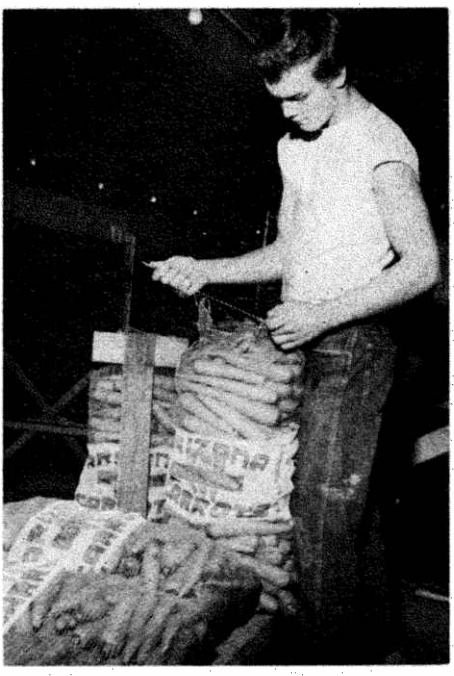

Figure 13.—Topped carrots being sacked in 50-pound bags ready for shipment.

method is that the identity of high quality Arizona carrots is not conveyed to the consumer.

A limited volume of relatively large or short, heavy carrots are sorted out in the shed or in the field and taken to the packing shed, washed and packed in 50-pound mesh bags. These are marketed to specialized consumers. Carrots packed and marketed in this manner are usually not suitable for film packaging.

YIELDS

Excellent yields of high quality carrots are normally obtained by Arizona growers. However, yields will vary from 250 crates to as high as 650 crates per acre. The average yield is around 400 crates per acre.

INSECTS[3]

So far insects have not been a serious problem in carrot production. However, at times and under certain conditions, insects may cause sufficient damage to warrant control.

TULIP BULB APHID *Anuraphis tulipae* (Fonsc.)

The tulip bulb aphid attacks many of the bulb and root crops. On carrots its presence is often invited when the crown of the carrot is covered with soil by such post-planting cultural practices as cultivating and refurrowing. Once soil is thrown over the crown of the plant, an ideal situation is created for development of the aphid.

The tulip bulb aphid is a small, soft bodied insect varying in color from yellowish green to almost black. It resembles the melon aphid in color and size. The most apparent difference is that the tulip bulb aphid has a fine, white, powdery wax that covers the body of the wingless form. This waxy substance gives these aphids a grey, powdery appearance and protects them from un-

[3]The author wishes to express his appreciation to Dr. Paul D. Gerhardt, associate entomologist, and Dr. Lemac Hopkins, formerly assistant entomologist, University of Arizona, for supplying information on insects.

Figure 14.—Tulip Bulb Aphid infestation at the base of leaves and at the crown of the carrot plant. This plant has been deliberately wilted to part the stems so the aphid infestation may be observed.

favorable environmental conditions.

This aphid attacks the carrot plant at the base of the leaf petiole (stem) and around the crown. Since they are localized in the crown area they are difficult to detect and control.

There are many insecticides that will kill the aphid, but successful control is limited in most cases by the difficulty of application rather than kind of material. Since the aphid is deep in the crown of the plant and covered with its waxy protective covering, thorough coverage is essential for control. Best control is obtained by using a spray of ¾ pound of actual parathion[4] in 100 gallons of water per acre, plus a wetting agent to help get better coverage over the waxy covering on the insect. Application should be made as soon as the insect is detected.

[4]Parathion residue tolerance is one part per million (ppm) and should not be applied later than 15 days before harvest.

Nozzles of the sprayer should be directed over the center of the plant rows so that good penetration and coverage reaches infested plant parts. A 2 per cent parathion[4] dust, applied at 30 to 40 pounds per acre and blown down into the crowns of the carrots, is also effective. In most cases sprays are more effective than dusts against the tulip bulb aphid.

Regarding other insecticides that may be used, consult your county agent for tolerances and other requirements for their use under the Miller bill.

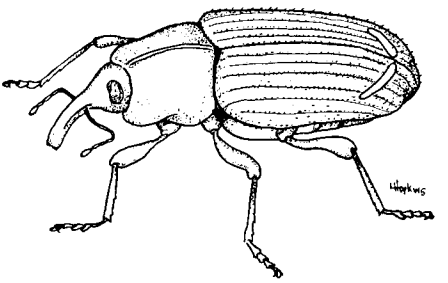

Figure 15.—Vegetable weevil.

VEGETABLE WEEVIL *Listroderes costirostris obliquus* (Klug)

The vegetable weevil, although a more serious pest of celery, may occasionally attack carrots. Damage usually occurs during the winter and early spring months.

Adults of this insect are about half an inch long and are brownish to buff in color. They are typical weevils with a short, broad snout. Each wing has a diagonal mark across the wing cover that is almost white in color. When the wings are folded these marks form a V-shaped configuration. There is also a small tubercle near the tip of the wing covers. Larvae or grubs are legless, cream colored and about half an inch long when full grown. Both the adult and grub feed on the foliage of several winter and spring vegetables. The larvae also feed on the roots of carrots. Eggs are laid in the crown of the plant or on the ground near the plant during winter and spring. This insect usually causes injury shortly before harvest.

Control measures should begin as soon as the first larvae are found in the field. Five per cent malathion[5] dust may be applied at a rate of 25 to 30 pounds per acre with ground equipment. Effective control may also be obtained with 1½ pints of 57 per cent malathion in 100 gallons of water applied at 20 gallons per acre.

For other insecticides that may be used, consult your county agent for tolerances and other requirements for their use under the Miller bill.

Occasionally GRASSHOPPERS, *Melanoplus spp.*, CRICKETS, *Acheta spp.*, YELLOW-STRIPED ARMY WORM, *Prodenia ornithogalli* Gue-

[5]Malathion should not be applied later than seven days before harvest.

nee, and the GREEN PEACH APHID, *Myzus persicae* (Sulzer) may cause considerable damage by feeding on carrot seedlings. It is suggested that you consult your county agricultural agent for control measures for these insects.

DISEASES[6]

ROOT-KNOT NEMATODES, *Meloidogyne sp.*

Root-knot is a serious problem is Arizona because most of the large, commercial acreages of carrots are usually grown on the lighter soils. These soil types are typical of those most commonly infested by root-knot nematodes, *Meloidogyne sp.*

These microscopic worms, nematodes, enter the roots and eventually cause localized swellings or "knot-like" galls to be formed. The tap root, as well as small lateral roots, may be deformed by the disease. If the tip of the tap root is infected, it often becomes forked. Tops of infected plants are frequently stunted.

Once a field is infested it cannot be completely rid of the pests, but the nematode population can be sufficiently reduced to allow for successful carrot production. Carrots that show nematode damage will be rejected by state and federal inspectors.

A crop rotation of winter grains with sorghum for one or two years will reduce the number of nematodes. A dry summer fallow is also effective provided weeds are thoroughly controlled.

Soil fumigation has been successfuly used in Arizona to control carrot root-knot. The overall type of fumigation is recommended. It is important that the soil be free of plant debris and large clods. Best results are obtained when the soil is moist but not wet (preferably as soon as soil can be worked after an irrigation), and at a temperature of 50 to 85 degrees F. Because of the rapidly changing list of fumigant materials available it is suggested that you consult your county agricultural agent for specific materials to use.

COTTONY ROT or SCLEROTINIOSE *Sclerotinia sclerotiorum* (Lib.) DeBary

Cottony rot is a disease which is most severe during cool, moist weather. It is caused by a fungus *Sclerotinia sclerotiorum* which lives in the soil.

Carrots are first attacked near the top of the root and at the bases of the leaves where they join the root. Mature plants are especially susceptible. The disease is readily identified by a white cottony appearing fungus that covers the infected area and eventually contains hard, black resting bodies, "sclerotia," that can be 1/8 to 3/4 inch in diameter. These black pieces of fungus can live for years in the soil and infect many vegetable crops.

Consequently, if the disease has been found in previous crops (such as lettuce, celery, cabbage,

[6]The author wishes to express his appreciation to Dr. R. B. Marlatt, assistant plant pathologist, University of Arizona, for supplying the information on diseases.

cauliflower, and broccoli) in a given field, it is wise to avoid planting carrots in that field for several years. Growing small grains in infested soil will help to decrease the amount of disease in subsequent vegetable crops.

Cottony rot has been controlled by application of 800 to 1000 pounds of calcium cyanamide per acre (before irrigating) and disking prior to bedding. In years following this heavy application, some growers have controlled cottony rot by applying 300 to 500 pounds per acre of calcium cyanamide. From the time of application of calcium cyanamide, **planting should be delayed three days for each 100 pounds of chemical applied.** Therefore, apply calcium cyanamide the appropriate number of days ahead of planting to take care of the above-mentioned delay.

VIRUS DISEASES

California aster-yellows virus may attack carrots in Arizona. Affected plants may be stunted and the leaves become purple-red. The latter symptom should not be confused with the purple-red discoloration caused by low temperatures. Surest test of aster-yellows infection is to remove plants from the row and examine the tap roots. If aster-yellows infection is present, the tap root will be covered by numerous fibrous rootlets.

Since several species of leafhoppers are known to carry aster-yellows virus, control consists of keeping the population of these insects low.

BLACK ROT *Alternaria radicina*

The black rot disease is not common in Arizona but occasionally may cause damage to carrots grown on desert soil. The disease attacks only the tap root. The crowns seem to be more susceptible to the disease if injured by weed sprays, soluble salts, insects — especially aphids — and through mechanical injury. In addition to these, the disease occurs only under very humid conditions brought about by heavy top growth and periods of humid weather and frequent irrigation.

There are other diseases that are sometimes a problem in specific areas. For information concerning these diseases and abnormal plant growth see your county agent.

Production Cost Guide — Carrots

	No. Times	COSTS[1] Per Acre	Per Sack	YOUR COSTS Per Acre	Per Sack
Land Preparation & Planting[2]					
Plowing	1	$ 3.00			
Disking	1	.50			
Land-planing	1	1.50			
Pre-planting irrigation[7]	1	1.25			
Disking[7]	1	.50			
Furrowing-out	1	1.00			
Bed Shaping and Planting	1	1.00			
TOTAL		8.75	0.029		
Cultural[2]					
Cultivations—without spikes	1	.65			
—with spikes[3]	3	1.95			
Weed Control—with Oil	1	1.25			
—by Hand	1	4.00			
Irrigations	15	18.75			
Fertilizer Applications	2	3.00			
Insecticide Application	1	1.00			
TOTAL		30.00	0.102		
Materials					
Irrigation Water (Pump 5 ac. ft.)[4]		45.00			
Fertilizer—75 lbs. N, 125 lbs. P_2O_5		23.90			
Seed—3 lbs. @ $1.70/pound		5.10			
Oil for Weeding—50 gal.		11.00			
Insecticide 25 lbs. Malathion		3.40			
TOTAL		88.40	0.295		
Harvesting					
Digging		5.00			
Snapping or Topping (10c/bushel)		63.00			
Hauling (2½c/bushel)		15.75			
Washing, Bagging and Loading on Car (12½c/bushel)		75.00			
Sacks (300 @ 10c)		30.00			
TOTAL		188.75	0.629		
Farm Overhead					
General Farm Expense—6 mo.[5]		32.00			
Equipment Depreciation & Expense—6 mo.[6]		8.50			
Industrial Insurance		6.25			
Interest on Investment—6 mo.		9.00			
Taxes—6 mo.		3.25			
TOTAL		59.00	0.197		
GRAND TOTAL		$375.50	1.252		

[1]Based on 1954-1955 Survey of Commercial costs in SRV for production of 300 50-pound bags of topped carrots per acre.
[2]All items of Land Preparation, Planting, and Culture, include labor, fuel, grease, but not overhead (Not custom operator price.)
[3]In the fall crop only two (2) spiking cultivations are generally used.
[4]Spring crop normally uses only 3.5 ac. ft. (Cost under SRVWUA $4.50 per ac. ft.)
[5]General Farm Expense includes Management, fence repair, weed control (not in crop), and miscellaneous items.
[6]Equipment Depreciation and Expense include depreciation on all equipment used to produce a carrot crop.
[7]These operations are optional.

Adapted from information prepared by Ray L. Milne, formerly Assistant County Agricultural Agent, U of A Agricultural Extension Service, Maricopa County, Phoenix, Arizona.

Management Checklist for Growing Carrots

(Listed in normal sequence)

SOIL PREPARATION*

1. Plow
2. Disk
3. Border and Pre-plant Irrigate
4. Pre-plant Fertilize (Optional)
5. Disk
6. Float or Land-plane

PLANTING AND GROWING

7. List or Furrow-out for Planting
8. Shape Beds and Plant (Sled Planting)
9. Irrigate
10. Irrigate
11. Cultivate and Refurrow
12. Irrigate
13. Apply Weed Control Oil
14. Cultivate, Fertilize, and Refurrow
15. Irrigate
16. Cultivate and "Spike"† and Refurrow
17. Hand Weed
18. Irrigate
19. Cultivate and "Spike"† and Refurrow
20. Apply Nitrogen Fertilizer
21. Irrigate
22. Cultivate (Optional)
23. Irrigate as Needed (Approximately 9 Times)

Dust for Insect Control as Needed. Apply Insecticide When Insect Damage is First Observed.

*All listed operations are not always necessary.
†See text pages 12 and 13 for description of operation referred to as "spiking."

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Harold E. Myers

Dean
College of Agriculture
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