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A. G. B. Bouquet
Horticulturist (Vegetable Crops)

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Carrots have become an increasingly consumed article of food in recent years. The acreage of carrots as a truck crop for shipment has increased from 9,770 acres in 1923 to 43,500 acres in 1939 and 46,800 acres in 1940. Much of this change has been due to an increase in shipments of bunched carrots grown in southern states. Carlot shipments of carrots have increased from 1,773 cars in 1921 to 13,133 cars in 1939.

Statistics regarding the acreage of carrots grown for processing in the United States are not available, but the pack of canned carrots has increased from 239,930 cases in 1931 to 1,127,985 cases in 1939. The above figures do not include diced carrots mixed and canned with peas.

Oregon began canning carrots in 1919 with a pack of 2,650 cases, which had increased in 1926 and 1927 to over 100,000 cases. In 1930, 137,137 cases were canned. Then followed a period of five years of a low pack which did not in any one year exceed 86,000 cases. In 1936 the canned production reached 139,172 cases, 291,166 cases in 1937, and 298,986 cases in 1939.

Oregon packs by far the largest amount of carrots canned in the West, which packs about one-third to one-quarter of the national total.

In 1937 in a total pack of 316,494 cases in the western states, 149,864 cases were in No. 10 cans and 154,195 in No. 2's.

Carrots are frozen to some extent but represent the smallest commercial frozen item in the vegetable pack. In the Pacific Northwest in 1939, figures indicate 10,795 pounds of carrots were frozen and peas and carrots together represented 240,815 pounds. The total frozen pack of carrots for the U.S. is approximately 500,000 pounds.

Several thousand cases of carrot juice are packed each year in Oregon.

Carrots are a good source of vitamins A, B and C, as well as being fairly rich in carbohydrates. Experiments in Iowa indicate that the cortex or outer portion of the carrot is richer in sugar and food value than the core, and that the outside skin is the richest of all parts of the root in vitamin B. The vitamin A value of mature carrots has been found to be twice that of young carrots.

Climatic and Soil Conditions. The carrot prefers moderately cool conditions for its best development, although the young plants will thrive during the warm weather of the summer. By far the greatest development of the roots takes place during the months of September and October, following the occurrence of fall rains.

The normal rainfall of western Oregon is usually insufficient to induce a maximum yield of carrots without irrigation unless the crop is planted on soil that is unusually retentive of moisture. Continuous rain coupled with warm weather in the fall may cause considerable cracking of roots especially in fields where there was no irrigation. The root is hardy to light fall frosts but must be protected when the weather shows several degrees below freezing for a continuous period.

Carrots grow well on almost any kind of soil which is in reasonably good physical condition, but the heaviest yields of the smoothest roots are obtained from sandy and silt loam soils and organic lands. The roots are smoother and more symmetrical when grown in a loose soil. Organic soils are highly retentive of moisture, so it is possible to grow a large tonnage of carrots on them without irrigation. On sandy and silt loam land irrigation is desirable to provide a uniform degree of moisture for the entire growing season. It is especially important that the land be reasonably free from weed seeds so as to eliminate extra cost of production.

The Influence of Environment on Plant and Varietal Characteristics. In Miscellaneous Publication 361, of the U. S. Department of Agriculture, regarding "Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots," considerable data are presented regarding the influence of temperature and soil on the characteristics of the carrot plant and root.

Of particular interest is the influence of temperature upon maximum root development and growth, which probably occurs between 65 and 70° F. or several degrees lower than the optimum for foliage growth.

In addition to hereditary factors that may cause branched or forked roots, there are a number of environmental factors that have a marked influence on the shape of carrot roots. The presence of undecayed manure or plant refuse in the soil results in branching or divided roots, and soils of heavy texture produce more misshaped roots than those of a lighter or more open texture. Branched or forked roots may also be caused by an injury to the young tap root or to any impediment to its downward growth. In the case of Red-core Chantenay, low soil moisture and low soil phosphorus resulted in roots being more pointed than where optimum amounts were supplied.

The root shape of carrots seems to be affected to a considerable degree by air temperature. The typical shape of the Red-core Chantenay variety is most readily produced when the roots are grown at a constant temperature of approximately 65° F. When grown at a mean temperature of approximately 55°, the roots have been longer and more slender, and when grown at approximately 75° they were shorter and less slender. Although Nantes is a longer, more slender and nearly cylindrically shaped variety, the temperature has essentially the same effect as on Chantenay.

The smoothness of the root surface is influenced greatly by environmental conditions. Excessive moisture following a period of water shortage may frequently result in white corky outgrowths at the points of side root emergence.

There is also considerable influence of environment on the color of carrots. By means of chemical methods it is possible accurately to determine the effect of different growth conditions on the carrot root color. The total color as measured by the carotene content is in general decreased by continuous temperatures above 70° F. and below 60°. Roots grown at a mean temperature of 55° had less total color than those grown at 65° and the exterior color of the roots was much lighter.

Growing the plants at a mean temperature of about 45° after the roots had started to enlarge resulted in still poorer total color. Cool nights, 45°, and warm days, 65°, resulted in a better color than continuous growth at 45°.

Carrots grown on sandy soils or soils high in organic matter seem to be of better color than those grown on a silt loam soil.

In a soil of moderate fertility, an increase in the amount of different plant food elements failed to increase appreciably the color of the roots. Varying amounts of a 4-12-4 fertilizer had no material influence on color, nor did the addition of a mixture composed of boric acid, manganese sulfate, copper sulfate, barium chloride, potassium iodide, and zinc sulfate, nor 800 pounds per acre of fertilizers varying widely in percentages of nitrogen, phosphoric acid and potash.

Development of Shape and Color of Carrot Roots. The carrot root as it increases in age and size changes in color from a yellowish-white when very young to whitish-yellow, light yellow, dark yellow, and orange, according to the variety. These changes in color are due to the accumulation of carotene which appears in varying intensities, producing the orange or orange-red color.

In fairly uniform strains the larger roots usually have a higher concentration of carotene than the smaller roots of the same age, while in mixed stocks the larger roots are liable to be lighter colored. In uniform strains the smaller, old roots usually have more carotene than younger roots which are larger.

Carotene is first laid down in the oldest cells of the cortex and then in the oldest cells of the core. The rate of increase in color depends to some extent on moisture and temperature but usually increases most rapidly during the early part of the plant growth. It is not known how long the increase in carotene will continue under optimum conditions, but records have shown that it increased up to 142 days of age in the Red-core Chantenay variety.

The increase in diameter of the carrot is most rapid at the top or crown of the root and as the plant becomes older, the lower portion of the root increases in diameter in varieties where this change is characteristic.

In tests of eating quality, sugar content and color intensity, data of the New York Experiment Station indicate superiority of "old" or fully grown carrots over young bunched carrots. Carrots delivered to processing plants are, therefore, most likely to be fully equal if not superior to bunched young roots.

Soil Fertilization and Preparation. Unless the manure is well rotted and the weed seeds are rotted out of it, it is not advisable to use barnyard manure previous to sowing carrot seed. It would be preferable to use such material for a crop the previous year. Many of the commercial soils used in growing carrots are high in organic matter, hence no added manure is necessary. In the case of sandy loam soil, the turning under of green manures would be advantageous in providing organic matter.

The crop is one which removes a considerable amount of potash from the soil. In a ten ton crop of roots, figures indicate removal of 46 pounds of nitrogen, 26 pounds of phosphoric acid, and 106 pounds of potash. If a commercial fertilizer is used, therefore, it should be one which carries a moderately high per cent of potash as well as a reasonable ratio of nitrogen and phosphoric acid. A fertilizer having a ration of 1-1-2 or 1-2-2 should be suitable for this crop. Such a fertilizer

might have an analysis of four per cent nitrogen, 12 per cent phosphoric acid, and 10 to 12 per cent potash, of which 500 pounds and upward might be broadcasted per acre. This application would be considered as being a trial one, possibly to indicate the effect of the fertilizer on the ensuing crop.

It seems desirable, also, to apply some commercial borax to carrot land to aid in preventing internal blackening or breakdown. A minimum of thirty pounds per acre may be mixed with the commercial fertilizer used for the crop and applied in the manner discussed below. (See also paragraph under Crop Troubles.)

There are two alternative methods of applying such a fertilizer — one broadcasting it before planting, the other being a side dressing of the fertilizer in a band alongside the rows after the plants can be seen. The latter method would reduce the amount of fertilizer necessary by possibly 50 per cent.

Carrots are not very tolerant of an acid soil and grow best in a pH range of between 6.0 and 6.5.

A well prepared seedbed is necessary for the sowing of carrot seed for the seeds are small and the seedlings are comparatively weak. It is necessary, therefore, to have a soil that is loose and friable, which will not crust after a rain. Previous to seeding, the soil should have such plowing and disking followed by harrowing and leveling so as to be in fine mellow condition for a good seedbed. If the land is to be irrigated, it will have to be properly leveled for the passage of water from the main ditch to the ends of the rows. This will be unnecessary, of course, in the case of water being distributed by overhead sprinkling.

Varieties, Seed Strains and Seeds. The most widely grown variety of carrots for processing purposes is the Red-core Chantenay. This variety is characterized by a medium long root that tapers slowly from the neck downward, terminating abruptly at the bottom, being what is known as half long, thick and stump rooted. The roots should be deep reddish orange, 5-1/2 to 6 inches long, about 2-1/4 inches thick at the shoulder, tapering but stump rooted. The core is a reddish orange, almost the same color as the flesh, and quite inconspicuous, which is desirable in a carrot for canning or freezing.

In tests with various strains of Chantenay from different seed sources, it has been found that there is considerable difference between the percentage of roots that have the most desirable qualities for canning or freezing. In a comparative test of strains of Chantenay carrots at the Oregon Experiment Station, it was found that there was a variation of from 45 to 71 per cent of good roots, that is, those that are placed as being first class for processing. The per cent of fair roots ranged from 21 to 40 per cent, while the per cent of poorer roots varied from 8 to 25 per cent. The value of these roots was based largely on uniformity of shape and smoothness, desirable type and proper interior flesh color of both the cortex and the core.

Nantes is a variety having a cylindrically shaped root of even diameter from neck to base. Roots are 5 to 6 inches long. Core is small and inconspicuous. End of root is blunt. The flesh is of a deep orange color and of fine texture and flavor.

Fresh seed is desirable for planting carrots for it does not have a long viability. The grower should know something about the germination of the seed before planting so as to adjust the number of pounds of seed sown accordingly. The amount of seed used per acre varies from 3 to 5 pounds, depending upon the size of carrots desired and the distance between rows. Planting at a distance of 20 inch rows and growing carrots for slicing or dicing purposes, three pounds of seed are desirable to make a uniform stand with no thinning necessary. The amount of seed used will also be dependent upon the type of soil. Where the soil is loose and readily penetrated by roots, a thicker seeding can be used than when the soil is heavier, for the roots can then not shove out toward the sides of the rows. Some growers plant in rows 24 inches apart, but if the land is heavier and apt to be weedy, the distance between rows may be wider.

Most of the planting for carrots grown for canning or freezing in western Oregon is done between April 20 and the first week or two in May but plantings may be made up to June 15 if there is plenty of moisture available and deliveries can be made later in the season.

Maintenance. In the cultivation of carrots a "speed" hoe and a tooth cultivator are useful tools. It is necessary to work the ground only when the object is to eliminate weeds or to stir the soil after an irrigation or rain.

The work of eliminating weeds is one of the greatest costs in the production of a crop unless the land in the first place is reasonably clean. It is also important that the weeding be done as soon as the young carrot plants in the row can be worked on. When the land is not weedy, possibly one or two weedings when the plants are up nicely may be sufficient. Cultivation between the rows is mainly for the purpose of weed elimination and there is no value in frequent cultivation for the theoretical purpose of controlling moisture.

Irrigation is especially desirable for carrots in providing a uniform amount of moisture during the growing season, inducing a steady growth of the plants and roots, increasing the yields, and making it possible for the roots to reach the best size for harvesting at the proper season. There is also less danger of the roots cracking in the fall, when the rains begin, if the roots have been irrigated.

Carrot irrigation is done either by the gravity method, which necessitates the preparing and smoothing of the land in the early spring so that the water may be applied as economically as possible, or by the sprinkling method, using either rotary sprinklers or the mist-spray system. The first irrigations will probably be made early in July and as often thereafter as necessary to keep a uniform amount of moisture in the soil.

Harvesting and Yields. The harvesting of carrots extends over a considerable period of time, beginning usually when the cannery can handle the roots, which is about the first of October onward. The season of harvesting roots may extend well into the latter portion of the year. A common way to get the carrots out of the ground is to chop the tops off with a sharp hoe, plow them out and pick up. Sometimes a spading fork is used to loosen the roots which are then pulled up and the tops twisted off by hand.

Yields of carrots will be dependent quite largely on the stand of plants in the field and soil moisture, but in general the average planting will produce about 20-25 tons per acre. Good yields may sometimes be as high as 40 and even 50 tons, but these are exceptions rather than the rule.

The cost of growing carrots will depend quite largely upon the amount which has to be spent for maintenance, namely, weed elimination and watering. This may be a comparatively small item in some fields but will usually run as high as $25 per acre. It is probable that on the basis of an 18 to 20 ton yield, the cost of producing and delivering carrots is approximately $6 to $8 per ton.

Insect Pests, Diseases and Miscellaneous Crop Troubles. Carrots are sometimes affected with nematodes, gophers, moles and maggots.

Nematodes are microscopic eel-like worms that are persistent in the soil and are easily spread. The small nodule-like galls are visible on the fine roots issuing from the main carrot root. Soils known to produce carrots with nematodes on them should not be planted the next year to a crop susceptible to this worm. Sacks containing infected roots must be sterilized. The carrots themselves may not be injured by the presence of the nematodes, which are removed when the roots are peeled.

Moles and gophers are controlled in the usual manner, either by trapping or poisoning, as the case may be.

Maggots, which are small white grubs of the carrot rust fly, have been known to infect carrot fields in certain parts of the Northwest but do not seem to be prevalent at the present time in Oregon. In case any of these are present, the Department of Entomology, Oregon State College, should be consulted for assistance as to their control.

There are few, if any, diseases of carrots, but in the last year or so there have been some outbreaks of internal blackening of roots, which has done much damage in certain fields. Compared with the widespread study and knowledge of the breakdown of other kinds of roots, such as beets, little is known at the present time concerning this blackening of carrot roots.

In the carrot the blackening or breakdown seems more frequently to be found in the core, although the outbreak may occur at almost any part of the root. Sometimes the whole core through its entire vertical section may be blackened. In other roots blackened areas may occur irregularly in certain areas of the cortex or core.

It would seem that the carrot must be added to the list of plants for which boron is an essential constituent, and it is recommended that 30 or 40 pounds of commercial borax be applied per acre in conjunction with the usual fertilizing materials and methods.

Useful Reference

U. S. D. A. Misc. Pub. No. 361. Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots.

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