

on of Carrot Root Sizes

studies made of spacing and seed germination to determine possible cause of size variation

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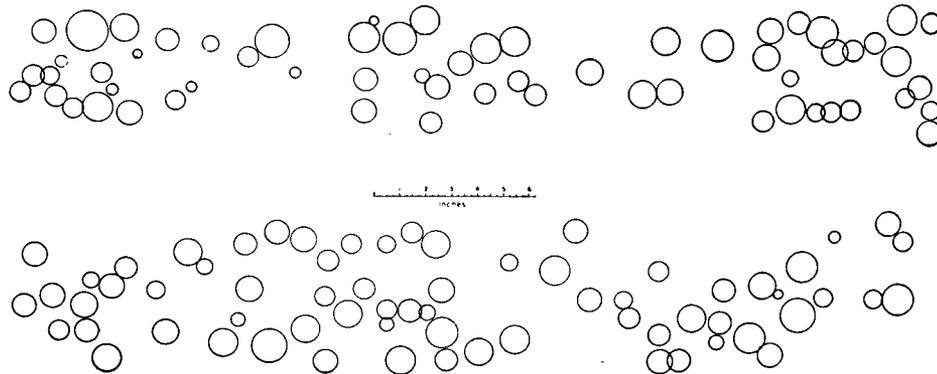
Cullage of carrots grown for bunching causes considerable loss of yield because the roots are so highly variable in size.

When carrot fields in the southwestern United States are harvested for the fresh market, all the roots are dug at one time. A large proportion of the roots are culled out in the field because they are too small or too large to bunch.

Usually bunch weights are standard and though the number of carrots per bunch may vary widely, six to seven roots of uniform size are preferred. In bunches of this size most of the roots vary between one and $1\frac{1}{4}$ inches in diameter. Any practice which would lead to a more uniform root size would, in effect, increase yield.

Two factors which might affect root size of field-grown carrots were studied: 1, the distance between roots—the spacing—and 2, the nonuniform germination of seeds in the field.

The effect of spacing on root size was examined in a commercial field by removing the tops, carefully mapping the position and diameter of the roots.



A map showing the location and diameter of carrot roots planted by the use of a wide shoe. Note that small carrot roots may be located where there is little competition from other roots.

The rows studied in this bed were planted with a wide shoe so that the seeds were scattered in a band five or six inches wide. Spacing of the plants was quite irregular but despite this there was little evident relation between spacing and root size.

In another test, seeds were planted by hand in $2'' \times 2''$ squares. While many seeds did not germinate, so that spacing

was not uniform, the spacing was relatively wide as compared to commercial practice. Here again, the root diameter had little relation to spacing. The size distribution for 42 roots from this planting indicates that, even with wide spacing, great variation in size occurs.

While these data indicate that spacing is not a major factor controlling root size under field conditions, it is necessary to avoid planting so thickly that crowded and misshapen roots are formed, or so sparsely that yield is reduced. At the present time, precise spacing of carrots is difficult for the commercial grower because of the low percentage of germination of most carrot seed.

Some growers are making trial plantings with pelleted seed to obtain more uniform spacing.

Percentage of germination and number of seeds per ounce were determined for 23 samples of Long Emperor seed.

Six replicates of 100 seeds of Emperor were germinated on each of three media—on moist filter paper in small flat dishes, in soil flats in a lath house and

under commercial conditions. Mean germination for the seed in the field, in soil in flats, and in the petri dishes were 47.3%, 51.5%, and 64.8% respectively.

While field germination of carrots is markedly affected by soil and climate, a fair estimate of field germination probably could be made with some knowledge of the conditions under which the seeds are to be germinated.

In an attempt to increase germination, several treatments were tried, such as soaking in hot water— $50-52^{\circ}$ C, 10 minutes—soaking in thiourea—0.1% to 5.0%—and scarifying by cutting or with sulphuric acid—soaking in concentrated acid up to two minutes. None of these treatments increased germination over that of untreated seed.

To determine if early or late germination of seeds within a single planting had any effect on the size of the roots which develop in the field, seedlings were identified as they appeared above ground by applying a small amount of oil paint to one of the cotyledons.

All seedlings were painted on a certain date and then after a specified number of days the new crop of seedlings was marked.

When the roots reached marketable size, all were dug and the maximum root diameter recorded. The seeds in two experiments were planted with a wide shoe that scattered them in a band five to six inches wide. In a third experiment the seeds were planted by hand in $2'' \times 2''$ squares. The roots which grew from the early-germinating seeds of the first two experiments were significantly larger than the roots from seeds which germinated later.

Seeds which germinate early may produce relatively large roots because they have more time for growth, or because they place the later germinating seedlings at a competitive disadvantage, either by shading or by the roots which, even in young plants, may extend laterally several inches.

The difference in growing time for early and late seedlings is small relative to the total growth period and it seems doubtful that age differences alone could account for the mean size differences for the germination dates within the tests.

In the experiment where the seeds were hand planted in $2'' \times 2''$ squares, the seeds were widely spaced, the competitive effects were reduced and the size differences were not significant.

Nonuniform germination of seeds in the field evidently contributes to the variation in root size which seems to be associated with competition between early and late germinating seeds rather than

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Nitrogen for Orange Trees

experiments on the use of urea applied to the foliage as a source of nitrogen now under study

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Urea sprays designed to supply nitrogen to the foliage of orange trees are being tested at the Citrus Experiment Station in Riverside.

For many years it has been common practice to apply essential elements—zinc, manganese and, occasionally, copper which are needed in small quantities—to the foliage of citrus trees.

Such materials as nitrogen, which are used in larger quantities by the trees, have been applied to the soil for absorption by the roots.

At the present time, a new proprietary urea product is being used in the production of apples in the eastern states where careful regulation of the nitrogen nutrition of the tree is important for the production of good fruit color.

The experience with apples has stimulated interest among citrus growers in the use of urea sprays.

The application of such nitrogen carriers as sodium nitrate or ammonium sulphate to apple foliage has resulted in leaf injury at rather low concentrations of nitrogen.

Urea caused less injury than the other nitrogen carriers and thus offered a possibility that it can be used under some conditions as a foliage spray.

Experiments with urea sprays on oranges were started at the California Citrus Experiment Station in the spring of 1947.

In one trial spray concentration of five pounds, 7½ pounds, 10 pounds, and 15 pounds of the urea product per 100 gallons of water were applied to Washington navel orange trees at the Citrus Experiment Station.

Applications were made on different groups of trees in February, in April, and in May. These treatments were repeated a second year to the same trees.

Leaf analysis indicated little or no increase in nitrogen as a result of the sprays; however, nitrogen was relatively high in these leaves before the application of the spray.

It appears that these nonvigorous trees were not limited by nitrogen and under such conditions very little absorption occurred through the leaves. No foliage injury resulted from the sprays and no tree response was noted.

A second trial was started in November 1947 in Azusa. A block of vigorous

navel orange trees which were somewhat limited by lack of nitrogen were sprayed with urea compound at the rate of 10 pounds per 100 gallons of water in November 1947, April 1948, August 1948, and November 1948.

Leaf samples were collected for analysis in February 1949. The leaves from the nonsprayed trees contained 2.39% nitrogen and those from the sprayed trees 2.69% nitrogen. It is clear from the analysis that the sprayed trees are at a higher level of nitrogen nutrition than are the unsprayed trees. In this experiment also there has been no noticeable tree response. There was no foliage injury observed.

In a third trial, two applications of spray were made to the same trees. The first application of 15 pounds of the urea product per 100 gallons of water was made in February 1948, and the second of 10 pounds per 100 gallons of water in May 1948. These trees are in the unfertilized plots of the long-term fertilizer trial at Riverside, and are consequently nitrogen-starved.

Leaf analysis in May—about 10 days after the spray application—showed the leaves of the check trees to contain 2.24% nitrogen and of the sprayed trees 2.52% nitrogen.

In the following January—1949—with no additional spray, the leaves of the check trees contained 1.99% nitrogen and the sprayed trees 2.18%.

In this trial the sprayed trees showed a marked increase in green color, a slight increase in vegetative growth, and an increase in fruit production over the unsprayed trees which have produced very little fruit.

A fourth trial, on Valencia orange trees in Mentone, was started in April 1949. At this time the nitrogen in the leaves was relatively low and the leaf color as well as a light crop indicated a nitrogen deficiency of moderate degree.

On April 1st the trees were sprayed at the rate of 15 pounds per 100 gallons of water.

At the same time a soil application of an equal amount of nitrogen was made to other trees. Fifteen days later the leaves from the check trees contained 2.19% nitrogen, from the soil application 2.21% nitrogen, and from the sprayed trees 2.58% nitrogen.

On May 25th the soil application was repeated and a part of the sprayed trees were resprayed. Ten days later the leaves from the check trees contained 2.17% nitrogen, from the soil application 2.17% nitrogen, from the trees sprayed once 2.19% nitrogen, and from the trees sprayed twice 2.43% nitrogen.

The use of urea in these spray trials with orange trees has caused no injury to this date. However, under some conditions injury has resulted to citrus and to other crops from the use of urea as a spray.

Unless the nitrogen content is high for the condition of the trees, the nitrogen is readily absorbed by the leaves of orange trees. It is apparent that a more rapid increase of the nitrogen in the leaves can be accomplished by spray application than by soil application. Whether the amount of nitrogen that can be absorbed through the leaves will suffice for all the nitrogen required by the tree is yet to be determined.

More research on the application of nitrogen to orange trees as foliage sprays is needed before its value is known.

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simply the age differences among roots at the time of harvest. The factors which affect nonuniform germination in the field are not known.

While spacing among individual roots does not seem to be related to root size, thickness of planting will affect over-all variation in root size insofar as it controls the competitive effect among seedlings germinating at different times.

Even with uniform germination, there seems to be a remarkable inherent variation in carrot root size where differences in time of germination and spacing are minor factors.

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