2,4-D Treatment of Citrus Seed

hormone treatment doubled production of healthy sweet orange seedlings in glasshouse experiments

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In the germination of citrus seed, usually many weak seedlings fail to survive after they emerge from the seed coats—a loss apart from the losses caused by fungus attacks.

To determine whether a 2,4-D treatment would improve the germination and subsequent growth of citrus seedlings, while the seed was still attached, tests were made with sweet orange seed in the propagation chambers in the glasshouse of the Department of Plant Biochemistry of the University of California at Riverside.

Four Lots Tested

Seeds were removed late in the afternoon of October 1, 1953, from fruits obtained from a Koethen sweet orange tree. The seed was thoroughly washed and freed of adhering pulp. Four lots—each of 75 healthy-appearing seeds—were chosen for the tests. Two lots of seed—*A* and *B*—were left standing in a dry state overnight in a beaker.

Early the following morning both lots of seed were planted in well drained and uncovered propagation beds consisting of a fresh mixture of half plaster sand and half peat moss and maintained at 75° F with bottom heat. Lot *A*—when planted on October 2, and whenever required thereafter—was sprinkled freely with tap water. Lot *B* also was sprinkled freely at planting but with tap water containing .0075 ppm—parts per million—of 2,4-D. The stock solution used in these tests was the acid form of 2,4-D and contained 10 mg—milligrams—per liter of distilled water. The solution was used at the rate of three ml—milliliters—in four liters of tap water.

Tap water was sprinkled on Lot *B* whenever water was required but on November 2, and November 9, the water contained the 2,4-D treatment.

Differences Apparent

The upper illustration in columns two and three shows the condition of the seedlings when photographed on November 16, 1953. Subsequently the differences became even more pronounced. At no time was albinism evident in the seedlings of either Lot *A* or Lot *B*. It is possible that the keeping of the seed in a dry state overnight eliminated the weak albino seedlings. A fair appraisal on the day the photograph was taken—November 16—indicated an approximately 40% stand of the seedlings in Lot *A* and about an 80% stand in Lot *B*.

The number of seeds in the third and the fourth lots—Lot *C* and Lot *D*—the time of planting, and the treatment while in the propagation chambers were precisely like those of Lot *A* and Lot *B*. The single exception in the treatment was that Lot *C* was soaked overnight in a beaker of tap water before planting and Lot *D* was soaked for the same period in tap water to which 2,4-D was added to make a concentration of .0075 ppm.

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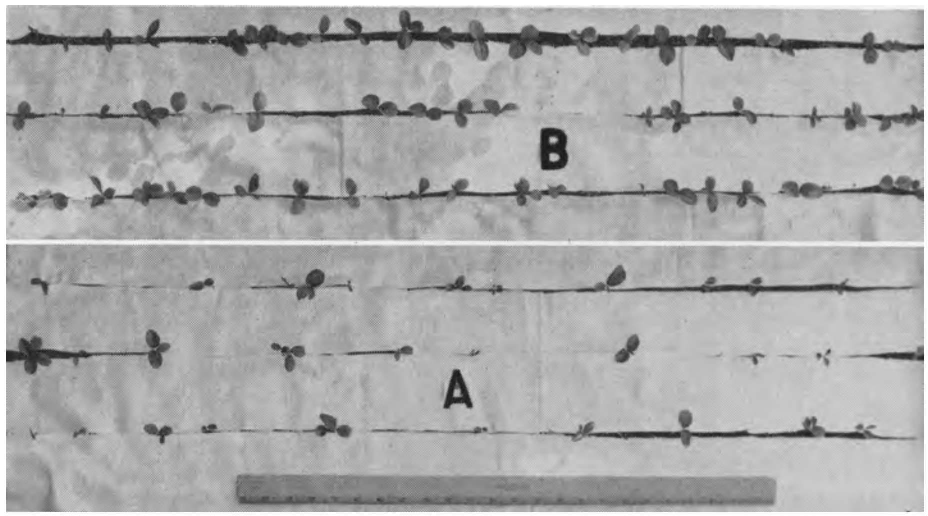
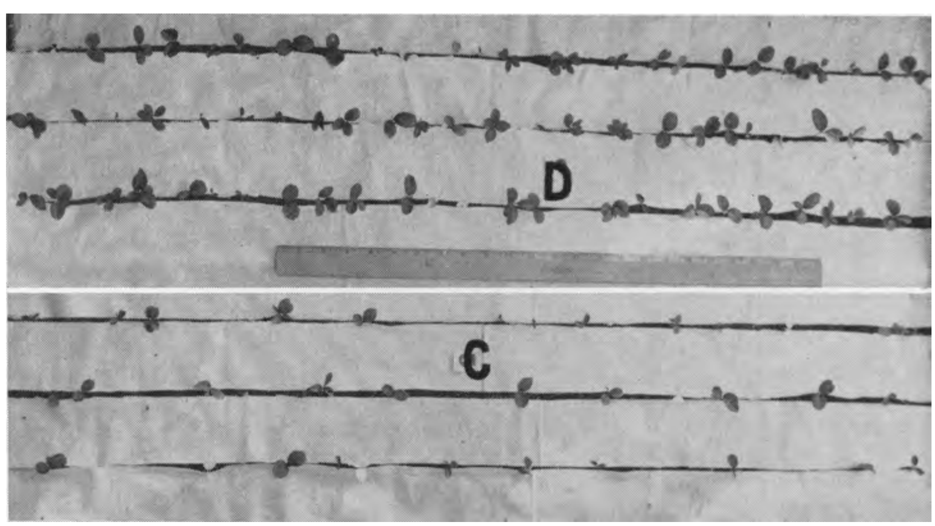


Effect of 2,4-D soil treatment of Koethen sweet orange seed upon their germination and seedling growth. Lot A—three lower rows—received tap water. Lot B—three upper rows—received tap water containing 2,4-D. Planted October 2, 1953; photographed November 16, 1953.

Germination and growth of Koethen sweet orange seed soaked overnight: Lot C in tap water only and Lot D in tap water with 2,4-D added. Photographed November 16, 1953.



DOUBLE VARIETIES

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row, long-petioled leaves. Discarding the Slenders discards most of the singles. The Slender trisomic has the pair of whole chromosomes that normally determines singleness and doubleness, plus an extra chromosome—about half as long—that also carries either the *S* or the *s* factor.

Genetic Features

Several main features of the usual genetic behavior of Slender trisomics seem well established. The extra chromosome reduces the chances of survival of the germ cells and embryos that receive it, thus decreasing the proportion of trisomic and—especially—of tetrasomic Slender, and increasing the proportion of the vigorous normal seedlings. The extra chromosome is transmitted more often by the eggs than by the pollen, but a pollen grain can even carry *Sl* if it also has an *sL* chromosome. One *S* factor is dominant over two *s* factors.

Apparently a trisomic plant can not carry more than one *Sl* chromosome. There is convincing evidence that the best progeny ratios—with the largest proportions of normal doubles—are produced by Slender parents that have their *Sl* in the extra half chromosome—*sL/sL/*(*Sl*). Such plants, if their *S* never crosses over to a whole chromosome, must give only Slender single and normal double progeny; the small actual percentages of normal singles and Slender doubles must result from crossing-over. Much poorer but somewhat similar observed ratios probably result from location of the *Sl* in a whole chromosome; presumably these ratios are improved by crossing-over of *Sl* to the half chromosome. The extra chromosome of Slender evidently adds to the usual possibilities of irregular changes in the inheritance of doubleness—further complicating the plant breeder's problem.

Research Applied

The practical possibilities of Slender were demonstrated by a plant breeder who obtained colored races of *Matthiola incana* which had been produced at the Citrus Experiment Station. By further crossing and selection plant size was improved, the susceptibility to a bacterial disease reduced, and the number of available colors increased, in high-doubleness varieties.

A commercial seed grower near Guadalupe, after several years of breeding, utilizing Slender trisomics, raised a field of branching stocks of various colors, which at first glance appeared to be all doubles—and the grower's records showed 86% doubles and 14% singles in the field. The field was an excellent demonstration of the use of scientific data to produce a practical result.

Stock seed is now available at wholesale under a trade name which designates races in which the commercial seed is obtained from trisomic Slender plants. All plants can be grown without sorting, with the probability of a low proportion of singles. Another method discards the weaker, smaller-leaved seedlings; this tends to reduce the proportion of singles. If this sorting is done when the plants have several leaves, and those with narrow, long-petioled leaves are thrown away, most of the singles—and the occasional rather weak Slender doubles—may be eliminated. Besides the narrow-leaved trisomics there may also be a few weak little tetrasomic Slenders, with very narrow leaves, to be discarded.

Without selection, the great majority of the plants should have double flowers. If the second—seedling-selection—method is carefully followed nearly all the plants will be doubles.

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AVOCADO

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leaf injury on all five seedlings. Sodium at 14% killed three seedlings and prevented the growth of two, while 26% sodium killed all the plants.

Chemical Composition

Leaves of seedlings showing slight to moderate potassium burn contained 3.8% potassium: severely burned leaves contained 5.5%. Leaves of seedlings with slight sodium burn patterns contained .26% sodium while moderate to severe patterns were associated with .50% leaf sodium. Two plants which remained alive—but did not grow—in the 14% sodium soil contained only .33% leaf sodium. Leaf calcium and magnesium were not significantly affected by 14% exchangeable potassium or sodium but were slightly reduced by 25% potassium.

Increasing potassium and sodium percentages increased the manganese content of the leaves while excess lime decreased it. The chemical analysis data for manganese were in agreement with visual observations. The leaves of the seedlings in treatments which contained excess lime, showed slight manganese deficiency patterns, while the seedlings in the potassium and sodium series did not show deficiency patterns.

Tests with other plants have shown that growth of tomatoes, barley, vetch, radishes, lettuce, onions, alfalfa, and carrots is not reduced until concentrations of 30% to 40% or more exchangeable potassium and 20% to 40% sodium are attained. Higher concentrations are necessary for leaf burn.

Studies with citrus plants indicate that, in general, they are slightly more tolerant to these cations than were the Topa Topa seedlings. For example, 14% potassium caused leaf burn of the avocados but did not damage sweet or sour orange seedling leaves. Recently, a citrus orchard in Orange County which had been interplanted to avocados was observed to show no burn of citrus leaves but leaves of many of the avocado trees exhibited typical sodium burn patterns.

These studies indicate that soil sodium percentage considered low for most plants may be high for avocados. The sodium is quickly adsorbed. Sodium burn patterns began to appear within 10 days to two weeks after planting.

The rather marked variation in severity of sodium or potassum injury indicates that individual plants vary in their susceptibility to sodium injury.

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CITRUS SEED

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The lower picture in columns two and three on page 8 shows the effect of 2,4-D on the germination and seedling growth of Koethen sweet orange seed when the two lots of seed were soaked overnight. A fair appraisal on November 16, 1953, when the photograph was taken, showed Lot *C* as having 37% healthy seedlings compared with 76% for Lot *D* which was 2,4-D treated. In addition, Lot *C* had 8% surviving albino seedlings and Lot *D* had 11%.

Other studies with large citrus seedlings have shown the seedling growth to be increased—even when the seed no longer remains attached to the plant—when very dilute concentrations of 2,4-D occur in the nutrient solution applied to soil cultures.

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