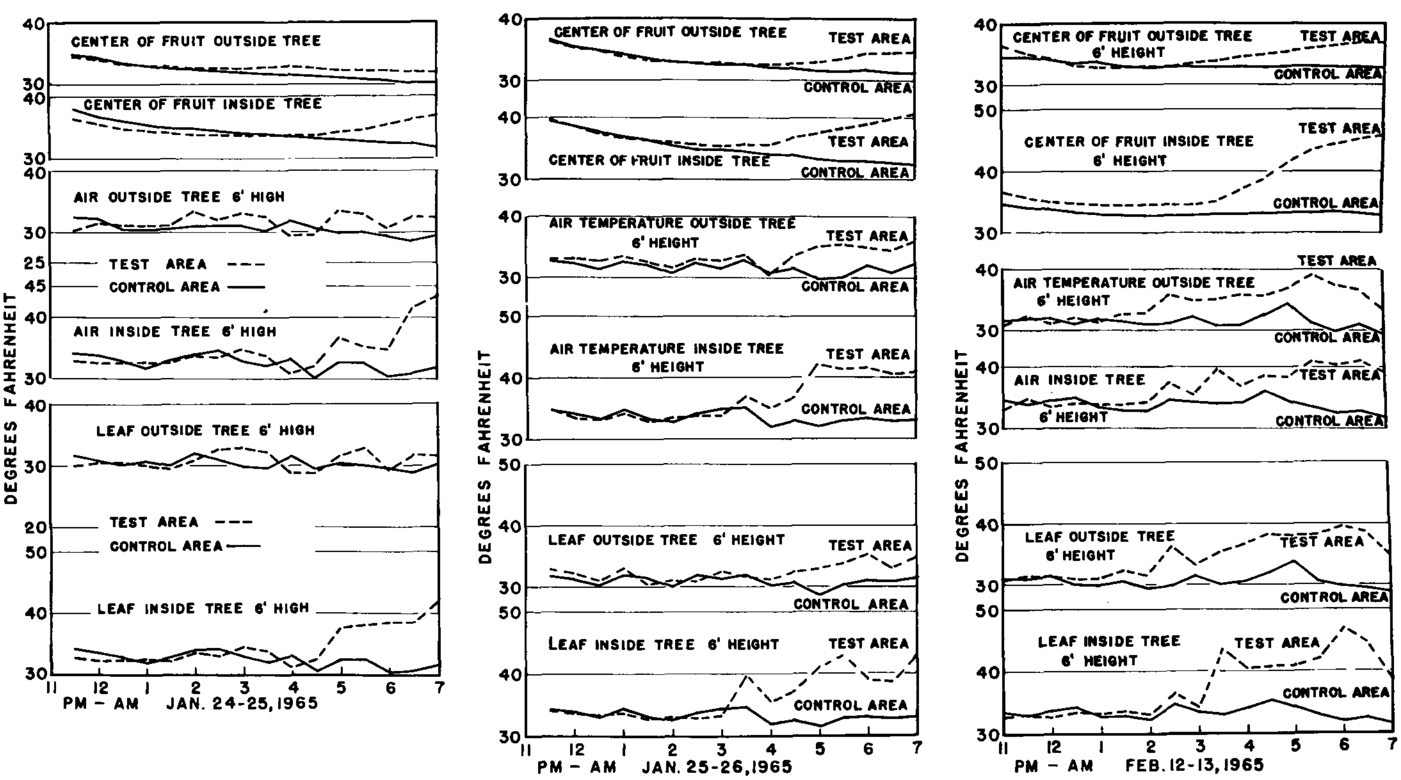
Snuffer used to extinguish candle-type orchard heater.

SOLID FUEL CANDLE ORCHARD

M. P. MILLER • F. M. TURRELL • S. W. AUSTIN

Solid fuel, candle-type heaters have been tested to determine their effectiveness when used, both under trees and in the open, to protect against freezing damage in a citrus orchard. Two heaters under each tree were found effective in increasing fruit temperatures under the tree by about 3°F, and heaters both under the tree and outside the tree more than doubled the temperature rise. Heaters placed outside the tree were less than half as effective as those under the tree in increasing fruit temperature—either for fruit inside the tree or for exposed fruit on the outside of the tree.

ORCHARD FRUIT, AIR AND LEAF TEMPERATURES DURING THREE TEST PERIODS WITH SOLID FUEL HEATERS



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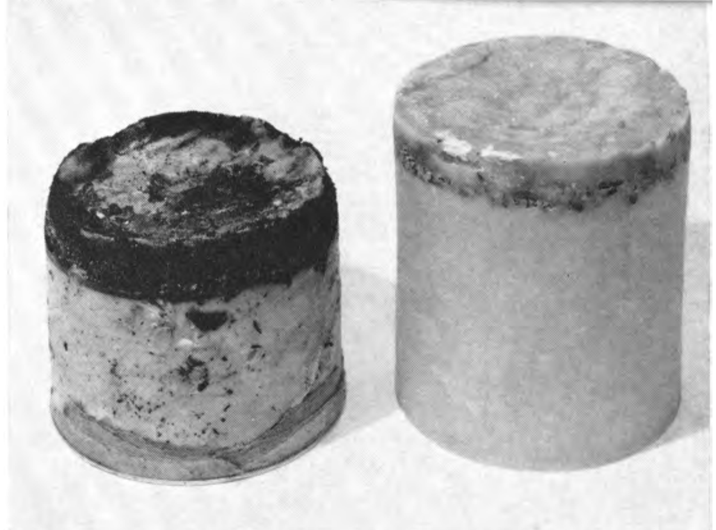
HEATERS



Solid fuel candle-type orchard heaters with cardboard containers removed. Candle on left burned for 12 hours.

SOLID FUEL HEATERS with a low flame for use under a tree are on trial for orchard heating. Oil companies have designed and are experimenting with several types of these heaters. This report discusses tests using solid petroleum wax candles as a source of heat.

Heaters used in these tests were contained in cylindrical cardboard cartons about 8 inches in diameter and 10 inches high. The cartons were filled with a petroleum wax and had a fiberglass wick or matting on top. Lighting was done with an orchard heater torch filled with a mixture of gasoline and kerosene. The candles were extinguished with a lid from a return stack heater fastened to a long handle, which acted as a candle snuffer.

The idea of supplying heat beneath the canopy of the tree is a new approach to orchard heating. In the past the efficiency of heaters in orchards has been low because much of the heat is dissipated into the atmosphere or radiated to the sky where it is lost and does not warm the trees. This new method is much more efficient since a higher percentage of the heat can be retained by the tree.

Grapefruit

To determine the effectiveness of these solid fuel heaters for frost protection, field trials were conducted to study temperature responses. A grapefruit orchard with both large and small trees, located about two miles northwest of Lake Elsinore, Riverside County, was used in the tests.

The heaters were tested on five different nights requiring limited frost protection: January 24–25, and 25–26; February 11–12, 12–13, and 16–17, 1965. The orchard was heavily instrumented with thermocouples to record air, leaf, wood and fruit temperatures both inside and outside the trees. Similar temperature measurements were made in the control area outside the influence of the heaters. Wind speed and direction were also recorded, as well as soil temperature, wet and dry bulb temperature, and three radiometer readings. Temperature recordings from test trees were compared with temperatures at similar locations on unheated control trees. Air and fruit temperatures were taken at a height of about 6 ft.

Two heaters

On the night of January 24–25 a test was made using two heaters under each large tree. There were 104 heaters lit. The test started at 4:00 a.m. and ended at 7:00 a.m. The heaters were difficult to light as they were wet from a rain the previous day. The average temperatures of the test trees and the control trees were compared for the two-hour period from 5:00 to 7:00 a.m.

As shown on the chart for January 24–25, the temperature of fruit outside the canopy of the tree in the test area remained about the same during the test while the control temperature went down. The average difference was 1.5° F. Temperature of fruit inside the canopy of the tree started to increase about one-half hour after lighting the candles, and increased steadily until 7:00 a.m. The average difference when compared with the control tree was 3.0°, and the difference at 7:00 a.m. was 11.6°.

Air temperature outside the tree for the same period averaged 3.1° F higher than the control, while the air inside the tree averaged 6.7° higher than the corresponding control. Leaf temperatures were similar to air temperatures. Outside leaf temperatures were only 1.6° warmer than the control, while inside leaf temperatures averaged 7.3° higher than similar leaves on the control trees.

Heaters in rows

On the night of January 25–26, two heaters were lit under each tree and additional heaters were placed in the rows between the large and small trees. Lighting started at 3:00 a.m., and required one hour and forty minutes for the 230 heaters. Many went out and relighting, sometimes two or three times, was necessary. A count at 5:00 a.m. showed 21% were either out or not burning properly. Average temperature response was taken from 4:00 to 7:00 a.m.

The temperature response of the test tree showed fruit on the outside of the tree averaged 1.9° F warmer than the unheated control tree. Fruit inside the tree during the same period averaged 6.4° warmer. Air temperature on the outside of the tree at 6-ft height averaged 3.1° warmer, while air temperature at the same height inside the tree averaged 7.0° warmer than the control tree. Leaf temperatures were similar to air temperatures. Outside the tree the leaf temperature was 3.0° warmer than the control tree, and leaf temperature inside the tree averaged 7.2° warmer.

Under trees

On February 12–13, heaters in the rows between the trees were lit before those located under the trees. About one hour was required for lighting. Outside heaters were started from 1:00 to 2:00 a.m., and the under-tree heaters were started from 3:00 to 4:00 a.m. Temperature responses from 2:00 to 3:00 a.m. were used to indicate the response to the first lighting, and from 4:00 to 7:00 a.m. for the response with heaters both under the trees, and in the rows between the trees.

There was little increase in fruit temperature when outside heaters were lit. The outside fruit averaged 0.3° F warmer, and the inside fruit 1.7° warmer than the control tree. Later when the inside heaters were lit, the average temperature of outside fruit was 2.8° warmer than the control, and the inside fruit was 8.9° warmer than the control.

Air temperature response outside the tree at 6 ft averaged 3.1° F warmer than the control when the outside heaters were lit, and increased to 5.2° when the inside heaters were lit. Air temperature inside the tree was 1.8° higher when the outside heaters were lit and increased to an average of 5.4° warmer than the control when heaters were burning both outside of, and under, the trees.

Leaf temperature with outside heaters burning was 3.4° F warmer than the control, and after both inside and outside heaters were lit the difference increased to 7.0°. The leaf temperature inside the tree, when compared with the control, was 1.1° higher when the outside heaters were lit, but when the inside heaters were lit, the difference in temperature was 8.9°.

On February 16–17 heaters were lit only on the outside of the tree. In general, the temperature responses were slightly better than those observed during the period when outside heaters were burning on the night of January 24–25. However, due to fluctuating winds, there was considerable temperature variation during the night. Wind movement during all tests was typical of radiation-frost nights, moving from 0.25 to 2.50 mph, and averaging about 1 mph.

Radiometer readings were made on the nights of February 11–12, 12–13, and 16–17. The night of February 11–12 showed the strongest radiation with a net flux of about 0.0023 gram calories per square centimeter per second, and the lowest total return flux averaging 0.0051 gram calories per square centimeter per second. This compares with an average of about 0.0016 and 0.0060, respectively, for the other nights of February 12–13 and February 16–17. Dew points for the night of February 11–12 ranged from 8° to 15° F, as compared with a range of 15° to 27° for the other two nights.

The heaters were difficult to light, and many required relighting to keep them burning. Modification of the wick design by the oil company's research staff is reported. The heaters burned slower than anticipated. Most burned a total of 27 hours, producing an estimated 10,000 B.t.u. per hour. Heaters under canopies of dense, large trees burned with a lower flame than heaters under smaller trees, and required more frequent relighting.

Two heaters under each tree were effective in increasing fruit temperatures inside the tree by about 3° F, and heaters both under and outside the tree more than doubled the temperature rise. Heaters outside the tree (when compared with under-tree placement) were less than half as effective in increasing fruit temperature, either for fruit inside the tree or for exposed fruit on the outside of the tree.

M. P. Miller is Farm Advisor, Riverside County; F. M. Turrell is Professor of Biochemistry, and Plant Physiologist, and S. W. Austin is Laboratory Technician, Department of Biochemistry, University of California, Riverside.

Planting Date Effects on Cotton in Imperial Valley

G. F. WORKER, JR. • P. H. VAN SCHALK

Cotton lint yields of Acala 4-42, Deltapine Smooth Leaf, and Strain A decreased as planting was delayed after March 22, but an earlier planting (March 8) did not increase yields in tests at the Imperial Valley Field Station in 1962 and 1963. Gin turnout (expressed as percentage of lint) of Acala 4-42 increased slightly as planting was delayed, but decreased in Strain A and DPL-SL. There seems to be no advantage in planting cotton before March 20 in the southern part of Imperial Valley. The advancement of pink bollworm infestations in Arizona and Bard Valley, California, puts further emphasis on planting dates for help in control of this pest.

COTTON-DATE-OF-PLANTING experiments were conducted in 1956, 1962, and 1963 to determine the response of Acala 4-42 (A 4-42) Deltapine Smooth Leaf (DPL-SL), and Strain A (not included in 1956) in terms of lint yield, lint percentage, height, and a number of other characters. The cotton was planted solid in dry soil on 40-inch beds and irrigated up. A uniform stand was obtained by thinning to a 6″ spacing. The 1956 crop was hand picked. The 1962 and 1963 crops were each picked twice by machine.

The 1956 plantings of A 4-42 and DPL-SL were made every three weeks, from March 20 to August 14. Lint yields for both varieties were affected similarly as planting was delayed. Yields decreased from 3.18 and 3.65 bales to 1.34 and 1.44 bales for A 4-42 and DPL-SL, respectively, from the March 20 to July 3 plantings. An early frost on November 5 killed the July 24 and August 14 plantings which were in small-boll and square-forming stages. Lint yields differed only .04 and .13 bale for A 4-42 and DPL-SL between March 20 and April 10 plantings, respectively, as shown in table 1. Lint percentage was not affected to any degree. Plant height was similar until the July 3 planting from which time it decreased as planting was delayed.

The experiment was repeated in 1962 and 1963 with three varieties, A 4-42, Strain A and DPL-SL, planted at two-week intervals starting March 8 and ending May 17.