

FIGURE 1 — Petroleum coke solid fuel grove heaters packed two 2-pound bricks to a polyethylene-wrapped package.

Solid Fuel Heaters For Citrus Groves

By Kenneth K. Barnes and Kenneth R. Frost

A number of oil companies are developing solid fuel orchard heaters. Performance evaluations of this type of heater were conducted at The University of Arizona's Yuma Mesa Citrus Station during the winters of 1964-65 and 1965-66.

During 1964-65 wax candles were tested. The wax candles burned for from 12 to 14 hours and if snuffed out after one night's use could be used for protection on a second cold night. The effectiveness of the candles was judged by measurement of air temperature five feet above the ground at the periphery of trees. These air temperatures were compared with corresponding air temperatures in adjacent unheated grove areas to determine the temperature rise attributable to the heat released by the burning fuel. The heated test areas were about 2½ acres in extent. In the 1964-65 tests, trials were conducted with one candle per tree under the trees, two candles per tree under the trees, two candles per tree between trees, and three candles per tree between trees.

Two conclusions were drawn from the tests with wax candles. First, the same temperature difference resulted from under-tree placement and between-tree placement of candles. Second, one candle per tree will give a temperature rise of from 1½ to 2 degrees Fahrenheit, and the tempera-

ture rise will be proportional to the number of candles used per tree.

Petroleum Coke Tried

A petroleum coke brick grove heater was evaluated in 1965-66. In addition to measurement of its influence on temperature, a number of observations were made regarding labor requirements for distributing and lighting the units. The material was in the form of two-pound bricks packed in pairs in polyethylene bags to form a 4-pound package as shown in Figure 1.

These packages burned for from 4 to 5 hours after lighting. Trials were made of seven different patterns of placement of packages in the grove. The patterns are defined in Figure 2. They include a comparison of under-tree placement (pattern 3A) with between-tree placement (pattern 3B) and a comparison of distributed between-tree placement (pattern 2A) and in-line between-tree placement (pattern 2B). In all there were tests with 1, 2, 3, 4 and 6 packages per tree. Tree spacing in all tests was 22' x 23'. Figure 3 is a view between two rows of trees in a grove where solid fuel packages have been placed three per tree as in pattern 3B.

Results of a typical test are shown in Figure 4. The packages were ig-

nited between 12:00 midnight and 1:00 A.M. The temperatures given for each test area and for the check area are the average of thermometer readings at the tree periphery five feet above the ground. Two packages per tree in pattern 2B were not as effective as two per tree in 2A. This is thought to be because of the greater chimney effect in 2B, with rapid rise of heated air above the concentrated heat source of the two packages grouped together.

Placement Important

Figure 5 summarizes the results of all tests. It is noted that at 3 packages per tree there is essentially no temperature rise difference between under-tree placement and distributed between-tree placement. It is thought that if, in the case of pattern 6, the 6 packages per tree had been

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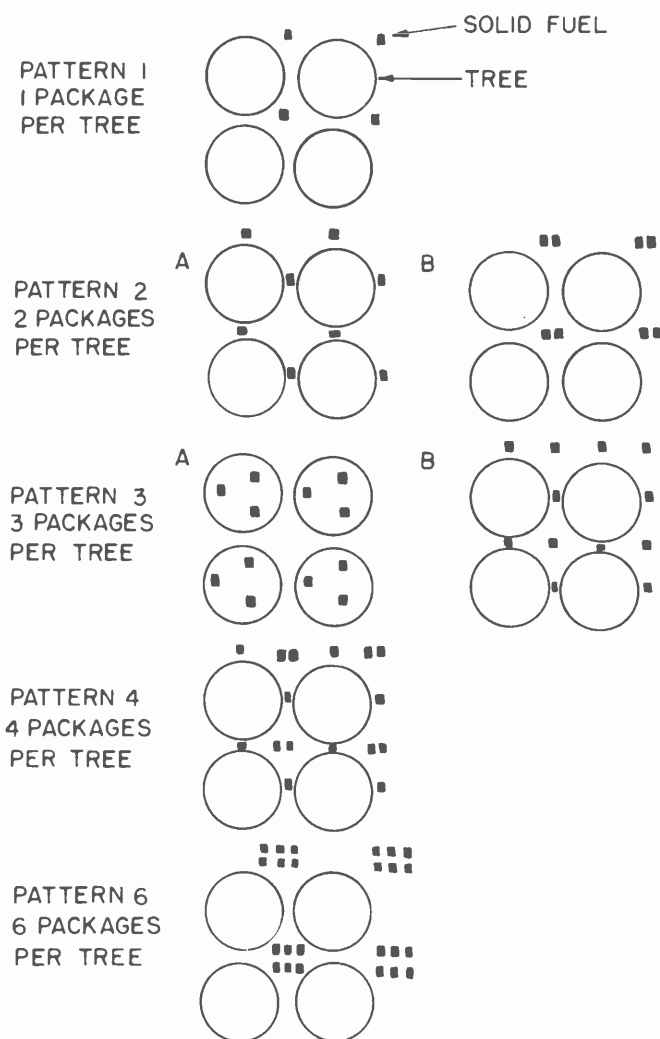


FIGURE 2 — Distribution patterns used in trials of petroleum coke, solid fuel grove heaters during 1965-66.

Respectively professor and head, and professor, Agricultural Engineering Department.



FIGURE 3 — Petroleum coke grove heating packages distributed three per tree as in pattern 3B, illustrated in Figure 2.

Labor Requirements for Distributing Petroleum Coke Heating Packages in Groves*
Man-hrs./100 Trees

Pattern	Packages per Tree					
	1	2	3	4	5	6
In-Line Patterns	<u>0.5</u>	0.7	0.8	1.0	1.1	<u>1.2</u>
Distributed Patterns	<u>0.5</u>	<u>0.8</u>	<u>1.2</u>	<u>1.6</u>	1.8	2.2
Under-Tree Patterns	1.0	1.3	<u>1.8</u>	2.0	2.4	2.7

* Underlined figures are observed data. Other figures are developed from personal judgment.

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distributed about the tree more uniformly, an additional 2 degrees of temperature rise would have been achieved.

All tests were run at air temperatures above 30° F. to insure that the operation of wind machines in adjacent grove areas would not interfere with results. It is assumed that the temperature increases obtained from solid fuel in the 30 to 40 degree air temperatures could also have been obtained in 20 to 30 degree air temperatures.

Labor studies of operations with the petroleum coke packages covered a range of systems of handling and distributing the product in the grove and of lighting of the fuel.

For Labor Efficiency

Table 1 gives expected labor requirements as drawn from results of the field studies. In-line patterns such as 1, 2B and 6 which allow straight-line movement through the grove result in minimum labor ranging from 0.5 man-hours per 100 trees for one package per tree to 1.2 man-hours per

100 trees for six packages per tree. Distributed patterns such as 2A, 3B or 4 which require movement in and

out of the rows require additional labor.

In some cases it may be possible to minimize this by tossing the packages into the in-row position. Under-tree placement requires greatly increased labor when the tree canopy comes to the ground all around, as was the case in the grove treated in these tests. All experience reported here used a three-man crew in which one man drove a tractor pulling a trailer load of fuel and two men distributed the packages.

In addition to the distribution labor presented in our table, labor was required for loading packages onto the trailer. Solid fuel packages used in these tests were delivered packed 12 to a fiberboard carton. Time studies showed that opening cartons and dumping heating packages onto a flatbed trailer required 0.8 man-hours per 100 cartons. Additional labor time must be allowed for carton disposal and for travel to and from grove areas.

In summary, the total time for loading and distributing 3 packages per tree in a uniform pattern such as 3B may be expected to be 1.5 man-hours per 100 trees, allowing for some travel time.

Time to Ignite

Labor is also required for ignition of the solid fuel. Liquid fuel torches which burn a combination of gasoline (Continued on Next Page)

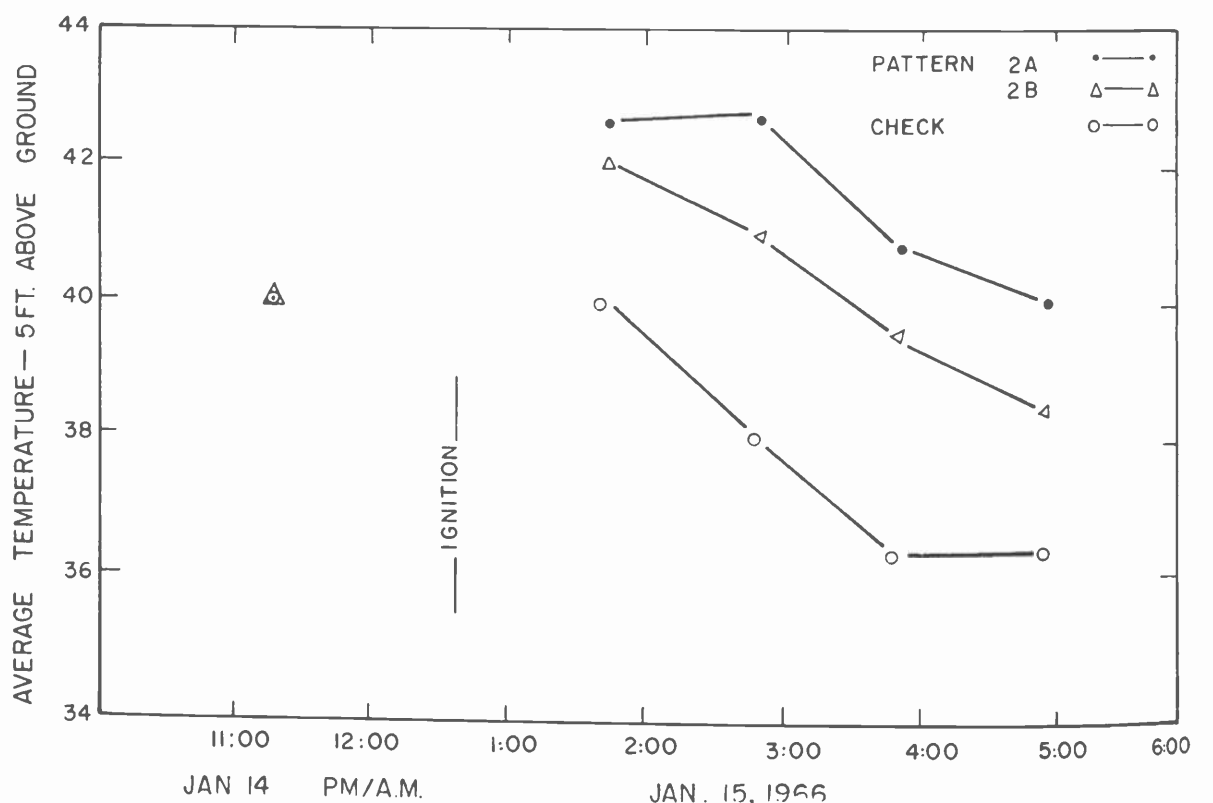


FIGURE 4 — Typical air temperature differences resulting from release of heat from petroleum coke grove heaters during 1965-66 tests.

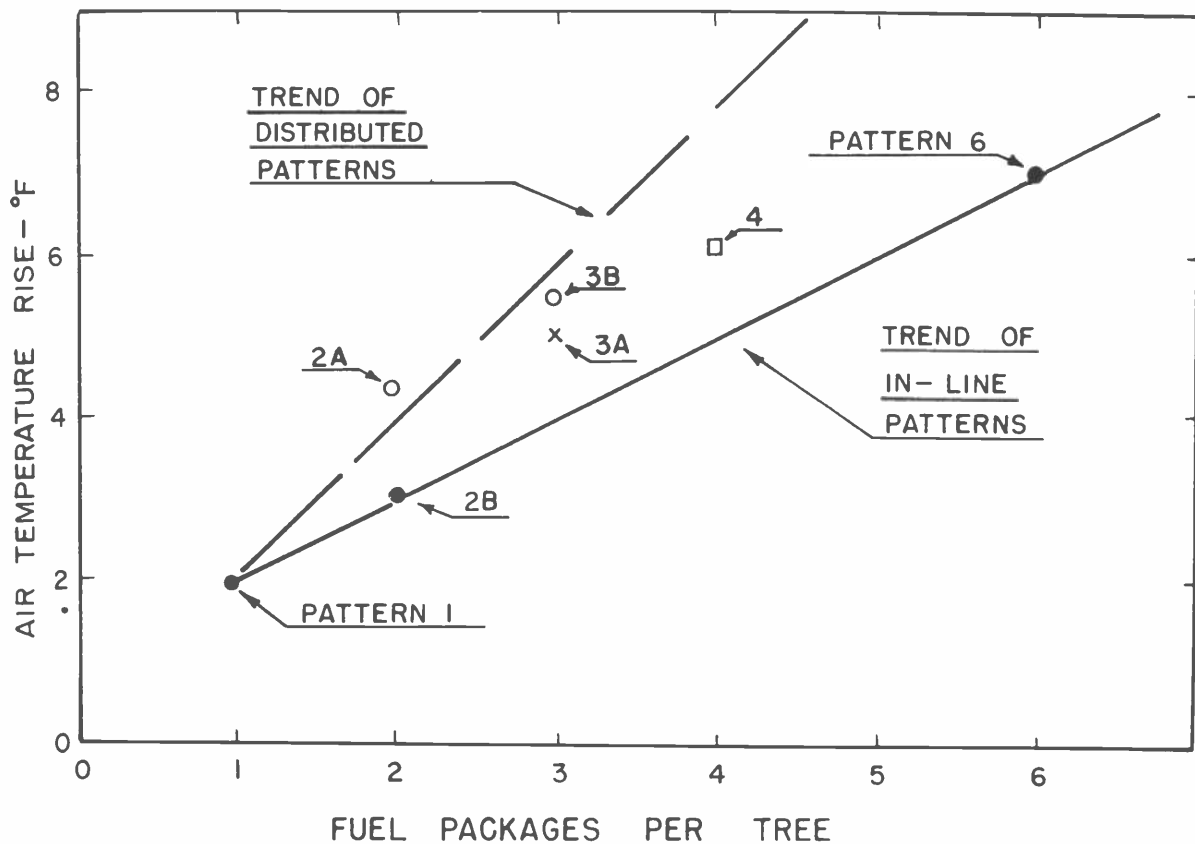


FIGURE 5 — Temperature rise above unheated areas achieved by various amounts and placements of petroleum coke grove heaters during 1965-66 tests.

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and diesel fuel are very effective. The upper surface of the solid fuel package can be quickly covered with the burning liquid fuel to achieve good ignition. Igniting the solid-fuel packages required 0.2 to 0.5 man-hour per 100 trees. The lower figure is for one package per tree, and the labor is increased for distributed patterns compared to in-line patterns. The 0.5 man-hour per 100 trees applies to six packages per tree in a distributed pattern. Placement under trees having low canopies required two to three times the lighting labor of between-tree patterns.

Typically one might achieve a six degree temperature rise for four hours using three 4-pound packages of petroleum coke fuel per tree, uniformly distributed in the grove, with a total expenditure of labor for handling and lighting the fuel of 1.9 man hours per 100 trees.

Conclusions:

Solid fuel petroleum coke grove heating products in 4-pound packages may be effectively used in grove heating with expectation of the following inputs of labor and heating results.

1. Labor for loading and placing in grove in practical patterns will range from 0.6 man-hour per 100 trees for one package per tree to 1.7 man-hours per 100 trees for six packages per tree. Labor for opening and disposing of cartons will be an additional 0.8 man-hour per 100 cartons.

2. Lighting will require 15 minutes per 100 trees for one package per tree to 30 minutes per 100 trees for six packages per tree placed in groups of two around the trees.
3. Average air temperature rise at the 5-foot level in groves may be expected to be 1½ to 2° F. per package per tree with the high figure applying to the lower numbers of packages per tree and the most uniform distribution patterns. Two degrees per tree may be expected at one package per tree. Nine degrees per tree may be expected if six packages per tree are distributed about trees in groups of two.

TURKEY

For Thanksgiving and Christmas

By C. D. Busch

(A staff member reports on his travels from last Nov. 15 through Jan. 15, which were devoted to evaluating a Turkish irrigation project.)

ing the outlook of a village teacher known for centuries as the "Hodja." One such story concerns a gathering where the people were discussing the merits of youth and old age. They all agreed that a man's strength decreases as the years go by.

The Hodja dissented: "I don't agree with you gentlemen," he said. "In my old age I have the same strength as I had in the prime of my youth."

"How do you mean, Hodja, sir?" asked somebody. "Explain yourself."

"In my courtyard," explained the Hodja, "There is a massive stone. In my youth I used to try to move it. I never succeeded. Neither can I move it now."

In a somewhat similar spirit we eight irrigation development evaluators (four Israelis and four Americans) were asked to suggest ways of moving the large obstacles to completion of the farm irrigation development for 130,000 acres. Youth was exemplified in the five year construction period; age, in the practices born of centuries of non-mechanized experience and tradition.

Plenty of Water

The Seyhan Irrigation Project, fed by the Seyhan River water, is designed to irrigate an area of 425,000 acres in the Adana Plain (see accompanying map). The river, with much of its watershed high in the Taurus Mountains, has ample water for irrigating the entire area. Winter rainfall, averaging about 30 inches, has provided enough moisture for winter grains, for dryland cotton, and for a considerable drainage problem. However, the long, hot, dry summers make irrigation necessary to permit citrus, double cropping, and increased yields from winter crops.

Water for irrigation is available from the district's main canals. To enable utilization of the water on the farmer's land, irrigation ditches, land leveling, and tile drainage are needed. This, of course, necessitates financing, with credit from the Agricultural Bank, an institution that proved to be notoriously wrapped in red tape, and tied to severe collateral requirements.

Slow and Difficult

Over the past two years, only 21 farmers had been approved for credit. The average time to arrange an improvement loan had been seven months. A man's credit approval for land levelling might be near completion, when his need to borrow for seed or fertilizer would ruin his credit rating — and thereby scuttle his plans for land improvement.

Operation of the irrigation system's

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