HELICOPTERS

for

Frost Protection

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Tests in Riverside County to study the effectiveness of a helicopter for frost protection in citrus resulted in a beneficial response in both air and fruit temperatures.

GROWERS ARE REAPPRAISING their frost protection methods and equipment because of new regulations, increasing labor costs, and the development of new equipment and methods. Until recently only a few research tests had been made with helicopters, although several commercial trials had been conducted. Interest in using helicopters for frost protection has increased during the last few years, partly because more machines are available and are being used for such things as forest fire fighting, transportation of equipment to inaccessible places and in agricultural spraying or dusting. The winter season often is a time when there is less demand for helicopters so that they are available for night flying for frost protection.

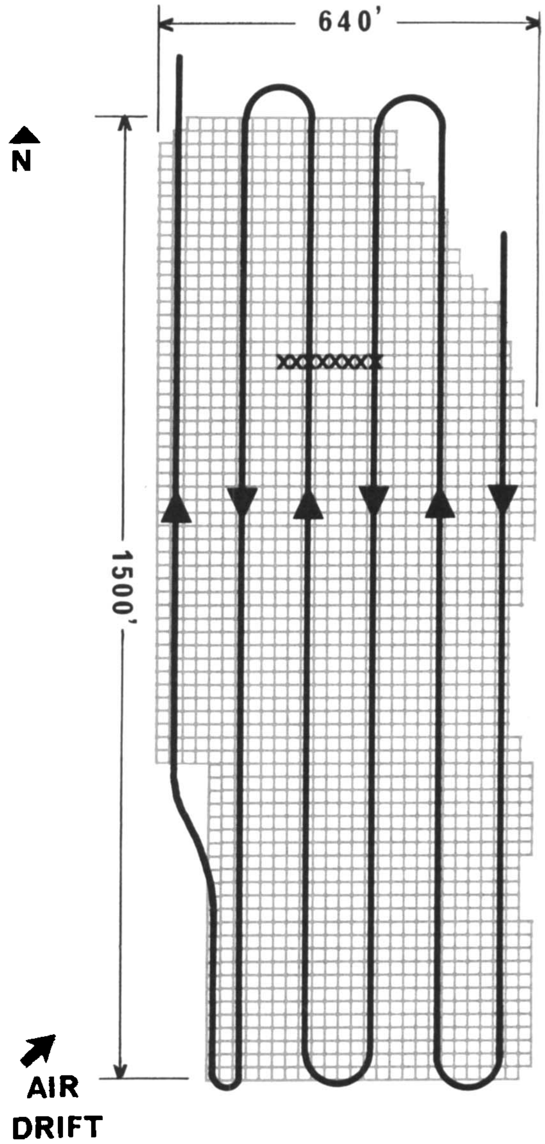
The helicopter is usually effective for frost protection under the same conditions as those effective for wind machine operation. A warm inversion layer is needed. With the helicopter, the operator has the advantage of being able to choose the level of inversion where the temperature is most beneficial. The wind machine is limited to a set height.

During the winter of 1970–71 a series of tests was made in a 20-acre lemon grove to observe the temperature response obtained from flights of a helicopter. The grove was 29 rows wide and 72 trees long, with the rows running north and south. It was a part of a small canyon. The helicopter was a Bell Model 47G3B-1 with a gross load of 2,950 lbs.

Thermocouple recordings were made by a multipoint recorder of leaf, air and fruit temperatures in eight adjacent trees in a line across the lower portion of the 20-acre grove. A continuous recorder showed air temperature fluctuations in one of the trees. The leaf temperature followed the air temperature closely. Temperature and humidity recordings were made at three locations in the grove and at an outside location. Wind speed recordings were made at a nearby station. During the tests the helicopter flew in north and south lines starting at the east row of the lemon grove and finishing over the west row (see flight pattern sketch).

Temperatures reported in the graph were for the night of January 7–8, 1971, which was typical of a radiation frost. Maximum day temperature on January 7 was 54° F. The dew point was 14° F. There was little wind. During the night when the tests were run there was an inversion temperature difference of 10 to 14 degrees, measured between thermometers 5 ft above the ground, and in the helicopter at 75 to 100 ft. No measurements were made of temperatures at wind machine height. There was a southwest air drift of ½ to 1½ mph.

The first of a series of test flights was made just after 12 midnight. The flight pattern covered the grove one time. The helicopter ground speed was estimated to be about 20 mph and was flown at about 100 ft elevation. An average of 5 points on the multipoint recorder showed a 3½ degree air temperature increase 10 minutes after the flight started. The air temperature returned to the level observed before the flight started in about 30 to



Typical flight pattern over test orchard. X's indicate eight trees used for temperature measurement.

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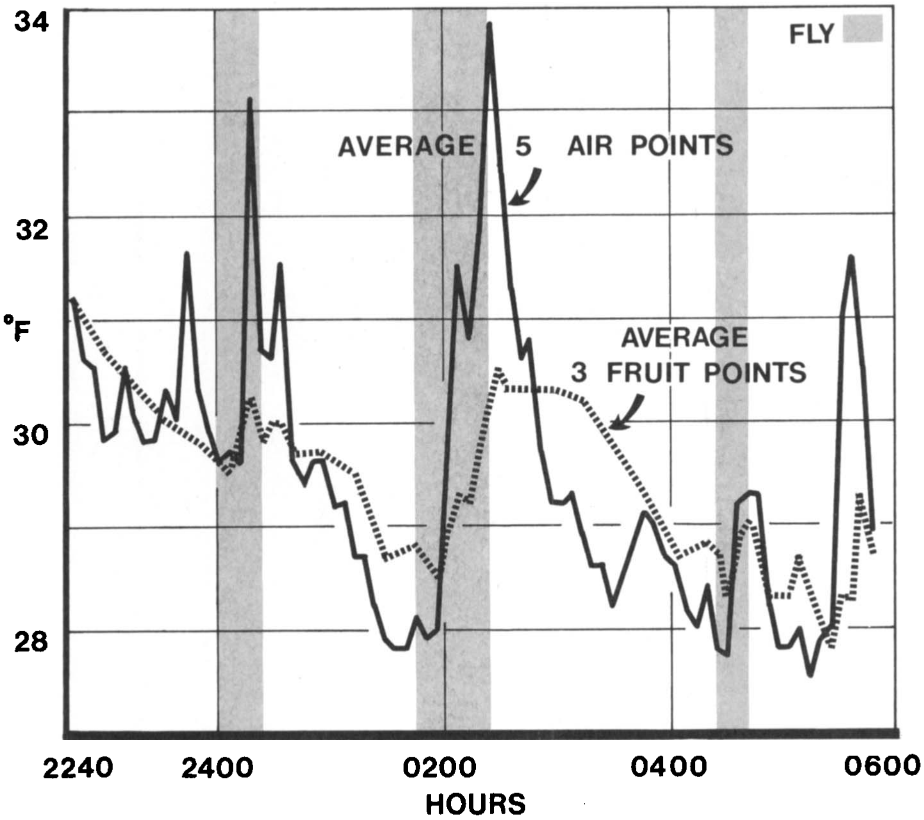
TEMPERATURE FLUCTUATION OF AIR AND FRUIT RELATED TO HELICOPTER FLIGHTS, NIGHT OF JANUARY 7–8, 1971



40 minutes. A maximum fruit temperature increase of only ½ degree was recorded.

A second flight starting just before 2:00 am was made at a height of 50 to 75 ft, at a speed of about 5 mph. The helicopter covered the 20 acres two times in 35 minutes. This thorough mixing of air raised the air temperature 6 degrees. It required about two hours after the flights stopped for the air temperature to drop to the original level, giving about 2½ hours of protection. The fruit temperature rose about 2 degrees with some benefit apparent for about 2½ hours.

A third flight starting about 4:30 am was made at a height of about 150 ft, flying at a speed of about 20 mph. The flight lasted about 15 minutes, covering the grove one time. The maximum air response was about 1½ degrees. The beneficial response of both air and fruit was lost in about one-half hour.

The continuous air drift from the southwest influenced the location affected by the downdraft below the helicopter. When the helicopter flew east of the temperature measuring station there was no temperature response recorded. There was a temperature change at the recorder only when the helicopter passed south or west of the station.

A thorough mixing of the air updrift from the station produced the best response under existing conditions, as shown by the second in the series of flights. Flying at a higher level or faster speed did not produce the beneficial temperature response observed when the helicopter was flying slower and at the lower level. At that time there was a stronger jet of air directed down into the trees.

Helicopter costs depend upon the size of the helicopter and the agreement made in the individual grower-operator contract. A standby charge or contract for a minimum number of hours is made to be assured that the helicopter and pilot will be available when needed. Some growers have contracted for a minimum of 60 hours to be used in a two-month period at the rate of $100 per hour. The estimate of contract hours depends upon the anticipated hours needed for frost protection.

The acreage which can be protected by a helicopter will vary depending upon several factors such as the weight of the helicopter (down thrust), the amount of the inversion, the skill of the helicopter operator and the ability of those directing the operation. The second flight, which lasted 35 minutes, produced a benefit for 2½ hours on 20 acres. On this basis, one helicopter flying continuously could protect 75 to 100 acres. There are some trials when a smaller acreage was protected and some observations of commercial operations which have produced a good temperature response on a larger acreage.

Helicopter aids

Aids to the practical operation of the helicopter included: (1) A thermostatically controlled blinking light (like a highway blinker) mounted on a pole to place the light above the tree tops. The thermostat should be placed in the grove below the light and set to turn on the light when the temperature drops to the danger point. This alerts the helicopter pilot to the cold location. As the helicopter flies over the light and the temperature rises the light goes out. A second pass over a cold location may be desirable if one pass does not put the light out.

(2) A rapid response thermometer should be in the helicopter to determine the temperature in the different parts of the inversion layer and enable the pilot to select the best height at which to fly.

(3) If the areas to be protected are not uniformly cold and adjacent to each other, a 2-way radio between the ground and the helicopter is vital to an efficient operation. The helicopter can be used in nearby groves by reporting the temperature by radio and moving the helicopter to the colder locations. A passenger familiar with the groves and local conditions can direct the pilot to the area indicated by the radio reports. Orchard heaters or flares burning at the corners of the orchard can identify the groves to be protected.

(4) A pilot experienced in frost protection flying can improve the efficiency of the helicopter by relating the speed and flying height with the temperatures in the inversion layer.

Additional tests are planned to get information to increase the efficiency of the helicopter for frost protection.

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The Corona Foothill Lemon Company made available the lemon grove and arranged for the controlled flights of the helicopter. Cover photo by Max Clover was of a helicopter flight courtesy of Western Helicopters Inc.