

# Air-Carrier Spray Equipment

economical and effective in applying concentrated spray mi

**Field investigations** with different spray methods have shown that heavy applications—1,100 gallons per acre on average sized trees, to 2,500 gallons on larger trees—are not necessary to obtain satisfactory deposits of the spray chemicals and control of the insects and plant disease problems.

Field tests in 1947-48 demonstrated the practicability of using more concentrated spray mixtures and applying less gallonage per tree, by using equipment which supplied a large volume of air at a comparatively low velocity.

This resulted in the application of from 200 to 450 gallons of dilute spray per acre—depending upon the size of the trees—and a great saving in the volume of water required, the time loss in refilling and the amount of spray chemical used.

In these applications the foliage was only wetted to the point of drip and there was practically no loss of the spray liquid from run-off. This method became known as the low-volume application of semi-concentrate sprays.

The use of air as a carrier of spray chemicals is dependent upon the ability of the equipment to displace the air in the tree area with the spray laden air produced by the equipment.

A few computations of the areas of fruit trees will show that in order to move the equipment at a reasonable rate of travel a comparatively large volume of air is required. When the trees are dormant and there is no interference from the foliage, the rate of travel may be slightly faster—1.5 to 1.75 miles an hour—than when the foliage and fruit are present—0.7 to 1.0 mile an hour.

The average deciduous fruit orchard equipment which discharges a volume of 30,000 cubic feet of air per minute—through a full peripheral pattern—is usually adequate. Where there are very large trees a higher volume is desirable.

Some equipment is designed with a one-sided delivery and produces around 15,000 cubic feet of air per minute, and requires applications from both sides of each row. The velocity of the air stream in this type of equipment varies considerably though there is a tendency to keep the velocity down.

Velocities are usually measured at the discharge head and become very difficult of measurement any great distance from

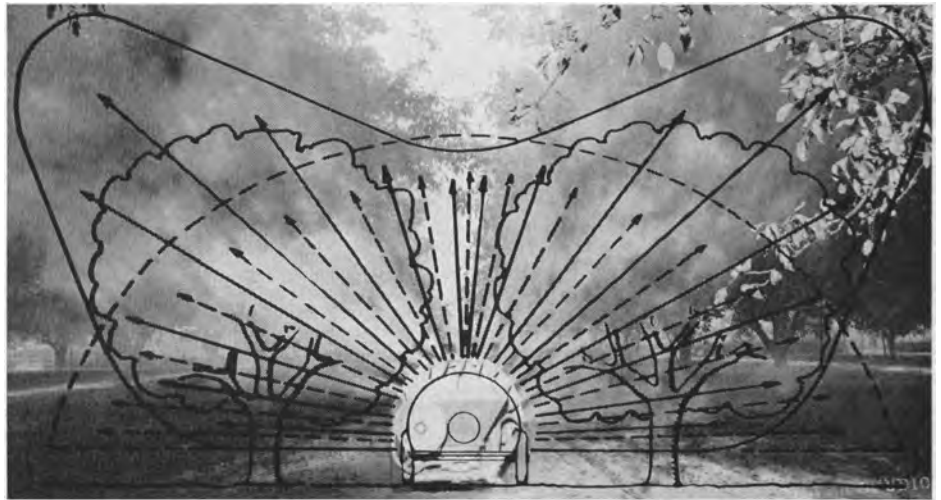
the opening. Some reports of injury to the fruit close to the discharge head have been attributed to high velocity of the air stream.

## Spray Pattern

The pattern of the spray discharge is most important if even deposits of the spray chemicals are to be obtained in the high tops as well as the low limbs. A semicircular pattern is not adequate, but by use of deflectors in the fan housing, more of the air can be directed toward the high tops and by the proper arrangement of the nozzles a so-called butterfly

nozzles is reduced to from six to 10 nozzles per side with disc openings ranging from 0.062 to 0.087—depending upon the amount of gallonage required per acre. The discharge in gallons per minute, under 50 pounds pressure through each nozzle, is approximately 0.1 gallon per 0.020 inch opening.

The type of nozzles used has varied considerably but the best results apparently have been obtained with a cone-type nozzle with a removable disc. A better distribution of the liquid in the air stream is obtained with this type nozzle and the discs are more readily changed and cleaned.



Photograph of dusting equipment with butterfly pattern diagramed.

wing pattern can be obtained. This will insure more even deposits throughout the tree.

The number, type and arrangement of the nozzles are important in determining the amount of liquid discharged; the way the liquid is broken up in the air stream; and the pattern of the discharge.

In bulk sprays discharged in a full peripheral pattern from 75 to 96 nozzles—each having a disc opening of about 0.096 inch—may be employed. The discharge is somewhere around 80 gallons per minute.

In low volume applications the number of nozzles is reduced to between 36-42 and the disc openings are about 0.062 inch—with a discharge approximating 18 gallons per minute.

In concentrate sprays, the number of

To obtain the most desirable spray pattern, the arrangement of the nozzles requires more nozzles in the side area which directs the air stream to the high tops of the trees and fewer nozzles on the top and bottom of the discharge head. The position of the nozzles with regard to the air stream varies with different models. Some are placed in the air stream and discharge in the same direction. Others discharge at an angle at the edge of the air stream.

## Droplet Size

The droplet size of the spray discharge is important if the spray liquid is to impinge the surface of the fruit, foliage or wood.

When the droplet size is too small, the droplets not only do not wet the surface,

## xtures

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but there is a loss of material from drift, convection currents and evaporation—especially in summer when the air is warm or dry.

Though only a limited number of measurements have been made of spray droplets under orchard conditions considerable work has been done in the laboratory.

Some field investigations of the droplet sizes of dilute oil emulsions showed that good wetting was obtained when 80% of the droplets measured from 30 to 50 microns in diameter and less than 1% measured under four microns and only 1% to 2% were over 100 microns.

Under the low pressures—60 pounds per square inch—employed on this type of equipment the type of nozzle and its position in the air stream probably determine the droplet size though air velocity undoubtedly is a factor.

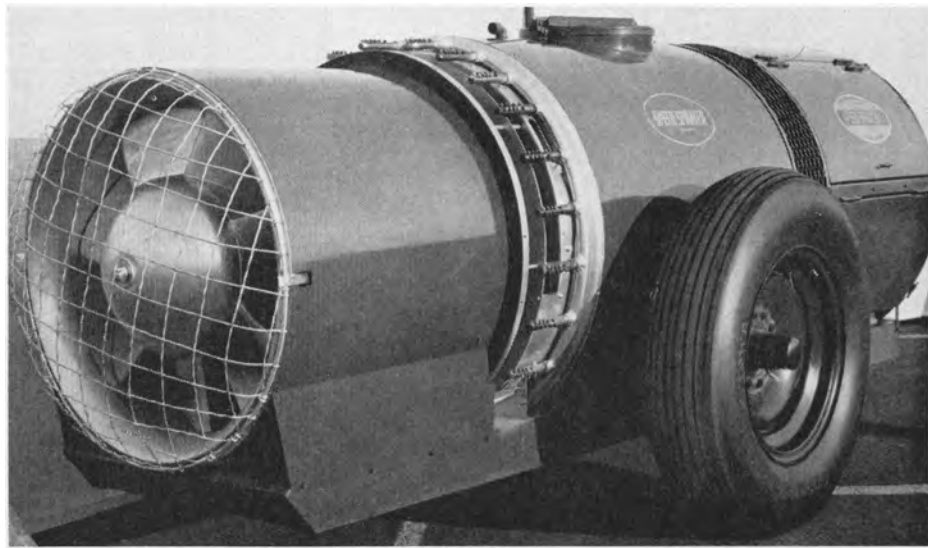
### Chemical Concentrations

The concentration of the spray chemicals in the spray liquid is greater than that in bulk spraying. In the low volume method the amount required in order to obtain the desirable deposits is an increase of from 50% to 75% over the amounts used in bulk sprays.

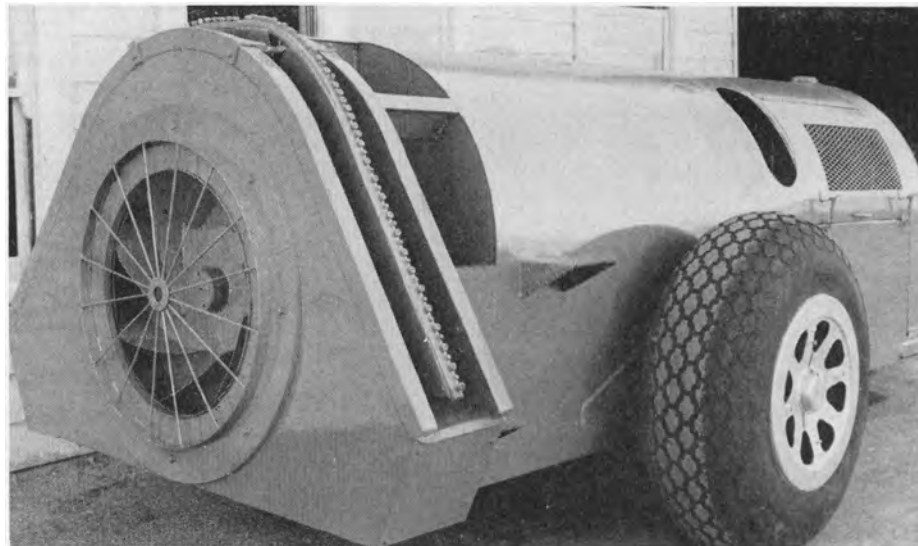
In concentrate sprays the amount of material is often increased from three to five times that used in bulk sprays. To obtain adequate and even coverage in the application of semi-concentrate and concentrate sprays the deposits should approach, as near as possible, a continuous film of the spray chemical on the surface of the foliage and fruit. When too concentrate spray mixtures are employed and the applied gallonage per tree or per acre is greatly reduced such deposits are not generally obtainable. A certain applied gallonage is required to obtain a uniform deposit on the trees. Frequently, the concentration of the spray liquid—figured on the amount of spray chemical required per acre—is too great to permit an applied gallonage sufficient to give adequate deposits.

In large trees there is no substitute for adequate air volume. In smaller orchards where the trees are less dense and not so large a single sided delivery outfit may prove adequate if more time can be allowed for the application.

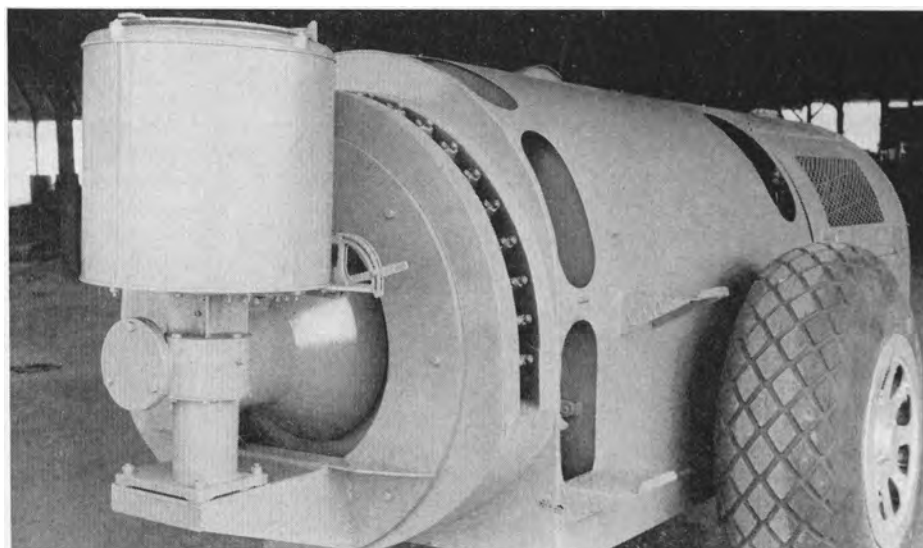
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**Air-carrier equipment employs high volume of air at a low velocity. Delivers over 30,000 cubic feet of air per minute.**



**Equipment with oscillating vanes on each side of the discharge head. The movement of the vanes causes the air stream to stir the foliage.**



**Close-up of dusting attachment for air-carrier, showing discharge head. Note nozzles on body of sprayer.**

## AIR-CARRIER

Continued from preceding page

Dusting equipment for the application of dry dust materials in orchards has not been very satisfactory. Undoubtedly this has been due to the employment of a low volume of air at a comparatively high velocity and the uneven feeding of the dust mixture into the air stream.

For the past two years, experiments have been undertaken in designing an orchard duster which employs a high volume of air at a lower velocity and the use of precision feed of the dust into the air stream. The benefits derived from the use of a larger volume of air are apparent and improvements have been made in the feeding devices.

Some manufacturers have designed dusting attachments which can be mounted on the rear of their air-carrier equipment. In this way the air volume of the sprayer may be used for both liquid and dust applications. In one model the dust is fed directly into the fan housing and in another model the dust is fed into the air stream as it leaves the discharge head.

### Volute Attachments

The volute attachment for air-carrier equipment is used especially in very large trees or where the foliage is very dense—walnuts, olives, citrus—and all the air discharge is directed to one side of the equipment.

The discharge openings are much wider and longer and the air stream is directed to the tree tops. Though the shape may vary from a large flat horn to that of a long wide boom the effect is largely directional. The use of oscillating vanes in the opening of the discharge stirs the foliage and permits a more uniform wetting.

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## INJECTIONS

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sulting from the original injection of dipotassium phosphate, six additional trees were injected with a solution containing 200 grams of this salt.

To differentiate between a potassium and a phosphorus response, five trees were injected with four liters of a 0.1 normal solution of mono-calcium phosphate and five trees were injected with three liters of solution containing 250 grams of potassium citrate. Three trees were injected with distilled water to determine if the injection reaction itself was stimulating the trees. All trees in this orchard received uniform nitrogen application to the soil.

## Specifications of Equipment Designed for Bulk and Semi-Concentrate Liquid Applications

| Model* | Engine hp | Type of fan | Discharge |         | Air               |              | Tank capacity gallons |
|--------|-----------|-------------|-----------|---------|-------------------|--------------|-----------------------|
|        |           |             | Type head | Nozzles | Volume cubic feet | Velocity mph |                       |
| A      | 110       | axial flow  | 2 sided   | 80      | 43,000            | 127          | 500                   |
| B      | 55        | axial flow  | 2 sided   | 76      | 30,000            | 127          | 400                   |
| C      | 110       | centrifugal | 2 sided   | 44      | 30,000            | 125          | 400                   |
| D      | 40        | centrifugal | 1 sided   | 44      | 15,000            | 125          | 300                   |
| E      | 145       | centrifugal | volute    | 60      | 60,000            | 100          | 500                   |
| F      | 125       | axial flow  | 2 sided   | 34      | 30,000            | 165          | 400                   |
| G      | 35        | axial flow  | 1 sided   | 16      | 15,000            | 165          | 300                   |
| H      | 92        | centrifugal | 1 sided   | 26      | 15,000            | 125          | 300                   |

\* Letters designate available commercial spray equipment.

## Specifications of Equipment Designed for Concentrated Liquid Applications

| Model* | Engine hp | Type of fan | Discharge |         | Air               |              | Tank capacity gallons |
|--------|-----------|-------------|-----------|---------|-------------------|--------------|-----------------------|
|        |           |             | Type head | Nozzles | Volume cubic feet | Velocity mph |                       |
| A      | 45        | centrifugal | 1 sided   | 6       | 20,000            | 110          | 300                   |
| B      | 26        | axial flow  | 1 sided   | 6       | 13,000            | 140          | 200                   |
| C      | 5         | axial flow  | 1 sided   | 8       | 7,500             | 75           | 200                   |

\* Letters designate available commercial spray equipment.

## Specifications of Equipment Designed for Dust and Concentrated Liquid Spray Applications

| Model* | Engine hp | Type of fan | Discharge       |         | Air               |              | Capacity  |          |
|--------|-----------|-------------|-----------------|---------|-------------------|--------------|-----------|----------|
|        |           |             | Type head       | Nozzles | Volume cubic feet | Velocity mph | Tank      | Hopper   |
| A      | 24        | axial flow  | fishtail        | 4       | 10,000            | 200          | 50 gals.  | 150 lbs. |
| B      | 30        | centrifugal | double fishtail | 8       | 3,500             | 175          | 100 gals. | 150 lbs. |

\* Letters designate available commercial spray equipment.

Frequent observations were made on these treatments and there is no doubt that a stimulation of vegetative growth was produced by the new injection series. The combination of phosphorus and potassium appeared to produce the best growth. Considered separately, phosphorus seemed to produce a greater response than potassium, which, in turn, appeared to produce more growth than nitrogen alone did on the check trees. Injection of distilled water produced no effect whatsoever on the trees. On the basis of these results and of supplementary studies with sand cultures, it appeared that the leaf symptoms for potassium deficiency in the field might be a combination of both the leaf patterns of potash and phosphorus deficiency, or some secondary effect re-

sulting from a deficiency of one or the other or both of them.

While it is recognized that the data reported in this article were obtained from a single citrus variety—Wheatley Eureka lemon on rough lemon stock—growing in a very limited soil area, the results obtained to date indicate that the relationship of these findings to other citrus problems should be established. With respect to the limited area involved, it should be noted that the soil in the experimental plots at Fillmore is a Yolo gravelly, fine sandy loam, with a pH—the measurable acidity and alkalinity—of 5.8 which is moderately acid, in the depth to six inches and a pH of 6.3—slightly acid—in the depth of six to 18 inches. The quan-

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