Air-Blast Sprayer Calibration for Pecan Orchards

Louisiana State University
Agricultural Center
Louisiana Cooperative Extension Service

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Chemical pesticides are the most commonly used method for controlling arthropod and disease pests on pecan. These pesticides are applied primarily with large spray machines known as air-carrier sprayers. Air-carrier sprayers are also referred to as air-blast sprayers or mist-blowers. Rather than using large quantities of water to deliver the pesticide to the target, these sprayers use air. The spray is delivered to the target by radial fans to generate a current of high-speed air which, when passing over the spray nozzles, picks up the spray as it leaves the nozzles.

Air-carrier sprayers vary considerably in size, volume, air speed generated and pressure of liquid delivered, as well as nozzle type and arrangement. Air-carrier sprayers can be engine-driven, or PTO driven.

Dilute vs Concentrate Spraying:

An early method of spraying pecan trees involved spraying the tree canopy to the point of runoff, usually with a hand-held hydraulic sprayer. This procedure was often referred to as dilute spraying. The spray applied varied from 160 to 400 gallons per acre (GPA), depending on tree size and spacing. Recommendations were usually expressed in a specific amount of pesticide to be mixed in 100 gallons of water. This type of spraying is used primarily for treating individual trees or small groups of trees. It is seldom used in large, commercial orchards.

In contrast, air-carrier sprayers are referred to as concentrate sprayers, because water and air deliver the spray to the target. This ensures that equal coverage is obtained, but less water is used. Rates of pesticide are usually expressed in a specific amount of pesticide to be applied per acre. Pesticide concentration varies, depending on the type of sprayer used. Air-carrier sprayers usually use less water per acre than dilute sprayers. Although the amount of water is reduced, the amount of pesticide applied per tree, or per acre, remains the same.

Example: The application of a recommended amount of pesticide in an air-carrier sprayer applying 100 gallons of water per acre, instead of 400 gallons of water per acre, would be considered concentrate spraying. The correct rate of pesticide would be delivered using only one-fourth the amount of water of the dilute spray. Therefore, the concentration of the spray would be 4X. The amount of pesticide delivered per tree or per acre would be the same. Only the gallons of water used per tree or per acre change, not the rate of pesticide.

Procedure for Calibrating Air-Carrier Sprayers:

Several factors should be considered to select and calibrate an air-carrier sprayer properly for spraying pecan trees. These include volume of spray discharged, travel speed, nozzle sizes and arrangement, pressure, tree spacing, tree height, gallons of spray discharged per minute and total gallons of spray applied per acre.

Selecting the Sprayer: If you plan to purchase a sprayer, or already own a sprayer, it’s important to remember that an air-carrier sprayer must be capable of displacing the air in and around the trees and replacing it with a mixture of pesticide and air. The volume of air delivered by the sprayer (expressed in cubic feet per minute) must at least equal the volume of space between the outlet of the sprayer and the far side of the trees as they are passed during a given interval of time. The amount of air volume to be displaced depends on tree volume, travel speed and the distance from the spray outlets to the far side of the tree canopy.

These equations can be used to compute the required amount of spray to be discharged, in cubic feet per minute (CFM), by an air-carrier sprayer. This equation considers tree size, travel speed and distance from the tree. To calculate CFM, you must calculate the area under the tree canopy in square feet, determine the travel speed and the distance from the spray outlets to the edge of the tree canopy.

A. Area (Square Feet) = (D X H) + [1/4 (TS - D) X H]
D = diameter of tree canopy in feet
H = height of trees in feet
TS = distance from spray outlets to edge of tree canopy

B. Travel Speed (ft/min) = MPH X 88 ft/min

C. CFM = Area sprayed (sq. ft.) X speed (ft/min)

Example: What CFM is required for spraying a row of trees 25 feet high, 15 feet in diameter, spaced 20 feet from the spray outlets, at 2 MPH travel speed?

Solution:

Area = (15 X 25) + [1/4(20 - 15) X 25]

Area = 375 + [1.25 X 25] = 406.25 sq. ft.

Speed = 2 mph X 88 = 176 ft per minute

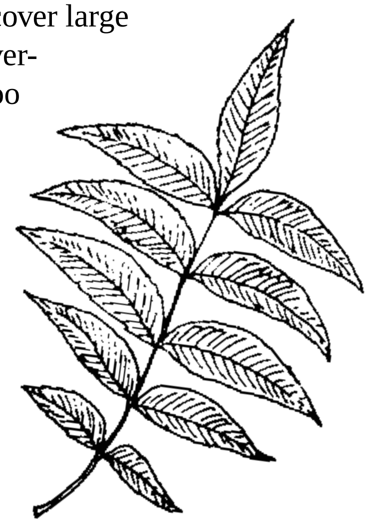
CFM = 406.25 sq. ft. X 176 ft/ min = 71, 000 CFM @ 2 mph

Or CFM = 53,000 CFM @ 1.5 mph

When spraying two rows of trees at the same time, you must double the CFM required for spraying one row. Therefore, the volume of air required for a two-row sprayer would be 71,000 X 2 = 142,000 CFM @ 2 mph.

Travel Speed: It's not uncommon for growers to operate air-carrier sprayers at higher than optimum travel speeds. Producers usually travel too fast, trying to cover large areas as quickly as possible. Traveling at too high a speed gives insufficient coverage. At the opposite end of the spectrum, one can travel too slow, resulting in too much spray being applied.

As a rule, a travel speed of 0.5 to 3.0 mph is ideal. Travel speed can vary, depending on the size of the trees, tree density and sprayer type. Smaller trees can usually be sprayed faster, since air penetration is less critical. At travel speeds of more than 4 mph, the momentum of the air leaving the sprayer is greatly reduced. This reduces the coverage on the upper part of the tree canopy, even though the gallons of spray applied per tree remain the same.



Air velocity diminishes rapidly as the distance from the fan outlet increases. Beware of this, because time is required for the spray to reach the outermost part of the tree canopy. This distance should be the determining factor in selecting the optimum travel speed.

The first step in calibrating a sprayer is to determine travel speed. Select a spot in the orchard where you can measure a distance of 40 feet to 50 feet per mph of speed. This implies a distance of 100 feet to 125 feet for a sprayer traveling 2.5 mph.

It's best to measure travel speed in the orchard with a full sprayer tank of water. This reflects the conditions under which you'll be spraying. Speed can be calculated by measuring the time required to travel a known distance.

The following formula can be used to compute travel speed:

Speed (MPH) = (Feet / Second) X (0.682)
Note: 0.682 is a conversion factor to convert feet per second to miles per hour

Example: The sprayer, with a full tank of water, travels 99 feet in 27 seconds.
Speed (MPH) = (99 ft / 27 seconds) X (0.682)
Speed = 2.5007 or 2.5 mph

Nozzle Selection and Arrangement:

Pesticide coverage is defined as the number of drops of spray deposited per square inch of target surface. Many variables affect the quality of coverage from a given sprayer. One important factor is the nozzles and their arrangement on the sprayer. The design of the sprayer manifold and the way the nozzles are arranged on the manifold varies considerably, depending on the type and brand of sprayer.

It's important to direct most of the spray toward the upper portion of the tree canopy. As a rule, direct about two-thirds or 67 percent of the spray material toward the upper half of the tree canopy, and the remaining one-third or 33 percent directed toward the lower half of the canopy. Again, this can vary, depending on tree size and the brand, or type, of sprayer used.

For calibration purposes, make a drawing of the sprayer manifold. Indicate on the drawing which outlets will be used. About two-thirds or 67 percent of the spray should be discharged from the top half of the manifold. The remaining one-third or 33 percent should be discharged from the bottom half of the manifold.

To select the correct size and number of nozzles to install, compute the gallons per minute (GPM) of spray mix. To compute the GPM, it is necessary to know the sprayer travel speed (MPH), the gallons per acre (GPA) of spray mix to be applied and the spacing between the rows of trees or sprayer swath width. Once these variables are determined, a simple equation can be used to determine the GPM. Since this equation is for one side of the manifold, the amount of spray mix applied per minute must be doubled for a two-sided sprayer.

To calculate the total GPM per side:

GPM (Per side) = [(Speed MPH) X (Row Spacing ft.) / 2 X GPA] / 495
GPM = Gallons per minute discharged by the sprayer
GPA = Gallons per acre
MPH = Travel speed in miles per hour
Row Spacing = Swath width or width of area sprayed in feet
Usually one-half of row spacing
495 is a conversion factor

Example: You have decided to apply 100 gallons per acre while traveling at 2.5 mph. The rows are spaced 40 feet apart. What are the required gallons per minute (GPM) per side?

Solution:

GPM (Per Side) = (2.5 MPH) X (40 ft./2) X (100 GPA) / 495
GPM (Per side) = 10.1
Note: The row spacing is divided by two to obtain the width of the area sprayed by each side of the sprayer.
Divide the total (GPM) per side into proportional parts.

Example:

Upper Half of Manifold: 10.1 GPM X 2/3 (67%) = 6.77 GPM
Lower Half of Manifold: 10.1 GPM X 1/3 (33%) = 3.33 GPM

Next, select the correct nozzle type, size and operating pressure. The correct nozzle sizes can be selected by using nozzle flow rate charts that list nozzle sizes and gallons per minute at various pressures. These charts are in the operator’s manual that came with your sprayer or spray nozzle catalogs. The sprayer operator’s manual will list recommended spray pressures also. The proper nozzle size and the number of nozzles can be computed with the following procedure.

Number of nozzles is known - Determine nozzle size and spray pressure:

Nozzle Flow Rate = (Flow Required GPM) / (Number of Nozzles)

Example: Flow required is 6.77 GPM and four nozzles will be used.

Nozzle Flow Rate = (6.77 GPM) / (4 Nozzles)
Nozzle Flow Rate = 1.69 GPM per nozzle
Note: Use spray nozzle flow chart to select a nozzle with a flow rate of 1.69 GPM at the recommended pressure.
Nozzle size is known - Compute number of nozzles required:
Number of Nozzles = (Flow Required GPM) / (Flow Per Nozzle GPM)

Example: Flow required is 6.77 GPM and flow per nozzle is 1.69 GPM.

Number of nozzles = (6.77 GPM) / (1.69 GPM Per Nozzle)
Number of nozzles = 4.0
Note: Use four nozzles that have a flow rate of 1.69 GPM each at the recommended pressure.

The GPA that can be applied with an existing nozzle arrangement can be computed with the following procedure. First, compute the GPM that can be discharged with the existing nozzle arrangement. Then compute the gallons per acre that can be applied.

GPM = (Flow Per Nozzle GPM) X (Number of Nozzles)

GPA = (GPM X 495) / [(Speed MPH) X (Row Spacing Feet) / 2]

Example: The sprayer is equipped with six nozzles that have a flow rate of 1.69 GPM each at the recommended spray pressure. Speed is 2.5 mph and row spacing is 40 feet.

GPM = (1.69 GPM Per Nozzle) X (6 Nozzles) = 10.15 GPM

GPA = (10.15 GPM X 495) / (2.5 MPH X 40 ft./ 2) = 100

Field Calibration Check: Now that the nozzles have been selected and installed, the next step is to verify that the intended amount of spray is actually being applied. An easy way to determine the actual GPA being applied is to fill the sprayer with a known quantity of water, spray a known area, determine the amount of water discharged and compute the finished spray rate or GPA actually being applied. The following formulas can be used to **calculate the actual GPA** being applied.

GPA = (Gallons Applied) / (Area Covered Acres)

Gallons Applied= (Initial Volume Gallons) – (Final Volume Gallons)

Area Covered = (Length X Width) / (43,506 Square Feet Per Acre)

Example: Initial volume of water in sprayer was 400 gallons and final volume was 350 gallons after spraying an area 20 feet wide X 1100 feet long

Area Covered = (20 ft. X 1100 ft.) / 43,560 = 0.50 Acres

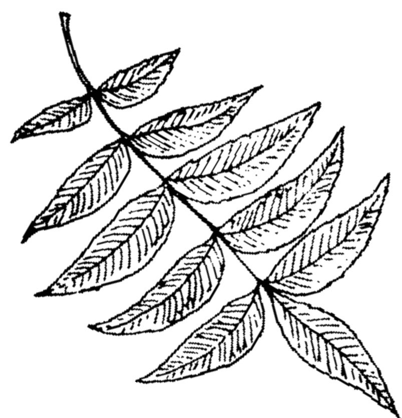
Gallons Applied = (400 Gallons) – (350 Gallons) = 50 Gallons

GPA = (50 Gallons) / (0.50 Acres) = 100 GPA

Summary: This publication provides an overview of procedures for the calibration of air-carrier sprayers. These procedures should work for the more widely used pesticide applications, but it must be noted that the actual amount of spray applied per acre will vary if ground speed or row spacing changes. Errors also will be induced if nozzle flow rate changes because of nozzle wear, nozzle blockage caused by contaminates in the spray mix or changes in spray pressure. Sprayer operating procedures also will change the actual amount of material applied. For example, leaving the sprayer on while turning at row ends, or turning the sprayer off between trees in rows with missing trees will affect the actual spray applied per acre. It also is difficult to calibrate the sprayer precisely when row spacing varies or the trees are not planted in rows.

Regardless of how you calibrate your sprayer, always remember to read the label and use the correct amount of insecticide or fungicide. Be sure your sprayer is capable of delivering the volume of air and pesticide needed to penetrate the tree canopy and provide thorough coverage. Travel speed should be adjusted to assure coverage of the entire tree, but not too slow, so as to avoid overspraying. Maintain the sprayer in good working order and replace all nozzles (discs and whirl-plates) at the beginning of each growing season. Periodically check sprayer calibration during the spray season to assure that the correct amount spray is being applied. In addition, the sprayer must be equipped with an agitation system capable of keeping the pesticide in suspension to assure a homogenous spray mixture.

Michael J. Hall, Entomologist, Pecan Research - Extension Station
Darryl Rester, Specialist (Engineering), Louisiana Cooperative Extension Service



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Louisiana State University Agricultural Center, William B. Richardson, Chancellor

Louisiana Cooperative Extension Service, Jack L. Bagent, Vice Chancellor and Director

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