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# Sprayers for Effective Pesticide Application in Orchards and Vineyards

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Among other things, selection of the best and the most appropriate spray equipment is essential for effective, efficient, and environmentally friendly application of pesticides. A much higher-level decision-making process is required when selecting sprayers for orchards and vineyards rather than field crops—especially when spraying for insects and diseases within the canopy.

Field crop sprayers are equipped with nozzles on a horizontal boom. The boom is positioned a short distance above the relatively uniform target of the field crop. The target in vineyard and orchard spraying, however, is usually a canopy with much more variation in type, depth, and height. In addition, the droplets must travel longer distances, which requires sufficient momentum to spray the near side, far side, top, and bottom of the target.

Although the type of sprayer selected will significantly affect the efficacy of the pesticide being sprayed, certain tasks must be accomplished during the spraying, regardless of the sprayer chosen:

1. Mix pesticides uniformly (especially dry products) in the sprayer tank. This can be accomplished only if the agitation system in the tank has sufficient capacity for its size and is operating properly.
2. Choose a pump with sufficient capacity to deliver the required gallonage (gal/acre) to the nozzles.
3. Ensure that hoses and fittings between the pump and nozzles are properly sized to minimize pressure losses.
4. Ensure that there is a minimum loss of pesticides delivered from the nozzles to the target.
5. Attain maximum retention of droplets on the target (minimum rebound).
6. Provide thorough and uniform coverage of the target with droplets carrying active ingredients.

The most important factors for selecting a vineyard or orchard sprayer are that it delivers the required application rate, sprays droplets of the proper size on the target uniformly, and that it minimizes the loss of spray on the ground and in the air.

Different types of sprayers are used for treating pests (weeds, insects, diseases) in orchards and vineyards because of variations in:

- Canopy structure and characteristics (height, depth, density).
- The width of the distance between rows of canopy.
- The size of the area treated (from smaller than an acre to hundreds of acres).

# Orchard and Vineyard Sprayers

## HYDRAULIC SPRAYERS

### Manually Operated Sprayers (hand pumps, hand cans, and backpacks)

These sprayers are designed for spot treatment and for spraying smaller areas in vineyard. Two rules of application accuracy apply to all spraying equipment, including manual sprayers:

1. Maintain a uniform speed—in this case walking speed—to keep the application rate relatively uniform throughout the operation. A faster walking speed will result in a lower application rate.
2. Maintain a uniform spraying pressure to keep the application rate and the droplet size uniform during the application. Low spraying pressure leads to lower application rates and larger droplets. Consider installing a small pressure regulator on the sprayer wand to eliminate variations in spray pressure at the nozzle where droplets are formed, and where flow rate is determined.

Additional information on operation and calibration of manually operated sprayers is available in Ohio State University Extension publication (FABE-531) “Proper Calibration and Operation of Backpack and Hand Can Sprayers,” (**ohioline.osu.edu/factsheet/fabe-531**).

*Javier Campos, Polytechnic University of Catalonia, Spain.*

**Figure 1. A man spraying vines using a backpack sprayer with a wand.**

*Javier Campos, Polytechnic University of Catalonia, Spain*

**Figure 2. Backpack sprayer with a with a T-shaped wand that has four nozzles along its length.**

## HYDRAULIC SPRAYERS

### Hydraulic Sprayers with a Vertical Boom

These sprayers (shown in Figures 3,4, and 5) are very similar in design to the hydraulic sprayers used for spraying field crops like corn, soybean, and wheat. The key differences are the orientation of the boom on both sides of the tractor and the spray pressure. In orchard and vineyard sprayers, the boom is vertical as opposed to horizontal, and the spray pressure is higher to help droplets penetrate into the dense fruit tree or grapevine canopy.

Since the droplets are released from the nozzle in a horizontal trajectory without air assistance, this type of sprayer should be used in orchards and vineyards that have a properly pruned canopy that is planted in relatively narrow rows. When using hydraulic sprayers, it is extremely important that every row of the orchard or vineyard is sprayed from both sides to ensure that adequate penetration of droplets into the canopy is achieved.

*Javier Campos, Polytechnic University of Catalonia, Spain.*

**Figure 3. Sprayer with vertical boom and conventional nozzles.**

*croplands.com*

**Figure 4. Sprayer with vertical boom and adjustable-flow nozzles.**

*silvan.com.au.*

**Figure 5. Close-up of vertical boom with two adjustable-flow nozzles spraying the vineyard canopy.**

## AIR-ASSISTED HYDRAULIC SPRAYERS

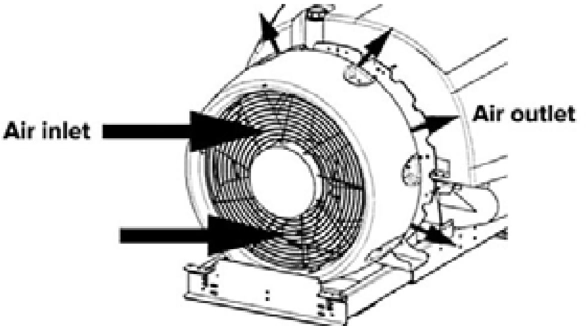
Most of the sprayers used in orchard or vineyards are in this category. These sprayers direct air generated by a fan at a liquid spray discharge system that is pointed towards the canopy. Droplets discharged through a nozzle are blown by the air toward the target canopy. Without the fan's air assistance (as is the case with vertical hydraulic boom sprayers discussed previously) the droplets will likely not penetrate deep into the canopy.

The fan's powerful, high-volume air flow efficiently transports the droplets to the target canopy while also creating a turbulent environment in the canopy. This results in uniform coverage of the upper and undersides of the target leaves while penetrating both horizontal and vertical directions in the canopy. Liquid spray distribution from air-assisted sprayers is significantly influenced with the air flow pattern.

Therefore, the right type of air-assisted sprayer should be selected based on the canopy conditions in a vineyard or orchard. There are a wide range of air-assisted canopy sprayers available commercially.

### Radial Discharge Airblast Sprayers

These sprayers are by far the most widely used sprayers in orchards and vineyards. The sprayer is equipped with a powerful fan (usually an axial-flow fan) mounted behind the sprayer as shown in Figure 6. The fan pulls the air from behind the sprayer (shown as "Air inlet" in Figure 6) and discharges it at a 90-degree angle (shown as "Air outlet" in Figure 6) away from the fan, and in a 180-degree arc that sprays the canopies on both sides of the sprayer.



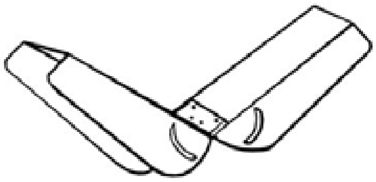

*The Ohio State University*

**Figure 6. Air inlet and outlet on an airblast sprayer most commonly used in orchards and vineyards.**

The spray liquid is introduced into this powerful airstream by a set of nozzles that are located inside the manifold or near the fan where the air exits the fan. In other parts of the world, sprayers used in orchards and vineyards are operated under 150 psi. In the U.S., much higher spray pressures are used unnecessarily to make sure the nozzles produce small droplets that can travel longer distances in the airstream. These smaller droplets tend to penetrate into the canopy more efficiently than larger droplets.

Unfortunately, because of their design, the traditional airblast sprayers discharge air radially in a 180-degree arc all around the fan outlet, including the top portion of the air outlet where there is no canopy (as shown in pictures below). This is not only wastes of a significant portion of the air generated, but it also contributes to loss of pesticide applied and results in the excessive spray drift problems that are associated with airblast sprayers.

To reduce an airblast sprayer's inefficiency, most (but not all) sprayer manufacturers attach two deflectors on top of the fan—one on each side of the sprayer—that can direct the air flow toward the canopy (Figures 10–13). Even with these deflectors, the air discharged towards the canopy with this type of airblast sprayer is not uniform from the top to bottom of the canopy. This lack of uniform air discharge is due to factors such as the direction the axial-fan blades are spinning. If they are turning clockwise, most of the air on the right side of the sprayer will be directed towards the ground, while a significant portion of the air on the left side will be directed upwards where there is very little or no canopy.



*The Ohio State University*

**Figure 10. Deflector plate that can be mounted on top of the sprayer to direct air-assisted spray towards the canopy.**

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**Figure 7. Airblast sprayer with no deflector plates. Notice the top three nozzles should have been turned off because they are not directed towards the target.**

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**Figure 8. Airblast sprayer with no deflector plates. The top nozzles are turned off—a desirable practice.**


**Figure 9. Airblast sprayer with two undesirable spraying practices that will likely lead to spray drift: producing too many extremely fine droplets (probably as a result of a combination of nozzles with very small orifices and extremely high spray pressure), and letting spray emit from the top nozzles that are not turned off.**


**Figure 11. Airblast sprayer with adjustable deflectors. Notice the nozzles on this sprayer are located inside the air outlet port of the fan.**

**Figure 12. Airblast sprayer with a relatively wider air outlet section equipped with adjustable deflectors. Notice the nozzles on this sprayer are located inside the air outlet port of the fan.**

**Figure 13. This rear view of the airblast sprayer shows the deflectors properly adjusted according to the canopy height.**

*Photos by Erdal Ozkan, The Ohio State University*

## Tower-Type Airblast Sprayers

To avoid the uneven vertical distribution of air flow when using conventional airblast sprayers, some sprayers come with a vertically oriented shroud that discharges the air from the fan in a horizontal direction. These types of sprayers are usually called Tower Sprayers. Some manufacturers of tower sprayers install adjustable air deflectors inside the shroud to improve air flow uniformity throughout each section of the tower from top to bottom. The principle behind the tower sprayer concept is the same regardless of the brand, but the design of the shrouds varies as shown in Figures 14–27. In addition to providing horizontal or near horizontal air flows, some of these sprayers also include deflectors to further improve spray deposition, especially in the upper parts of the canopy as shown in Figures 23–28 on the next two pages.

Figure 14 (left). Tower sprayer with slanted air-outlet shroud.

Figure 15 (below). Close up of the vertical air shroud with internal deflector plates for uniform distribution of the air from top to bottom of the air delivery shroud.

Figure 16. Close up of the vertical air shroud with internal deflector plates for uniform distribution of the air from top to bottom of the air delivery shroud.

*Photos by Erdal Ozkan, The Ohio State University*

Figure 17. Tower sprayer with three different sizes of air exit ports. Notice the seven ports near the ground have the smallest cross section of the port allowing less air to be discharged, while the top eight ports have the widest cross section allowing more air to be discharged from the top part of the shroud.

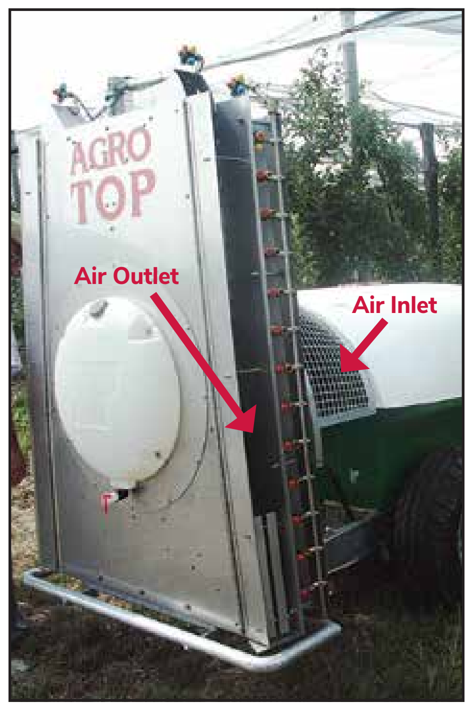


Figure 18. Tower sprayer. Air enters in from the axial fan inside meshed housing ahead of nozzle, and exits the sprayer shroud horizontally. Notice the lower part of the air exit port is blocked and usually the first three nozzles just above the ground are turned off to reduce pesticide deposits on the ground.

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**Figure 19. An airblast sprayer that includes characteristics of both a tower sprayer and a conventional sprayer.**

*Erdal Ozkan, The Ohio State University*

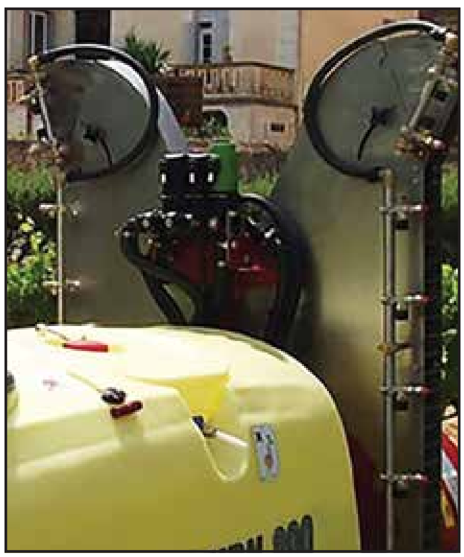
**Figure 20. A tower-type airblast sprayer with deflectors.**

*Erdal Ozkan, The Ohio State University*

**Figure 21. Side view of the airblast tower sprayer in Figure 20.**


*Erdal Ozkan, The Ohio State University*

**Figure 23. A tower type airblast sprayer with deflectors.**



*hardi.co.uk*

**Figure 22. A tower type airblast sprayer with deflectors.**

*Erdal Ozkan, The Ohio State University*

**Figure 24. Tower sprayer with extended deflector and nozzle assembly.**

*Erdal Ozkan, The Ohio State University*

**Figure 25 (left). Tower sprayer shown in Figure 24. Spray pattern provided by nozzles oriented horizontally and vertically over the top of the canopy provides improved spray deposition and coverage.**

## SPRAYERS WITH ADJUSTABLE SPOUTS

There are a wide variety of vineyard sprayers with adjustable spouts, as shown in Figures 26–32. Adjustable spout sprayers usually have fans that generate a high-speed, low-volume airstream through corrugated tubes. Nozzles are situated either inside spouts where the air exits the corrugated tubes (Figure 27), or are found on the side of a narrow, elongated manifold attached to the corrugated tubes (Figure 30). The biggest advantage of these types of sprayers is the flexibility and accuracy they provide in adjusting the direction of the spray towards the canopy, or even towards a certain part of the canopy needing protection against certain insects or diseases. The height of the spouts and the angle of each spout and nozzle setup can be adjusted (up and down and forward and backward). Some or all of the nozzles in some spouts can be turned off to spray only the target canopy conditions. Since precise spray targeting may be the most important role in the efficacious control of insects and diseases, adjustable spout sprayers have experienced increased popularity in recent years. In general, they result in higher pesticide efficacy, use pesticides more efficiently (less pesticide is used per acre), and reduce spray drift considerably compared to conventional airblast sprayers with radial air flow and spray discharge.

*Photos by Javier Campos, Polytechnic University of Catalonia, Spain*

**Figure 26 (above). Sprayer with adjustable air ducts.**

**Figure 27 (right). A view of a nozzle that is affixed to the inside of the end of one of the flexible sprayer tubes shown in Figure 26.**

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*hardi.co.uk.*

**Figure 28 (above). Tower sprayer with adjustable air ducts and with two nozzles per spout.**

**Figure 29 (left). A view of the nozzle just outside the spout at the end of a flexible air-duct tube for a sprayer similar to the one shown in Figure 28.**

*hardi-international.com*

**Figure 30. Sprayer with adjustable air ducts in a vineyard.**

## MULTI-ROW ADJUSTABLE SPRAYERS

Spraying both sides of the two rows located on either side of the sprayer in one pass is the method used by most fruit and grape growers. However, sprayers that treat multiple rows of canopy during one pass are also available for large-acreage vineyards growing on fairly level ground (no steep slopes). The operating principles of these sprayers are the same as the principles previously reviewed for operating single-row sprayers with adjustable spouts. Depending on the canopy conditions (especially row width), multi-row units that contain two to eight rows of grapevines can be sprayed in one pass as shown in Figures 31–33. Multi-row sprayers are much more expensive than conventional radial airblast sprayers, but spraying multiple rows in one pass greatly reduces the time spent applying pesticides in large-acreage orchards and vineyards. As mentioned at the beginning of this publication the amount of time it takes to apply pesticides is one of several factors playing a major role in successful pest control. In some cases, timing alone could be the difference between crop-protection success or failure. However, as the width of the sprayer increases from two to eight rows, so do concerns for the stability and physical integrity of the sprayer chassis. Fortunately, sprayer manufacturers take these concerns into consideration in their designs.

Generally, two types of multi-row sprayers are used in vineyards. The type used depends on the number of rows to be treated in one pass and the width of the rows:

- A multi-row sprayer consisting of either horizontal or vertical air spouts with nozzles that spray both sides of each row in one pass (Figure 31).
- A multi-row sprayer with vertical air spouts and nozzles that spray both sides of the rows (Figures 32–33).

There are two types of the second sprayer design that deploys vertical spouts between rows.

1. If the row spacing is narrow, a sprayer like the one shown in Figure 32a may be used. These sprayers have one vertical manifold that travels between the rows. Air spouts and nozzles on both sides of the manifold spray one side of the two adjacent rows.
2. The second sprayer type of this kind is shown in Figure 33. These sprayers have two vertical manifolds per row spraying both sides of the two adjacent rows of the canopies.

*hardi-international.com*

**Figure 31. Sprayer covering both sides of two rows of grapevine in one pass.**

*berthoud.com*

**Figure 32a. Sprayer with single vertical manifolds between rows with air spouts and nozzles on both sides spraying multiple canopy rows.**

*berthoud.com*

**Figure 32b. Close up photo of the vertical manifolds shown in Figure 32a.**


**Figure 33 (left). Sprayer with two vertical manifolds per row. Each manifold has air spouts and nozzles on one side which allows each manifold to only spray one side of the row.**

## AIR-ASSISTED SPRAYERS WITH MULTI-HEAD FANS

These sprayers are not common in orchards and vineyards in the U.S., but are used elsewhere in the world in single, two, and three-row combinations. Two air-assisted sprayers with multi-head fans that are used to spray two rows simultaneously are shown in Figures 34 and 35.

Most manufacturers of these sprayers use several small axial fans driven by hydraulic or electric motors. These fans direct an airblast through hydraulic nozzles. Operators can change droplet size by changing nozzle size or system pressure. Usually, each fan carries six to 10 recessed nozzles as shown in Figure 36.

Although usually two fans facing each side of a grapevine row are preferred by grape growers, owners of fruit tree orchards can get sprayers equipped with up to six fans facing each side of the crop rows. The fans can be adjusted according to the canopy characteristics (angle, height, and width) to improve uniformity of spray deposition and coverage while reducing spray drift and ground deposits.

Care should be taken while adjusting the fans so that they are facing at least 5–10 degrees backwards rather than being positioned to direct their airflow directly at each other. In early season, check the effect of two diagonally opposed fans, rather than using all four fans. Some manufacturers have fan speed controllers in the tractor cab that are independent of the tractor hydraulic system.

*Santiago Planas, University of Lleida, Spain*

**Figure 34. Air-assisted sprayer with four fans per row.**

*GreenTech International Pty Ltd.*

**Figure 35. Air-assisted sprayer with three fans per row.**

This independent control allows operators to adjust fan speeds for different canopy conditions and to compensate for being upwind or downwind.

*Erdal Ozkan, The Ohio State University*

**Figure 36: Fan with eight nozzles.**

## TUNNEL SPRAYERS

Tunnel sprayers have one or two tunnel-shaped enclosures. Each enclosure covers one or two rows of fruit trees or grapevine as shown in Figure 37. Some models have no fans blowing droplets into the canopy, while others have fans creating air-assistance to enhance the deposition of droplets deeper into the canopy. The fans are usually rotary types on a vertical shaft and are located on opposite corners of the tunnel. Each fan directs the air at an angle to create a clockwise or counterclockwise air current inside the tunnel. Tunnel sprayers are preferred by some growers for four key reasons:

1. They significantly reduce airborne spray drift, especially during applications early in the season when there is very little canopy on the fruit tree or vine.
2. They eliminate contamination of soil from pesticides, a problem that occurs when using radial discharge airblast sprayers with their lower nozzles turned on.
3. In general, they provide a better deposition of pesticide into the canopy and an improved uniformity of deposition in all parts of the canopy.
4. They reduce pesticide consumption because the tunnel sprayer can be designed to capture and recirculate any spray excess passing through the crop canopy. The tunnel sprayer shown in Figure 37 is equipped with the recirculation system. Research indicates that tunnel sprayers can reduce pesticide consumption by 50–70% at the earliest growth stages of the crop—or 10–30% at full foliage development—without having any deficiency in pest control.

*Santiago Planas, University of Lleida, Spain*

**Figure 37. A two-row tunnel sprayer with excess spray recirculation system.**

On the other hand, tunnel sprayers are not preferred by most growers for three reasons:

1. Their higher cost.
2. Their reduced maneuverability which may pose challenges for sprayer operators in orchards and vineyards with hilly, sloped, and uneven ground.
3. An inability to determine the volume of pesticide that is being recovered and recirculated.

## PNEUMATIC AIR-SHEAR SPRAYERS

With these sprayers (Figures 38–40), the fine droplets coming out of the sprayers are not produced by a nozzle operated under high pressures as is the case with other air-assisted hydraulic sprayers. Pneumatic air-shear sprayers use a low-pressure liquid emitter that is inserted into the exit port of a venturi tube as shown in Figure 41. Air generated by a squirrel cage or rotary fan passes through the venturi tube, then discharges the liquid from the emitter or nozzle, where it is sheared into extremely fine droplets that are directed at the target. Because the liquid is turned into very small droplets, the spray volume applied per acre is significantly reduced compared to airblast sprayers. Since pneumatic sprayers are designed

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**Figure 38. Three-point-hitch air shear sprayer.**

to provide low-volume application rates using very small droplets, adverse weather conditions such as low relative humidity, high temperatures, and windy conditions significantly affect the efficiency of the spray application process. Therefore, these sprayers are not preferred and should not be used in regions where these environmental conditions are prevalent.

The basic three-point hitch version of these sprayers usually have one set of spouts on each side of the sprayer discharging droplets in an upward trajectory (Figures 38 and 39). This arrangement may provide adequate coverage on the bottom and center of small to medium-height canopies. For taller canopies and more effective coverage of the top of the canopy, another set of manifolds should be attached above the fan and then positioned to face downward as shown in Figure 40. It's important to be aware that while some air-shear sprayers may allow adjustment of the direction of the spray plume to improve uniform canopy coverage, other models cannot be adjusted.

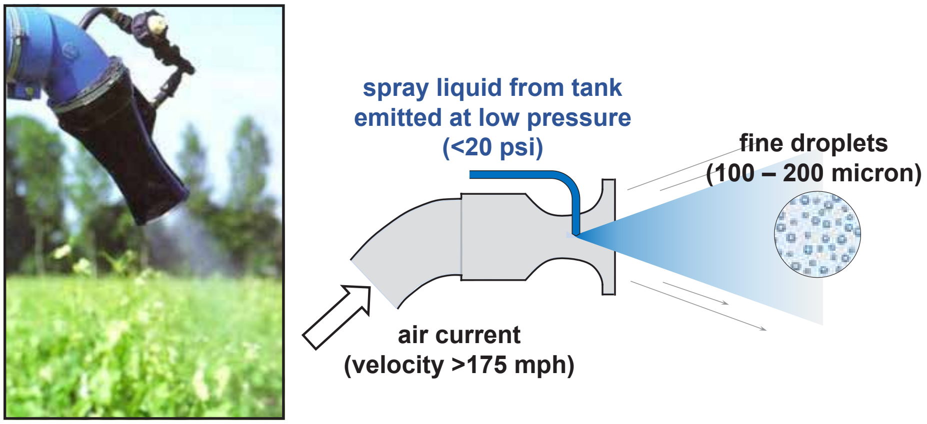
With a second type of air-shear sprayers, multiple atomizer heads are installed in one large manifold, as shown in Figure 42.

*cima.it*

**Figure 39. Three-point-hitch air shear sprayer.**

**Figure 40. Pull-type air shear sprayer with an elevated air-shear delivery system.**

*Erdal Ozkan, The Ohio State University*




*Emilio Gil, Polytechnic University of Catalonia, Spain*

*Javier Campos, Polytechnic University of Catalonia, Spain*

**Figure 41a (left) . Low-pressure liquid emitter inserted into the exit port of the venturi tube. Figure 41b (right). Schematic representation of how the low-pressure liquid emitter is inserted into the exit port of the venturi tube.**

*Erdal Ozkan, The Ohio State University*

**Figure 42. Air-shear sprayer with multiple liquid emitters in one large manifold (the yellow disc shown in the picture is used to regulate the flow rate of emitters).**

As mentioned previously, improving the deposition and number of spray droplets on target surfaces (i.e., the coverage) while reducing spray drift is the desired outcome when spraying pesticides. Large droplets have low drift potential and generally provide satisfactory deposition and coverage when sprayed on the topsides of leaves, but do not adequately treat the undersides of leaves. Conversely, smaller droplets provide improved coverage on the topsides and undersides of leaves, but droplets below a critical size tend to be blown away from the spraying area of their intended targets.

Electrostatically charged small droplets have been proven to further improve deposition of small droplets on the target leaves, especially the underside the leaves. This occurs because objects with opposite electrical charges attract each other. Electrostatic loading of droplets is most effective on small droplets because of higher charge-to-mass ratios. The effectiveness of electrostatic charging does, however, diminish as charge-to-mass ratios decrease. This occurs when droplet sizes enlarge as they are discharged from nozzles. An excellent discussion on principles and types of electrostatic charging mechanism is given in Electrostatic Spraying in Agriculture (Deveau, Jason 2018) available at **sprayers101.com/electrostatic/**.

Electrostatic spraying was first utilized in the early 1930s in a variety of industrial applications. It was especially effective in automotive painting, which uses extremely small droplets in closed indoor environments where there is no air movement to change the intended trajectories of droplets. The 1980s saw the advent of this technology in pesticide application. The electrostatic spraying concept was first applied to boom sprayers used for spraying field crops like corn and soybeans. This technology was abandoned shortly after its use on boom sprayers for a number of reasons:

- safety concerns, such as the potential risk of accidental electrical shocks which may be experienced by sprayer operators and others involved in sprayer maintenance


*Emilio Gil, Polytechnic University of Catalonia, Spain*

**Figure 43. Orchard sprayer equipped with electrostatic charging system.**

*Emilio Gil, Polytechnic University of Catalonia, Spain*

**Figure 44. Close up view of the electrostatic charging system on the sprayer shown in Figure 43. The metal plate with the "O" ring shown in the center of the picture is electrostatically charged which affects the polarity of the droplets passing through the ring.**

- low or zero improvements in spray drift and spray efficiency (deposition and coverage)
- no noticeable economic return to justify added costs

Electrostatic spraying was, however, found to be well-suited to orchard and vineyard sprayers because of the small size of droplets they generate, which provides a high charge-to-mass ratio, and the high-velocity air that carries the charged droplets deeper in the canopy. Although some field experiments were conducted to compare the performance of electrostatic sprayers with conventional sprayers, the outcomes were inconclusive. Experiments conducted in vineyards by Salcedo et al. (2020) used a multi-row vineyard sprayer (Figure 43) equipped with the electrostatic charging system shown in Figure 44. When the electrostatic charging system was activated, greater amounts of spray deposited on leaves. This occurred even with a spray volume rate 68% lower than treatments without the electrostatic function operating on the same sprayer, or when using a conventional radial-blast, air-assisted sprayer. However, another experiment conducted in a commercial apple orchard by the same researchers using three different sprayers equipped with electrostatic charging systems showed no benefit when their charging mechanisms were activated.

The mixed results of electrostatic spraying systems suggest that a thorough analysis and evaluation of available sprayer options should be considered before purchasing an orchard/vineyard sprayer equipped with the electrostatic charging system When choosing an electrostatic sprayer, the following points should be taken into considerations:

- effectiveness of the system
- economic and environmental benefits (less drift)
- the complexity electrostatic charging systems add to the already complicated spraying process
- the need for qualified personnel to properly operate, maintain, and repair the electronic parts when needed

Electrostatic spraying provides great potential for efficient applications of pesticides in indoor environment such as greenhouses. However, its effectiveness in outdoor orchard and vineyard spraying environments requires additional research to confirm its superiority in improving deposition and coverage, lowering the spray volume rate, and reducing spray drift during pesticide application.

## Summary and Recommendations

As mentioned previously, selecting sprayers for vineyards and orchards requires a much higher level of decision-making, especially when spraying for insects and diseases within the crop canopy  in comparison to selecting sprayers for field crops. This is a function of differences in the target canopy of field crops and orchards or vineyards. The target treated with field crop sprayers is relatively uniform, and at a short distance directly below the nozzles affixed on a horizontal boom. The target in vineyard or orchard spraying is usually a canopy with much variation in type, depth, and height. In addition, the droplets must travel longer distances requiring sufficient momentum to provide coverage from the near side of the target (canopy) to the far side, and from the top of the target to the bottom.

This publication includes only a brief description of most of the sprayers used in orchards and vineyards. All the sprayers mentioned in this publication apply pesticides at a constant rate, regardless of the changes in target canopy size and type, a practice that leads to highly inefficient use of pesticides. In recent years, some new concepts have come to fruition that may significantly reduce pesticide consumption without reducing biological efficacy expected from the pesticide applied. The sprayers equipped with recent technological developments include remotely piloted aerial spraying systems (drones), sprayers equipped with site-specific application technology, and sprayers capable of applying pesticides at a variable rate (such as the "intelligent sprayer" developed in Ohio) depending on the target canopy shape, size and density of foliage. Detailed information on these sprayers is available in the Ohio State University Extension publication (FABE-538) "Advancements in Technology for Reduction of Pesticides Used in Orchards and Vineyards". **ohioline.osu.edu/factsheet/fabe-538**

Selecting the right type of a sprayer may be the first step in achieving success in pesticide application, but how the sprayer is calibrated and operated properly is as important as selecting the best sprayer. An overview of the proper spraying concepts is given in the Ohio State University Extension publication (FABE-539) "Best Practices for Effective Spraying In Orchards and Vineyards" **ohioline.osu.edu/factsheet/fabe-539**. Detailed information on various aspects of orchard and vineyard spraying have been given in several Ohio State University Extension (OSUE) publications which are listed in References at the end of this publication.

Here is a summary of the topics discussed in this publication and covered in the other OSUE publications listed below, and some final recommendations for effective, efficient, and safe application of pesticides in orchards and vineyards:

- Carefully read and follow the recommendations provided on the pesticide label, in the nozzle manufacturers' catalogs, and in the sprayer operator's manuals.
- Choose the right equipment. Choose a sprayer that delivers the required application rate with droplets of the desired size to the target with minimum loss of spray on the ground and in the air.
- Select the right type and size of nozzle to achieve maximum pesticide deposit and coverage on the target. Utilize apps developed by sprayer/nozzle manufacturers when selecting nozzles.
- Calibrate the sprayer to ensure the recommended amount of pesticide (based on the product's label) is applied.
- Understand how to calculate the correct amount of chemical product to mix in the tank.
- Check the sprayer setup to ensure that the pesticide is distributed evenly on all parts of the target canopy.

*iStockphoto.com by Getty Images*

- If more than one type of chemical is added to the sprayer tank, check the products' labels to ensure mixing is done in the appropriate order.
- Operate the nozzles at a pressure that allow them to produce the spray quality (droplet size), if required or recommended on the product label.
- Keep spray drift in mind. Take precautions to reduce it to a minimum. Consider using drift-reduction nozzles.
- Slow down when spraying. Spray coverage at the inner parts of the canopy is usually improved at slower speeds. Travel speeds that are too slow, however, are likely to result in excessive use of pesticides and increased spray drift.
- Take advantage of technological advancements in spray technology, such as variable-rate and site-specific application that reduces pesticide consumption.
- Conduct tasks such as sprayer calibration, and mixing and loading of chemicals in areas that are free of ground/surface water pollution.
- Be safe. Wear protective clothing, goggles, rubber gloves, and respirators as recommended on the product's label when calibrating the sprayer, doing the actual spraying, and cleaning the equipment.

The following websites are excellent sources of additional information on spraying orchards and vineyards:

- **platform.innoseta.eu**
- **sprayers101.com/airblast101**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