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Constructing a Cheap and Effective Strawberry Sprayer

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Introduction

Strawberry production and consumption has increased rapidly in the last few decades and an expansion of farmers markets and interest in local food systems has led to an increase in small-scale strawberry production in places such as the Mid-Atlantic and Mid-South[1]. Diseases such as Grey Mold (*Botrytis cinerea*) and Anthracnose Fruit Rot (*Colletotrichum spp.*) can drastically reduce strawberry yields for growers. Sustainable production practices, such as crop rotation, cover cropping, integrated pest management, cultural controls, and other strategies can help growers achieve prolonged success in their operations[2]. An effective disease management program that includes weekly foliar fungicides during bloom is required to be successful in both organic and conventional production, because the warm and rainy climate in our region allows diseases to thrive. Many factors must be considered when developing and implementing a sustainable foliar fungicide spray schedule. These include fungicide timing, fungicide selection, rain fastness, and plant/canopy size. One often overlooked aspect of a fungicide protection program is fungicide spray coverage of the plants, flowers, and fruit. To achieve adequate level of protection, at least 15-20% of the leaf undersides, fruit and stems must be exposed to a fungicide.

Not all types of agricultural sprayers can achieve adequate spray coverage on strawberry plants, especially once canopies become dense in the spring. Using a sprayer that doesn't provide adequate spray coverage of the plants and fruit will allow some amount of the disease to persist in the crop and can lead to an increase in pest pressure[3]. Although many commercial sprayers exist on the market, they are often designed for large acreage, or are air-blast sprayers that were designed for other cropping systems. Many new and experienced strawberry growers struggle to find an economical solution that will work on small acreage. This fact sheet will demonstrate how to build a cost efficient and effective pesticide sprayer for commercial plasticulture strawberry operations (Figure 1). The following step-by-step guide will show you how to go from an easily accessible boom sprayer (Figure 2) to a sprayer designed for excellent coverage in strawberries. The materials needed are shown below (Table 1) in addition to a few tools commonly found in farm workshops.

Figure 1. Strawberry sprayer attached to an existing tractor mounted boom sprayer. By changing the hose connections, you retain the ability to use both sprayers.

Figure 2. Tractor mounted boom sprayer which can be easily adapted for spraying strawberries.

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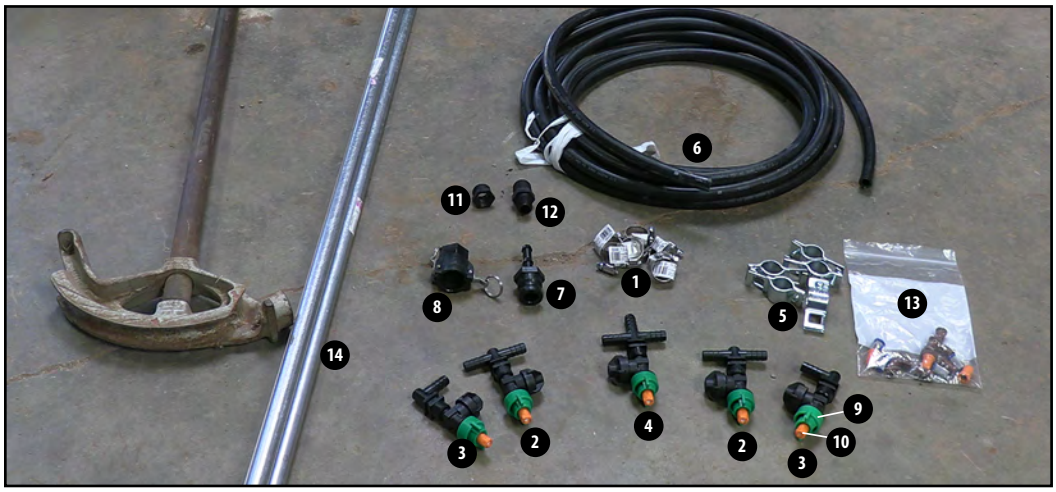
Table 1. Costs associated with adapting a tractor mounted boom sprayer for spraying strawberries.

Parts required	Quantity used in sprayer	Price each	Total cost
1. 1/2 - 1 1/8-inch hose clamps	10	$0.99	$9.90
2. 1/2-inch hose barb 1 outlet QJ200 single nozzle body for dry applications – 2-way split	2	$7.41	$14.82
3. 1/2-inch hose barb 1 outlet QJ200 single nozzle body for dry applications - single end	2	$7.41	$14.82
4. 1/2-inch hose barb 1 outlet QJ200 single nozzle body for dry applications 3-way tee	1	$7.41	$7.41
5. 3/4-inch vari-spacing boom hose clamps for holding nozzles	5	$2.00	$10.00
6. 30 foot 1/2-inch ID sprayer hose	15	$0.99	$14.85
7. Cam action adapter fitting - 1/2-inch male adapter x 1/2-inch hose shank	2	$3.99	$7.98
8. Cam action coupler fitting - 1/2-inch female coupler x 1/2-inch FPT	1	$7.99	$7.99
9. Cap and gasket - TeeJet	5	$1.03	$5.15
10. Conejet orange ceramic VisFlo hollow cone spray tips	5	$5.14	$25.70
11. Pipe reducer bushing fitting 3/4-inch MPT x 1/2-inch FPT	1	$1.99	$1.99
12. Pipe reducer nipple fitting 3/4-inch MPT x 1/2-inch MPT	1	$0.59	$0.59
13. Tip strainer 50 mesh	5	$0.94	$4.70
14. 3/4-inch x 10 foot EMT conduit round tube	1	$10.72	$10.72
U- bolt 5/16 inch by 2 3/4 inch	4	$1.98	$7.92
Total Sprayer Price			**$144.54**

Prices shown reflect price at time of purchase in 2023 and were sourced from local and online sources.



Helpful Tools
Conduit bender
Tape measure
Crescent wrench
Phillips and regular screw drivers
Cordless drill/driver with screwdriver bits
Pipe cutter
Hose cutter

Pre-Construction Considerations

Strawberries often require a specialized sprayer that can output around 100 gallons per acre (GPA) directed to a small and dense area of foliage. If you already have a boom or broadcast sprayer, it most likely has a roller PTO pump that can be adapted for use in strawberry. Check that the pump is in working condition and provides adequate pressure at operating RPMs for nozzles that can achieve adequate spray coverage. We test fitted five TeeJet ConeJet TXVK-18 with all other nozzles blanked on the boom to simulate a 5-nozzle boom with high flow rate nozzles, and ultimately determine if our existing pump would maintain an operating pressure that produced very fine droplets (see nozzle manual for pressure/droplet size information). It's possible to achieve very fine droplets at lower pump operating pressures by using nozzles with lower flow rate; however, spray coverage will likely be inadequate under 80-100 GPA. Remember to clean any lines, filters or strainers that exist on the boom sprayer prior to testing pressure. If the spray boom and spray tank have previously been used to apply herbicides, make sure to thoroughly clean the tank as crop injury can occur from any residual herbicide remaining in the equipment[4]. Consult pesticide labels and MP532 or FSA2170 for more information about cleaning spray equipment.

There are numerous nozzles on the market with different patterns, sizes, and outputs. Nozzle selection will influence droplet size, drift management, spray pattern, and the flow rate, or amount of material applied in gallons per minute (GPM). For this fact sheet and for the sprayer we use in our strawberry trials at the Vegetable Research Station in Kibler, Arkansas, we used TeeJet ConeJet TXVK-18 because they produced a "fine" droplet size at our operating pressure of 80 psi. Later we determined the nozzles delivered an output of 122 GPA in our five-nozzle configuration applying to a 36-inch bed.

Construction

To begin constructing the sprayer, first measure the width of the strawberry bed being sprayed to determine the length of conduit needed for the base sprayer structure. Most plasticulture strawberry beds tend to be 28-30 inches on the top of the bed[5]. The strawberry bed we assessed was 36 inches at the base, so we knew our frame had to be wider than 36 inches, plus the length of the nozzle bodies, the bends in the conduit, and the distance required for a uniform spray pattern from the nozzles. Expect nozzles to be at least 6 inches from the side of the bed when spraying for proper coverage. It might take more than one prototype before you find what configuration works best for your operation (Figures 3 & 4).

Figure 3. Conduit frame being assessed for fit after construction to assure proper spacing around the canopy.

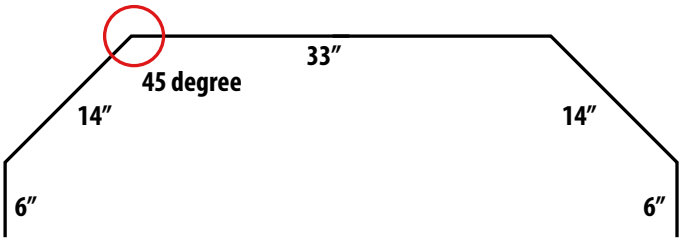


Figure 4. Strawberry frame prototype based on a 36-inch plastic bed and using 45-degree bends in the conduit.

Step 1: Measure, Mark, and Cut Conduit

Measure and mark the total length of conduit needed for the frame. Measure and mark the lengths needed for making the 45-degree bends on the conduit with a marker. Use a pipe cutter to cut the conduit and de-burr the ends. (Figure 5; Figure 6).

Figure 5. Total conduit length being measured and marked prior to making bends.

Figure 6. Pipe cutter being used to cut the length of conduit.

Step 2: Use Conduit Bender

Use a conduit bender to make the 45-degree bends at marked locations. The conduit bender has marked angle increments on the tool, making it easy to get a 45-degree bend. Try to keep the bends uniform in direction so the frame remains level (Figure 7).

Figure 7. Conduit bender being used to make 45-degree bends at the previously marked locations

Step 3: Use Reducers to Install ½ Inch Female Cam Action Coupler

Locate the pressure control unit on the existing boom sprayer. Various reducers or nipple fittings may be necessary to get to a ½ inch Male Pipe Thread (MPT) in order to thread on the ½ inch female cam action coupler (Figure 8). This coupler accepts the ½ inch male cam action coupler, which attaches the interchangeable boom and frame sprayer hoses as shown in Step 4 (Figure 8).

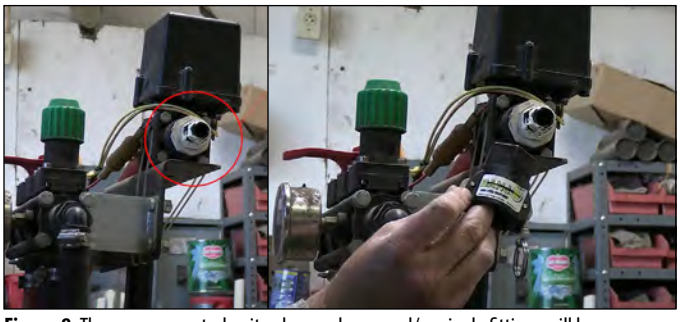


Figure 8. The pressure control unit, where reducers and/or nipple fittings will be necessary to get to a ½ inch male pipe thread (MPT). The ½ inch female cam action coupler will be threaded onto this fitting.

Step 4: Attach Male Cam Action Couplers

Using a hose clamp, attach the ½ inch male cam action couplers to the spray hoses (existing boom hose and strawberry sprayer hose). Next, seat the male cam action coupler into the female coupler on the pressure control unit to confirm the connection (Figure 9).

Figure 9. The ½ inch male cam action coupler being attached to the ½ inch inside diameter (ID) sprayer hose using a hose clamp.

Step 5: Attach Nozzle Bodies to New Sprayer Frame

Use a screwdriver or cordless drill to attach the nozzle bodies to the frame using the ¾ inch vari-spacing hose clamps. Start by attaching a single side nozzle at the edge and work across the frame. Next, attach the two-way nozzle, the three-way nozzle in the middle, a two-way nozzle, and finally the last single side nozzle on the other end of the frame. Feel free to install the hollow cone nozzles and 50 mesh strainers, along with the cap and gaskets to the nozzle bodies at this time. Position your nozzles on the sprayer frame to completely cover the canopy with some overlap (Figure 10).

Figure 10. Nozzle body attachment orientation to the frame using the ¾ inch vari-spacing hose clamps. This spacing was used for a 5-nozzle setup.

Step 6: Cut Lengths of ½ Inch ID Sprayer Hose

Using a hose or pipe cutter, cut the lengths of ½ inch inside diameter (ID) sprayer hose needed to connect the all the nozzles together (Figure 11).

Figure 11. Measuring and cutting ½ inch inside diameter (ID) sprayer hose needed to connect the all the nozzle body together.

Step 7: Attach Hoses to Nozzle Bodies

Attach all the hoses to the nozzles using the hose clamps and a screwdriver or cordless drill (Figure 12).

Figure 12. Sprayer hoses being attached to nozzle bodies using hose clamps.

Step 8: Attach Strawberry Sprayer to Boom Sprayer Frame

Using 5/16-inch U-bolts, connect the newly constructed strawberry sprayer frame to the boom sprayer frame. We anchored ours with four U-bolts at four locations on the frame (Figure 13).

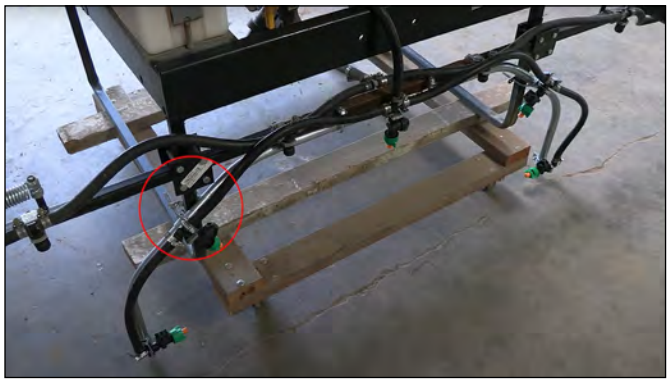


Figure 13. Strawberry sprayer frame sprayer attached to the boom sprayer frame using 5/16-inch U-bolts. The red circle highlights one of the connection points to the boom sprayer frame. Another U-bolt is mirror opposite the red circle, with the remaining two U-bolts located in the middle of the frame.

Step 9: Connect ½ Inch ID Sprayer Hose from Pressure Control Unit to New Sprayer

Lastly, connect the ½ inch ID sprayer hose from the pressure control unit to the top of the three-way nozzle body using a hose clamp (Figure 14).

Figure 14. Connection of the pressure control unit to the top of the three-way nozzle body using ½ inch ID sprayer hose and hose clamp.

Sprayer Calibration

To achieve good spray coverage, sprayers need to be properly calibrated based on the number of nozzles and the area being sprayed. Tractor speed, operating pressure, and nozzle selection are also extremely important in helping to determine output/carrier volume (gallons per acre - GPA). Several commercially available calibration tools are available to assist with determining flow rate in gallons per minute (GPM) (Figure 15), which is necessary to determine sprayer output[6]. Calibration can also help determine if nozzles are worn or plugged and need to be replaced, as determined by manufacturers' nozzle catalogs and technical information. Spray tips are considered worn and ready for replacement when their flow rate is 10% greater or less than that of newly installed spray tips[7]. Calibrate spray equipment prior to the start of the season or if changes are made such as changes in operating pressures or new nozzles[8]. An example calibration for a 36-inch prepared strawberry bed and a five-nozzle sprayer is provided below. Consult your local extension office for additional sprayer calibration methods and resources.

Figure 15. Calibration tool for determining nozzle output in gallons per minute.

Calibration Example

In this example the GPA equation below is used along with known constants to calibrate a five-nozzle hoop sprayer for a 36-inch strawberry bed (Figure 16).

$$GPA = \frac{GPM \times 5940}{MPH \times (\text{Swath Width}/\text{Nozzles per Swath})}$$

$$GPA = \frac{0.37 \times 5940}{2.5 \times (36 \text{ in.} / 5)}$$

First, determine a comfortable RPM, gear, and speed to spray; this will ultimately affect spraying pressure (psi) which will change sprayer output if adjusted. Speed can be changed later, but make sure pressure stays constant or there will be a need to recalibrate. Most setups have a pressure adjustor to help keep a constant pressure at different RPMs and speed, but a higher RPM may be needed for high pressure. In this case, a tractor traveling at 2.5 MPH and a pressure of 80 PSI from the pump powered the nozzles. Once speed is determined, the flow rate of nozzles (GPM) must be calculated using either the catch method (catch and measure one nozzle output for one minute, report as gallons per minute) or using a calibration tool (Figure 15). We recorded the flow rate from all five of our nozzles, which averaged 0.37 GPM. Next, determine the spray swath, or the width of area that spray material will be hitting with each pass. An application with a boom that contains drop nozzles is generally a banded application, therefore spray swath should be divided by the number of nozzles applying to that band (Figure 16). In this case the spray swath measured 36 inches divided by 5 nozzles, meaning we used a value of 7.2 inches (use inches if using the 5940 constant). Last, use a constant of 5940 (for inches) to finish the formula and solve GPA (sprayer output in gallons per acre). In this case (0.37 x 5940) ÷ (2.5 x 7.2) = 122 GPA.

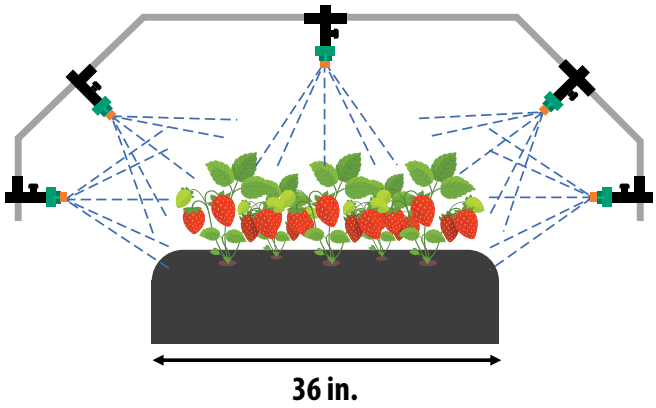


Figure 16. Hoop sprayer with drop nozzles applying pesticide to 36-inch strawberry bed with five nozzles. This would be considered a banded application to a 36-inch swath.

Accurately determining sprayer output is a necessary step of calibration and accurate pesticide applications. If GPA is not known, then the amount of pesticide product applied when pesticide applications are made is also not known. Overestimating GPA leads to underestimating the rate of pesticide, which could lead to failures to control disease or insects. Underestimating GPA could lead to overapplication of a pesticide rate which could conflict with label requirements and the law.

Conclusions

The goal of this fact sheet is to offer a simple solution to help increase pest management efficiency on the farm. We hope that this guide has helped shed light on the difficulties that exist in getting good coverage in strawberries, as many struggle to achieve low disease prevalence with existing sprayers or struggle to find a cost-effective sprayer that meets needs. For information on what you should spray, check out our YouTube video guides or the Southeast Strawberry IPM guide.

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