Lesson A7–5

Operating, Calibrating, and Maintaining Spraying Systems

Unit A. Mechanical Systems and Technology

Problem Area 7. Agricultural Equipment Systems

Lesson 5. Operating, Calibrating, and Maintaining Spraying Systems

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: **II:** Apply principles of operation and maintenance to mechanical equipment, structures, biological systems, land treatment, power utilization, and technology.

Benchmark: **II-A:** Perform scheduled services routines to maintain machinery and equipment.

Performance Standard: **6.** Maintain fluid levels. **7.** Maintain vehicle, machinery, and equipment cleanliness and appearance. **8.** Maintain fluid conveyance components, (e.g., hose and lines, valves, nozzles). **9.** Design a preventative maintenance schedule. **11.** Calibrate metering, monitoring, and sensing equipment.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Identify the types of sprayers.
2. Describe the selection of sprayers and their components.
3. Explain the operation of a sprayer.
4. Describe the calibration of sprayers.
5. Identify how sprayers are maintained.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Kiess, Aaron. *Chemical Application Management*. Moline, Illinois: Deere & Company, 1994.

List of Equipment, Tools, Supplies, and Facilities

Writing surface

Overhead projector

Transparencies from attached masters

Copies of student lab sheets

Personal protective equipment

Examples of sprayers

Terms. The following terms are presented in this lesson (shown in bold italics):

Air sparging

Atomization

Control valves

Nozzles

Pressure gauge

Pump

Relief valve

Screens

Strainers

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Have a student come to class wearing personal protective equipment and carrying a hand sprayer. Lead a discussion concerning pesticides, their application and safety associated with them.

Summary of Content and Teaching Strategies

Objective 1: Identify the types of sprayers.

Anticipated Problem: What are the types of sprayers?

I. Most pesticides are applied with sprayers. There are many variations and combinations of sprayer types. Each type of sprayer has guidelines for its proper use and for the use of the pesticide to be applied. Most liquid-pesticide application equipment falls into the following categories:

A. Hand-operated sprayers operate in the 5 to 40 psi range and are commonly used by home gardeners and others whose pest problems are relatively small. Compressed-air sprayers with a capacity from 1 to 5 gallons are simple in design, easy to operate and relatively inexpensive to buy and maintain. Pressure is provided by a hand operated air pump which fits into the tops of the tank. Air compressed in the tank above the spray material forces the liquid out of the tank through a tube. A valve at the end of a short length of hose controls the flow of liquid. Agitation is provided by shaking the tank.

B. Knapsack or back-pack sprayers have a small piston or diaphragm pump that is powered by the operator or by a small gasoline engine.

C. Low-pressure sprayers are the most widely used type of field application equipment. They are usually operated in the 20 to 50 psi range and apply from 5 to 60 gallons per acre.

1. They are relatively inexpensive and are adapted to many uses including pre- or post-emergence application of chemicals to control weeds, insects, and diseases.
2. Low pressure sprayers are available in many models and types and may be mounted on tractors, trucks, trailers, and aircraft.

D. Controlled droplet applicators apply low volumes of pesticide mixtures.

1. Typical volume is one to three gallons of spray mix per acre and are most often used with foliar applied herbicides.
2. Instead of nozzles, they use a spinning disc or cup with serrated edges onto which pesticides drop. Cups or discs, powered by electric or hydraulic motors, spin at speeds of 1000 to 6000 rpm, producing small droplets that are relatively uniform in size.

E. High-pressure sprayers are similar to low-pressure sprayers, with the exception that they are capable of higher working pressures of up to 1000 psi.

1. High pressure is used to force spray through dense foliage or to the tops of tall trees.
2. They range from models that have a single nozzle on a handgun to large units with multiple nozzles that are mounted on a boom.
3. High pressure sprayers are built strong to withstand extreme pressure and are more expensive than conventional low-pressure models.

F. Air-carrier sprayers or air-blast sprayers are often called mist blowers.

1. A high-speed air stream carries pesticide to the surface being treated.

2. Sprayers are rated in air capacity and velocity. Capacities range from 5,000 to 60,000 cubic feet per minute and air speeds range from 80 to 150 mph.
3. Since air carries the pesticide to the target, little dilution with water is needed and less time is required for filling the sprayer. This results in a more efficient operation.

G. Air-boom sprayers use a blower unit to carry small spray droplets into the target.
1. Lower volumes of carrier are used due to better coverage and reduced drift.
2. Adding air-assist equipment can increase the cost of a standard sprayer by approximately $15,000.
    a. Because of the added cost, use has been confined to high-value specialty crops and vegetables.
    b. A low-cost alternative is to use a system that mixes air and chemical at the nozzle.

H. Foggers and rope wick applicators are not really sprayers, but are used to apply liquid herbicides. Foggers apply pesticides, usually insecticides, as very fine droplets called aerosols. A single aerosol droplet is too small to see, but a concentration of droplets is visible, floating in the air like smoke or a cloud. Aerosol generators are frequently called foggers. Foggers are used to completely fill or blanket an area with insecticide and are most often used in enclosed spaces. Fine particles are easily moved by air currents before they contact all target insects. Rope wick applicators apply liquid herbicide by wiping it onto the plants. The pesticide in a pipe soaks out through rope segments, as the applicator crosses the field. The plants which reach above the pipe are contacted and the herbicide is wiped off the rope onto the plants.

I. Direct injection systems offer convenience and safety benefits. The basic design is one that holds undiluted pesticide and water or carrier in separate tanks. Undiluted pesticide is metered into nozzle lines by pumps or air pressure for blending with the carrier before it reaches the nozzle. This eliminates the need to add and mix chemicals in the spray tank, so there is no tank contamination. The chemical may be held in the original container, in a chemical carrying tank or in a sealed, returnable container. The returnable containers virtually eliminate all pesticide handling and disposal of the empty containers.

Use TM: A7–5A and A7–5B to emphasize pesticide safety and categories of application equipment. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 7 in Chemical Application Management

Objective 2: Describe the selection of sprayers and their components.

Anticipated Problem: How are sprayers selected and what are their components?

II. Sprayers come in different sizes, shapes, and brands.

A. Sprayers and other application equipment have three basic functions.

1. Storage of chemicals prior to application in the field.
2. Metering the quantity of material being applied.
3. Distribution of the material into the desired pattern.

B. Sprayers are composed of numerous components. Many different arrangements and combinations may be used.

1. For a particular situation, the best combination depends on four factors.
   a. The chemical being applied.
   b. The application rate.
   c. The crop being treated.
   d. The required accuracy.
2. Sprayers may have the following components.
   a. Sprayer tanks should have sufficient capacity, be easy to fill and clean, be corrosion resistant, and have a shape suitable for easy mounting and effective agitation.
   b. Most sprayers are equipped with some kind of agitator to maintain a uniform mixture. There are three agitation systems.
      i. Mechanical agitators are propellers or paddles mounted on a shaft near the bottom of the tank.
      ii. Hydraulic agitation returns a portion of the pump output to the tank and discharges it through a series of orifices in a boom along the bottom of the tank or through a volume-booster nozzle.
      iii. ***Air sparging*** is agitation by bubbling air through the liquid.
   c. The ***pump*** moves liquids from the tank to the nozzles and creates pressure to propel spray droplets to the target. There are five types of pumps.
      i. Diaphragm pumps have a flexible diaphragm that produces the pumping action. They are popular for medium-pressure applications and are durable because moving parts are sealed in an oil bath.
      ii. Roller pumps consist of cylindrical rollers that move in and out of slots in a spinning rotor. As the rotor spins, it creates space for liquid during half its rotation. Then, liquid is discharged from the pumping chamber during the remainder of the rotation. Roller pumps are self priming, easy to repair, inexpensive, and operate efficiently at power take off (PTO) speeds.
      iii. Centrifugal pumps are simple in design and durable. They can be used with abrasive materials and for low-pressure sprayers. Pumping action is created by a high speed impeller that forces liquid out of the pump. Centrifugal pumps are not self-priming, so they are mounted below the supply tank.
      iv. Piston pumps are self-priming and have high pressure capabilities. One or more pistons travel inside cylinders and force liquid through one-way valves. Piston pumps are positive displacement, where output is proportional to speed and is virtually unaffected by pressure.

v. Most metering pumps are driven by a ground wheel. When ground speed changes, the rate of pumping increases or decreases proportionately.

d. A ***relief valve*** is a safety device that releases liquid when the pressure exceeds a safe level. Relief valves can be used to regulate sprayer pressure by adjusting them to open at the desired setting.

e. The ***pressure gauge*** is used to measure the pressure in the system and is a valuable tool for diagnosing sprayer problems.

f. ***Strainers*** and ***screens*** are used to remove particles from the system. They are commonly used in three places.

   i. Tank screens are coarse screens that remove twigs and other large foreign material when the tank is filled.

   ii. Line strainers are necessary to prevent rust, scale, sand, or other small foreign materials from entering and damaging the pump.

   iii. Nozzle strainers remove fine particles that could clog nozzles.

g. Pipes and hoses convey the liquid through the sprayer. Liquid pressure varies at different points on the sprayer. Hoses and pipes must be strong enough to prevent bursting.

h. Sprayer frames must be strong and durable and provide convenient points for attaching the boom and mounting other components.

i. ***Control valves*** are used to start and stop flow of liquid to the nozzle. They are independent of the pressure regulator. Control valves may be operated manually or electronically, and typically break the boom into two or three controllable sections.

j. Selection of the correct type and size of spray nozzle is essential for each application. The nozzle determines the amount of spray applied to an area, the uniformity of the application, the coverage of the sprayed surface, and the amount of drift. N***ozzles*** meter liquids, atomize the liquid stream into droplets, and disperse droplets in a specific pattern. For a liquid, the flow rate depends on the effective size of the orifice and the pressure. Nozzle flow rate increases as pressure increases, but it is not proportional. Doubling the pressure does not double the flow rate. Pressure must be increased by a factor of 4 to double the flow rate. ***Atomization*** is the liquid breakup caused by the tearing action of the air. Liquid exits from the nozzle in an unstable sheet which breaks up into droplets. Droplet size is measured in microns, one micron is one millionth of a meter. Droplet size is affected by nozzle type and size, pressure, and liquid characteristics. As pressure increase, average droplet size decreases to a certain limit. Spraying nozzles are described according to the shape of the application pattern. Nozzles have been developed for practically every kind of spray application, but only a few are used in pesticide applications. These include the following:

   i. Extended-range flat-fan nozzles are frequently used for soil and foliar applications when better coverage is required.

ii. Even flat-fan nozzles apply uniform coverage across the entire width of the spray pattern, and should only be used for banding pesticides over the row.

iii. Flooding flat-fan nozzles produce a wide-angle, flat-fan pattern and are used for applying herbicides or mixtures of herbicides and liquid fertilizers. Pressure changes have a great impact on flooding nozzles.

iv. Turbo flood nozzles combine the precision and uniformity of extended-range flat spray tips with the clog resistance and wide-angle pattern of flooding nozzles. The design of the turbo flood increases droplet size and distribution uniformity.

v. Turbo flat-fan nozzles have improved pattern uniformity and a reduction in driftable fines has occurred through a wide range of pressures.

vi. Raindrop nozzles are recommended when spray drift is a major concern.

vii. Wide-angle full-cone nozzles produce large droplets over a wide range of pressures.

viii. Drift reduction pre-orifice nozzles effectively reduce the development of driftable fines in the spray pattern.

Use TM: A7–5C, A7–5D, A7–5E, and A7–5F to illustrate various sprayer components. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 7 in Chemical Application Management is recommended.

Objective 3: Explain the operation of a sprayer.

Anticipated Problem: How are sprayers operated?

III. Sprayer operation includes all activities, before, during, and after field use, that affect the quality of field. The following is a list of general guidelines to use when planning and conducting spraying:

A. Preliminary planning begins with the decision to apply a pesticide and to choose the particular chemical to be used. While selecting the chemical, several decisions must be made such as how it is to be applied, application rate, number and placement of nozzles, proper operating speed, nozzle tips needed for desired application rate, nozzle spacing, and travel speed.

B. Preliminary adjustment and setting based on label recommendations.

C. Proper calibration to ensure that the area being sprayed receives the right amount of chemical.

D. There are two factors to consider before loading a sprayer.

1. The quantity of pesticide to add to the tank and procedures to follow while mixing the pesticide.
2. Determine the amount of pesticide to add to the tank, sprayer-tank size, and amount of pesticide needed per treated acre must be known.

E. Transport loaded sprayers as little as possible. An accident could spill a load of chemicals on the road or in a ditch, where it could be very hard to contain and cleanup.

1. Mix as close to the field as possible and spray the entire load immediately.
2. Lock the boom or booms in the transport position and use accessory lights, SMV emblem, and other devices to warn operators of other vehicles.

F. During field operation, the operator must maintain constant ground speed and pressure as determined while calibrating. Monitoring the operation continuously for plugged nozzles, marker operation, leaks, weather, empty tank, and obstacles.

G. A sprayer should be carefully cleaned after application of each different pesticide, at the end of the season, and when repairs must be made.

1. Before cleaning the sprayer, review the pesticide label for any special recommendations. Commercial cleaning compounds are available.
2. The cleaning site should be located away from water supply sources, people, and pets to prevent contamination.
3. Wear protective clothing, including rubber boots, gloves and apron, and goggles.
4. The cleaning area should have a wash rack or cement apron, plus a sump to catch wash water and pesticides. The water and chemicals collected can be reapplied to the treated area, but only at a rate that does not exceed the maximum use rate listed on the pesticide label.

H. Store the sprayer in a dry, clean building. Polyethylene tanks and hoses need protection from sunlight to avoid damage.

Use TM: A7–5G to depict the proper cleaning of application equipment. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 7 in Chemical Application Management is recommended.

Objective 4: Describe the calibration of sprayers.

Anticipated Problem: What are the procedures to follow when calibrating sprayers?

IV. Most performance complaints about pesticides can be traced to poor application practices. Proper calibration helps insure that the area being sprayed receives the right amount of chemical. Nozzle flow rate, ground speed of the sprayer, and width sprayed per nozzle are variables that affect the amount of spray material applied per acre.

A. The gallons of spray applied per acre can be determined by using the following equation:

$$GPA = GPM \times 5940 / MPH \times W$$

GPA = gallons per acre

GPM = output per nozzle in gallons per minute

MPH = ground speed in miles per hour

W = effective width sprayed per nozzle

5940 = a constant to convert gallons per minute, miles per hour, and inches to gallons per acre

There are many methods for calibrating low-pressure sprayers, but they involve using the variables in the equation above. Any technique for calibration that provides accurate and uniform application is acceptable.

B. A more exact method for choosing the correct nozzle tip is to determine the gallons per minute (GPM) required for the conditions. Then, select nozzles that provide this flow rate when operated within the recommended pressure range. By following the ensuing five steps, you can select the nozzles required for each application well ahead of the spraying season.

1. Select the spray application rate in gallons per acre (GPA). Pesticide labels recommend ranges for various types of equipment. The spray application rate is the gallons of carrier (water, fertilizer, and so on) and pesticide applied per treated acre.
2. Select or measure an appropriate ground speed in miles per hour (MPH) according to existing field conditions. Do not rely on speedometers as an accurate measure of speed. Slippage and variation in tire sizes can result in speedometer errors.
3. Determine the effective width sprayed per nozzle (W) in inches.
   a. For broadcast spraying, W = the nozzle spacing.
   b. For band spraying, W = the bandwidth.
   c. For directed spraying or for drop pipes, W = row spacing (or band width) / number of nozzles per row (or band).
4. Determine the flow rate required from each nozzle in gallons per minute (GPM) by using a nozzle catalog, tables, or the following equation:

   $$GPM = GPA \times MPH \times W / 5940$$

   GPM = gallons per minute of output required from each nozzle

   GPA = gallons per acre from Step 1

   MPH = miles per hour from Step 2

   W = inches sprayed per nozzle for Step 3

   5940 = a constant to convert gallons per minute, miles per hour, and inches to gallons per acre
5. Select a nozzle that will give the flow rate determined when the nozzle is operated with the recommended pressure range. Use a catalog of available nozzle tips.
   a. If it is decided to use nozzles that are already on hand, select a speed that allows you to operate within the recommended pressure.
   b. With the proper nozzle tips selected, the rest of the calibration can be completed.

C. Determine the required flow rate for each nozzle in ounces per minute (OPM). To convert GPM to OPM, use the following equation. OPM = GPM × 128 (1 gallon = 128 fluid ounces)

D. Collect the output from one of the nozzles in a container marked in ounces.

1. Check several nozzles to determine whether their outputs fall within 5 percent of the desired OPM.
2. If it becomes impossible to obtain the desired output within the recommended range of operating pressures, select larger or smaller nozzle tips or a new ground speed, then recalibrate. It is important for spray nozzles to be operated within the recommended pressure range, which indicates the pressure required at the nozzle tip.

E. Determine the amount of pesticide needed for each tankful or for the acreage to be sprayed. Add the pesticide to a partially filled tank of carrier (water, fertilizer, etc.), then add the carrier to the desired level with continuous agitation.

F. Operate the sprayer in the field at the ground speed measured and at the pressured determined. After spraying a known number of acres, check the liquid level in the tank to verify that the application rate is correct.

G. Check the nozzle flow rate frequently. Adjust the pressure to compensate for small changes in nozzle output due to nozzle wear or variations in other spraying components. Replace nozzle tips and recalibrate when the output has changed 10 percent or more from that of a new nozzle, or when the pattern has become uneven.

Use TM: A7–5H and A7–5I to reinforce an understanding of sprayer calibration. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use LS: A7–5A, A7–5B, A7–5C and A7–5D is reinforce student understanding of the concepts. Use text material to strengthen student understanding of concepts. Chapter 7 in Chemical Application Management is recommended.

Objective 5: Identify how sprayers are maintained.

Anticipated Problem:

V. Preventative maintenance should be given first consideration in the use of sprayers in order to reduce the chances for breakage, costly repair bills, and loss of time.

A. Adequate and timely adjustment, repair, lubrication, and protection from the weather determines the life of a machine.

1. Consult the operator's manual for lubrication instructions for the machine and for the location of the parts to be lubricated.
2. Make certain all tires are inflated to the recommended pressure to provide level machine operation.
3. Inspect hoses, connections, and gauges for cracks or damage on a regular basis.
4. Inspect the boom and frame before, during, and after the season.

B. All spray equipment should be thoroughly cleaned inside and outside immediately after it is used. When cleaning equipment, always wear proper protective clothing, including rubber boots, a rubber apron, goggles, and possibly a respirator. Clean-up is important because many chemicals rapidly corrode some metals and may react with succeeding chemicals. Pesticide residue that is not removed from the sprayer system after application may damage the next crop or contaminate the next crop with illegal residue.

Use text material to strengthen student understanding of concepts. Chapter 7 in Chemical Application Management is recommended.

Review/Summary. Focus the review and summary around the lesson's learning objectives. Use classroom discussion to determine which areas, if any need to be covered in more detail.

Application. The following lab activities will be helpful to students in applying the lesson's content:

LS: A7–5A—Determining Ground Speeed
LS: A7–5B—Nozzle Tip Selection
LS: A7–5C—Sprayer Calibration
LS: A7–5D—Calculating Product Needs

Evaluation. Questions at the end of the chapters in the recommended resources will be helpful in evaluation. A sample written test is also attached.

Answers to Sample Test:

Part One: Matching

1 = d, 2 = f, 3 = e, 4 = b, 5 = c, 6 = a

Part Two: Completion

1. Air sparging
2. pressure
3. Control valves
4. calibration

Part Three: Short Answer

1. Nozzle flow rate, ground speed of the sprayer, and width sprayed per nozzle.
2. Pressure must be increased by a factor of 4 to double the flow rate.

Sample Test Name_______________________________

Test

Lesson A7–5: Operating, Calibrating, and Maintaining Spraying Systems

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. atomization
b. nozzles
c. pressure gauge
d. pump
e. relief valve
f. strainers

_______ 1. Moves liquids from the tank to the nozzles and creates pressure to propel spray droplets to the target.

_______ 2. Used to remove particles from the system.

_______ 3. Safety device that releases liquid when the pressure exceeds a safe level.

_______ 4. Meter liquids, atomize the liquid stream into droplets and disperse droplets in a specific pattern.

_______ 5. Used to measure the pressure in the system.

_______ 6. Liquid breakup caused by the tearing action of the air.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. ____________________ is agitation by bubbling air through the liquid.
2. Relief valves can be used to regulate sprayer _________________ by adjusting them to open at the desired setting.
3. ____________________ are used to start and stop flow of liquid to the nozzle.
4. Proper ____________________ helps insure that the area being sprayed receives the right amount of chemical

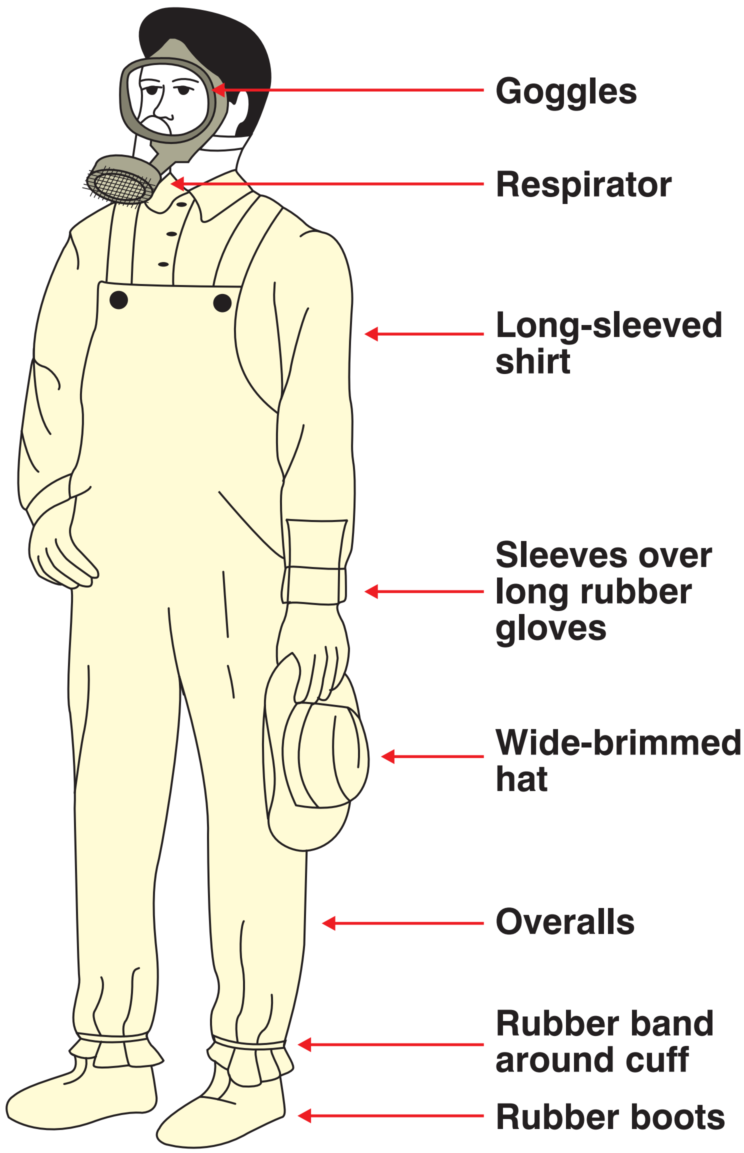
Part Three: Short Answer

Instructions. Provide information to answer the following questions. Use complete sentences.

1. What are the variables that affect the amount of spray material applied per acre?

2. Nozzle flow rate increases as pressure increase, but it is not proportional. What happens to the pressure when the flow rate is doubled?

PESTICIDE SAFETY



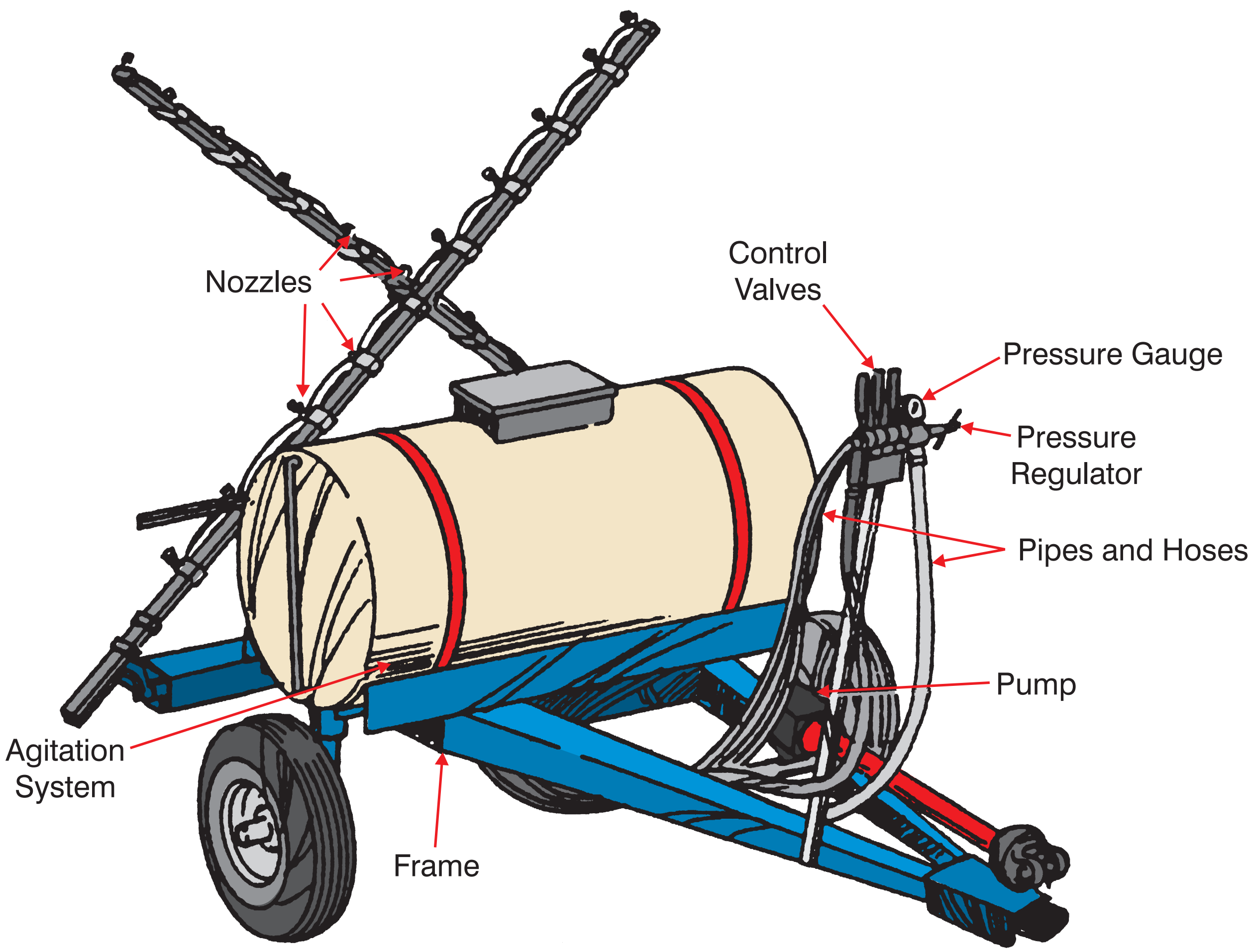
Consult the manufacturer guidelines regarding protective clothing when mixing and spraying pesticides.

(Courtesy, Interstate Publishers, Inc.)

CATEGORIES OF LIQUID PESTICIDE APPLICATION EQUIPMENT

1. Hand operated sprayers
2. Knapsack or backpack sprayers
3. Low pressure sprayers
4. Control droplet applicators
5. High pressure sprayers
6. Air-carrier/air-blast sprayers
7. Air-boom sprayers
8. Foggers and rope wick applicators
9. Direct injection systems

MAJOR COMPONENTS OF A SPRAYER



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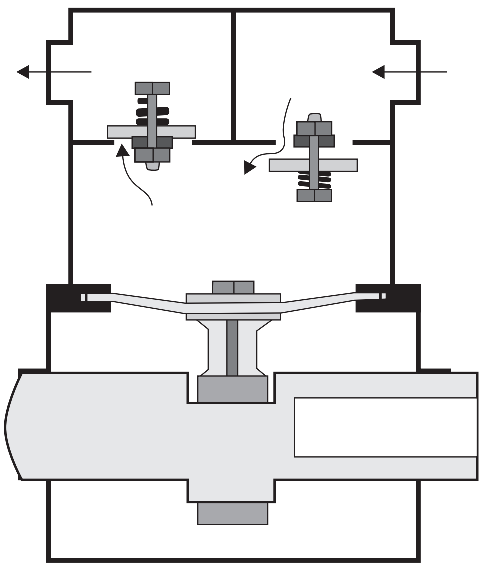
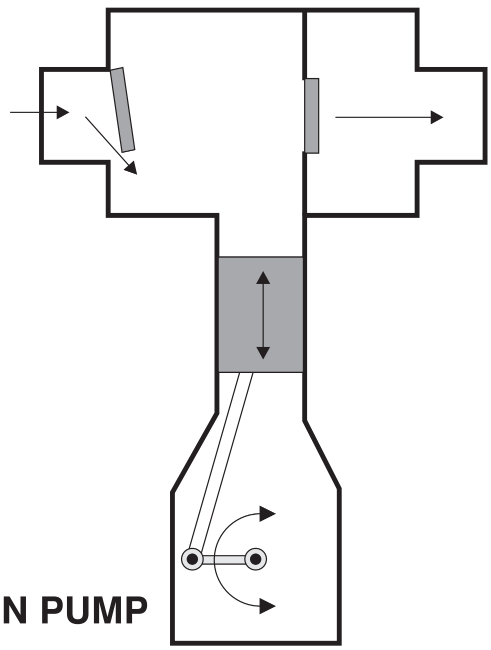
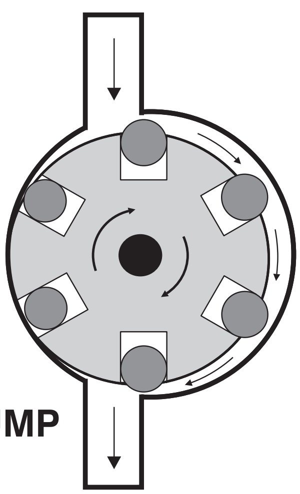
SOME PUMPS USED IN SPRAYERS



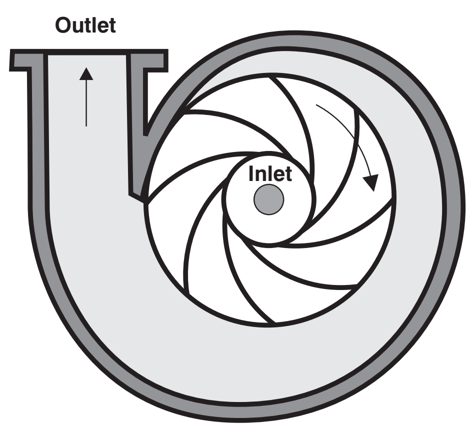
DIAPHRAGM PUMP



PISTON PUMP



ROLLER PUMP



CENTRIFUGAL PUMP

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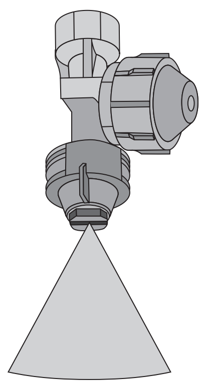
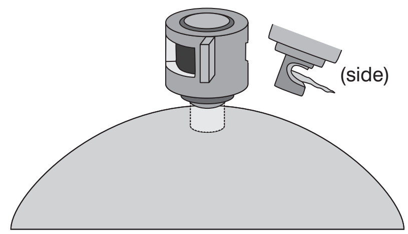
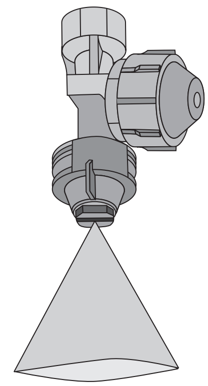
TYPES OF SPRAYER NOZZLES



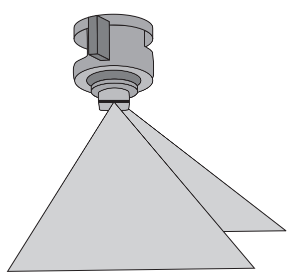
Even Flat-Fan



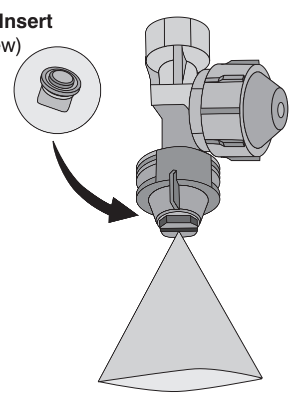
Flooding Flat-Fan (front)



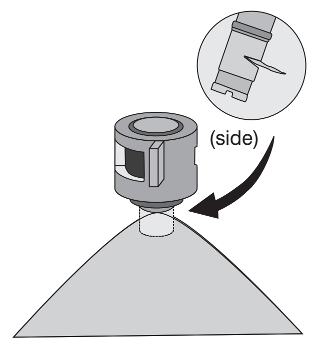
Flat-Fan Extended Range



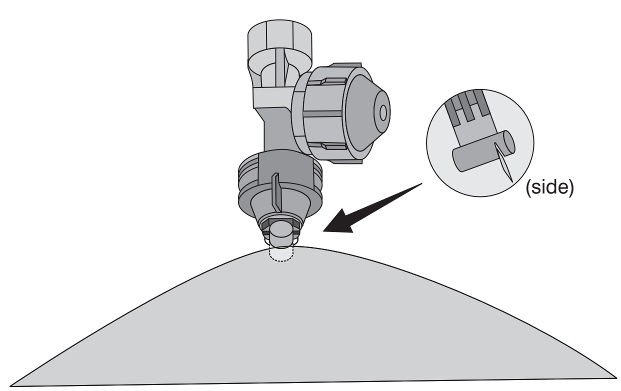
Twin Orifice Flat Fan



Drift Reduction Pre-Orifice Flat-Fan



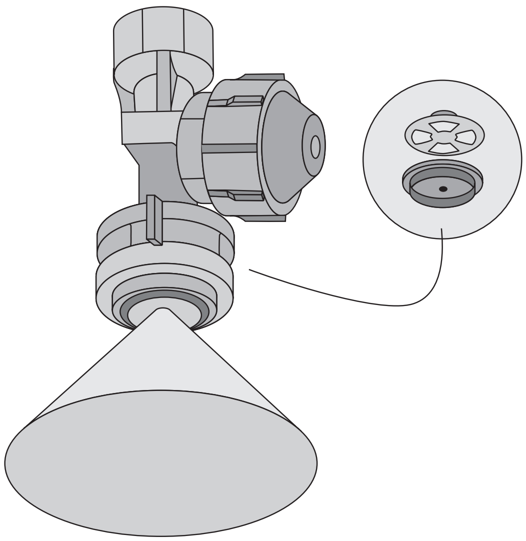
Turbo Flood Flat-Fan



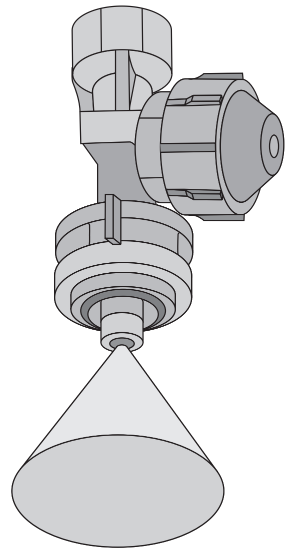
Turbo Flat-Fan (front)

(Courtesy, Interstate Publishers, Inc.)

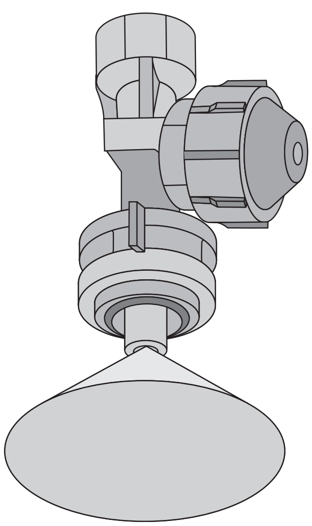
MORE TYPES OF SPRAYER NOZZLES



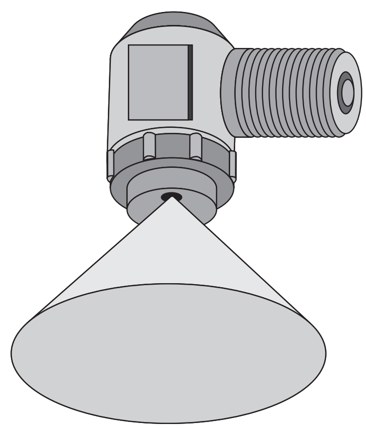
Hollow Cone (Disc-Core)



Hollow Cone (One Piece)



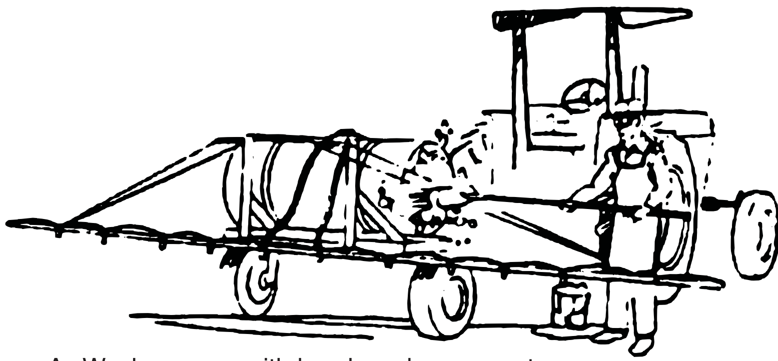
Wide Angle Full-Cone



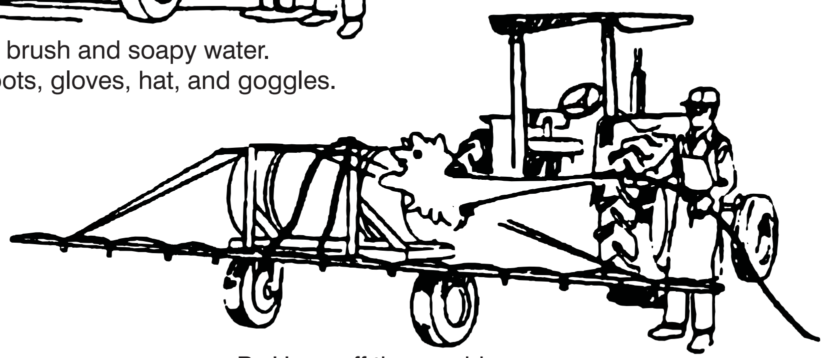
RA-Raindrop

(Courtesy, Interstate Publishers, Inc.)

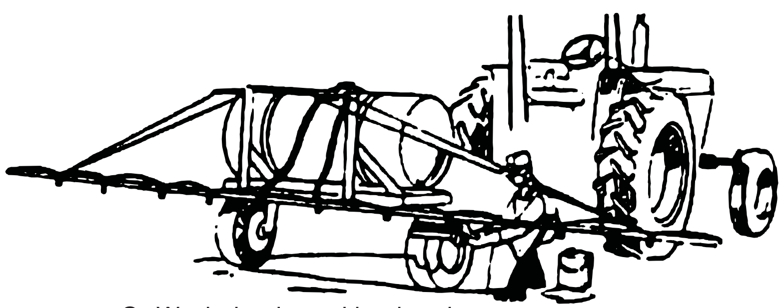
CLEANING APPLICATION MACHINERY



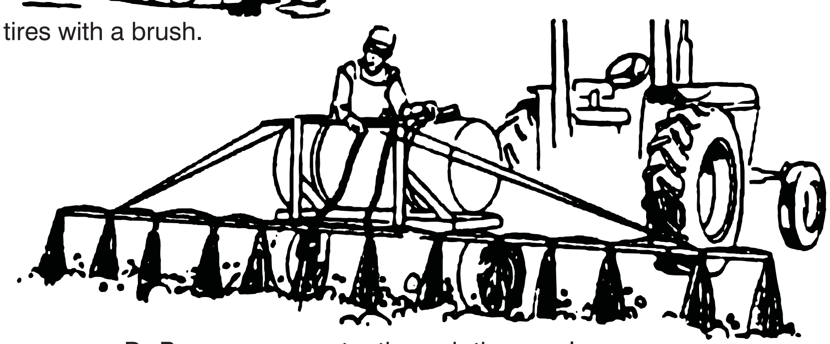
A. Wash sprayer with brush and soapy water.
Wear an apron, boots, gloves, hat, and goggles.



B. Hose off the machine.



C. Wash the tires with a brush.



D. Pump soapy water through the nozzles.

TURBOFLOOD FLAT-FAN NOZZLE CHART AND NOZZLE NUMBERING SYSTEM

Turboflood Flat-Fan Nozzles			
		Capacity	
Manufacturer: Spraying Systems	Liquid Pressure (psi)	gal/min (GPM)	oz/min (OPM)
TF2	10	.20	26
	20	.28	36
	30	.35	45
	40	.40	51
TF-2.5	10	.25	32
	20	.35	45
	30	.43	55
	40	.50	64
TF-3	10	.30	38
	20	.42	54
	30	.52	67
	40	.60	77
TF-4	10	.40	51
	20	.57	73
	30	.69	88
	40	.80	102
TF-5	10	.50	64
	20	.71	91
	30	.87	111
	40	1.0	128
TF-7.5	10	.75	96
	20	1.1	136
	30	1.3	166
	40	1.5	192
TF-10	10	1.0	128
	20	1.4	180
	30	1.7	221
	40	2.0	256

Explanation of a Typical Nozzle Numbering System		
Examples		
Extended-range flat-fan	XR 11004	XR—Extended-range 110—110-degree fan angle 04—.4 gallon per minute flow rate @ 40 psi
Even-fan	8002E	E—even spray patter 80—80-degree fan angle 02—.2 gallon per minute flow rate @ 40 psi
Turbo flooding	TF-4	TF—Turbo flood 4—.4 gallon per minute flow rate @ 10 psi
Turbo flooding	QCTF-40	QCTF—Quick attach turbo flood 40—4.0 gallons per minute @ 10 psi

FLAT-FAN AND HOLLOW-CONE NOZZLE CHART

Even Flat-Fan Nozzles			
Manufacturer (nozzle screen size)	Liquid Pressure (psi)	Capacity	
		gal/min (GPM)	oz/min (OPM)
Delavan LE-2 Spraying Systems 8002E Lurmark (50 mesh)	20 25 30 40	.14 .16 .17 .20	17.9 20.5 21.8 25.6
Delavan LE-3 Spraying Systems 8003E Lurmark E9503 Hardi 4598-10 (50 mesh)	20 25 30 40	.21 .24 .26 .30	26.9 30.7 33.3 38.4
Delavan LE-4 Spraying Systems 8004E Lurmark E9504 Hardi 4598-12 (50 mesh)	20 25 30 40	.28 .32 .35 .40	35.8 41.0 44.8 51.2

Hollow-Cone Nozzles			
Manufacturer (nozzle screen size)	Liquid Pressure (psi)	Capacity	
		gal/min (GPM)	oz/min (OPM)
Delavan HB-4 (HC-4) Spraying Systems TX-4 Lurmark HAF0480 (50 mesh)	30 40 60 75 90	.0583 .0670 .0817 .0917 .1000	7.5 8.5 10.5 11.7 12.8
Delavan HB-6 (HC-6) Spraying Systems TX-6 Lurmark HAF0680 (50 mesh)	30 40 60 75 90	.0867 .1000 .1217 .1367 .1500	11.1 12.8 15.6 17.5 19.2

 Name________________________________

Lab Sheet

Determining Ground Speed

Objective:

Determine the ground speed of spraying equipment.

Equipment:

Stopwatch or wristwatch with a stopwatch function
100-foot moisture resistant measuring tape
Pocket calculator
Colored, plastic flagging tape or stakes
Tractor and sprayer (any type of vehicle can be used that has a governed speed)

Procedure:

Example: A sprayer takes 22 seconds for the first pass and 24 seconds for the return pass to travel a measured course of 200 feet. What is the average speed in MPH?

_______ travel time first pass + _______ travel time second pass = _______ total travel time
_______ total travel time / 2 = _______ average travel time

Speed (MPH) = distance (feet) × 60 / time (seconds) × 88(1 MPH = 88 feet per 60 seconds)

______ MPH = _______ × 60 / _______ × 88

1. Lay out a know distance in the field you intend to spray or in a field with similar surface conditions. Suggested distances are 100 feet for up to 5 MPH, 200 feet for speeds from 5 to 10 MPH, and at least 300 feet for speeds above 10 MPH.
2. At the engine throttle setting and in the gear you plan to use during spraying with a loaded sprayer, determine the travel time between the measured stakes in each direction. Average the speeds.

_______ travel time first pass + _______ travel time second pass = _______ total travel time
_______ total travel time / 2 = _______ average travel time

3. Use the following equation to determine ground speed.

   Speed (MPH) = distance (feet) × 60 / time (seconds) × 88

   ______ MPH = _______ × 60 / _______ × 88

Questions:

1. Why where longer distances used for applicators going faster?

2. Why is a vehicle with governed speed used when spraying?

3. Why was the time traveled measured going in to different directions?

 Name ______________________________

Lab Sheet

Nozzle Tip Selection

Objective:

Determine the nozzle size from charts, based on the calculated flow rate per minute (GPM) per nozzle.

Equipment:

Pocket calculator, nozzle flow charts or TM: A7–5H and A7–5I

Procedure:

1. Calculate the flow rate per minute (GPM) per nozzle, using the flow rate equation.

   GPM = GPA × MPH × W / 5940

2. You want to broadcast a preplant incorporated herbicide at 15 GPA at a speed of 7 MPH using turbo flood nozzles on 40-inch spacings. What size of tip should you select?

   GPA = ______ MPH = ______ W = _____

   GPM = ______ × _____ × _____ / 5940 = _________ GPM

3. Convert GPM to fluid ounces per minute (OPM) then select the nozzle tip size from the included charts.

   OPM = GPM × 128 (1 gallon = 128 fl. Ounces)

   OPM = _______ × 128 = __________ OPM

   The nozzle size most appropriate for this application is ________________________.

 Name______________________________

Lab Sheet

Sprayer Calibration

Objective:

Determine the actual output of nozzles in ounces per minute (OPM).

Equipment:

Stopwatch or wristwatch with a stopwatch function
100-foot moisture resistant measuring tape
One or two-quart container calibrated for liquids in ounces
Pocket calculator
Calibrated pressure gauge with fitting compatible with spray nozzle fittings
Personal protective equipment (PPE), or it may be best to use a sprayer that has never had a pesticide passed through it.

Procedure:

1. Collect the output for one nozzle in a container marked with ounces or after collection, transfer material to another container for measurement (it is best not to transfer material, since some of the material may be lost or will remain in the container).

   ______ ounces collected, ______ projected ounces collected (from LS: A7–5B)

2. Based on the amount of product collected, which way should the pressure be adjusted, UP or DOWN?

3. Adjust the pressure up or down until the amount collected is equal to the amount required.

Questions:

1. Why should personal protective equipment be worn when calibrating sprayer systems?

2. What are the benefits of sprayer calibration?

3. At what percentage of output compared to desired output should nozzle tips be replaced?

LS: A7–5D Name________________________________

Lab Sheet

Calculating Product Needs

Objective:

Based on the recommended application rate, determine the amount of product needed.

Equipment:

Pocket calculator

Procedure:

Note: not all of the product in the bag of pesticide is an active ingredient, more will have to be added to get the final “acre’s worth” value. For dry formulations (DF), divide the percentage of active ingredient into the total. For liquid formulations, divided the recommended amount of active ingredient per acre by the concentration of the formulation.

Example 1. An atrazine label calls for 1.5 lbs. of active ingredient per acre (a.i/A.). Aatrex 90 DF has been purchased. The sprayer has a 400 gallon tank and is calibrated at apply 20 GPA. How much Aatrex 90 DF should be added to the tank?

1. Determine the number of acres you can spray with each tankful.

   Tank capacity (gallons/tank) / Spray rate (gallons/acre) = ________ number of acres/tankful

2. Determine the number of pounds of pesticide product needed per acre. In this case, 90 DF means that 90 percent of the contents of the bag is active ingredients.

   ______ lb a.i./A × 100 / 90 = _______ pounds of product/acre

3. Determine the amount of pesticide to add to each tankful.

   _____ acres/tankful × _____ pounds of product/acre = ______ pounds of product/tankful

Example 2. An trifluralin recommendation calls for 1 pound active ingredient per acre. Treflan 4E (4 pounds per gallon formulation) has been purchased. The sprayer has a 500 gallon tank and is calibrated to deliver 25 GPA.

1. Determine the number of acres you can spray with each tankful.

   Tank capacity (gallons/tank) / Spray rate (gallons/acre) = ________ number of acres/tankful

2. Determine the amount of pesticide product needed per acre, divide the recommended amount of active ingredient per acre by the concentration of the formulation.

   ______ lb a.i./A = _______ gallon/acre

   ______ lb a.i./gal

3. Determine the amount of pesticide to add to each tankful.

   _____ acres/tankful × _____ quarts (gallons) of product/acre = ______ quarts (gallons) of product/tankful