Section 24

Drift of Pesticides

Your goal is to get the pesticide from the application equipment to the intended target while avoiding non-target areas (such as nearby crops) and environmentally sensitive areas. The equipment you use could be a back pack sprayer, a seed drill, or a low pressure boom sprayer. The target could be a weed, a part of the crop plant, a seed or the seedbed.

As you decide on the best way to apply the pesticide, you need to remember the **"Three E's"** of application. The application needs to be:

- Effective
- Economical, and
- Environmentally friendly.

There is no one way to achieve these results. You must decide on the best method to avoid drift based on the:

- pesticide
- application equipment you have available to use
- environmental conditions that exist at the time of application
- crops and non-target areas adjacent to the area to be treated.

Different products, equipment and conditions make each pesticide application unique. However, to achieve the "Three E" results, some basic principles should be considered when applying pesticides.

This section defines drift and the conditions that cause it. It focuses on hov to use liquid sprays because that is how the majority of pesticides are applied to crops/plants. Suggestions for reducing drift by controlling or adapting to the conditions are included to help you decide on the best way to apply the pesticide product.

What is Drift?

Pesticides may move from the target site because of vapour drift and/or spray drift. Drift may reduce the effectiveness of the pesticide in the targeted area and may have a harmful effect on nearby plant or animal life.

Spray Drift (Particle Drift) is the movement of spray droplets away from the target area. This usually occurs when the wind is strong enough to pick up and carry the spray droplets. Small spray droplets drift more easily than large droplets. Granular and powder formulations will also drift. This type of drift is possible with all pesticides.

Vapour Drift is the movement of pesticide vapours. Some pesticides are volatile and change to the vapour state after a period of time in the air or on the plant. This vapour will be carried to other areas and may cause serious problems if susceptible plants are nearby. Vapour drift is a condition of the pesticide rather than the application method used.

Droplet (Particle) Size

Before you can understand how to reduce spray drift, you need to understand the behaviour of spray droplets.

The most important factor that affects drift is the initial size of the droplet. **Large droplets are not as likely to drift as smaller droplets.** The old saying "the bigger they are, the harder they fall" can be applied here. Actually, it could be said, the ***larger*** they are, the ***closer*** they fall. Equipment manufacturers focus on droplet size when designing nozzles to reduce drift.

The most common nozzle used is the flat fan style. This nozzle uses hydraulic pressure to "atomize" (form droplets) the spray mix into a wide range of droplet sizes. This range of droplet sizes provides a consistent result over a variety of spraying conditions. The small droplets will provide better coverage on the plants but these droplets are more likely to evaporate and drift. The small droplets slow down quickly once they leave the nozzle opening and take a much longer time getting from the nozzle to the target. Large droplets, on the other hand, resist evaporation and stay on target better (because they have more momentum), but they are also more likely to bounce off the plant and provide less coverage.

Before an application you must consider the range of droplet sizes that will be the best for the application. Insecticides and fungicides generally requir smaller droplets to obtain excellent coverage on all leaf surfaces. For a foliar herbicide application, a medium or coarse droplet size is usually used

How Droplet Size is Measured

Droplet size is usually measured in microns (micrometres). One micron equals 0.001 mm (one thousandth of a millimetre). To get an idea of the size of a micron, consider that one dime is about 1,270 microns thick.

Volume **M**edian **D**iameter (VMD or $D_{V0.5}$) is the common term used to describe the droplet size produced from a nozzle. The VMD is the droplet size at which one-half the spray volume consists of droplets larger than the VMD and one-half consists of the smaller droplets. VMD is a useful measure that allows you to make comparisons between nozzle types, spray angle and nozzle output (flow rate).

The following table shows the effect of droplet size on drift. The smaller droplets take longer to fall to the target, giving them more opportunity to be carried away in the air currents.

Effect of Droplet Size on Drift Potential

Diameter in microns	Time to Fall 10 feet in Still Air
1 (Fog)	28 hours
10 (Fog)	17 minutes
100 (Fog)	11 seconds
200 (Fine Spray)	4 seconds
400 (Coarse Spray)	2 seconds
1,000 (Coarse Spray)	1 second

Source: Ross, Merrill A. and Carole A. Lembi. 1985. Applied Weed Science. Burgess Publishing Company, Minneapolis, MN.

Droplets smaller than 100 microns are the droplets that are the most likely to drift.

Droplet sizes have been classified into fine, medium and coarse sprays by the British Crop Protection Council. The manufacturers of nozzles use this classification when describing the distribution of droplets from different types of nozzles.

Droplet Size Classification by the British Crop Protection Council

Classification	VMD	Description
Very fine	100	attach to under-leaf surfaces
Very fine/fine	154	tend to remain in the air
Fine/medium	241	land on stems and narrow leaves
Medium/coarse	356	land on large flat surfaces, like broadleaf weeds
Coarse/very coarse	451	wind tolerant, will run off crop

Remember – one nozzle can produce different classifications of droplets (different sizes) at different pressures. A nozzle might produce a medium spray at low pressure, but produce a fine spray when pressure is increased. The nozzle manufacturers can provide you with information on droplet size for each of the nozzles that they sell.

How to Manage Drift

Now that you understand some characteristics of droplets, you can make choices about your spray equipment and adjust your sprayer to reduce the chance of spray drift. You can also consider how to adjust your spraying for the environmental conditions at the application site (e.g. wind direction, sensitive areas nearby). The best way to prevent drift is to spray with a properly adjusted sprayer under the correct conditions.

Nozzle Type Selection

The type of nozzle you select is the most important factor affecting droplet size.

Choose the nozzle based on the pesticide you use, what the pest is, where it is, the kind and size of the target plant, and the weather conditions.

Nozzle Classification

Most manufacturers use similar systems to classify their nozzles. The example below shows how the manufacturer, Spraying Systems Co., describes its "TeeJet®" brand nozzles.

For TeeJet® nozzles, a combination letter and number system describes each type of nozzle.

For example, "XR 8002 VS" is a nozzle sold by TeeJet®.

XR	This describes the manufacturer's series; XR is "extended range".
80	This is the fan angle when spraying water at 40 psi; 80 degrees* (other angles are 110° and 65°).
02	This is the nozzle output in US gallons of water per minute; in this case 0.2 US gallons per minute at 40 psi.
VS	VS describes the nozzle material; in this example, "V" means the VisiFlo colour code and "S" means stainless steel.

* Wider angles produce finer sprays and allow the boom to be closer to the ground.

The chart below shows the prefixes (leading letters) that Spraying Systems Co. uses for the flat fan nozzles that they sell.

Prefixes of Spraying Systems Co.® Flat Fan Nozzles

Prefixes	Description	Features
XR	Extended Range	Maintains good spray pattern between 15 and 60 psi
DG	Drift Guard	Uses a pre-orifice design to give a coarse spray at standard pressures and nozzle output – pressure range 30 to 60 psi
AI	Air Induction	Uses a venturi to draw in air mixing with spray liquid to form coarse droplets.
TT	Turbo Jet	Uses a swirl chamber and a turbo flood jet design to create a wide angle coarse spray – pressure range 15 to 90 psi
TJ	TwinJet	Contains two orifices, one oriented slightly back, and the other slightly forward, to produce a finer spray at a given nozzle rate.

Colours

Newer nozzles follow a standard colour coding system which quickly identifies the nozzle output (flow rate) for you. Be careful with older nozzl – they are also coloured, but the colouring does not match the new standard colour coding system.

Nozzle Tip Colour	US Gallons per Minute at 40 psi
Orange	0.1
Green	0.15
Yellow	0.2
Blue	0.3
Red	0.4
Brown	0.5
Gray	0.6
White	0.8

Droplet size is influenced by the internal design of the nozzle. You must decide what type of nozzles you need to use to produce the right quality of spray for your application. The nozzle type you choose will determine the nozzle output (flow rate).

Nozzle Output or Flow Rate

Nozzles that give a higher output (flow rate) will produce larger droplet sizes because they have a larger opening (orifice). The following table shows how droplet size changes with different nozzle types when pressure remains the same.

Nozzle Type 40 psi	Flow Rate		
	0.2 GPM	0.5 GPM	0.8 GPM
	Volume Median Diameter in microns		
STD TeeJet® 80º	260	360	440
XR TeeJet® 80º	270	370	450
TT TeeJet® 110º	340	450	--
DG TeeJet® 80º	340	410	--

Source: TeeJet® Catalog 45A

The table shows that, if you choose nozzles with higher outputs, the spray will be coarser and less likely to drift. You will have to refill your tank mor often, but the increased amount of water or other carrier improves coverage and can increase pesticide effectiveness.

Spray Pressure

Spray pressure is one way to change the droplet size. The pressure affects the formation of the droplets as they leave the nozzle. Lower pressures create larger droplets. Higher pressures create smaller droplets. You might think that if you increase the pressure and speed up the droplets you get better spray penetration. But this does not improve penetration. Studies show that, although the droplets initially move faster, this does not last long.

Do not operate nozzles at pressures below their working limits. Follow the pressure recommended by the manufacturers. A pressure lower than recommended will prevent the spray plumes from reaching the designed spray angle. The spray from the boom will be less uniform.

Travel Speeds

A faster travel speed can increase drift. A faster travel speed across the field will lead to a faster breakup of the droplets in the spray sheet (shearing effect). Smaller droplets will be created, leading to drift. Even if you use a larger nozzle to produce a coarser spray, the shearing effect that comes with a higher travel speed may offset the benefits of the larger nozzle. Always decide what nozzle size and travel speed are appropriate under your spray conditions at the time.

Spray Angle

Wider spray angle nozzles can help to decrease drift. Nozzles that have wider spray angles (e.g. 110^{o}) create smaller droplets than nozzles with narrower spray angles (e.g. 80^{o}). Although smaller droplets are usually considered a disadvantage, the wider angle nozzles allow you to place the boom closer to the target. This placement greatly reduces drift. Using a lower pressure will help to prevent the formation of the smaller droplets.

Boom Height (Nozzle to Target Distance)

Lowering the boom of the sprayer can help to decrease drift. A lower boom reduces the distance that the spray droplets must travel and minimizes the effects of air currents. Each type of nozzle tip has a differen nozzle-to-target distance so check with the manufacturer for more information.

Take care to maintain a stable boom height to ensure uniform coverage. Booms that bounce cause uneven coverage and drift.

Wind Speed

Spray operations should be carried out when winds are light to moderate. If you notice that drift is occurring because of the wind, stop spraying until the wind subsides.

Drift can also occur even if you spray under calm conditions. When temperatures are cooler and humidity is high, the life of the droplet will be longer. Fine spray droplets will hang in a layer of air close to the ground. As the sun rises, increasing soil and air temperatures cause this layer of air to move, taking with it small pesticide droplets that could cause drift six or seven hours after the spray application.

The Beaufort Scale

The Beaufort Scale (or Beaufort Wind Force Scale) is a method for estimating wind strength without the use of instruments. It is based on observing the effects wind has on the physical environment. The scale was devised in 1805 by Sir Francis Beaufort, a British naval commander (1774-1875). The scale is still useful today to estimate wind speeds, especially when anemometers are not available.

The following table shows the standard Beaufort Scale measurements in the first three columns. Two more columns have been added to describe spraying conditions and the approximate airspeed at boom height.

Beaufort Scale	Description	Wind Effects on Land	Spraying Notes	Approximate Airspeed at Boom Height
Force 0	Calm	Smoke rises vertically	Avoid fine sprays on warm sunny days	Less than 2.0 km/h (1.2 mph)
Force 1	Light Air	Direction shown by smoke drift	Avoid fine sprays on warm sunny days	2.0 to 3.2 km/h (1.2 to 2.0 mph)
Force 2	Light Breeze	Leaves rustle, wind felt on face	Ideal Spraying	3.2 to 6.5 km/h (2.0 to 4.0 mph)
Force 3	Gentle Breeze	Leaves and twigs in constant motion	Good Spraying	6.5 to 9.6 km/h (4.0 to 6.0 mph)
Force 4	Moderate	Small branches moved, raises dust	Avoid pesticides with finer sprays	9.6 to 14.5 km/h (6.0 to 9.0 mph)
Force 5	Fresh Breeze	Small trees sway	Exercise extreme caution with all sprays	
Force 6	Strong Breeze	Large branches sway	Off target movement very likely	
Force 7	Moderate Gale	Whole trees in motion	Better luck tomorrow	

Wind Direction

Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive areas. Try to spray when the wind direction is stable, and blowing away from these areas. Always wait for a period of low wind speed.

Temperature and Relative Humidity

Air temperature and relative humidity affect droplet life. As soon as a droplet leaves the nozzle, it begins to evaporate. On a very warm day, spray droplets will evaporate more quickly and are more likely to drift. Large droplets may become very small during the time it takes them to travel the distance between the nozzle and the target. As a general rule, if the relative humidity is above 70 percent, the conditions are ideal for spraying. Spraying at a relative humidity below 50 percent may increase drift.

Temperature Inversions

A **temperature inversion** occurs when cool air near the soil surface is trapped under a layer of warmer air. This happens at night when the earth cools off. Under these conditions there is very little mixing of the air, even with a breeze. If you spray too early in the morning when the temperature is still cool, small spray droplets may remain suspended over the treated area for long periods of time. These small droplets hang like a cloud or fog over the treated area until the first gentle breeze. Then the wind can move this drift cloud to sensitive areas causing severe damage. To avoid problems caused by a temperature inversion, wait until the temperature has risen 2 to 3Esince sunrise before spraying.

Volatile Formulations

Some pesticides change more quickly into vapour than others. They have a high volatility. To reduce volatility, avoid spraying when temperatures are high, and use low volatility formulations. For instance, 2,4-D is available in amine or ester formulations. The ester formulations are volatile, so only the amines should be used near susceptible crops.

Adjuvants

Adjuvants will affect droplet size by changing the physical properties of the spray mix (e.g. viscosity and surface tension). How droplet size is affected depends on the specific adjuvant and can also depend on the formulation of the pesticide. Some adjuvants increase droplet size, others decrease it, while others have no effect at all.

Buffer Zones

Do not spray right to the edge of environmentally sensitive areas such as woodlots, ponds, and stream banks. Leave an untreated area of natural vegetation to protect these areas. This is called a buffer zone. Some pesticide labels tell you to leave a buffer zone when you spray, but others may not. A buffer zone is always a good idea, whether or not the label says so.

Hoods, Screens and Air Assist

You can protect the spray from air currents by using:

- < hoods
- < perforated screens
- < air assist.

Individual nozzle hoods protect the top portion of the spray. Other hoods cover the whole boom. There are some disadvantages to using hoods. For example, you must keep a near perfect seal at the front and back of the shields to prevent air movement underneath. Some boom hoods make it impossible to see your nozzles and force you to use a monitoring system.

Perforated screens reduce the air speed passing over the spray. Small droplets hit and stick to the screen, combine with others, and fall to the target. One disadvantage of these screens is that they may affect how the boom folds.

Air Assist or air curtain sprayers use an air stream to carry small droplets down to the target. The air gives the droplet momentum and prevents it from hanging in the air. Its exposure to air currents is reduced. When using an air assist sprayer, you must adjust the speed and direction of the air stream to match the crop canopy and the environmental conditions of the application.

All hoods and screens must be carefully cleaned to prevent contamination t other crops and sensitive plants.

Wiper or Wick Weeders

You can apply a herbicide with a wiper or wick weeder to eliminate drift. Since no droplets are formed, no spray drift is possible. For wick weeders to work well, the weeds must be higher than the crop so that the weeds are the only plants touched by the herbicide. Two passes in the opposite direction may be needed to adequately apply the herbicide.

Read the Label

Always read and follow the label directions. Instructions on the label include information about ways to reduce drift and procedures to follow when you apply near and around environmentally sensitive areas. Look for specific directions about:

- < water volumes (sprayer outputs)
- < nozzle and pressure suggestions
- < acceptable conditions for spraying
- < weather conditions to avoid.

Remember, only use a pesticide when necessary and use it according to label directions.

Review Questions

1. What is spray drift (particle drift)?

2. Large droplets are not as likely to drift as smaller droplets.

   TRUE FALSE

3. What is Volume Median Diameter (VMD)?

4. If leaves are rustling, and wind can be felt on your face, should you be spraying pesticides?

5. Which of the following is the **most** important factor affecting spray droplet size?

   a) travel speed
   b) spray pressure
   c) type of nozzle
   d) relative humidity