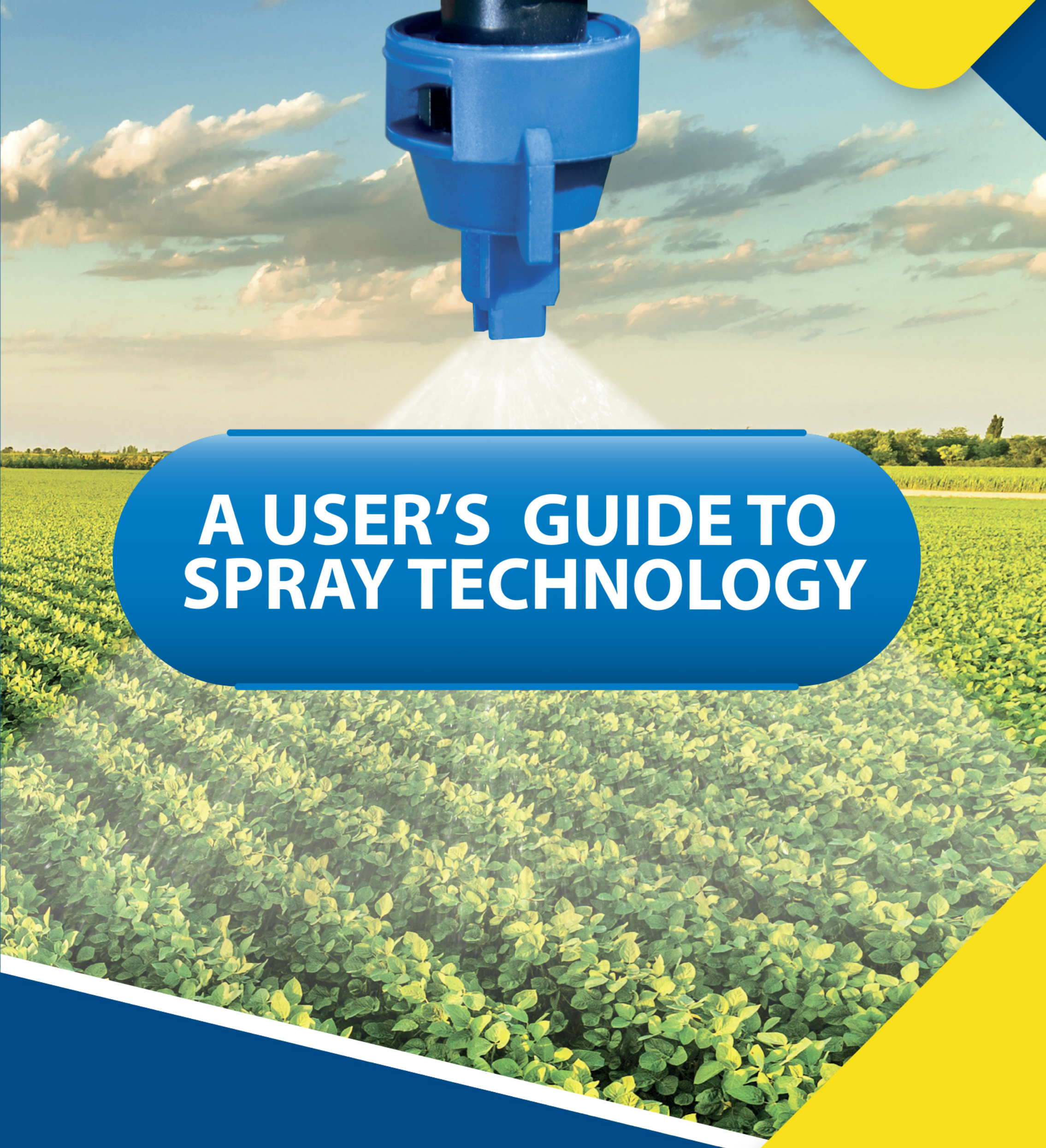


A USER'S GUIDE TO SPRAY TECHNOLOGY

TeeJet® TECHNOLOGIES

TeeJet® Technologies

At **TeeJet Technologies** our primary focus is on application technology. Our company and products have been part of agricultural, turf, and right-of-way applications since the first crop protection products came on to the market in the 1940's. This knowledge and experience in the areas of spraying and fertilizing means no other company is better suited to provide quality products and technical solutions for your business.

Innovative, industry-leading products are what you expect from **TeeJet Technologies**. However, there is more to our company than great products. We also possess a wealth of technical information about applications and technologies that we wish to share.

Spray nozzles are highly engineered, precision components. Full consideration should be given to the manufacturer and the manufacturer's capabilities.

Content

Preface

A ***User's Guide To Spray Technology*** is educational and informative, providing the most relevant and high-quality content related to Application Technology. It provides facts, not opinions.

In this guide, you will find content that will help improve your application technology knowledge in a simple, practical, and effective way. This will help you to achieve safe, efficient, and environmentally responsible applications with high-performance. We hope this guide enables you to better evaluate performance claims published by all nozzle manufacturers.

1 Introduction to Application Technology

1.1 Introduction to Application Technology

In the past few decades, agriculture has evolved a lot in terms of:

- Seed quality.
- Crop genetics and characteristics.
- Crop protection product molecules are becoming more effective and less toxic to humans.
- Crop protection product application technology improvement.
- New agriculture equipment that offers greater efficiency and safety during the application.
- Spray tips engineered to reduce drift and provide better performance, ensuring that the applied product stays in the field and on the target.

This application technology improvement has occurred in response to a better understanding of many factors, such as:

- The knowledge of the target and its location.
- The spraying equipment type and its parts.
- The environment type and weather conditions where the application will occur.
- The correct moment for the application.
- The product type that will be applied.

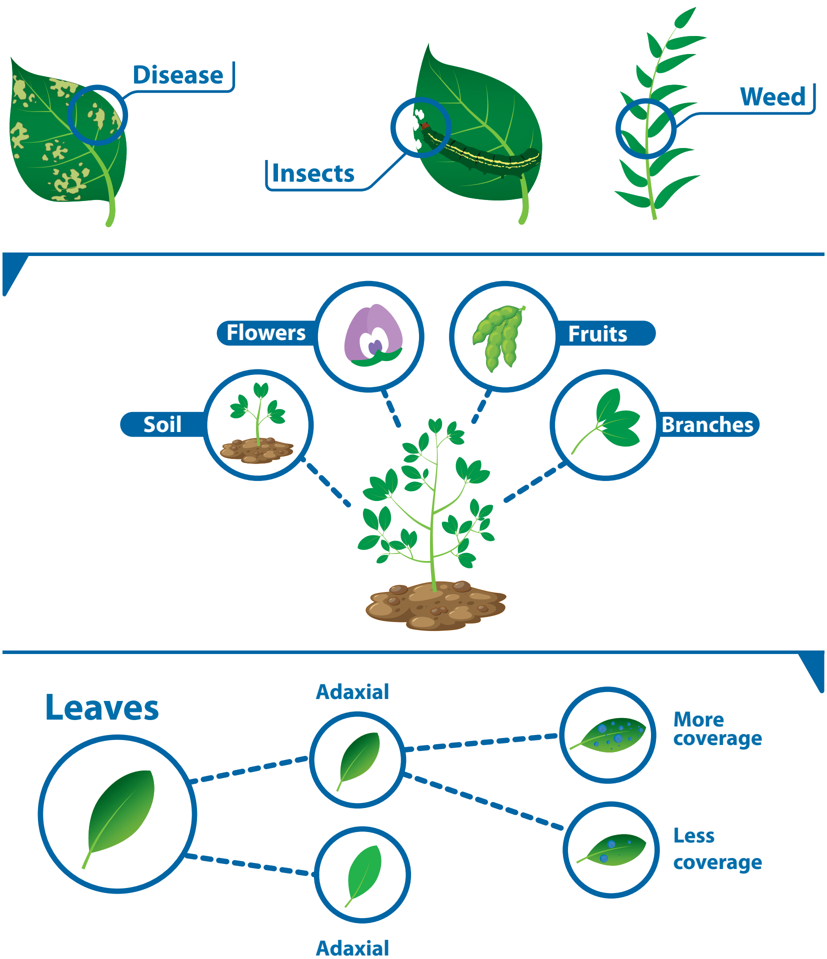
Crop protection product application technology can be defined as the use of scientific knowledge that provides the correct placement of the biologically active product on the intended target in the necessary quantity, in an economical manner, and with minimal contamination of non-target areas (MATUO, 1990).

To have a successful application, it is necessary to understand the entire process and answer some questions:

- What is the target pest and where is it located?
- In which growth stage will the application occur?
- Where is the crop protection product application going to take place?
- What are the ideal weather conditions?
- What type of product will be applied, and how does it translocate in the plant?
- What type of sprayer will be used to apply crop protection products?
- What spray tip should I use? Who is the spray tip/nozzle manufacturer and why does it matter?

1.2 What is the target and where is it located?

To choose the appropriate crop protection product and application technology to control the target, it is important to understand where it is placed in the field. Is this target in the soil, or in the flowers, fruits, branches, leaves? Is it on the lower surface (adaxial) or upper surface (adaxial) of a leaf? Does it need more or less coverage to be controlled?

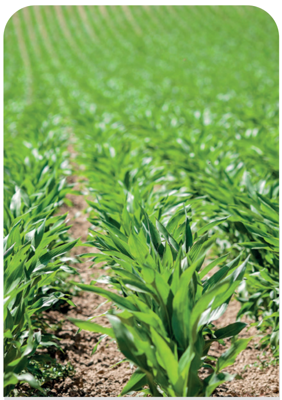


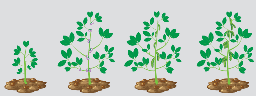
TeeJet TECHNOLOGIES

1.3 In which crop growth stage will the application occur?

The crop protection product application occurs at different times along the crop growth stages, with a variation of vegetative mass amounts on the field leading to adjusting the ideal technology for the application. Areas with an open canopy (left photo), require the choice of a spray tip that provides different coverage and penetration than areas with a greater plant density - canopy is completely closed (right photo).

Beginning of the vegetative growth stage:
Open canopy.





End of the vegetative growth stage and beginning of the reproductive:
Canopy starting to get more closed, but still possible to see rows.

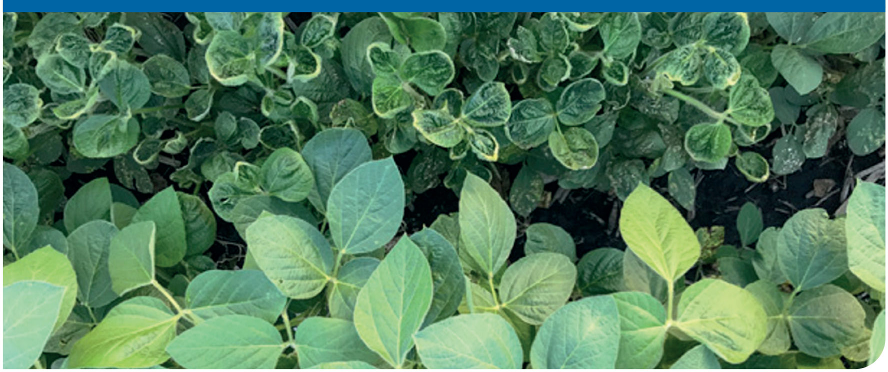
End of reproductive growth stage:
Canopy completely closed.

1.4 Where is the crop protection product application going to take place?

If the application occurs near susceptible crops, urban areas, livestock, or bodies of water (rivers, lakes, and ponds), the concern should be for maximum application safety. Several things should be considered to help keep the product on the target, such as spraying under the recommended weather conditions and choosing a spray tip engineered to produce fewer fine droplets that could drift off-target.

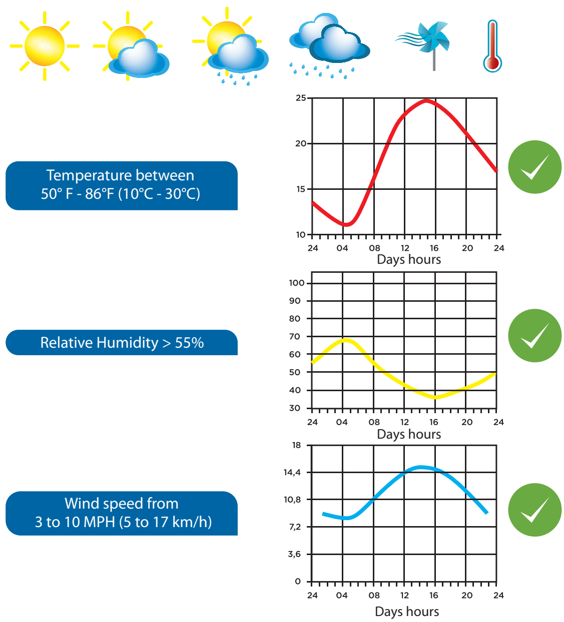
Urban areas

Surrounding susceptible crops



1.5 What are the ideal weather conditions?

Temperature, relative humidity, wind speed, and wind direction all influence the effectiveness of the crop protection spray application. The recommended weather conditions for a safe application are temperatures lower than 86°F (30°C) and above 50°F (10°C), relative humidity higher than 55%, and wind speed between 3 and 10 MPH (5 and 17 km/h)*.



As illustrated above, temperature, relative humidity, and wind speed vary throughout the day. Therefore, it is necessary to be attentive to the weather conditions during the application to control the crop protection product applications and to prevent spray drift.

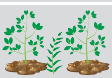
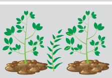
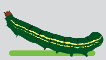
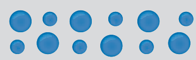
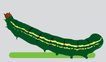
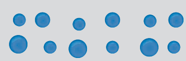
Hint: spray your most sensitive areas during the best conditions of the day

*** According to the crop protection products labels.**

1.6 What type of product will be applied and how does it translocate in the plant?

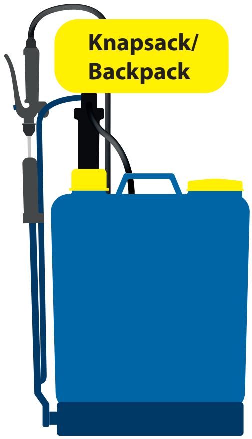
The different categories of products: fungicides, insecticides, and herbicides, depending on the form of translocation within the plant, will determine the best coverage to effectively control the fungi, insect, and weed, respectively. Contact products, that do not translocate inside the plant need more complete coverage than systemic products.

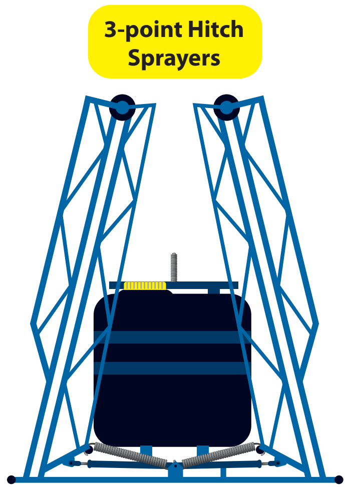
The table below shows the ideal coverage of different crop protection products according to the number of droplets per square area. The information on this table is an important indicator to understand if the chosen parameters, such as spray tip, flow rate, and operating pressure are adequate to provide the ideal coverage of the intended target.

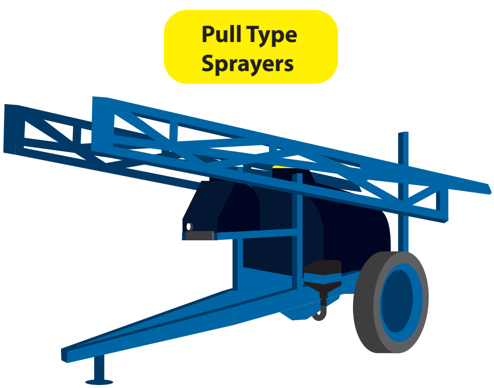
Target	Product	Droplets / cm²	Droplets Size
	Pre-emergent herbicide	20 to 30	
	Post-emergent systemic herbicide	20 to 30	
	Post-emergent contact herbicide	30 to 40	
	Systemic insecticide	20 to 30	
	Contact insecticide	50 to 70	
	Systemic fungicide	50 to 70	
	Contact fungicide	> 70	

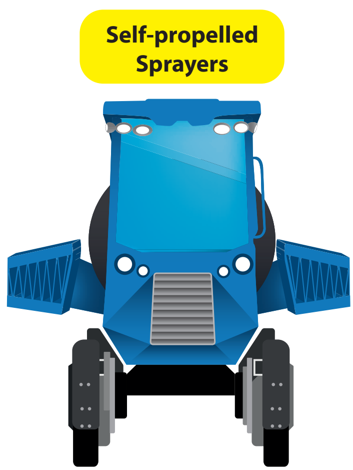
1.7 What type of sprayer will be used to apply crop protection products in your field?

Each original equipment manufacturer (OEM) produces several types of sprayers with different configurations that will generally be adjusted and calibrated to different applications. conditions.





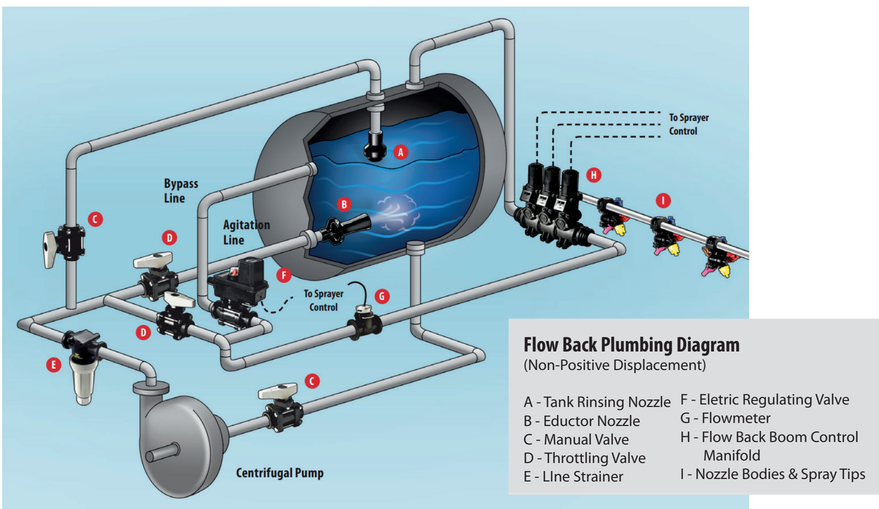




1.7.1 What type of sprayer will be used to apply crop protection products in your field?

Most boom sprayers have many different components, such as tank rinse nozzles, tank mixing nozzles, manual or electric shutoff valves, pressure relief valves, manual or electric regulating valves, flowmeters and/or pressure sensors, strainers, spray tips, and caps for attaching and sealing the tip while spraying.

Making sure you know each of these components and that they are properly working will result in higher performance at the time of application. Spray tips need special attention because they are responsible for producing and delivering the droplets with the crop protection product active ingredient during the application (MATUO, 2001).



Flow Back Plumbing Diagram
(Non-Positive Displacement)

A - Tank Rinsing Nozzle
B - Eductor Nozzle
C - Manual Valve
D - Throttling Valve
E - LIne Strainer
F - Eletric Regulating Valve
G - Flowmeter
H - Flow Back Boom Control Manifold
I - Nozzle Bodies & Spray Tips

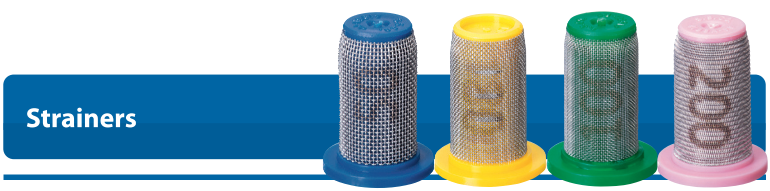
1.8 What spray tip should I use?

Each spray tip is carefully engineered to provide adequate performance according to the product, target, and timing of application. A poor choice in spray tips or use of underperforming tips can lead to re-spraying, reduced performance, or even an environmental and/or neighbor contamination problem.

The spray tip model will determine:

- The amount or volume of crop protection product applied to an area.
- The uniformity of the application.
- The coverage of the crop protection product applied on the target surface.
- The amount of potential drift.

It is also necessary to choose the recommended strainer mesh size according to the spray tip model and its capacity. This will help to avoid unnecessary clogging of the spray tip.

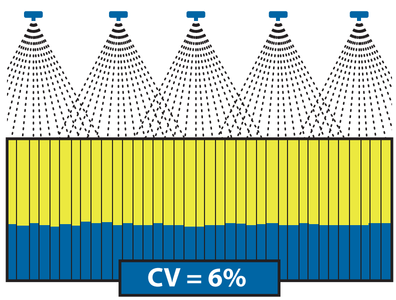


1.9 Who is the nozzle manufacturer and why does it matter?

The choice of a high quality spray tip will ensure maximum performance during application while maintaining the highest safety.

Quality spray tip manufacturers must have the experience, knowledge, and willingness to produce spray tips with tightly controlled flow rate repeatability and distribution across the boom swath for maximum performance.

TeeJet® Technologies spray tips are precisely designed and manufactured to provide maximum performance, quality, and safety. They comply with the highest requirements of the international performance rating and certifying institutes. Some of those institutes are referenced below.



* See page 41 for more infromation on CV

Germany — JKI Julius Kühn-Institut

UK — LERAP ★★★ · LERAP ★★

France — INRAE

United States — EPA

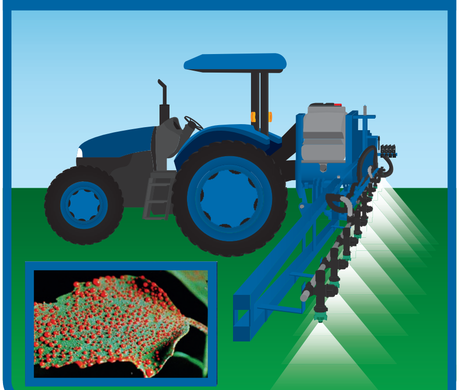
ISO

2.1 What is the difference between an application and spraying?

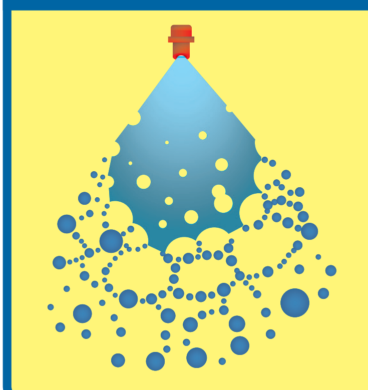
Application – consists of the use of the appropriate techniques to place the active product on the target as recommended by the product manufacturer.

Spraying – consists of the fragmentation of atomized liquid into droplets, without necessarily hitting the target.

Application



Spraying



2.2 What is the difference between a spray tip and a nozzle?

Both spray tips and nozzles have a very similar role in their function: spraying. They are often referenced interchangeable, but there are slight differences.

The main difference between the spray tip and nozzle is how they are attached to the cap.

Spray nozzles generally have a thread to connect directly to the cap, presenting a set with a few parts. In some situations, a nozzle can be attached directly to the boom - via the thread.

A spray tip features a flanged base that fits into the cap, and creates an assembly that can attach to a nozzle body.

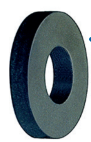
Nozzle

Threaded TurfJet nozzle

Cap

Spray Tip

Flanged base TT spray tip



Cap and gasket Quick TeeJet®

A spray tip does not work by itself, and it needs to be part of a nozzle assembly, which is made up of:

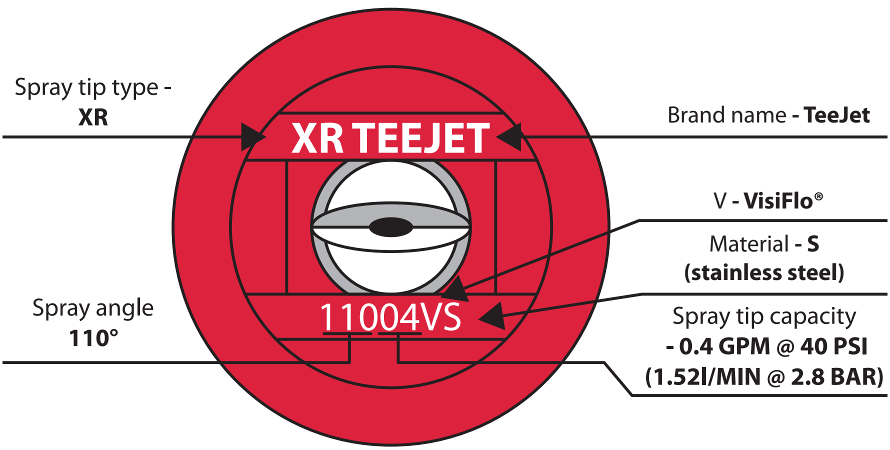
Functions of spray tips:

- Determine flow rate (quantity/ volume).
- Produce droplets of a certain size (quality).
- Allow a good distribution of the sprayed liquid (quality).

2.3 Spray tip nomenclature

Most TeeJet® Technologies spray tips feature the following markings:

- The tip type.
- The brand.
- A sequence of two to three numbers representing the spray angle (usually 80° or 110°).
- A sequence of two to four numbers that represent the tip nominal flow rate in US Gallons per minute - GPM at 40 PSI (2.8 bar) - (0067,015, 02, 03, etc).
- In some cases, just after the nominal flow rate, there is the letter "V", indicating that the tip is classified according to the VisiFlo®/ ISO color coding system.
- The last letter represents the material the tip is made of (P – polymer, K – ceramic, and S – stainless steel).



2.4 Nominal flow rate

The nominal flow rate of a spray tip is determined by the volume sprayed by this tip, in a unit of time, when operated at 40 PSI of pressure (or 2.8 bar) with water at 69.8ºF (21ºC). The flow rate printed in a spray tip is represented in North American Gallons per minute (GPM) (1 GPM = 3.785 l/min).

2.5 VisiFlo® system/ ISO color standard

VisiFlo® is a color-coding classication system, in which each-color represents the nominal ow of a spray tip at 40 PSI (2.8 bar). The VisiFlo® system was developed by TeeJet® Technologies in 1985 and quickly became a standard classication system in the agricultural spray tip industry, as well as by the international ISO 10625 standard.

VisiFlo® and ISO 10625 Color Coding Standard Table

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
01	**0.10**	**0.38**	**Pure orange**

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
015	**0.15**	**0.57**	**Traffic green**

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
02	**0.20**	**0.76**	**Zinc Yellow**

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
025	**0.25**	**0.95**	**Signal violet**

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
03	**0.30**	**1.14**	**Gentian blue**

Spray Tip Flow Rate	Capacity (GPM at 40PSI)	Capacity (l/min at 2.8 bar)	Color
035	**0.35**	**1.33**	**Purple red**

Spray Tip Flow Rate
04

Capacity (GPM at 40PSI)
0.40

Capacity (l/min at 2.8 bar)
1.52

Color
Flamed red

Spray Tip Flow Rate
05

Capacity (GPM at 40PSI)
0.50

Capacity (l/min at 2.8 bar)
1.89

Color
Nut brown

Spray Tip Flow Rate
06

Capacity (GPM at 40PSI)
0.60

Capacity (l/min at 2.8 bar)
2.27

Color
Signal grey

Spray Tip Flow Rate
08

Capacity (GPM at 40PSI)
0.80

Capacity (l/min at 2.8 bar)
3.03

Color
Traffic white

Spray Tip Flow Rate
10

Capacity (GPM at 40PSI)
1.0

Capacity (l/min at 2.8 bar)
3.79

Color
Light blue

Spray Tip Flow Rate
12

Capacity (GPM at 40PSI)
1.2

Capacity (l/min at 2.8 bar)
4.55

Color
Raspberry red

Spray Tip Flow Rate
15

Capacity (GPM at 40PSI)
1.5

Capacity (l/min at 2.8 bar)
5.68

Color
Yellow green

Spray Tip Flow Rate
20

Capacity (GPM at 40PSI)
2.0

Capacity (l/min at 2.8 bar)
7.57

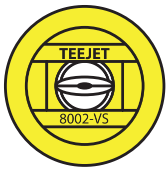
Color
Graphite black

2.6 Spray tip materials

The spray tip material is responsible for the tip's capability to resist wear due to abrasion and the chemical attack of applied product damage. Regardless of the tip material, the spray quality and performance are related to the design and quality of the manufacturer.

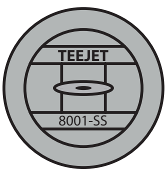
Spray tips used for crop protection product applications can be manufactured in polymer, stainless steel, ceramic, hardened stainless steel, and brass. The three materials boxed in red are the main materials used by TeeJet® Technologies for agricultural spray tips.

VP
Polymer
VisiFlo®

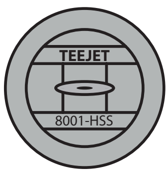


VS
Stainless Steel
VisiFlo

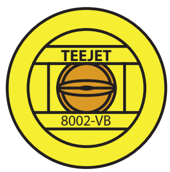
VK
Ceramic
VisiFlo



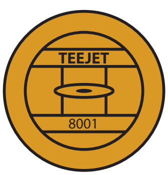
SS
Stainless Steel



HSS
Hardened
Stainless Steel



VB
VisiFlo
Brass



Brass

Ceramic Tips

Example:

XR 11003 VK

Good resistance to:

- Chemicals
- Abrasives
- Corrosives
- Damage

Note:

The strength of ceramic tips means greater resistance to the material. Spray quality of ceramic is similar to that of polymer and stainless steel, depending on the specific nozzle manufacturer.

Examples of TeeJet ceramic spray tips:

Polymer Tips

Example:

XR 11003 VP

- Good chemical resistance
- Excellent molding properties
- Long wear life
- Great performance, quality, and durability
- Orifice is susceptible to damage when cleaned improperly
- Polymer can, in some cases, be more fragile than other materials and can be damaged more easily. However, with advancements in manufacturing techniques and with proper care, the life wear of plastic nozzles can be quite good.
- TeeJet® uses four polymer types to produce tips on its portfolio:
  - Acetal
  - UHMWPE
  - Nylon
  - Polypropylene

Polymer Tips

Example:

XR 8003 VS

- Excellent chemical resistance
- High precision in tip flow rate
- Orifice with lower susceptibility to damage

2.7 Types of spray tips

There are many different types of tips and spray patterns available; the best choice will depend on the application. The most common types are flat fan, cone spray, and streaming nozzles (solid stream).

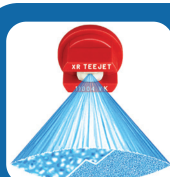
Flat fan

A flat fan spray tip forms a thin spray pattern, like an inverted “V” letter. In a typical broadcast spraying application the deposition is heaviest at the center of the pattern and dissipates towards the outer edges. A uniform distribution pattern across the boom is achieved when the boom height and tip spacing are optimized for proper spray pattern overlap of adjacent tips.

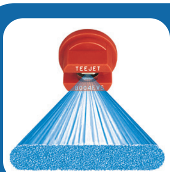
Flat fan type variations include:

- Extended flat fan for broadcast spraying - designed to operate with a wider range of spray pressure.
- Even flat fan for band spray – non-tapered spray pattern provides even coverage without overlapping.
- Flooding or deflector flat fan for broadcast application - wide angle flat pattern using larger droplets. New deflector type flat fan sprays tips produce larger droplets, with a more uniform droplet size, and a lower coefficient of variation (check page 41 for more information).

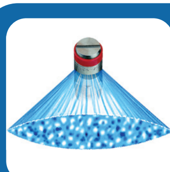
Flat fan spray pattern

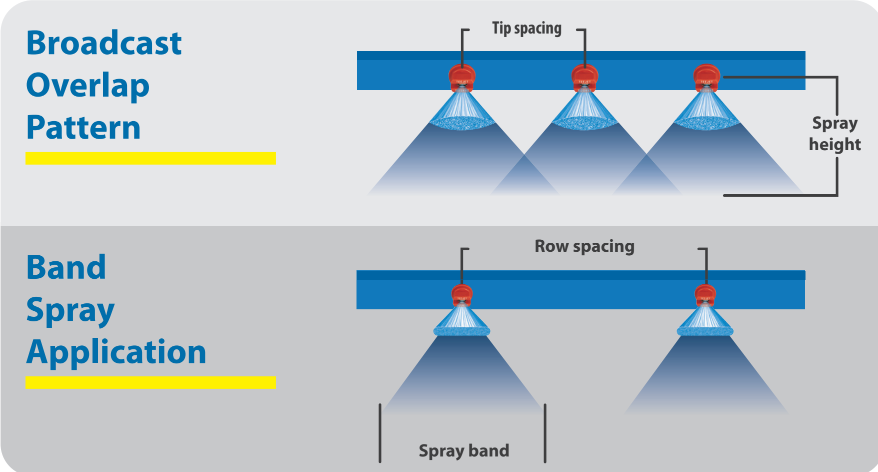


Extended range flat fan spray pattern



Even spray pattern


Wide angle flat fan spray pattern (Deflector)



Hollow cone

The hollow cone spray tip forms a circular-shaped pattern, producing very fine to fine droplets, providing good coverage* and penetration. These unique characteristics make hollow cone tips well suited for air blast applications, as well as specialty and directed spray applications. Hollow cone tips may be offered in a single-piece tip design or a two-piece disc and core design.

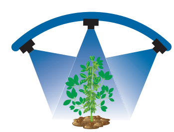
- **Air induction hollow cone**

Air induction hollow cone tips are a more recent development that produce a spray pattern like a traditional cone spray, but with much coarser droplets to reduce drift.

Hollow cone single-piece tip example – TXA

Hollow cone two-piece tip example – Disc-Core

Air Induction Hollow Cone tip example – AITXA

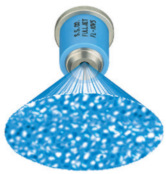


Spray band application

*** Hollow cone spray tips, in general, when positioned in sprayers with horizontal booms provide uneven deposition along the treated area, as adjacent sprays do not overlap properly, resulting in areas that will receive an underdose or overdose at the time of spraying.**

Full cone

The full cone spray tip creates a filled, circular spray pattern. Full cones typically produce coarser droplets and are offered in larger capacities than hollow cone spray tips. These spray tips are typically used for airblast sprayers, directed spraying and other specialty applications.



Full cone single-piece tip example – FL

Full cone two-piece tip example – Disc-Core

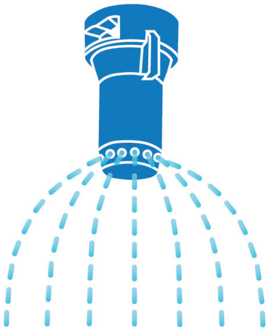
Directed spraying example

Solid Stream

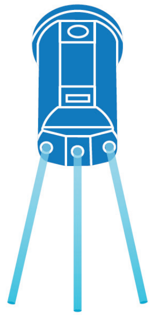
Solid stream spray tips are offered in a variety of sizes anywhere from 1 to 7 individual streams. By utilizing individual liquid streams instead of a fan spray, liquid fertilizer can be applied more directly to the soil surface where it is needed. This minimizes foliar coverage in standing crops reducing the chances of leaf burn and makes the likelihood of spray drift extremely low. Fertilizer streaming tips are not recommended for pesticide application.

- 3-stream (or similar) tips produce a narrower coverage area and project liquid more directly to the soil surface. These are more commonly used in directed spray applications.
- 7-stream (or similar) tips produce a wider coverage area making them ideal for broadcast application in both standing crops and bare soil. Due to the greater number of streams and wider spray pattern these tips are ideal for higher boom heights as well as higher ground speeds.

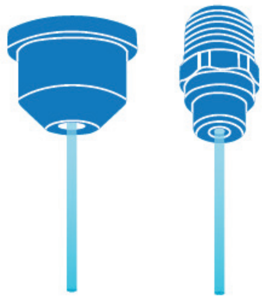
Single stream tips are often used in conjunction with a coulter or knife which creates a trench in the soil surface and allows the liquid fertilizer to penetrate into the root zone where it is most accessible to the plant.



7-stream tip



3-stream tip

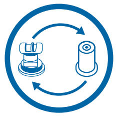


Single stream tip

2.8 Factors affecting spray distribution

The factors that directly affect the spray distribution over the treated area are:


Spray tips


Spray tip type

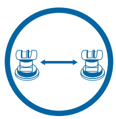

Spray pattern


Tip capacity


Liquid pressure


Spray angle


Spray tip
overlap pattern


Tip spacing

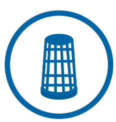

Spray pattern quality


Boom height

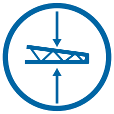

Spray tip wear


Pressure drop

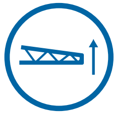

Clogged or
damaged tips


Clogged strainers

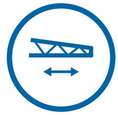
In addition, under field conditions, other factors can impact spray distribution, such as:



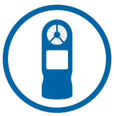
Boom stability



Vertical movements



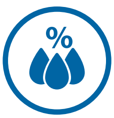
Horizontal movements



Weather conditions

Wind speed

Wind direction



Air relative humidity

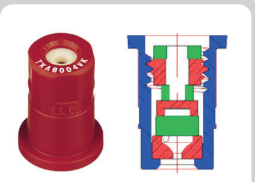
Presure drop (sprayer)

Sprayer travel speed
and turbulence

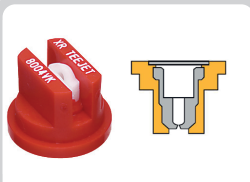
2.8.1 Spray tip type

TeeJet® Technologies offers an extensive selection of tips designed to maximize the performance of your crop protection product application. Your best choice will depend on the target, crop protection product, and application time.

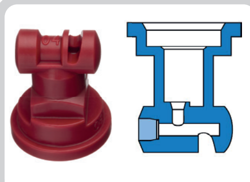
Each spray tip features specific characteristics that were developed for different applications, such as droplet size, spray pattern, spray angle, dual spray pattern, and attack angle. Therefore, to obtain an adequate distribution, it is important to use the same tip type and capacity along the entire spray boom.



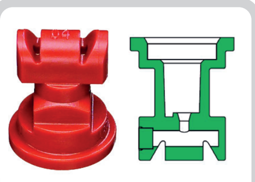
TXA
Hollow cone



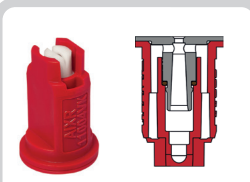
XR
Simple flat fan



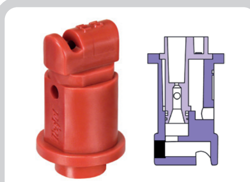
TT
Turbo flat fan



TTJ60
Turbo twin flat fan



AIXR
Air induction flat fan



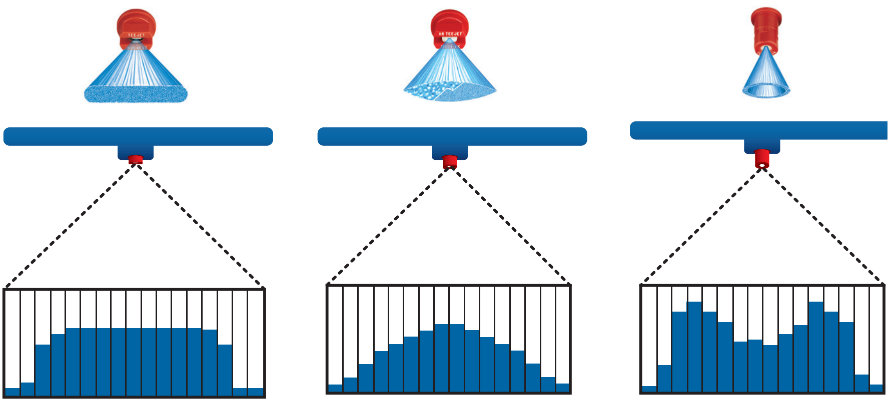
TTI
Turbo air induction flat fan

2.8.2 Spray pattern

Even flat fan provides even coverage without overlapping and is recommended for banded applications.

Flat fan includes the most used spray tips for agricultural use due to producing a low coefficient of variation* over the treated area when the adjacent sprayer overlaps properly.

Hollow cone tips are not recommended for broadcast applications because the spray pattern of these tips does not provide an ideal overlap of adjacent sprays along with the boom.

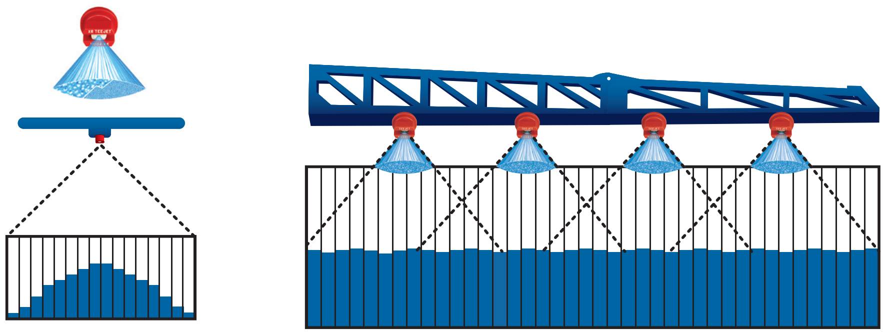


Even flat fan | **Flat fan** | **Hollow cone**

***Check page 41 for more coefficient of variation information.**

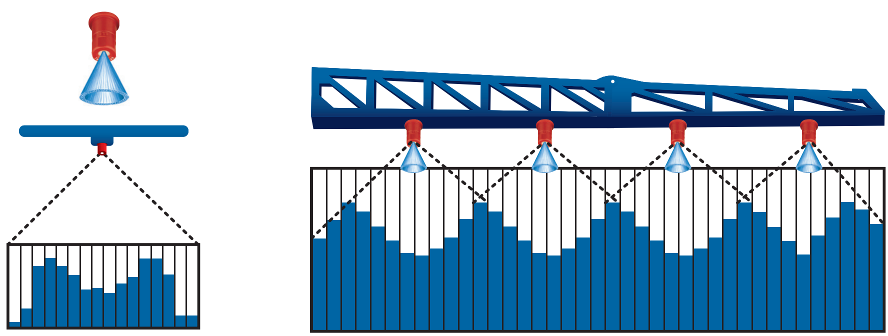
2.8.3 Spray pattern overlap

As we previously mentioned, flat fan tips form a tapered pattern, and the optimum overlap will result in a uniform application. Spray tips must be placed so patterns overlap a minimum of 30% on each spray tip pattern edge.



Ideal overlap

The hollow cone spray tips may provide a very uneven distribution across the treated area because the adjacent distributions may not overlap properly. Some areas could receive overdoses while others receive an insufficient amount of the sprayed product.



Poor overlap

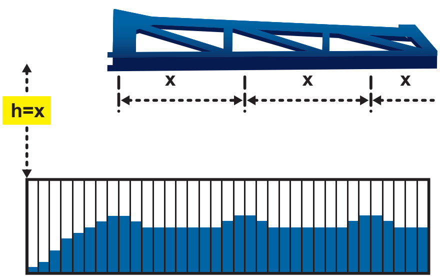
***Full cone spray tips produce a similar uneven distribution as hollow cone tips.**

2.8.4 Tip spacing and boom height

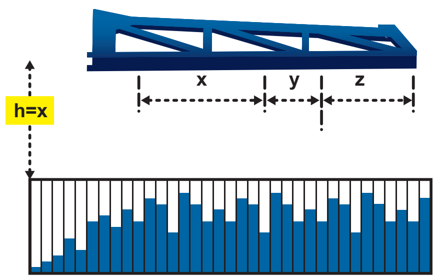
Spray tip spacing and boom height must be adjusted according to the spray tip manufacturer's recommendation. A uniform distribution across the boom is achieved when the spray boom height and tip spacing are adjusted to cross the adjacent fans correctly. These heights are based on laboratory testing and provide the overlap required to obtain uniform distribution.

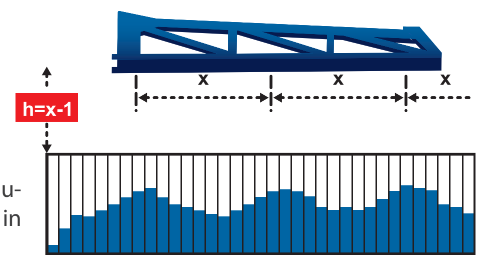
In many cases, typical adjustments are based on 1:1 tip spacing to height ratio. For example, 110° angle flat spray tips, when spaced 20”/50 cm apart are commonly set 20”/50 cm above the target.

Proper ratio between tip spacing and boom height.



Tip spacing unlike the spray tip manufacturer's recommendation, results in uneven distribution.





Boom height unlike the spray tip manufacturer's recommendation, resulting in uneven distribution.

*** Always check the spray tip manufacturer's catalog for recommended spacing and boom height for each spray tip model.**

2.8.5 Flow rate and pressure

The spray tip flow rate varies with the spray pressure.

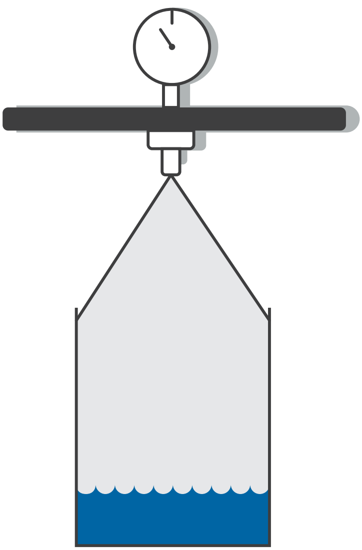
For most flat fan tips, the relationship between pressure and flow rate is a square root, which means that to double the spray tip flow it is necessary to quadruple the pressure, as shown in the formula and example below.

$$\frac{GPM_1}{GPM_2} = \frac{\sqrt{PSI_1}}{\sqrt{PSI_2}}$$

(US unit)

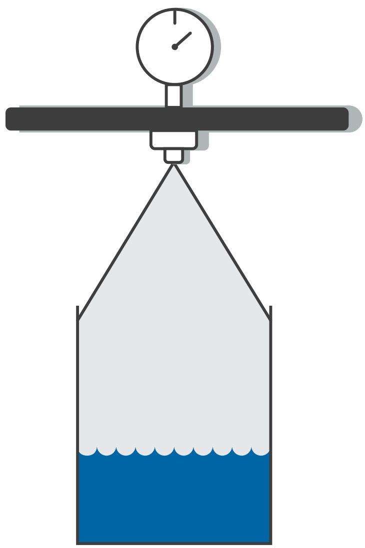
$$\frac{L/min_1}{L/min_2} = \frac{\sqrt{bar_1}}{\sqrt{bar_2}}$$

(metric unit)



11002

1.0 bar (15 PSI) =
0.46 l/min (0.12 GPM)



11002

4.0 bar (60 PSI) =
0.92 l/min (0.24 GPM)

2.8.5.1 Importance of a precise nominal flow rate

A new spray tip can vary its nominal flow rate by +5% or -5% according to the standard ISO 16122-2.

TeeJet® Technologies excels in spray tip production and is committed to producing high-quality products. It is the reason reliable products are produced with a low variation in the nominal characteristics, maintaining the repeatability of spray tips flow rate, spray angle and distribution, resulting in a uniform application along the treated area.

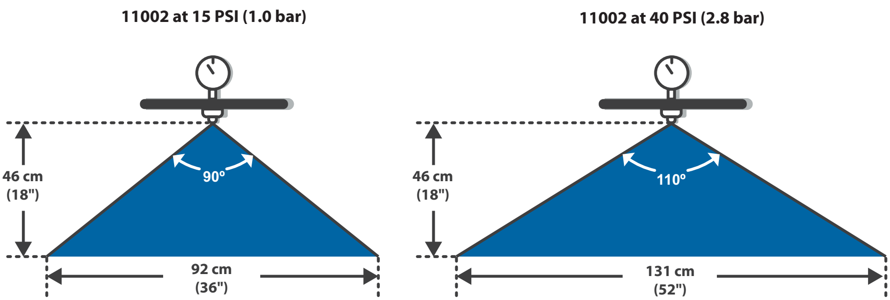
2.8.6 Spray angle

The spray angle indicated at the spray tips is nominal, which means the angle of a spray tip operating at 40 PSI (2.8 bar) with water. The nominal angle is stamped on the spray tip and is included in the TeeJet catalog.

The spray angle opening is a function of pressure and the tip model. A higher pressure results in a wider spray angle within a certain limit*.

*For example, a spray tip with an 80° spray angle will never achieve an angle of 110° if operated at high pressures.

Example:

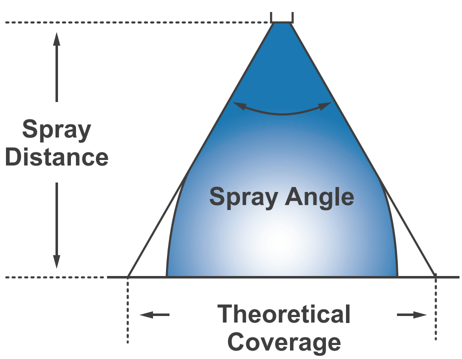


Relationship between pressure and spray tip angle.

In general, wider spray angles provide greater theoretical coverage. The tables on the next page show theoretical coverage according to the tip angle and the spray distance.

Included Spray Angle	Theoretical coverage at various spray heights (in inches)							
	8”	10”	12”	15”	18”	24”	30”	36”
15º	2.1	2.6	3.2	3.9	4.7	6.3	7.9	9.5
20º	2.8	3.5	4.2	5.3	6.4	8.5	10.6	12.7
25º	3.5	4.4	5.3	6.6	8.0	10.6	13.3	15.9
35º	4.3	5.4	6.4	8.1	9.7	12.8	16.1	19.3
40º	5.0	6.3	7.6	9.5	11.3	15.5	18.9	22.7
45º	5.8	7.3	8.7	10.9	13.1	17.5	21.8	26.2
50º	6.6	8.3	9.9	12.4	14.9	19.9	24.8	29.8
55º	7.5	9.3	11.2	14.0	16.8	22.4	28.0	33.6
60º	8.3	10.3	12.5	15.6	18.7	25.0	31.2	37.5
65º	9.2	11.5	13.8	17.3	20.6	27.7	34.6	41.6
73º	10.2	12.7	15.3	19.2	22.9	30.5	38.2	45.8
80º	11.8	14.8	17.8	22.0	27.0	36.9	44.0	53.0
85º	13.4	16.8	20.2	25.2	30.3	40.3	50.4	60.4
90º	14.7	18.3	22.0	27.5	33.0	44.0	55.4	66.4
95º	16.0	20.0	24.0	30.0	36.0	48.0	60.0	72.0
100º	17.5	21.8	26.2	32.8	40.3	52.4	65.5	78.6
110º	19.1	23.8	28.6	35.8	43.3	57.2	71.6	103
120º	22.8	28.5	34.3	42.8	51.4	68.5	85.6	
130º	27.7	34.6	41.6	52.0	62.4	83.2	104	
135º	34.3	42.9	51.5	64.4	77.3	103		
140º	43.8	54.8	65.7	82.2	98.6			
150º	59.6	74.5	89.5					

Included Spray Angle	Theoretical coverage at various spray heights (cm)							
	20 cm	30 cm	40 cm	50 cm	60 cm	70 cm	80 cm	90 cm
80º	33.6	50.4	67.1	83.9	101	118	134	151
85º	36.7	55.0	73.3	91.6	110	128	147	165
90º	40.0	60.0	80.0	100	120	140	160	180
95º	43.7	65.5	87.3	109	131	153	175	196
100º	47.7	71.5	95.3	119	143	167	191	215
110º	57.1	85.7	114	143	171	200	229	257
120º	69.3	104	139	173	208	243		
130º	85.8	129	172	215	257			
135º	97	145	193	241	290			
140º	110	165	220	275				
150º	149	224	299					



2.8.7 Coefficient of Variation – CV

The uniformity of spray distribution along the spray boom is evaluated by the coefficient of variation (CV) resulting from the overlap of the distribution of the set of spray tips assembled on the boom.

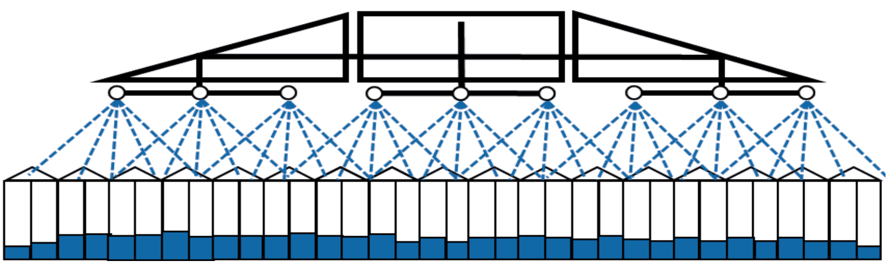
The coefficient of variation (CV) is a statistical method that compiles all of the data collected from a distribution of multiple spray tips in a distribution table and summarizes it into a percentage that indicates the variation within the given distribution.

$$\boxed{CV = 100\,x\,\frac{S}{\bar{x}}} \qquad S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}} \qquad \bar{x} = \frac{\sum x_i}{n}$$

ISO 16122-2 (2015)

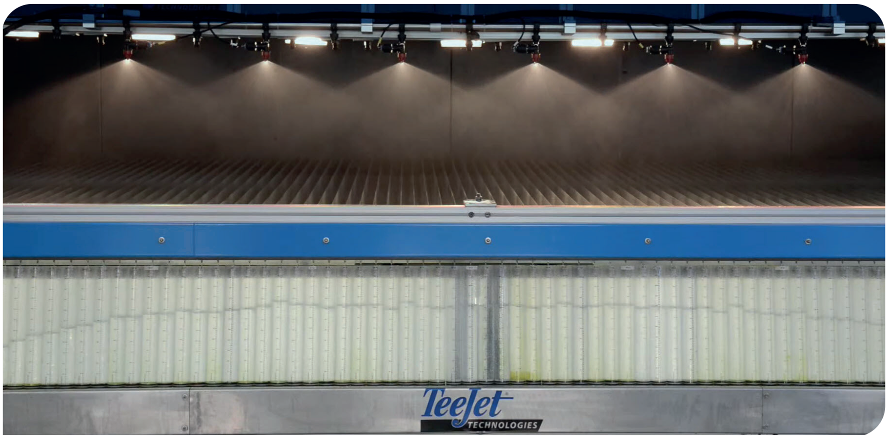
Where:

- CV: Coefficient of variation, represented as a percentage (%)
- S: is the standard deviation of the volumes collected in the collectors
- $\bar{x}$: is the average/mean volume collected per collector
- x_j: is the volume of liquid in the ith tube
- n: is the number of collectors



The higher the coefficient of variation, the higher the variation in the distribution and the less uniform the application.

According to the ISO 16122-2 standard, good quality distribution along the treated area must have a CV value <= 10%. TeeJet® Technologies has a precise and rigid spray tip production process that guarantees a CV better than the standard. In the image demonstrated below, we can observe the excellent distribution resulting from the TT11004 spray tip application, with a CV lower than 5%.



TT 11004

Spacing: 20"(50 cm)
Boom height: 20" (50 cm)
Pressure: 40 PSI (2.8 bar)

CV < 5%

2.8.8 Spray tip wear

Spray tips don't last forever, yet it is extremely difficult to detect wear because it may not be visible. Spray nozzle wear of 10, 20, or even 30% won't be visible. Using even slightly worn tips is very costly. Water, crop protection product, and labor are wasted, and crop protection product application quality can be compromised.

The spray tip wear depends on:

- Tip material
- Crop protection formulation type (e.g. wettable powder)
- Water quality
- Operating pressure
- Cleaning procedure

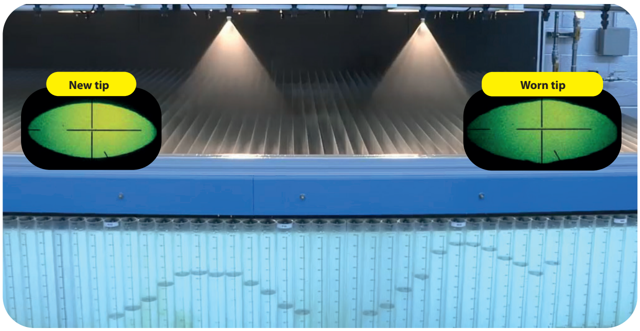
Rather than relying on visual inspection, it is better to compare the flow rate from a used spray tip with the flow rate from a new tip of the same size, type, and pressure. If the flow from the used spray tip is 10% greater or more, replace it (quantitative method).

Measurement of the volume sprayed by a new tip vs a spray tip on the sprayer
Ex. Spray Tip TTJ60 11004

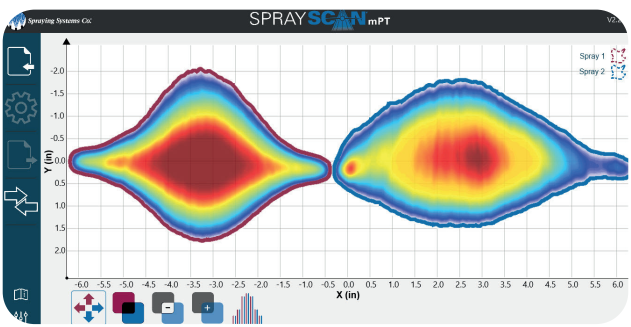
Volume collected by a worn spray tip on the sprayer	Volume collected by a new spray tip
In 30 seconds = 30 fl oz (0.23 GPM)	In 30 seconds = 26 fl oz (0.20 GPM)
Expected: 0.40 GPM	Expected: 0.40 GPM
Actual: 0.47 GPM	Actual: 0.41 GPM
+17.2%	+1.6%

Compare the deposition pattern of a new and used spray tip in a distribution table and check if the used tip pattern shows a different distribution than the new tip (qualitative method).

In the image below it is possible to observe a distribution table comparing a new tip (left) with a worn tip (right) spray pattern. The worn nozzle is spraying 30% over the capacity. Comparing the spray coming from the new and worn nozzle only with our eyes would be hard to detect because the spray patterns look identical.



It is also possible to use a software that can compare the spray pattern of a new tip vs a worn tip (qualitative method). In the image below, it's possible to observe the SprayScan® mPT software comparing the spray pattern of a new tip (left) with a worn tip (right). In this example, the new spray tip has excellent droplet distribution uniformity, preserved deposition at the center, and dissipation towards the edge. The droplets are concentrated at the center of the spray, represented by the red colors. Worn spray tips, on the other hand, present an uneven distribution, represented by the irregular spray distribution color pattern.

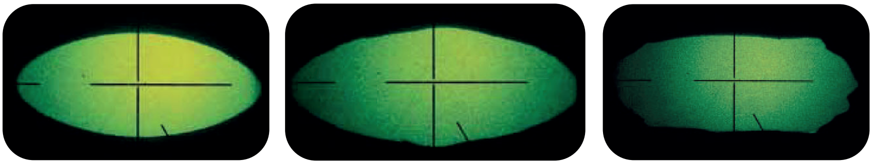


2.8.9 Damaged Spray Tip

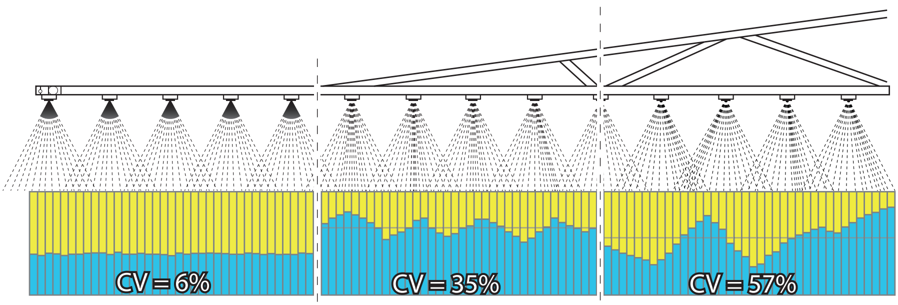
Flat spray tips have finely crafted thin edges around the orifice to control the spray. Even the slightest damage from improper cleaning can cause both an increased flow rate and poor spray distribution.

Be sure to use adequate strainers in your spray system to minimize clogging. If a tip does clog, only use a soft bristled brush or compressed air to clean it – never use a metal object. Use extreme care with soft tip materials such as plastic, because even a wooden toothpick can distort the orifice.

In the image below we can take an inside look at tip orifice wear and damage, compared with a new tip. The edges of the worn tip appear more rounded than the edges of the new tip. Damage to the tip was caused by improper cleaning. The spray results from these tips can be seen below.



New Spray tip | Worn Spray tip | Damaged Spray tip



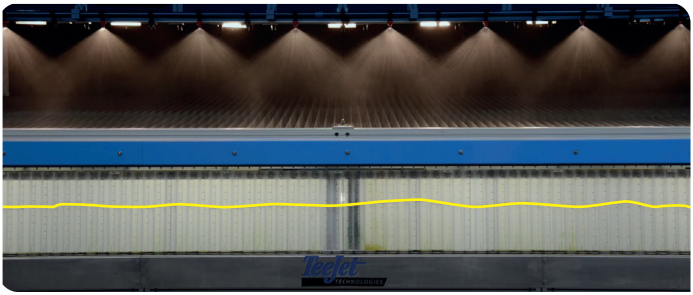
NEW SPRAY TIPS
Produce a uniform distribution when propely overlapped.

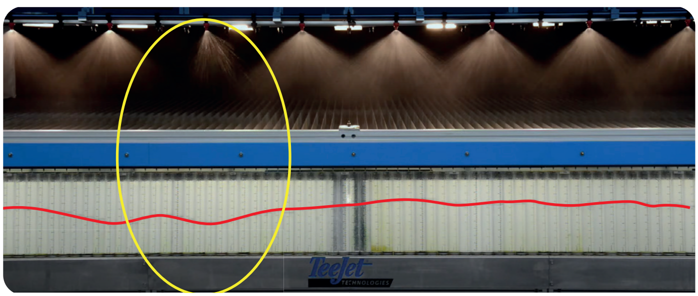
WORN SPRAY TIPS
Have a higher output with more spray concentrated under each tip.

DAMAGED SPRAY TIPS
Have a very erratic output - poor overapplying and underapplying.

2.8.10 Clogged spray tips

Clogged spray tips impact the flow rate variation and spray pattern. In the images shown below, we can compare how a single clogged spray tip along the spray boom can negatively impact the CV.





AIXR 11004

Spacing: 20" (50 cm)
Boom height: 20" (50 cm)
Pressure: 40 PSI (2.8 bar)

CV = 3.6% vs 17.4% with a single clogged spray tip along the boom

2.8.11 Strainer maintenance

The plumbing systems of agricultural sprayers contain several components. The line strainer and tip strainers are very important to the systems and must be properly sized, placed, and in good condition to prevent spray tip clogging and assure a correct filtration of the tank mixture.

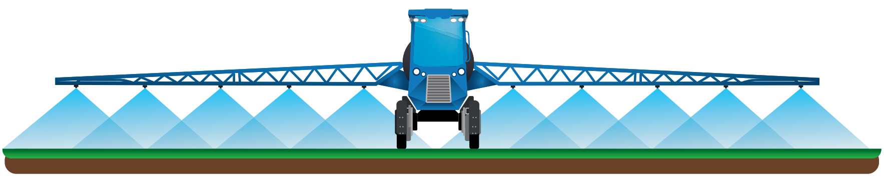
The image below shows different strainers of a spray system under poor maintenance conditions of use.

2.8.12 Spray boom stability

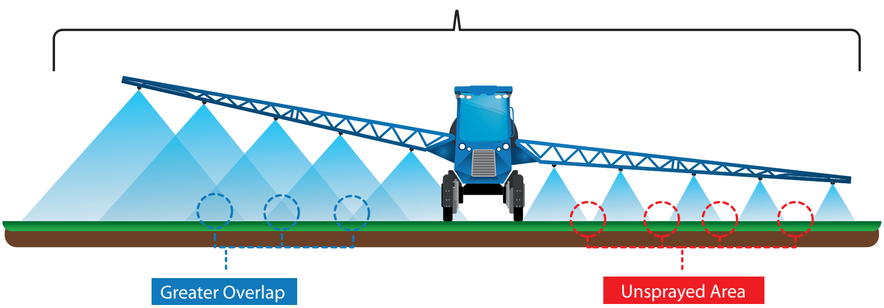
For agricultural spraying equipment, good boom stability is very important to ensure less vertical (up/down tilt) and horizontal (right/left yaw) movement and for better uniformity at the time of the application across the spray boom.

The following image illustrates (top) the recommended overlap of the sprays with good stability, and (bottom) an uneven overlap with low stability. The absence of stability results in unsprayed areas and areas with a greater overlap which negatively impacts the distribution across the spray swath.

Recommended overlap



Uneven overlapping along the boom



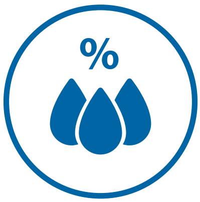
2.8.13 Weather conditions

Temperatures above 86°F/ 30°C, relative humidity below 55%, and wind speed above 10 MPH (17 km/h) directly impact particle movement and volatility drift, affecting the efficacy and the distribution of the crop protection product in the field.

Wind speed

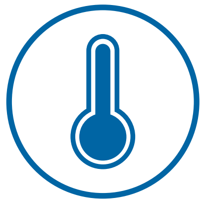
Between 3 - 10 MPH (5 - 17 km/h)

Relative humidity



Above 55%

Air temperature

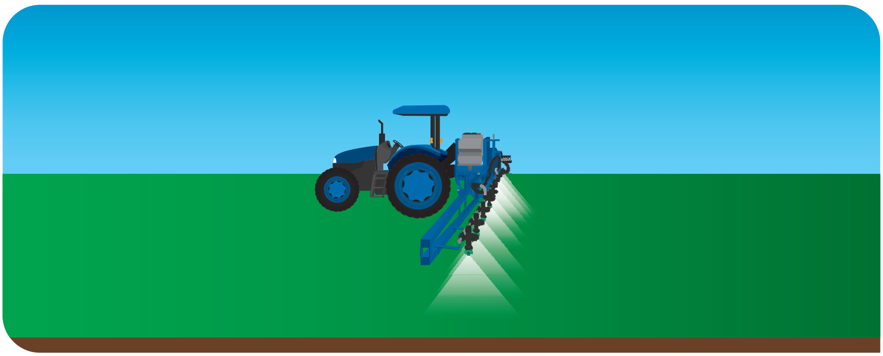


Between 50ºF - 86ºF (10°C - 30°C)

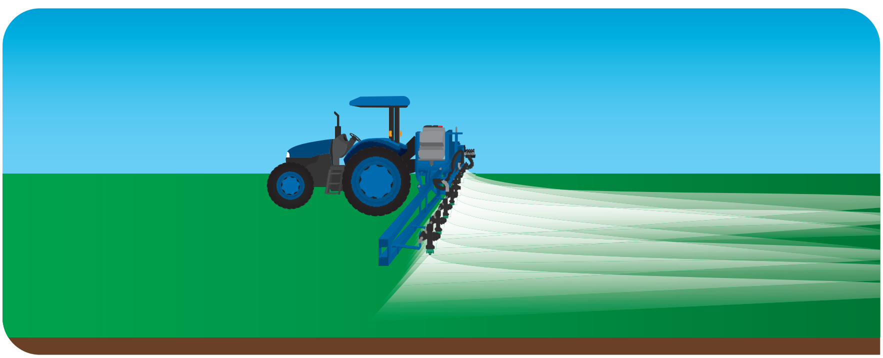
2.8.14 Sprayer travel speed and spray drift

When increasing the sprayer speed and maintaining the same application rate, the pressure of the system will automatically be increased, resulting in smaller droplets. Therefore, the greater the sprayer travel speed, the greater likelihood of spray drift.

Lower travel speed



Higher travel speed

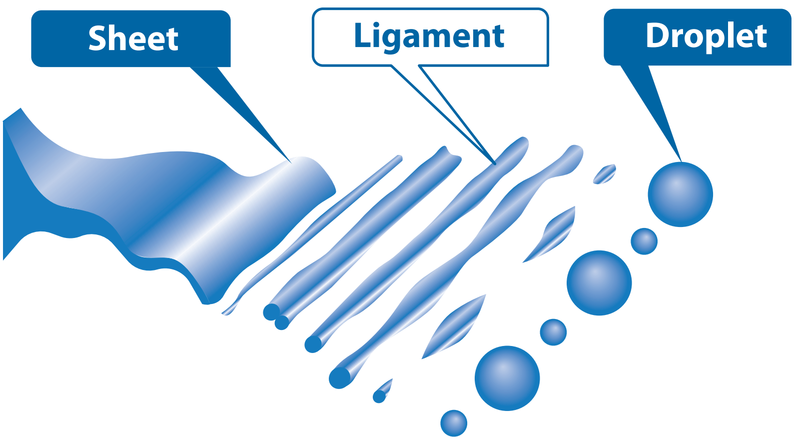


3

3.1 Droplet formation

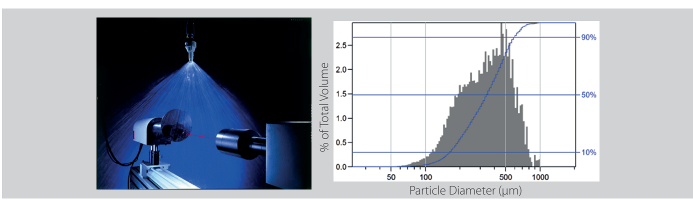
Droplet size information has increased considerably during the last decade. Having accurate information on the size of the droplet is a very important factor for the effectiveness of a crop protection product. This depends; 1) the type of crop protection product that is being applied, its mobility within the plant, when this application is taking place, 2) the location of the target, 3) weather conditions, 4) the need for drift control, among other factors.

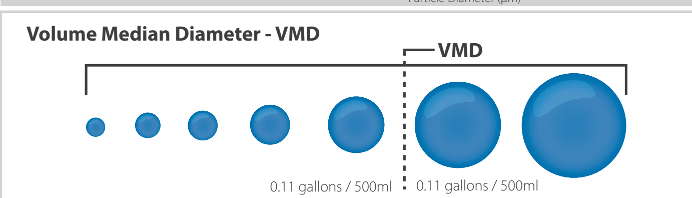
The droplet is a by-product of atomization, which begins by forcing liquid through the exit orifice of the spray tip. The liquid from the tip emerges as small ligaments. These ligaments then break up further into very small "pieces", called droplets.



Each spray provides a range of droplet sizes; this range is referred to as droplet size distribution.

The analysis of the droplet size distribution produced by a spray tip is measured by equipment with laser and imaging systems. These devices provide measurements used as parameters in the evaluation of droplet size, such as DV0.1, DV0.5 (or VMD), DV0.9, percentage of driftable fines, and relative span, which will be further detailed in this chapter.





Droplet size dividing the applied volume in two equal parts

Droplet size

Droplet size is determined by the diameter of a sprayed droplet. Droplet sizes are measured in microns (µm). A micron (1 µm) corresponds to 1/25,000 of an inch or about 0.001 mm. For perspective, the table below shows examples of known objects with their respective sizes in µm.

Objects		Relative Size (µm)
Point of a needle		25
Human hair		100
Sewing thread		150
Toothbrush bristle		300
Staple		550
Paper clip		850
#2 Pencil leadle		2000

The droplet size, distribution, and relative span can vary due to factors such as solution characteristics and viscosity, spray tip design, flow through the spray tip orifice, and pressure of the liquid.

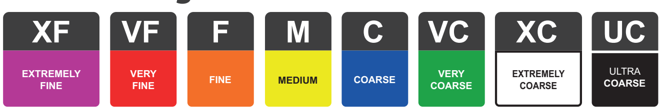
3.2 Droplet size classification standards

The droplet size classification follows a strict and concise standard, which was first created in 1985 in England by the British Crop Protection Council (BCPC). This classification system established a series of droplet size classes.

In 1999, the American Society of Agricultural and Biological Engineers (ASABE) developed a new standard for droplet size classification – ASABE S572, in which the droplet size boundaries were set by a series of defined TeeJet reference nozzles and operating pressures (ASABE, 2009). The ASABE S572 original standard established six droplet size classes (VF, F, M, C, VC, and XC), with 5 reference nozzles establishing the boundaries between them. Two additional droplet size classes were added in the same year on the review of the standard – ASABE S572.1, totaling eight classes (XF, VF, F, M, C, VC, XC, and UC).

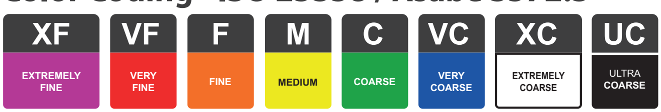
The International Organization for Standardization (ISO) worked on the development of an international droplet size classification standard and, in 2018, the ISO 25358 standard was published (ISO, 2018), which updated some droplet size classification ranges to better distribute the classification boundaries. Only the C/VC, VC/XC, and XC/UC boundaries have changed. The ASABE has updated the standard to match with the ISO 25358 as ASABE S572.3.

Color Coding - Asabe S572.1



(Asabe, 2009)

Color Coding - ISO 25358 / Asabe S572.3



(ISO, 2018 / asabe, 2020)

3.3 Droplet size parameters evaluated

To assess the droplet sizes produced by a spray tip, some measurements and parameters must be understood:

- **$DV0_{.1}$** - is a value where 10% of the total volume of liquid sprayed is made up of droplets with diameters smaller or equal to this value. For example, if the DV0.1 is listed as 100 µm, this means that only 10% of the volume of the spray is contained in droplets smaller than 100 µm (microns)*. The other 90% of the volume of the spray is contained in drople ts larger than 100 µm.

- **$DV0_{.5}$** - also known as VMD, is a value where 50% of the total volume of liquid sprayed is made up of droplets with diameters larger than the median value and 50% smaller than the median value. For example, if the VMD is listed as 250 µm, this means that 50% of the volume of the spray is in droplets both larger and smaller than 250 µm.

- **$DV0_{.9}$** - is a value where 90% of the total volume of liquid sprayed is made up of droplets with diameters smaller or equal to this value. For example, if the DV0.9 is listed as 500 µm, this means that 90% of the volume of the spray is contained in droplets 500 µm or smaller. Only 10% of the volume is contained in droplets larger than 500 µm.

- **Driftable fines droplets** – the percentage of droplets with a diameter smaller than 150 µm in an application volume.

- **Relative Span (RS)** – the parameter that indicates the droplet size uniformity distribution produced by a tip. The lower the RS value, the more homogeneous is the spray droplet spectrum.

* 1 micron (µm) = 1/25,000″ = 0.001 mm.

Relative Span - RS = $$\frac{DV_{0.9} - DV_{0.1}}{DV_{0.5}}$$

TIP 1	
$DV_{0.1} = 146$	µm
$DV_{0.5} = 340$	µm
$DV_{0.9} = 599$	µm

Relative Span - RS = $\frac{DV_{0.9} - DV_{0.1}}{DV_{0.5}}$

$$RS = \frac{DV_{0.9} - DV_{0.1}}{DV_{0.5}} \rightarrow RS = \frac{599 - 146}{340} = 1.33$$

TIP 2	
$DV_{0.1} = 144$	µm
$DV_{0.5} = 340$	µm
$DV_{0.9} = 467$	µm

Relative Span - RS = $\frac{DV_{0.9} - DV_{0.1}}{DV_{0.5}}$

$$RS = \frac{DV_{0.9} - DV_{0.1}}{DV_{0.5}} \rightarrow RS = \frac{467 - 144}{340} = 0.95$$

The lower **the relative** span value, the more homogeneous the spray droplet spectrum

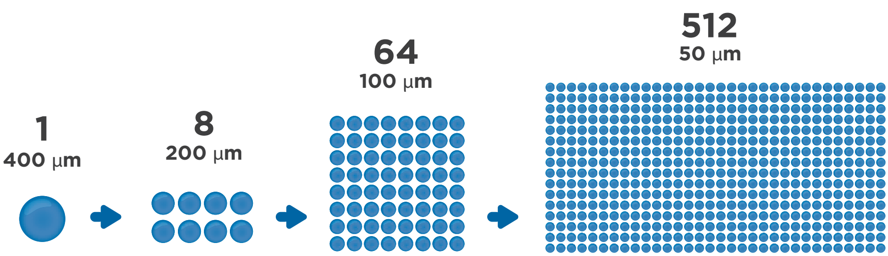
3.4 Droplet size classification standards

3.4.1 Droplet size classification standards

Considering the same volume, reducing the droplet diameter by half, the number of formed droplets is increased by eight times, and the covered area is duplicated, as represented by the formula and example described below.

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Therefore:



3.4.2 Operating pressure

When a liquid solution is sprayed at a certain pressure, the liquid is forced through the spray tip orifice and a range of droplets is formed. For most spray tips, the smaller the tip orifice size and the higher the system pressure, the smaller the droplets produced.

Remember, droplet size can vary based on pressure. For example, the TT 11002 tip produces coarse to very coarse droplets at pressures less than 30 PSI (2 bar), medium droplets size between 45 and 75 PSI (3 to 5 bar), and fine droplets when operated at pressures above 75 PSI (5 bar).

	Pressure (PSI)	Droplet Size
TT11002	15	VC
	30	C
	45	M
	60	M
	75	M
	90	F

3.4.3 Coverage

Coverage is the percentage of the target surface area that received spray droplets during application. The relationship between target coverage, application volume, crop leaf area index, and droplet diameter can be calculated and understood by Courshee's (1967) equation:

$$C=15\,\frac{(VRK)^2}{AD}$$

Where:

C = Coverage (percentage of area)

V = Application rate (l/ha)

R = \Recovery rate (percentage of the applied volume that reached the target)

K = Droplet spreading factor

A = Leaf area index (ha)

D = Droplet diameter (μm

Among the parameters that compose the Courshee equation, only the application rate and the droplet diameter can be easily manipulated at the time of application.

Therefore:

– To increase the target coverage, the application rate must also be increased, and/or the droplet size must be reduced.

– To use a lower application rate to maintain coverage, the droplet size must be reduced.

– To use coarse droplets and maintain coverage, the application rate must be increased.

– For contact crop protection products and products with limited translocation, fine to coarse droplets must be used and/or the application rate increased to promote greater coverage.

– Tips producing coarser droplets are typically used for systemic herbicides and pre-emergence soil applied herbicides.

3.4.4 Spray drift

The smaller the droplet, the greater the drift potential. Droplets most prone to drift are those with a diameter that is less than 150 µm. Therefore, during crop protection application, finer droplets lose momentum quickly, remaining suspended in the air for a longer time, and are more susceptible to wind and dispersal to more distant locations.

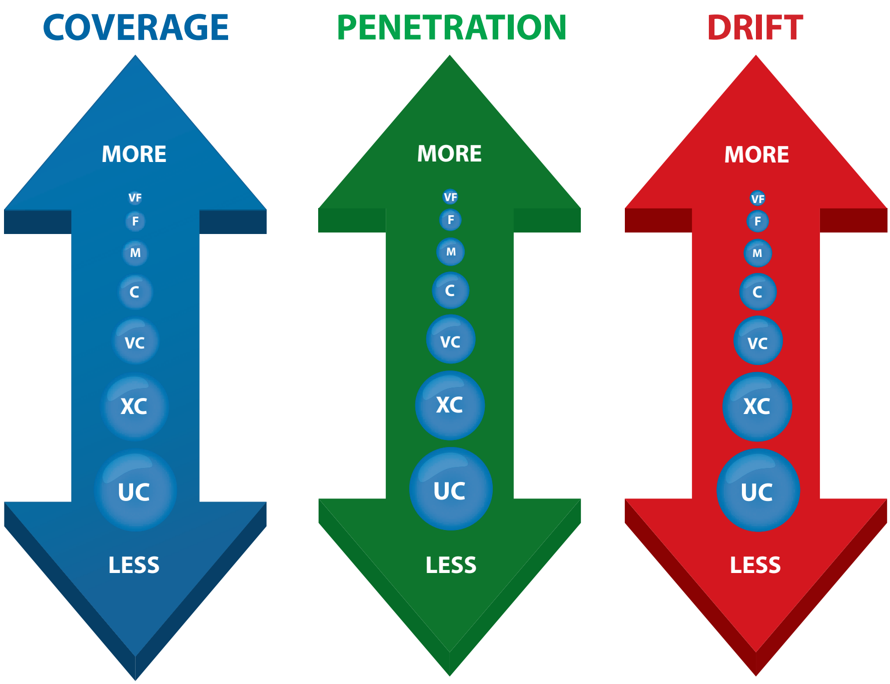
3.4.5 Penetration

Larger droplets have greater deposition on horizontal surfaces and greater difficulty in penetrating the crop canopy.

Field conditions: the wind and sprayer travel speed can influence the penetration behavior of different droplet sizes in the crop canopy.

Therefore:

Finer droplets provide greater coverage and have a superior penetration potential, however, they have less weight and inertia, so they will follow the air currents, increasing the risk of drift and environmental contamination.



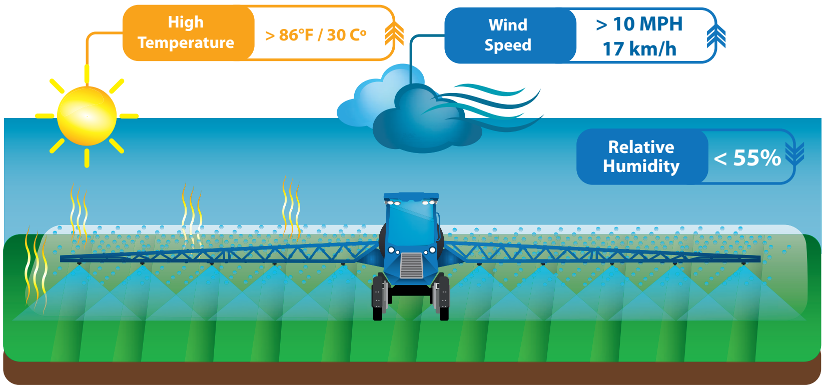
4.1 Drift definition

Spray drift is defined as the movement and deposition of spray particles through the air to non-target locations. The two forms of spray drift are particle drift and vapor drift.

Particle drift can occur during or after a crop protection product application, which results from droplets physically moving to non-target locations via air currents. The product movement out of the target area can also be known as exo-drift, while the product movement within the same area (e.g., superficial runoff), is also known as endo-drift.

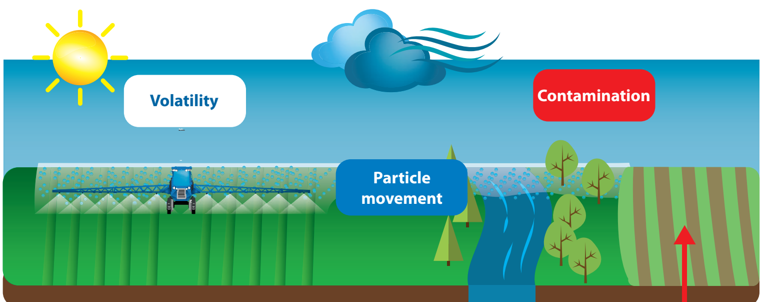
Vapor drift of the active ingredient occurs right after the crop protection product application when the crop protection product vapor from evaporated droplets and the target surface reaches non-target locations. It is dependent on the crop protection product solution characteristics when interacting with certain weather conditions, such as low relative humidity and high temperatures that directly impact vapor drift.

Weather conditions, such as wind speed and direction, relative humidity, and air temperature have a direct influence on the drift occurrence as exemplified in the image below.



Spray drift illustration

Crop protection product application in unsuitable weather conditions and/or improper application can cause drift due to volatility and/or particle movement of the applied product, resulting in contamination of adjacent areas and injury to crops susceptible to the applied product.



Spray drift illustration

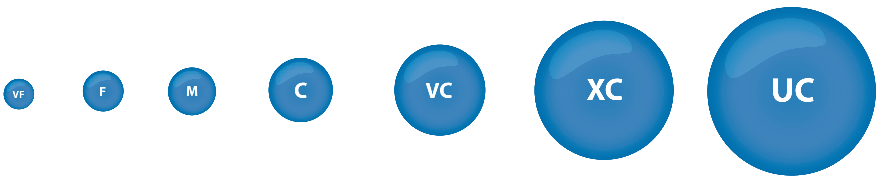
4.2 Causes of drift

Drift is a complex process, due to the many factors involved, such as:

- 4.2.1. Droplet size
- 4.2.2. Operating pressure
- 4.2.3. Boom height
- 4.2.4. Wind speed and direction
- 4.2.5. Air temperature and relative humidity
  - 4.2.5.1. Delta T
- 4.2.6. Temperature inversion
- 4.2.7. Spray tip capacity
- 4.2.8. Application volume
- 4.2.9. Sprayer travel speed

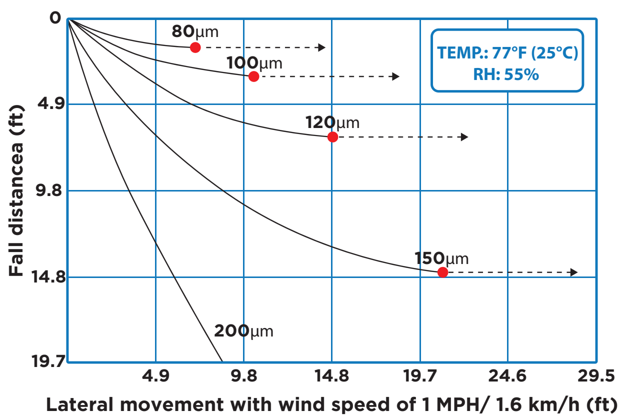
4.2.1 Droplet size

In a spray system, droplet size is one of the most important factors and it is directly related to spray drift. As mentioned in the previous chapter, droplets smaller than 150 µm in diameter are classified as droplets with high drift potential – also known as drift-able fines. Very fine droplets are more susceptible to both wind and evaporation effects, before reaching the target.



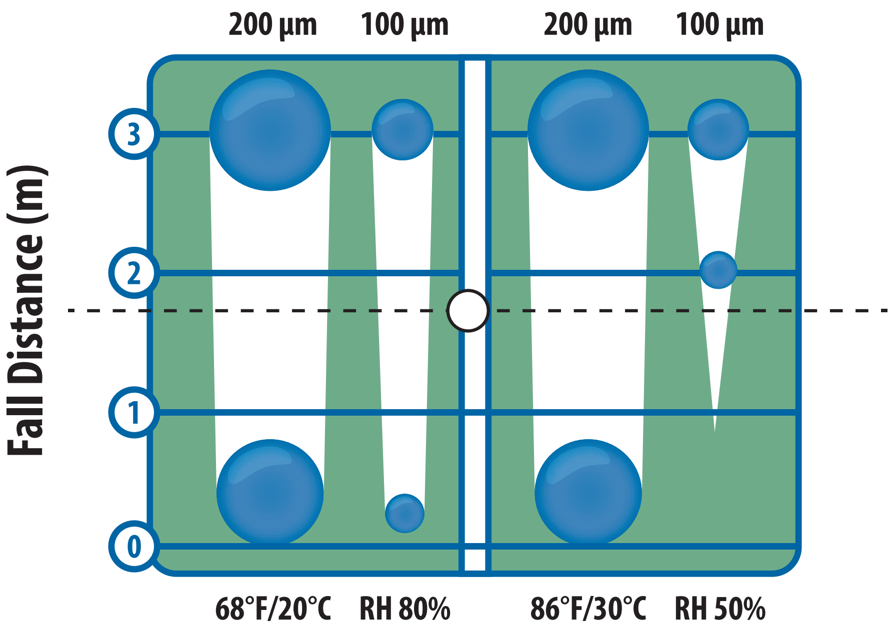
The graphic below illustrates the fall distance and lateral movement of droplets with different diameters. It can be observed that droplets smaller than 150 µm, even when applied in recommended weather conditions, are lost by evaporation and particle movement.

Droplets diameter / Temp: 77°F (25°C) RH: 55%



Adapted from Hofman and Solseg, 2004

The image illustrated below represents the change in droplet size due to evaporation of two droplets with 200 µm and 100 µm, in different application situations: in the first situation (left), the application happened at 68°F/20°C and 80% relative humidity, while in the second situation (right) the application happened at 86°F/30°C and 50% relative humidity. It can be observed, in the second situation, the 100 µm droplet evaporated before reaching the target, while the droplet with a larger diameter reached the target.



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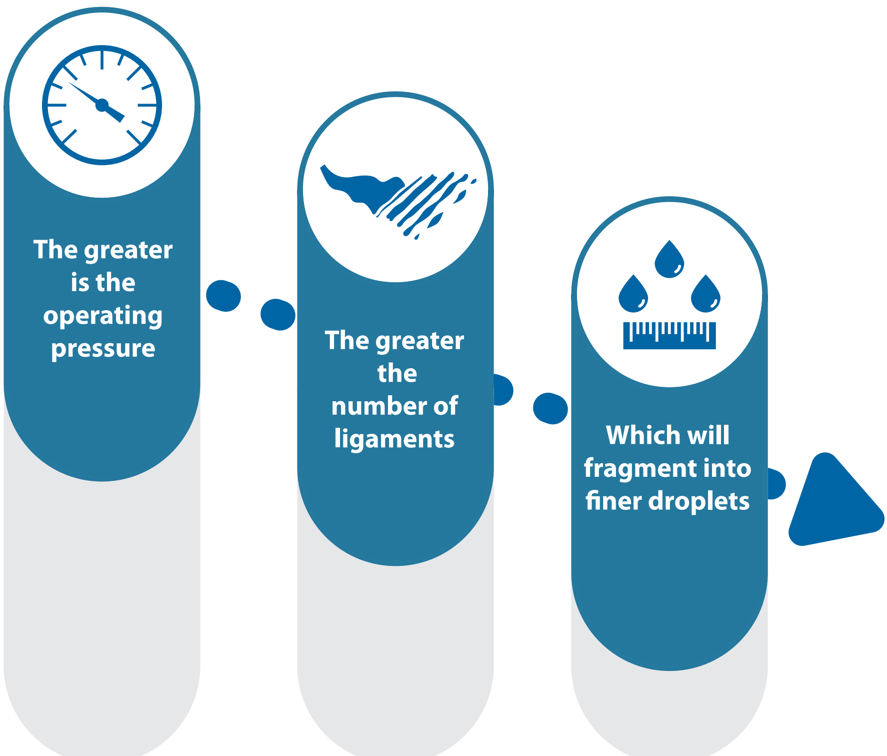
4.2.2 Operating pressure

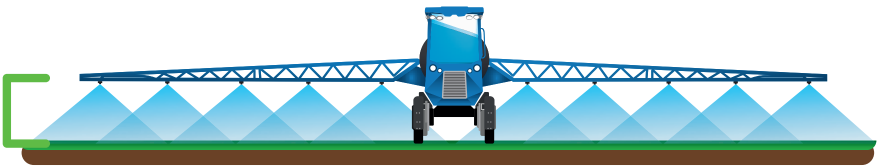
The operating pressure influences the droplet size produced by the spray tip. As mentioned in the previous chapter, the droplet is a by-product of atomization that begins by forcing the liquid through the spray tip orifice. Increasing operating pressure forces the spray to break into a greater number of ligaments, that break up further into smaller droplets. At lower pressure, the thicker ligaments result in larger droplets.



4.2.3 Boom height

The higher the spray boom is above the crop or target, the more opportunity the wind, airflow, and other weather factors have to move droplets from the intended target. The closer the spray boom is to the crop or target during a spray application, the less likely these droplets are to drift. However, boom height lower than the spray tip manufacturer's recommendation results in an uneven application with gaps along the treated area.

Ideal spray boom height

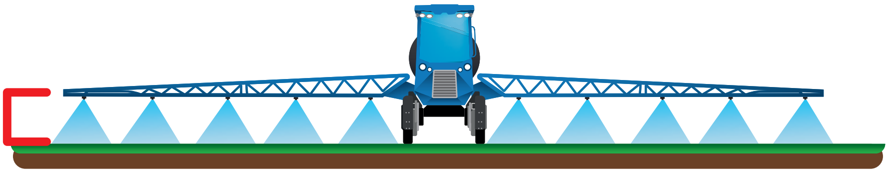


20" (0.5 m)

Spray boom height HIGHER than the spray tip manufacturer's recommendation

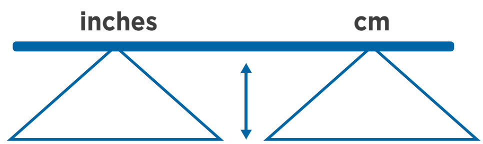
40" (1.0 m)

Spray boom height LOWER than the spray tip manufacturer's recommendation



12" (0.30 m)

The ideal boom height must be based on the spray tip manufacturer's recommendation for better uniformity of spray application. The boom height is dependent on the spray angle and nozzle spacing, which is also specified in the manufacturer's catalog, as in the table below.



		20"	30"	40"	50 cm	75 cm	100 cm
TP, TJ	65º	22-24"	33-35"	NR*	75 cm	100 cm	NR*
TP, XR, TX, DG, TJ, AI, XRC	80º	17-19"	26-28"	NR*	60 cm	80 cm	NR*
TP, XR, DG, TT, TTI, TJ, DGTJ, AI, AIXR, AIC, XRC, TTJ, AITTJ	110º	16-16"	20-22"	NR*	40 cm	60 cm	NR*
FullJet	120º	10-18"**	14-18"**	14-18"**	40 cm**	60 cm**	75 cm**
FloodJet TK, TF, K, QCK, QCTF, 1/4TTJ	120º	14-16"***	15-17"***	18-20"***	40 cm***	60 cm***	75 cm***

*** NR - Not recommended**
**** Nozzle/tip height based on orientation angle of 30º and 45º**
***** Nozzle/tip height with wider angle is influenced by the the cap orientation**

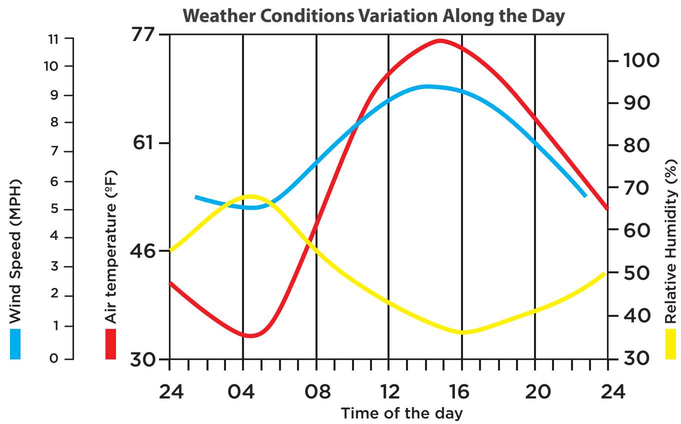
4.2.4 Wind speed and direction

Wind speed and direction are the most critical conditions. The greater the wind speed, the farther off-target small droplets will be carried. Very fine droplets are more affected by wind speed compared to coarse droplets (table below).

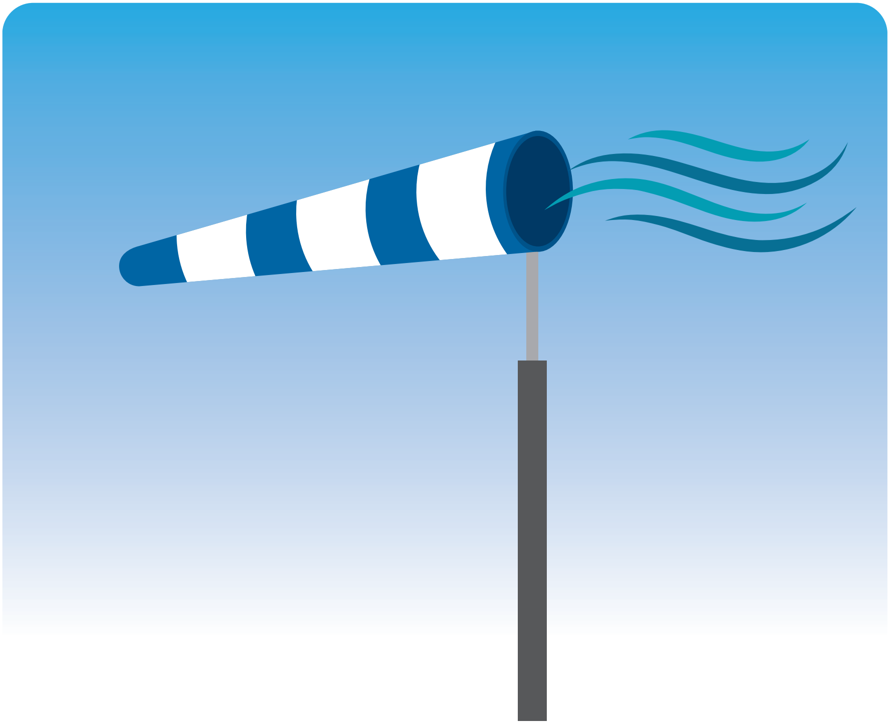
Droplet diameter (µm)	Drift (ft (m)) 1 MPH (1.6 km/h)	Drift (ft (m)) 5 MPH (8.0 km/h)
100 (Very Fine)	15 (4.6)	77 (23.5)
400 (Coarse)	3 (0.9)	15 (4.6)

The wind speed and direction become even more critical when the applied crop protection product can cause injury to susceptible crops in nearby areas. Therefore, if the wind is blowing towards an area with a sensitive crop, spray application should be avoided.

Wind speed below 3 MPH can indicate air instability, such as temperature inversion, resulting in drift loss. The recommendation is that applications must take place when wind speed is above 3 MPH (5 km/h) and below 10 MPH (17 km/h).



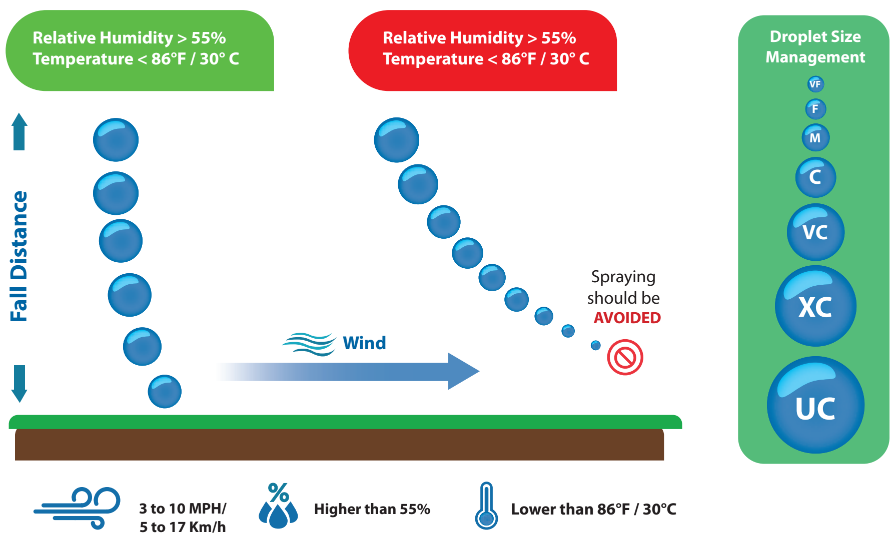
Thus, the wind speed should be measured at the beginning of the spray application and at each tank refilling, using a portable weather station.



4.2.5 Air temperature and relative humidity

Air temperature and relative humidity directly influence droplet evaporation. Finer droplets are more vulnerable to high temperatures and low relative humidity conditions, and when compared to coarser droplets they are less likely to reach the target.

In the example illustrated below, we observe two situations – on the left a spray simulation under ideal weather conditions, and on the right a simulation under non-recommended conditions. Under non-recommended conditions, with temperature >86°F/30°C and relative humidity <55%, the application must be avoided to prevent spray losses.



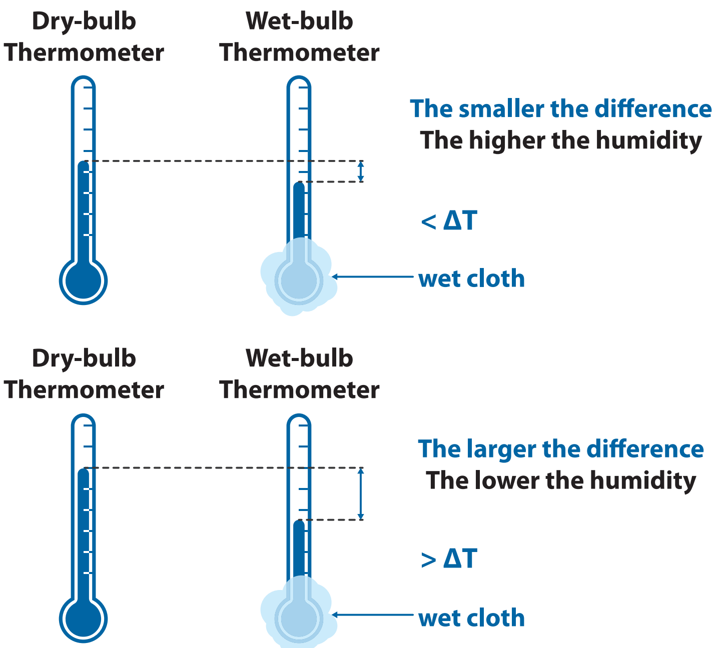
If spray application needs to take place under less than ideal weather conditions (high temperatures and low relative humidity), it is necessary to change some parameters during the application, such as using low drift tips, flat fan tips, and/or air induction tips that produce coarser droplets more resistant to drift.

4.2.5.1 Delta T

Delta T – is an atmospheric moisture parameter used to determine acceptable spraying conditions during crop protection product application. It is indicative of evaporation rate and droplet lifetime, estimated through the relationship between the wet and dry bulb temperature of a thermometer, represented by the equation:

Delta T (ΔT)= Tw – Td.
Tw - wet-bulb temperature
Td - dry-bulb temperature

The Tw is measured by a thermometer that has its bulb covered with a wet cloth (affected by air humidity), while the Td is indicated by a regular thermometer (unaffected by air humidity).



• The drier the air, the greater the evaporation capacity of the water in the cloth, and consequently, the lower the temperature of the thermometer.

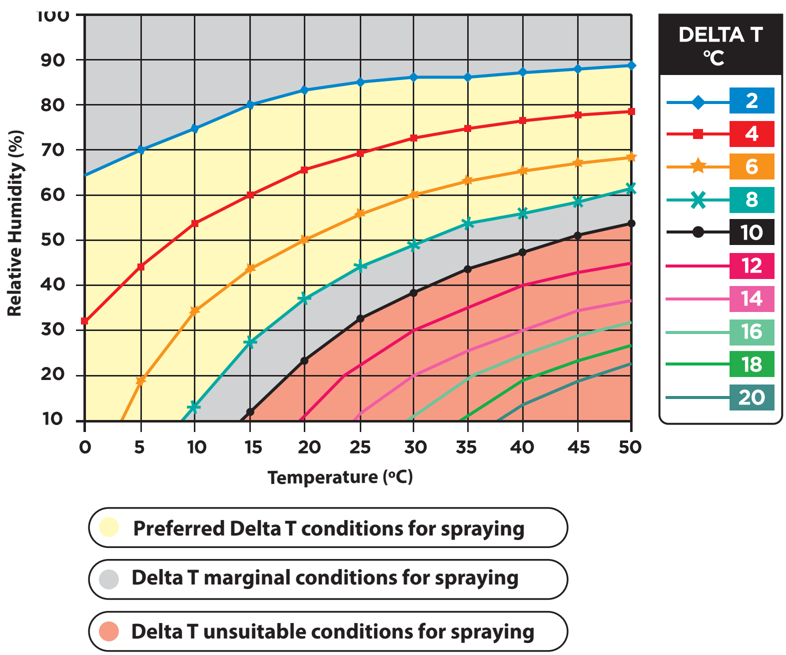
• **Lower Delta T** – longer survival time for finer droplets.

• **Higher Delta T** – lower droplet survival due to low relative humidity.

In this graphic below, we can observe the delta T values, which can range from 2 to 20. Recommended Delta T values for safe and high-performance spray application are between 2 and 8, with a temperature range between 41 and 77°F (5 and 25°C), and relative humidity between 60 and 95%.

Delta T values between 8 and 10 provide a marginal condition for spray applications, and it must take place only with the use of appropriate drift reducing techniques, such as air induction spray tips.

Crop protection product applications with delta T above 10 must be avoided due to the high risk of evaporation of all droplet sizes.



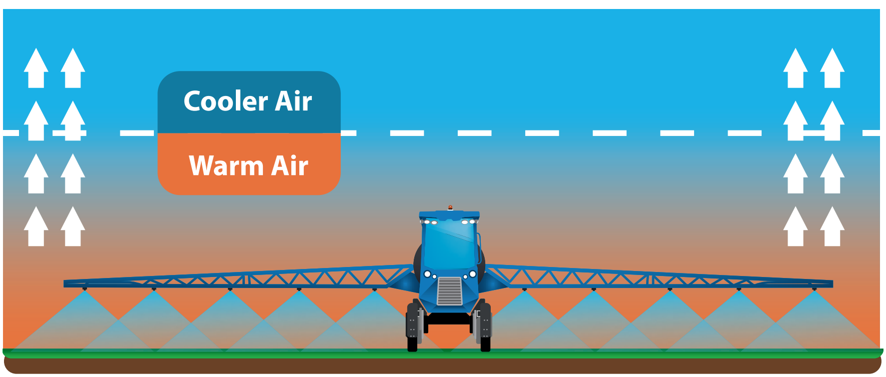
4.2.6 Temperature inversion

A natural atmospheric phenomenon in which the layer close to the ground has a lower temperature than the immediately higher one. The result is a very stable air layer that prevents vertical air movement. In this situation, it is very difficult to predict where and how far the crop protection product droplets will move. Crop protection product applied in these conditions can become trapped within the cool air layer, and air movement can drift droplets many miles away.

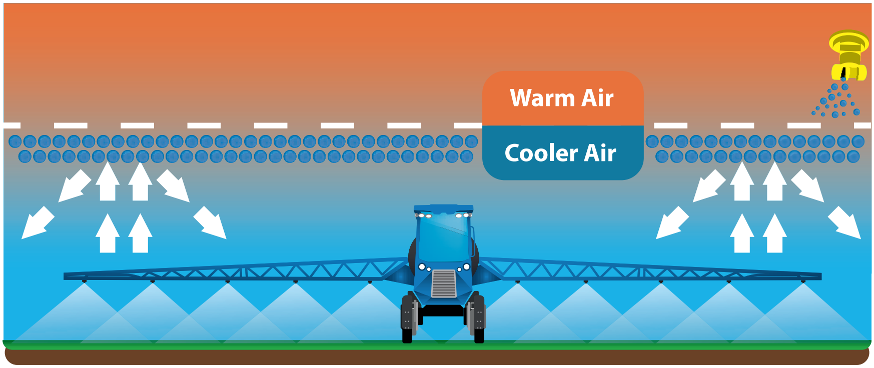
Very fine to fine droplets are the most vulnerable to suffering from a temperature inversion. As seen in the previous chapter, spray tips produce a range of droplets, and even low drift spray tips produce a small percentage of driftable fines, that could be trapped in the atmospheric inversion layer.

In the figure below, we can observe a normal atmospheric condition and on the image on page 76 a temperature inversion condition.

Normal Atmospheric Condition

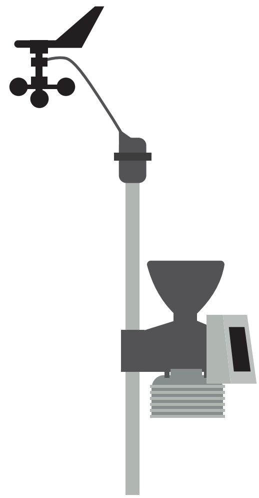


Temperature Inversion

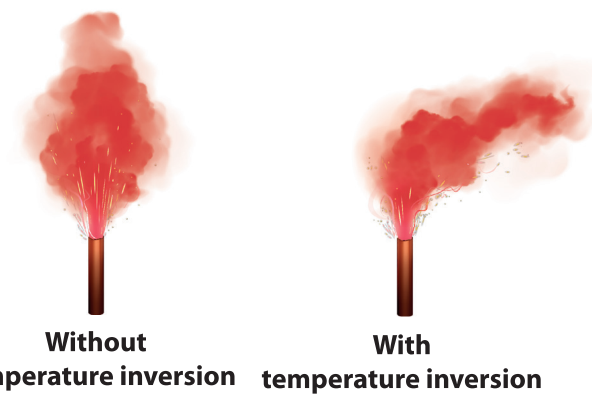


In the field, it is possible to observe the temperature inversion when we see a suspended fog layer above the ground (figure shown below).

The absence of wind can be considered an indicator of temperature inversion. Weather stations and smoke bombs can be good tools to use in the field to detect temperature inversions.



Example of a weather station and smoke bomb as temperature inversion indicators



4.2.7 Spray tip capacity

Spray tips with higher capacity also influence the droplet size. In general, larger spray tip exit orifices produce a thicker liquid sheet, resulting in coarser droplets when compared with smaller exit orifices (lower capacities) at the same pressure (examples below).

XR110	30 PSI
XR11001	F
XR110015	F
XR11002	F
XR110025	M
XR11003	M
XR11004	M
XR11005	M
XR11006	M
XR11008	M
XR11010	C
XR11015	C
XR11020	VC

AIXR	60 PSI
AIXR110015	M
AIXR11002	M
AIXR110025	M
AIXR11003	M
AIXR11004	C
AIXR11005	C
AIXR11006	C
AIXR11008	VC
AIXR11010	VC

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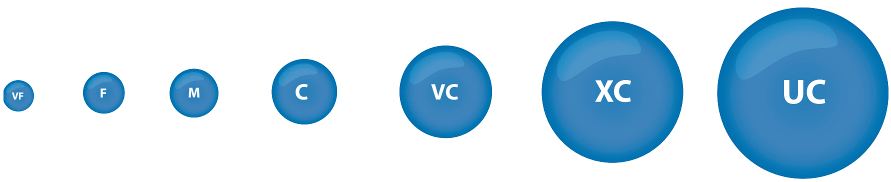
4.2.8 Application volume

Low volume applications are typically performed with spray tips that produce very fine to fine droplets to improve target coverage, which increases the risk of drift. To minimize the losses from drift, it is necessary to spray under extremely favorable weather conditions or using a pulse width modulation (PWM) system. On the other hand, applications with higher volumes are carried out with spray tips that produce medium to ultra-coarse droplets, that are more resistant to drift.



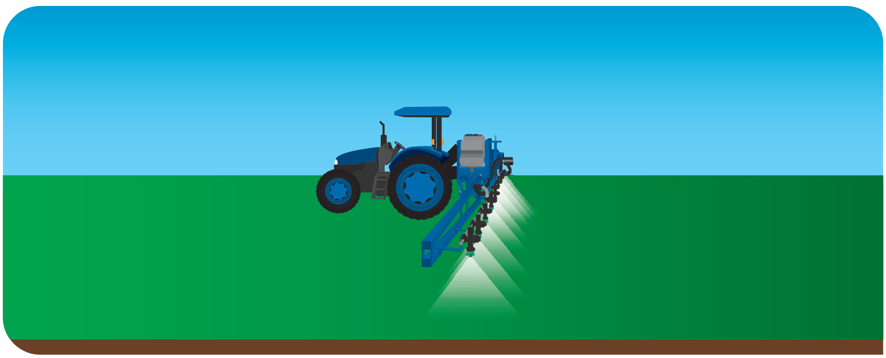
Nozzle Type (0.3 GPM/1.14 L/min)	Percentage driftable fines (<150µm) 40 PSI/2.8 bar*	Droplet Size (µm)**
Hollow Cone	>45%	Fine
Flat Fan	31%	Fine
Low drift flat fan	17%	Coarse
Low drift TwinJet flat fan	9.5%	Medium
Air Induction Flat Fan for Drift Control	9%	Coarse
Air Induction Flat Fan for Maximum Drift Control	<2%	Extremely Coarse

*** Data obtained from Oxford VisiSizer System spraying water at 75 °F (21 °C) under laboratory conditions.**
**** The droplet size classification follows the ISO 25358 standard at the date of printing. Droplet size classification is subject to change.**

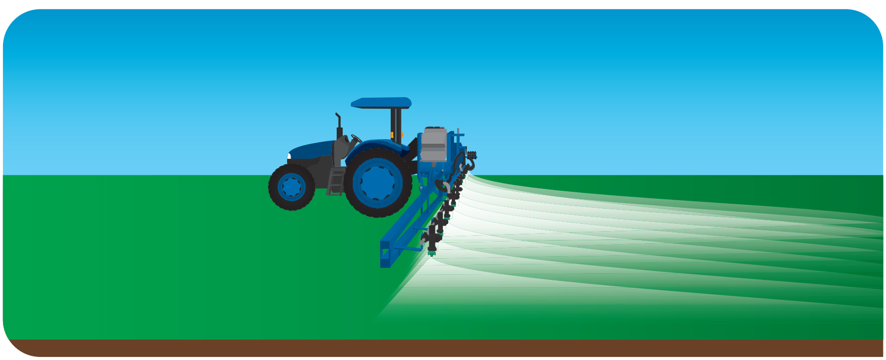
4.2.9 Sprayer travel speed

Sprayer travel speed is related to the type of sprayer/tractor, area topography, soil tillage, crop growth stage, and operator ability. Increasing sprayer speed promotes greater operating capacity, but decreases the safety at the time of application and increases the probability of drift. On the other hand, a slower sprayer travel speed provides higher quality and safety. Therefore, the sprayer travel speed must be adjusted to offer operating capacity, while ensuring the quality and safety of the job.

Lower Speed Travel



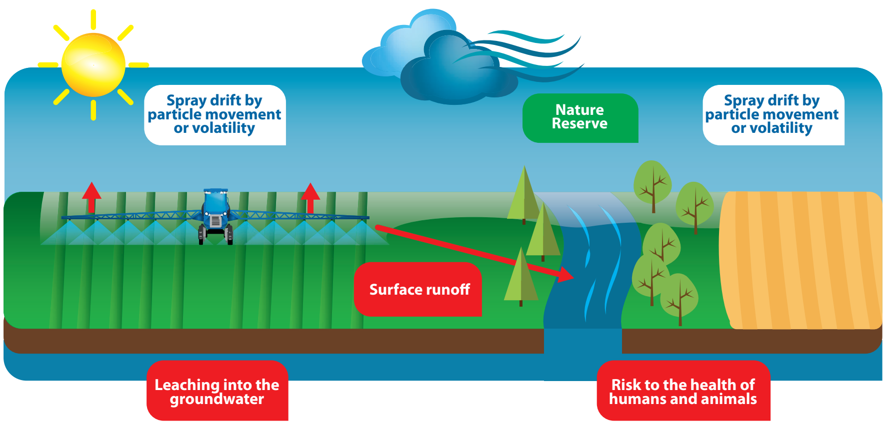
Higher Speed Travel



4.3 Problems related to drift

The major problem associated with crop protection product drift is that the product can be deposited where it is not desired, causing:

- Waste of resources.
- Damage to nearby sensitive crops.
- Crops on nearby farms can become unsalable if the detected crop protection product is not registered for use on the crop.
- Residue reaching surface water and nature reserve area.
- Contamination risk to human and animal health.
- Possibility of over or underapplication in the targeted area.



The most common risk to people getting contaminated in rural areas is from:

- Drift during the spray application
- Direct exposure to crop protection products
- Direct contact with the crop protection product during transportation and storage
- Mixing crop protection products
- Contact with contaminated containers

Health Risk in Urban Areas occurs:

- When the urban area is too close to the rural area
- Controlling weeds
- Squares, public gardens, flower beds, streets, and sidewalk Urban pest control Cockroaches, rats, doves, spiders, ticks, ants, and mosquitoes
- Crop protection product residue in the water
- Crop protection product applied to a rural area that drifted an urban area

Source:
https://luiziana.pr.gov.br/site/

Source:
https://www.gazetadopovo.com.br/

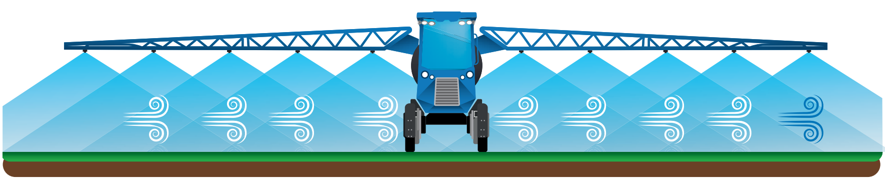
5.1 Spray boom height

The lower the spray boom is to the crop or target, the less opportunity the wind, airflow, and other weather factors have to move droplets from the intended target. But remember that a boom height lower than the spray tip manufacturer's recommendation results in an uneven application. So, before adjusting the sprayer boom height, make sure you are following the spray tip manufacturer's recommendations.

Ideal spray boom height

20" (0.5 m)

Spray boom height HIGHER than the spray tip manufacturer's recommendation



40" (1.0 m)

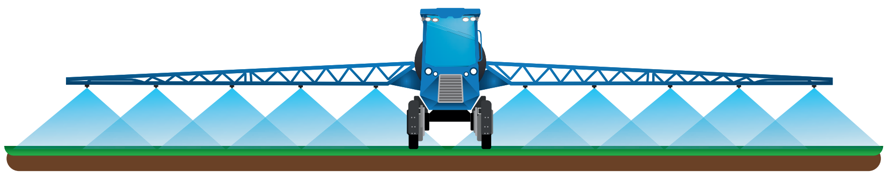
5.2 Spray boom stability

The resulting movement of a spray boom without stability can result in:

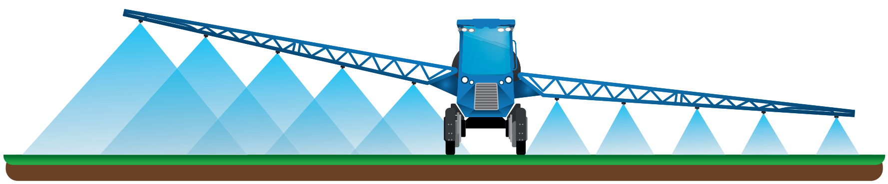
- Greater drift risk when the boom is working at a higher spray height
- Uneven distribution along the treated area

Therefore, sprayers equipped with a spray boom with great stability provide a uniform application and have better control of spray drift.

Ideal Boom stability



Absence of stability

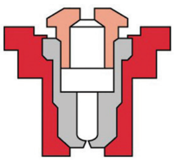


5.3 Spray tips for drift reduction

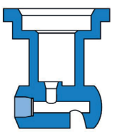
Drift potential can be minimized by using low drift spray tips. Low drift spray tips feature two mechanisms to produce coarser droplets and fewer driftable fines (droplets with a diameter smaller than 150 µm): pre-orifice and/or Venturi air induction technology.

- Pre-orifice flat fan spray tips

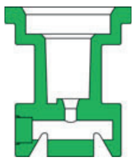
Pre-orific e spray tips reduce the operating pressure internally and produce larger droplets than conventional flat fan spray tips. The tip's pre-orifice restricts the amount of liquid entering the tip and creates a pressure drop through the tip. Fewer droplets prone to drift are produced creating excellent spray pattern uniformity. The examples of TeeJet® Technologies' low drift spray tips with a pre-orifice design are DG, TT, and TTJ60.



DG



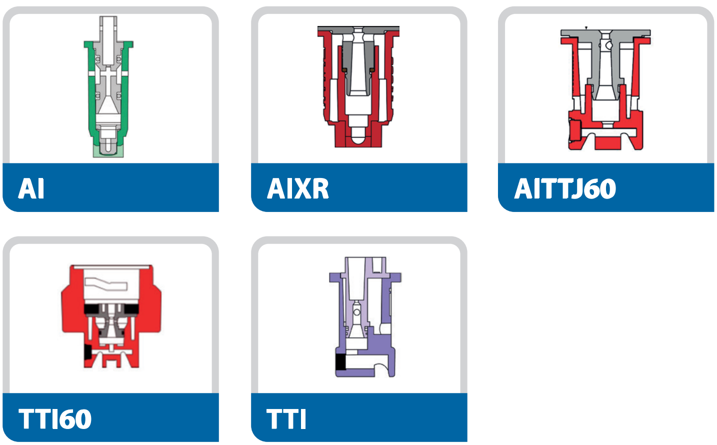
TT



TTJ60

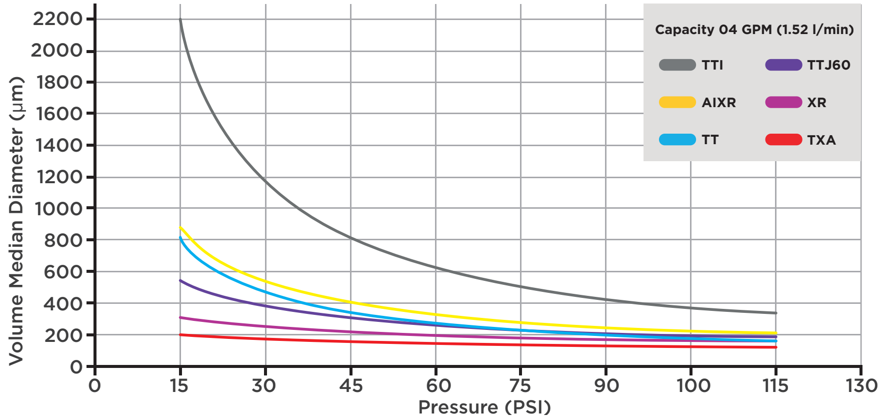
5.4 Venturi air induction spray tips

Air induction spray tips have two orifices. The first orifice, known as the pre-orifice, meters the liquid flow. The second orifice, known as the exit orifice, is larger than the pre-orifice and is responsible for forming the spray pattern. A Venturi system or air aspirator sits between the two orifices. This Venturi system draws air into the body of the tip where it is mixed with water. This mixing creates an air-entrained spray pattern at a lower pressure. The spray pattern is comprised of large, air-filled, coarse droplets with very few drift-susceptible droplets. The examples of TeeJet® Technologies' air induction tips are AI, AIXR, AITTJ60, TTI60, and TTI.



The graphic on the next page represents the volumetric median diameter (VMD) of the TXA, XR, TT, TTJ60, AIXR, and TTI spray tips with the same capacity of 0.4 GPM (1.52 l/min) operating at 40 PSI (2.8 bar). The TXA spray tip produces the smaller droplets (<VMD), followed by the XR, TTJ60/TT, AIXR, and TTI tips. The VMD value increases significantly from the TXA spray tip to the TTI, where at 40 PSI TXA presented a VMD of 149 µm and TTI a VMD of 790 µm.

Volumetric Median Diameter Pressure

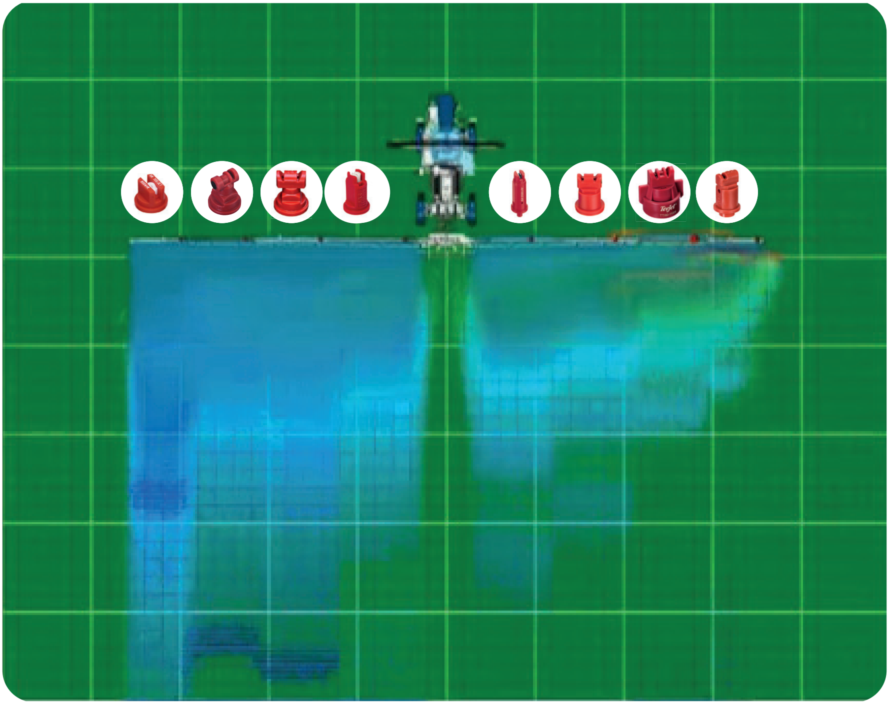


To choose the ideal low drift spray tip for a safer application, it is also important to evaluate the percentage of driftable fines produced by each spray tip type, as shown in the table below.

Spray Tip Type 0.4 GPM (1.52 l/min)	Driftable fines (<150 µm) 40 PSI (2.8 bar)*
TXA 8004	42%**
XR 11004	28%
TT 11004	17%
TTJ60 11004	10%
AIXR 11004	7%
TTI 11004	<2%

* Data obtained from Oxford Imaging VisiSizer system spraying water at 70° F (21°C) under laboratory conditions.
** Percentage of driftable fines of the spray tip TXA8004 @30PSI.

Based on the driftable fine data from the previous table and using a computational fluid dynamics (CFD) technique it is possible to create a simulation where we can observe the driftable potential plume of different spray tips - XR, TT, TTJ60, AITXA, AI, AITTJ60, TTI60, TTI, from the left to the right respectively (image below).



The simulation was carried out by comparing the spraying of all spray tips with the same capacity of 0.4 GPM at 40 PSI (1.52 l/min at 2.8 bar), with a wind speed of 10 MPH (17 km/h).

5.5 Operating pressure

The reduction of the operating pressure can be used as a measure to mitigate drift, as shown in the table below. However, if just by reducing the operating pressure the percentage of driftable fines are still above the limit for a safe application, the user must select a spray tip that produces coarser droplets with a lower percentage of driftable fines.

Spray Tip Type Capacity 0.3 GPM (1.14 l/min)	Driftable fines (<150 µm)	
	20 PSI (1.5 bar)	40 PSI (2.8 bar)
XR 11003	19%	31%
DG 11003	13%	18%
TT 11003	5%	17%
TTJ60 11003	4%	9.5%
AIXR 11003	4%	9%
AITTJ60 11003	2%	4%
AI 11003	2%*	5.5%
TTI60 11003	1%	< 2%
TTI 11003	1%	< 2%

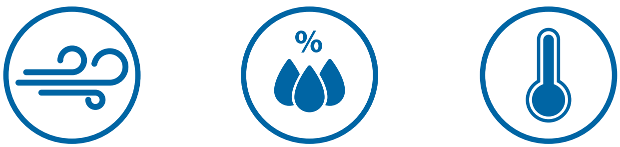
*** Percentage of driftable fines of the spray tip AI11003 @30PSI.**

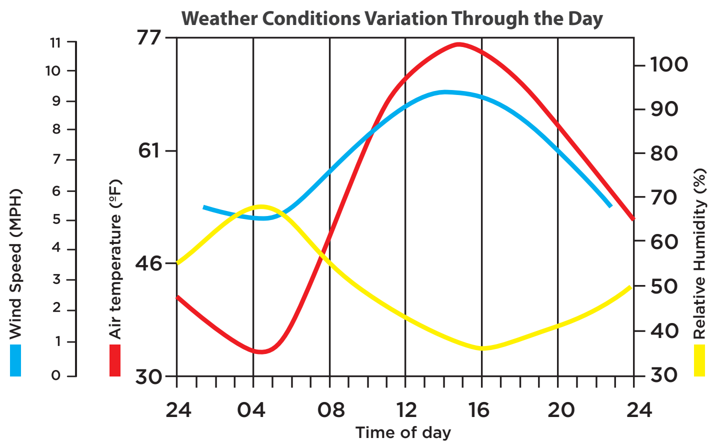
5.6 Weather conditions

In order to make the best application decisions to minimize spray drift, the applicator must be aware that weather varies throughout the day. Therefore, it is important to check the wind speed, temperature, and relative humidity before and during the spray application.

Thus, the wind speed measurement must be carried out at least at the beginning of spraying and at each tank re-filling, using a weather meter to check if the application is taking place within the recommended wind speed range.

Wind Speed	Relative Humidity	Temperature
3 to10 MPH (5 to 17 km/h)	**Above 55%**	**Lower than 86ºF/ 30°C**

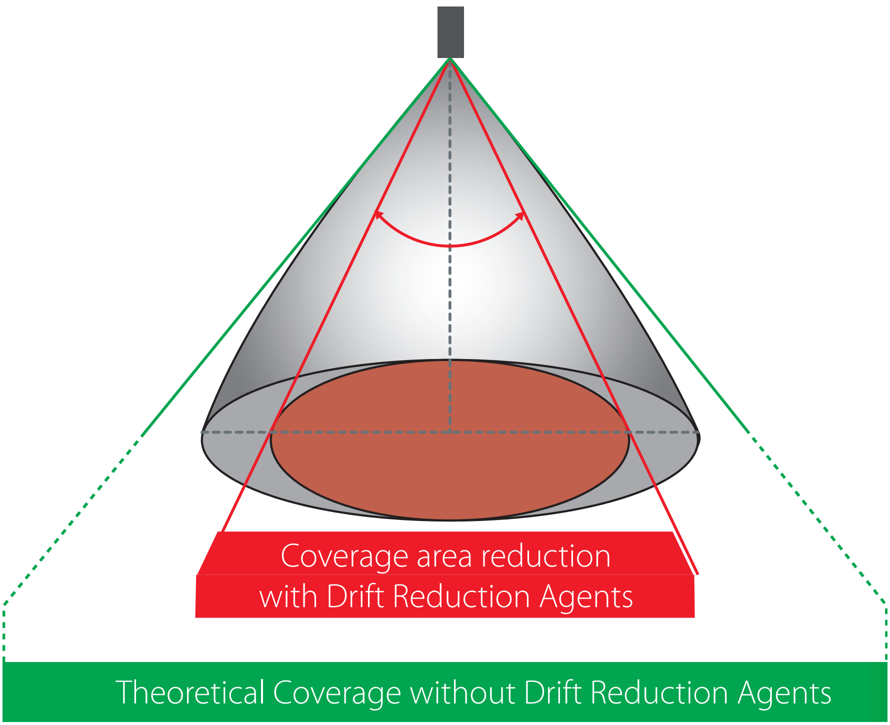




5.7 Drift Reduction Agents (DRAs)

The most critical factor in reducing spray drift is selecting a spray tip that produces the proper droplet size. The addition of Drift Reduction Agents (DRAs) to the tank mixture can reduce driftable fines but will never substitute for the use of the right tip for drift mitigation. DRAs' role is to assist the embedded technology in the spray tip.

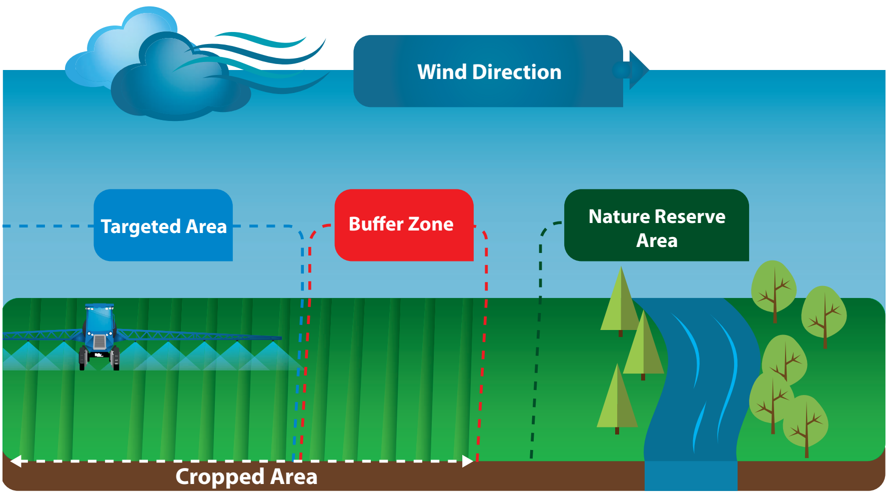
Pay attention to the spray angle when using DRAs – a more viscous solution can reduce the spray angle.



5.8 Buffer zone

A buffer zone is an area not treated with crop protection product, located between the target area and a sensitive area, such as:

- Sensitive crops
- Water source
- Urban areas



Important: Some new crop protection products have recommendations on their label regarding the minimum area for a buffer zone to avoid drift to nearby sensitive areas.

5.9 European regulations for drift reduction

Many European countries evaluate spray nozzles/tips for drift reduction. This makes general cooperation among agriculture, nature conservation, and environmental protection possible.

The use of low drift tips brings significant benefits to users in the United Kingdom, Netherlands, and Germany, as well as others around the world. Stricter requirements for buffer zones to protect surface water and sensitive areas around fields have led to the development of a program that assesses spray tip drift control as well as innovative tips producing larger droplet sizes. Depending on the location of the fields relative to environmentally sensitive areas, such as surface water and field boundaries, applicators must use specific low drift spray tips and manage the width of buffer zones.

TeeJet® Technologies features many spray tips designed to reduce drift that are tested and certified in each of these European countries ensuring an effective and safer application. The assessment is based on drift control using a reference system based on a tip specified by ISO 25358 droplet size classification. All approved and certified TeeJet spray tips are on our website: www.teejet.com. In Germany, the Julius Kuhn Institute – Federal Research Institute for Cultivated Plants (JKI) is responsible for testing spray tips for agricultural use. In the United Kingdom the tests are carried out by LERAP, in France by INRAE, and in the Netherlands by DRD.

Germany **United Kingdom**

JKI LERAP ★★★ LERAP ★★

6 Choosing a Correct Spray Tip Capacity

Now that we understand all the factors that affect distribution along with the application, let's consider how to choose the correct spray tip capacity.

6.1 Option 1: Method of calculating the required capacity of a spray tip for a given application volume

Example:

1 - Recommended application volume.........12.8 GPA (120 l/ha) (Crop protection product manufacturer's label)

2 - Measured sprayer speed....................................9 MPH (15 km/h)

3 - Spacing between tips...20 inches (50 cm)

4 - Droplet size...Coarse (C) - Very Coarse (VC)

$$\text{GPM (Per Tip)} = \frac{\text{GPA x MPH x W}}{5{,}940}$$

$$\text{l/min (Per Tip)} = \frac{\text{l/ha x km/h x W}}{60{,}000}$$

TeeJet Technologies

Where:

- **GPM** = is a single spray tip capacity in GPM – gallons per minute
- **GPA** = is the application volume in GPA – gallons per acre
- **MPH** = is the sprayer speed in MPH – miles per hour
- **W** = is the spacing between spray tips in inches for broadcast spraying
- **5,940** is the conversion factor

- **l/min** = the tip flow rate in liters per minute
- **l/ha** = application rate in liters per hectare
- **km/h** = the ground speed in kilometers per hour
- **W** = is the spacing between tips in centimeters for broadcast spraying
- **60,000** - is the conversion factor for the metric formula

$$\underset{\text{(Per Tip)}}{\text{GPM}} = \frac{\text{GPA x MPH x W}}{5{,}940} \qquad \text{GPM} = 0.39 \text{ GPM}$$

$$\underset{\text{(Per Tip)}}{\text{l/min}} = \frac{\text{l/ha x Km/h x W}}{60{,}000} \qquad \text{l/min} = 1.5 \text{ l/min}$$

Based on the calculated capacity (GPM / l/min), choose the spray tips that suit the best droplet size for your application. According to our example, we would need a 0.4 capacity nozzle (red) that produces a C - VC droplet size.

	Pressure (PSI)	Droplet size	Capacity one tip in GPM
AIXR11004 (50)	15	XC	0.24
	20	VC	0.28
	30		0.35
	40	C	0.40
	50		0.45
	60		0.49
	75	M	0.55
	90		0.60

	Pressure (bar)	Droplet size	Capacity one tip in l/min
AIXR11004 (50)	1.0	XC	0.91
	2.0	VC	1.29
	3.0	C	1.58
	4.0	C	1.82
	5.0	M	2.04
	6.0		2.23

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6.2 Option 2: Method using TeeJet Technologies spray tip catalog

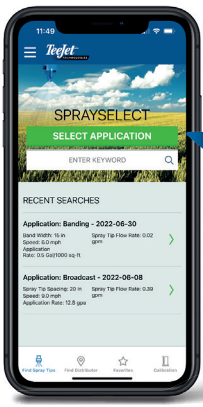
Example – Using the same data as the previous method, application volume of 12.8 GPA (120 l/ha), average spray speed of 9 MPH (15 km/h) and tip spacing of 20 inches (50 cm), and C - VC droplet size, in the TeeJet catalog find the target application volume within the chosen sprayer speed column and cross to the left to find the appropriate tip capacity and pressure.

TIP PART NO. (STRAINER MESH SIZE)	PSI	DROP SIZE	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ/MIN	APPLICATION RATE FOR 20" SPRAY TIP SPACING											
					GALLONS PER ACRE (GPA)								TURF APPLICATION GALLONS PER 1000 SQ. FT.			
					4 MPH	5 MPH	6 MPH	8 MPH	10 MPH	12 MPH	15 MPH	20 MPH	2 MPH	3 MPH	4 MPH	5 MPH
AIXR110015 (100)	15	VC	0.092	12	6.8	5.5	4.6	3.4	2.7	2.3	1.8	1.4	0.31	0.21	0.16	0.13
	20	VC	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6	0.37	0.25	0.19	0.15
	30	C	0.13	17	9.7	7.7	6.4	4.8	3.9	3.2	2.6	1.9	0.44	0.29	0.22	0.18
	40	C	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	50	M	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	60	M	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	75	M	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	90	M	0.23	29	17.1	13.7	11.4	8.5	6.8	5.7	4.6	3.4	0.78	0.52	0.39	0.31
AIXR11002 (50)	15	XC	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8	0.41	0.27	0.20	0.16
	20	VC	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1	0.48	0.32	0.24	0.19
	30	VC	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	40	C	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0	4.0	3.0	0.68	0.45	0.34	0.27
	50	M	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	60	M	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	75	M	0.27	35	20	16.0	13.4	10.0	8.0	6.7	5.3	4.0	0.92	0.61	0.46	0.37
	90	M	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
AIXR110025 (50)	15	XC	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	20	VC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	30	VC	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	40	C	0.25	32	18.6	14.9	12.4	9.3	7.4	6.2	5.0	3.7	0.85	0.57	0.43	0.34
	50	M	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	60	M	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6	1.1	0.70	0.53	0.42
	75	M	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	90	M	0.38	49	28	23	18.8	14.1	11.3	9.4	7.5	5.6	1.3	0.86	0.65	0.52
AIXR11003 (50)	15	XC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	20	VC	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	30	VC	0.26	33	19.3	15.4	12.9	9.7	7.7	6.4	5.1	3.9	0.88	0.59	0.44	0.35
	40	C	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
	50	C	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	60	M	0.37	47	27	22	18.3	13.7	11.0	9.2	7.3	5.5	1.3	0.84	0.63	0.50
	75	M	0.41	52	30	24	20	15.2	12.2	10.1	8.1	6.1	1.4	0.93	0.70	0.56
	90	M	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
AIXR11004 (50)	15	XC	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	20	VC	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	30	VC	0.35	45	26	21	17.3	13.0	10.4	8.7	6.9	5.2	1.2	0.79	0.60	0.48
	40	C	0.40	51	30	24	19.8	14.9	11.9	9.9	7.9	5.9	1.4	0.91	0.68	0.54
	50	C	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
	60	C	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67
	75	M	0.55	70	41	33	27	20	16.3	13.6	10.9	8.2	1.9	1.2	0.94	0.75
	90	M	0.60	77	45	36	30	22	17.8	14.9	11.9	8.9	2.0	1.4	1.0	0.82
AIXR11005 (50)	15	XC	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6	1.1	0.70	0.53	0.42
	20	XC	0.35	45	26	21	17.3	13.0	10.4	8.7	6.9	5.2	1.2	0.79	0.60	0.48
	30	VC	0.43	55	32	26	21	16.0	12.8	10.6	8.5	6.4	1.5	0.97	0.73	0.58
	40	VC	0.50	64	37	30	25	18.6	14.9	12.4	9.9	7.4	1.7	1.1	0.85	0.68
	50	C	0.56	72	42	33	28	21	16.6	13.9	11.1	8.3	1.9	1.3	0.95	0.76
	60	C	0.61	78	45	36	30	23	18.1	15.1	12.1	9.1	2.1	1.4	1.0	0.83
	75	M	0.68	87	50	40	34	25	20	16.8	13.5	10.1	2.3	1.5	1.2	0.92
	90	M	0.75	96	56	45	37	28	22	18.6	14.9	11.1	2.6	1.7	1.3	1.0
AIXR11006 (50)	15	XC	0.37	47	27	22	18.3	13.7	11.0	9.2	7.3	5.5	1.3	0.84	0.63	0.50
	20	XC	0.42	54	31	25	21	15.6	12.5	10.4	8.3	6.2	1.4	0.95	0.71	0.57
	30	VC	0.52	67	39	31	26	19.3	15.4	12.9	10.3	7.7	1.8	1.2	0.88	0.71
	40	VC	0.60	77	45	36	30	22	17.8	14.9	11.9	8.9	2.0	1.4	1.0	0.82
	50	VC	0.67	86	50	40	33	25	19.9	16.6	13.3	9.9	2.3	1.5	1.1	0.91
	60	C	0.73	93	54	43	36	27	22	18.1	14.5	10.8	2.5	1.7	1.2	0.99
	75	C	0.82	105	61	49	41	30	24	20	16.2	12.2	2.8	1.9	1.4	1.1
	90	C	0.90	115	67	53	45	33	27	22	17.8	13.4	3.1	2.0	1.5	1.2
AIXR11008 (50)	15	UC	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67
	20	XC	0.57	73	42	34	28	21	16.9	14.1	11.3	8.5	1.9	1.3	0.97	0.78
	30	XC	0.69	88	51	41	34	26	20	17.1	13.7	10.2	2.3	1.6	1.2	0.94
	40	VC	0.80	102	59	48	40	30	24	19.8	15.8	11.9	2.7	1.8	1.4	1.1
	50	VC	0.89	114	66	53	44	33	26	22	17.6	13.2	3.0	2.0	1.5	1.2
	60	VC	0.98	125	72	58	49	36	29	24	19.4	14.6	3.3	2.2	1.7	1.3
	75	C	1.10	141	82	65	54	41	33	27	22	16.3	3.7	2.5	1.9	1.5
	90	C	1.20	154	89	71	59	45	36	30	24	17.8	4.1	2.7	2.0	1.6
AIXR11010	15	UC	0.61	78	45	36	30	23	18.1	15.1	12.1	9.1	2.1	1.4	1.0	0.83
	20	UC	0.71	91	53	42	35	26	21	17.6	14.1	10.5	2.4	1.6	1.2	0.97
	30	XC	0.87	111	65	52	43	32	26	22	17.2	12.9	3.0	2.0	1.5	1.2
	40	VC	1.00	128	74	59	50	37	30	25	19.8	14.9	3.4	2.3	1.7	1.4
	50	VC	1.12	143	83	67	55	42	33	28	22	16.6	3.8	2.5	1.9	1.5
	60	VC	1.22	156	91	72	60	45	36	30	24	18.1	4.2	2.8	2.1	1.7
	75	VC	1.37	175	102	81	68	51	41	34	27	20	4.7	3.1	2.3	1.9
	90	C	1.50	192	111	89	74	56	45	37	30	22	5.1	3.4	2.6	2.0

TIP PART NO. (STRAINER MESH SIZE)	bar	DROP SIZE	CAPACITY ONE NOZZLE IN l/min	APPLICATION RATE FOR 50 cm SPRAY TIP SPACING l/ha												
				4 km/h	5 km/h	6 km/h	7 km/h	8 km/h	10 km/h	12 km/h	16 km/h	18 km/h	20 km/h	25 km/h	30 km/h	35 km/h
AIXR110015 (100)	1.0	VC	0.34	102	81.6	68.0	58.3	51.0	40.8	34.0	25.5	22.7	20.4	16.3	13.6	11.7
	2.0	C	0.48	144	115	96.0	82.3	72.0	57.6	48.0	36.0	32.0	28.8	23.0	19.2	16.5
	3.0	C	0.59	177	142	118	101	88.5	70.8	59.0	44.3	39.3	35.4	28.3	23.6	20.2
	4.0	M	0.68	204	163	136	117	102	81.6	68.0	51.0	45.3	40.8	32.6	27.2	23.3
	5.0	M	0.76	228	182	152	130	114	91.2	76.0	57.0	50.7	45.6	36.5	30.4	26.1
	6.0	M	0.83	249	199	166	142	125	99.6	83.0	62.3	55.3	49.8	39.8	33.2	28.5
AIXR11002 (50)	1.0	XC	0.46	138	110	92.0	78.9	69.0	55.2	46.0	34.5	30.7	27.6	22.1	18.4	15.8
	2.0	VC	0.65	195	156	130	111	97.5	78.0	65.0	48.8	43.3	39.0	31.2	26.0	22.3
	3.0	C	0.79	237	190	158	135	119	94.8	79.0	59.3	52.7	47.4	37.9	31.6	27.1
	4.0	M	0.91	273	218	182	156	137	109	91.0	68.3	60.7	54.6	43.7	36.4	31.2
	5.0	M	1.02	306	245	204	175	153	122	102	76.5	68.0	61.2	49.0	40.8	35.0
	6.0	M	1.12	336	269	224	192	168	134	112	84.0	74.7	67.2	53.8	44.8	38.4
AIXR110025 (50)	1.0	XC	0.57	171	137	114	97.7	85.5	68.4	57.0	42.8	38.0	34.2	27.4	22.8	19.5
	2.0	VC	0.81	243	194	162	139	122	97.2	81.0	60.8	54.0	48.6	38.9	32.4	27.8
	3.0	C	0.99	297	238	198	170	149	119	99.0	74.3	66.0	59.4	47.5	39.6	33.9
	4.0	M	1.14	342	274	228	195	171	137	114	85.5	76.0	68.4	54.7	45.6	39.1
	5.0	M	1.28	384	307	256	219	192	154	128	96.0	85.3	76.8	61.4	51.2	43.9
	6.0	M	1.40	420	336	280	240	210	168	140	105	93.3	84.0	67.2	56.0	48.0
AIXR11003 (50)	1.0	XC	0.68	204	163	136	117	102	81.6	68.0	51.0	45.3	40.8	32.6	27.2	23.3
	2.0	VC	0.96	288	230	192	165	144	115	96.0	72.0	64.0	57.6	46.1	38.4	32.9
	3.0	C	1.18	354	283	236	202	177	142	118	88.5	78.7	70.8	56.6	47.2	40.5
	4.0	M	1.36	408	326	272	233	204	163	136	102	90.7	81.6	65.3	54.4	46.6
	5.0	M	1.52	456	365	304	261	228	182	152	114	101	91.2	73.0	60.8	52.1
	6.0	M	1.67	501	401	334	286	251	200	167	125	111	100	80.2	66.8	57.3
AIXR11004 (50)	1.0	XC	0.91	273	218	182	156	137	109	91.0	68.3	60.7	54.6	43.7	36.4	31.2
	2.0	VC	1.29	387	310	258	221	194	155	129	96.8	86.0	77.4	61.9	51.6	44.2
	3.0	C	1.58	474	379	316	271	237	190	158	119	105	94.8	75.8	63.2	54.2
	4.0	C	1.82	546	437	364	312	273	218	182	137	121	109	87.4	72.8	62.4
	5.0	M	2.04	612	490	408	350	306	245	204	153	136	122	97.9	81.6	69.9
	6.0	M	2.23	669	535	446	382	335	268	223	167	149	134	107	89.2	76.5
AIXR11005 (50)	1.0	XC	1.14	342	274	228	195	171	137	114	85.5	76.0	68.4	54.7	45.6	39.1
	2.0	VC	1.61	483	386	322	276	242	193	161	121	107	96.6	77.3	64.4	55.2
	3.0	VC	1.97	591	473	394	338	296	236	197	148	131	118	94.6	78.8	67.5
	4.0	C	2.27	681	545	454	389	341	272	227	170	151	136	109	90.8	77.8
	5.0	M	2.54	762	610	508	435	381	305	254	191	169	152	122	102	87.1
	6.0	M	2.79	837	670	558	478	419	335	279	209	186	167	134	112	95.7
AIXR11006 (50)	1.0	XC	1.37	411	329	274	235	206	164	137	103	91.3	82.2	65.8	54.8	47.0
	2.0	VC	1.94	582	466	388	333	291	233	194	146	129	116	93.1	77.6	66.5
	3.0	VC	2.37	711	569	474	406	356	284	237	178	158	142	114	94.8	81.3
	4.0	C	2.74	822	658	548	470	411	329	274	206	183	164	132	110	93.9
	5.0	C	3.06	918	734	612	525	459	367	306	230	204	184	147	122	105
	6.0	C	3.35	1005	804	670	574	503	402	335	251	223	201	161	134	115
AIXR11008 (50)	1.0	UC	1.82	546	437	364	312	273	218	182	137	121	109	87.4	72.8	62.4
	2.0	XC	2.58	774	619	516	442	387	310	258	194	172	155	124	103	88.5
	3.0	VC	3.16	948	758	632	542	474	379	316	237	211	190	152	126	108
	4.0	VC	3.65	1095	876	730	626	548	438	365	274	243	219	175	146	125
	5.0	C	4.08	1224	979	816	699	612	490	408	306	272	245	196	163	140
	6.0	C	4.47	1341	1073	894	766	671	536	447	335	298	268	215	179	153
AIXR11010	1.0	UC	2.28	684	547	456	391	342	274	228	171	152	137	109	91.2	78.2
	2.0	XC	3.23	969	775	646	554	485	388	323	242	215	194	155	129	111
	3.0	VC	3.95	1185	948	790	677	593	474	395	296	263	237	190	158	135
	4.0	VC	4.56	1368	1094	912	782	684	547	456	342	304	274	219	182	156
	5.0	VC	5.10	1530	1224	1020	874	765	612	510	383	340	306	245	204	175
	6.0	C	5.59	1677	1342	1118	958	839	671	559	419	373	335	268	224	192

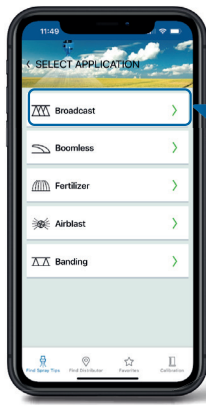
6.3 Option 3: Method using the SpraySelect App

Example – Using the SpraySelect App and the same data as the previous examples, application volume of 12.8 GPA (120 l/ha), average spray speed of 9 MPH (15 km/h) and tip spacing of 20 inches (50 cm), and C-VC droplet size:



1

Click on "Select Application" on the first screen



2

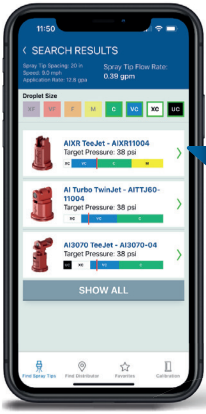
Select the Broadcast application option (or other according to your application)

3

Select the type of product to be applied - herbicide, fungicide, insecticide, and the crop protection product Mode of Action

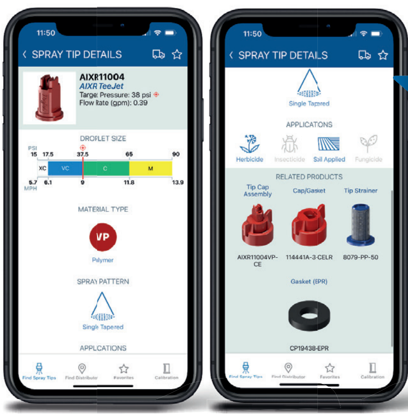
4

Select the parameters of the application – spray tip spacing (inches/ cm), sprayer speed (MPH/ km/h), application rate (GPA/ Gal/ 1000sq-ft/ l/ha) and optimum pressure (PSI / bar)



5

The SpraySelect App will provide the top spray tips solutions according to the selected parameters



6

By clicking on the spray tip of your choice, the App will provide information such as the target pressure and operating speed at which the tip will produce a given droplet size, the GPM / l/min of the tip at the selected parameters, material(s) type, spray pattern, tip applications, and related products to the tip - cap, gasket, and nozzle strainer to the selected tip capacity

Available on the App Store

Available on Google Play

TeeJet® SpraySelect
Download Today

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