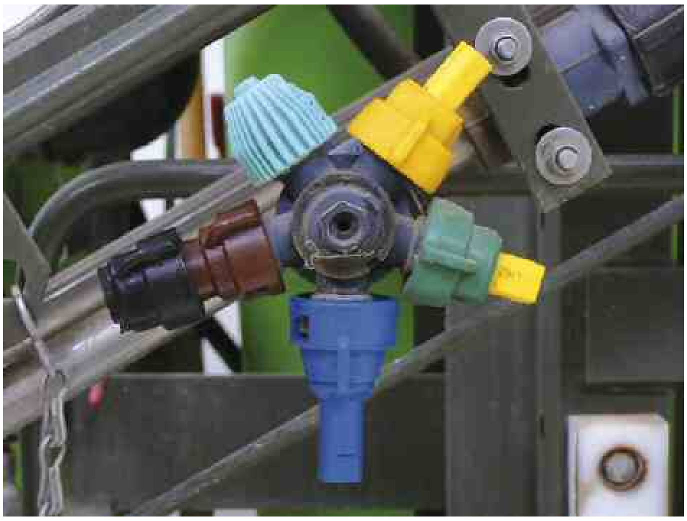
Spraying

Choosing appropriate nozzles to preserve efficacy

It is fair to assume that the establishment of unsprayed buffer zones and the introduction of compulsory sprayer MOT testing, will result in spraying nozzles being changed more often. But choosing appropriate nozzles is not an easy task. What type of nozzle should be chosen? Which ones are approved? Can treatment efficacy be affected? Here is some reference data to help farmers make the right choice, both in technical and regulatory terms.



The wide selection of nozzles available on the market allows to find a compromise between efficiency and drift according to the different types of products.

Choosing a nozzle is not a simple question of colour. The nozzle type should also be a major part of the decision process since it determines both spray quality and sensitivity to drift. On the whole, the most effective and common way of limiting the risk of spray drift is to produce larger droplets. Therefore, manufacturers offer a range of nozzle types often with the main difference between them being the size of droplets they produce.

First of all, there are conventional flat fan nozzles, used between 2 bars (minimum pressure to produce sufficient spray angles) and 3 bars maximum. Above 3 bars, the droplets are very small and the risk of spray drift becomes too high.

With a low pressure nozzle, the operator can work from 1.2 bars while maintaining an appropriate jet angle to achieve a good level of coverage. This lower working pressure helps to produce droplets with a larger diameter, and therefore to significantly limit spray drift. Those nozzles are the first generation of low drift nozzles. It is important to remember that it is possible to work with a pressure between 2 and 3 bars, but that this reduces the low drift effect.

> The most effective way of limiting the risk of spray drift is to produce larger droplets.

The second family of low drift nozzles consists of what is known as adjustable disc nozzles. The principle is simple: a disc situated upstream of the nozzle forms a decompression chamber which lowers the pressure, making it possible to produce droplets with a larger diameter.

Finally, "air induction" technology introduces air bubbles into the droplets, which greatly increases their diameter. Those nozzles, misleadingly called "anti-drift" nozzles, are the most effective type in reducing spray drift.

Conventional flat fan nozzles are used between 2 bars and 3 bars maximum.

Different types of nozzles available on the market (non exhaustive list) *(tab. 1)*						
			Low drift nozzles			
		Conventional flat fan	Low pressure	Adjustable disc	Air induction	
					conventional	Low pressure
TEEJET	Name	TP	XR/XRC (built-in nut)	DG TT (Mirror type)	AI/AIC (built-in nut)	AIXR TTI (Mirror type)
	Angle	65°/80°/110°	80°/110°	80°/110°	110°	110°/120°
	Pressure	2 to 3 bars	1.2 – 2 bars	2 to 3 bars	3 to 4 bars	1.5 to 5 bars
ALBUZ	Name	API	AXI/FAST CAP (built-in nut)	ADI	AVI	CVI
	Angle	80°/110°	80°/110°	110°	110°	110°
	Pressure	2 to 3 bars	1.2 – 2 bars	2 to 3 bars	3 to 4 bars	1.5 to 5 bars
NOZAL	Name	RFX/AFX		RLX/ALX	RRX/ARX	ADX
	Angle	80°/110°		80°/110°	80°/110°	120°
	Pressure	2 to 3 bars		2 to 3 bars	3 to 4 bars	
HARDI	Name	F-110		LD-110	INJET	MINIDRIFT
	Angle	110°		110°	110°	120°
	Pressure	2 to 3 bars		2 to 3 bars	3 to 4 bars	1.5 to 5 bars
LURMARK	Name	Fan TIP	VP-TIP	Lo-Drift	Drift BETA 120	Drift BETA 120
	Angle	80°/110°	80°/110°	80°/110°	120°	120°
	Pressure	2 to 3 bars	1.2-2 bars	2 to 3 bars	3 to 4 bars	3 to 4 bars
LECHLER	Name	ST	LU	AD	ID/IDN	IDK
	Angle	80°/110°	90°/120°	120°	120°	120°
	Pressure	2 to 3 bars	1.2-2 bars	2 to 3 bars	Id = 3-4 bars, IDK 2-3 bars	1.5 to 5 bars
AGROTOP	Name	SPRAY MAX			AIR MIX/TURBODROP	TDX
	Angle	80°/110°				
	Pressure	2 to 3 bars				1.5 to 5 bars
AGRILEAD/ BFS	Name				ABJ	ABJ
	Angle					
	Pressure				2-4 bars	2-4 bars
Low pressure air induction nozzles complete an already wide range.						

Air induction" technology introduces air bubbles into the droplets, which greatly increases their diameter.

In the early days, air induction required a rather high working pressure (above 4 bars). But technological progress has helped to lower the minimum pressure to 3 bars. Nowadays, new generations of air induction nozzles make it possible to work with a pressure as low as 1.5 to 2 bars. They form the low pressure air induction nozzle family *(see insert).* Table 1, which is not exhaustive, recaps the different types of nozzles available on the market and sorts them into families.

Nozzles to reduce Untreated Buffer Zones

Since September 2006, a decree authorizes the reduction of Untreated Buffer Zones alongside watercourses, for some plant protection products, subject to adhering to three conditions:

- to establish a 5 m wide green strip alongside the watercourse,
- to record scrupulously one's practices,
- to use an effective and approved method of reducing drift by a factor of 3.

Now, those methods figure on an official list of (the latest update dating back to 4th June 2008), comprising almost exclusively air induction type nozzles. But note that not all air induction nozzles are listed. Therefore, even if the list is fairly long and the choice is quite extensive, it is important to make sure that the air induction nozzle that is being used or about to be purchased to reduce the UBZ, does figure on that list *(table 2)*. In addition, each type of approved nozzle is assigned a maximum working pressure.

Reducing spray drift is a major objective and must be addressed, in order to preserve water quality. But this must not be to the detriment of treatment efficacy. Nozzles are key elements to reconcile those two objectives.

It is also worth remembering that this list approves nozzles for their ability to reduce spray drift. Using an approved nozzle therefore doe not guarantee that the treatment will be successful. In addition, the working pressures indicated are not always suited to the practice implemented by the operator. For example, it seems difficult, or even impossible, to use a nozzle with a pressure of 1 bar. In such conditions/In this condition/In this situation, the regulation function can barely operate and the anti-drip systems are ready to close. This is why we indicated under the table the minimum pressures required for the nozzles to operate normally and safely.

Reducing spray drift without affecting the efficacy of treatments

Reducing spray drift is a major objective and must be addressed, in order to preserve water quality. But this must not be to the detriment of treatment efficacy. If reducing drift means increasing the number of applications to achieve the same level of efficacy in each field, it does not benefit the environment.

It is true that increasing the size of the droplets limits the risk of spray drift, but it also reduces the quality of target coverage. Spray quality depends on two main factors: the size and the number of droplets. With equal volumes/ha, the finer the droplets are, the larger the area covered by the spray solution is. For example, with 150l/ha, the spray produced with a conventional flat fan nozzle will cover a greater target area than the same volume/ha with an air induction nozzle.

> Reducing spray drift is a major objective and must be addressed, in order to preserve water quality.

However, a spray is considered of good quality when the spray solution covers a target area large enough to achieve maximum efficacy of the product, while limiting spray drift as much as possible. But all products do not have the same requirements in terms of coverage. The “mode of action” or, more precisely, the “mode of travel” of the product inside the plant, often determines the required level of spray quality. In this case, large droplets are not necessarily to be avoided. In some cases, they are even advisable.

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The mode of action of the product used, be it residual, non systemic or systemic, influences the choice of nozzles

The efficacy of residual herbicides does not depend on the quality of the spray. Once they are in the ground, active ingredients travel through the water contained in the soil to reach the roots of the targeted plant. The efficacy of the product depends more on the presence of water in the soil or even on the clay or organic matter contents of the soil, than on the size of the droplets or the volume/ha applied (1 mm of rain = 10,000 l/ha).

So, it seems that, when such residual products are applied, spray drift control is the only constraint: the use of air induction nozzles is therefore highly recommended.

Conversely, non systemic products hardly travel through the plant at all. They are active where they "fall". Consequently, the larger the target area covered is, the more effective the treatment will be. With this type of product, spray quality is one of the main factors determining the efficacy of the treatment. Therefore, if the volume/ha is too low, it could significantly reduce the efficacy of the treatment. Likewise, a coarse spray (large droplets) combined with a low volume/ha can have significant impact on the efficacy of the treatment. We observed these phenomena for instance when Emblem was used to control weeds in maize *(figure 1a)*: low volume applications (50l/ha) with large droplets (air induction nozzle) are very noticeably less effective.

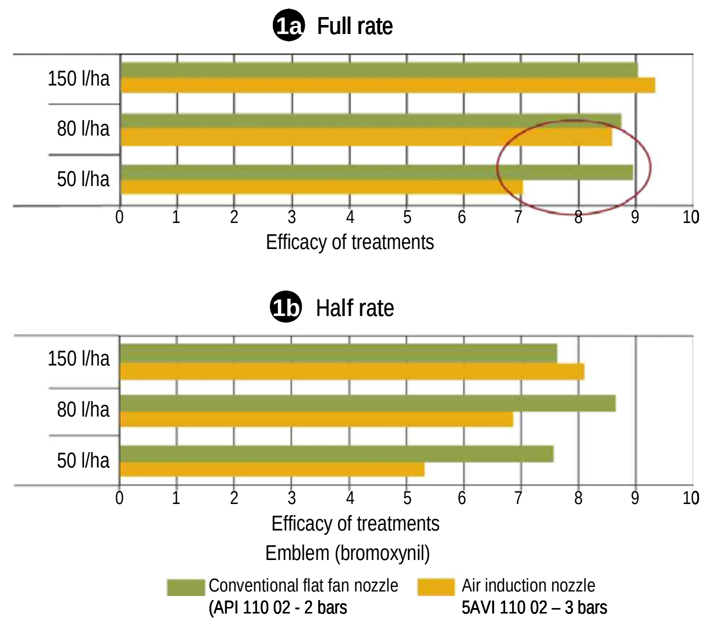
The efficacy of residual products depends more on the amount of water in the soil than on the size of the droplets.

Reduced rates (from 80l/ha) result in significantly different levels of efficacy between the two types of nozzle *(figure 1b).* With non systemic products, the operator should avoid combining risks. It is possible to use air induction nozzles if they are not combined with low volumes (below 100l/ha) and/or reduced rates.

These phenomena are even more marked in cases where the weeds are small and therefore difficult to reach. It is the case with early weed control in sugar beet crops *(figure 2)*, where, a significant difference in efficacy appears from 80l/ha, between a conventional nozzle (fine droplets) and an air induction nozzle (large droplets) used at a full rate.

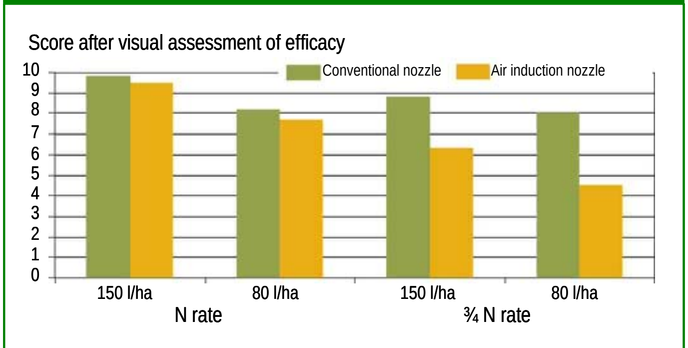
Conversely to non systemic products, systemic herbicides, once they are on the leaf, penetrate and travel through the plant. This greater mobility through the plant makes them less dependant on the quality of the spray. This being the most common type of product used, it is therefore possible to use nozzles that do not tend to cause much spray drift (air induction), without affecting the efficacy of the treatments. It is also possible to use them with lower volumes/ha.

Efficacy of weed control in maize, using non systemic products at full and half rates – Amalgamation of three trials at Bignan (Brittany) and La Jaillière (western France) 2004-2005 *(fig. 1)*



With low volumes, large droplets reduce the efficacy of the treatment. The combination of low volumes and reduced rates is not compatible with air induction nozzle use.

Impact of nozzle type and volume/ha on the efficacy of weed control treatments in sugar beet (ARVALIS-Institut du végétal/ITB 2005 and 2008) *(fig. 2)*



In order to guarantee the efficacy of the treatment, air induction nozzles must not be used with very low volumes/ha and/or rates

It is possible to use nozzles that do not tend to cause much spray drift (air induction), without affecting the efficacy of the treatments. It is also possible to use them with lower volumes/ha.

Official list of nozzles approved of reducing untreated buffer zones (latest update dating to 4th june 2008) *(tab. 2)*						
Calibre	Pressure	TEEJET		ALBUZ	LECHLER	
		Conventional air induction	Low pressure air induction + Mirror type	Conventional air induction	Conventional air induction	Low pressure air induction
Calibre ISO, 0.15 GREEN	1					IDK CERAMIQUE/POM120
	1.5					IDK CERAMIQUE 120
	2					
	3			AVI 110		
	4					
	5					
Calibre ISO, 0.2 YELLOW	1		TTI 110			IDK CERAMIQUE/POM 120
	1.5		TTI 110			IDK CERAMIQUE 120
	2	AI 110 vs / AIC 110vs	TTI 110			
	3	AI 110 vs / AIC 110vs	TTI 110	AVI 110	ID 120	
	4		TTI 110 et 4.5 b		ID 120	
	5					
Calibre ISO, 0.25 VIOLET	1		TTI 110			IDK CERAMIQUE/POM 120
	1.5		TTI 110			IDK CERAMIQUE 120
	2	AI 110 vs ou vp / AIC 110vs ou vp	TTI 110		IDN 110	
	3	AI 110 vs / AIC 110vs	TTI 110	AVI 110 et 3.5bars	ID 120/IDN 110	
	4	AI 110 vs / AIC 110vs	TTI 110 et 4.5 b		ID 120	
	5					
Calibre ISO, 0.3 BLUE	1		TTI 110			IDK CERAMIQUE/POM 120
	1.5		TTI 110			IDK CERAMIQUE120
	2	AI 110 vs ou vp / AIC 110vs ou vp	TTI 110		IDN 110	
	3	AI 110 vs / AIC 110vs	TTI 110	AVI 110	ID 120/IDN 110	
	4		TTI 110 et 4.5 b		ID 120 /IDN 110	
	5					
Calibre ISO, 0.4 RED	1		TTI 110			IDK CERAMIQUE/POM 120
	1.5		TTI 110			IDK CERAMIQUE120
	2	AI 110 vs ou vp / AIC 110vs ou vp	TTI 110			IDK CERAMIQUE 120
	3	AI 110vs / AIC 110vs	TTI 110	AVI 110	ID 120	
	4		TTI 110	AVI 110	ID 120	
	5		TTI 110	AVI 110		
	6		TTI 110			
	7		TTI 110			
Calibre ISO, 05 BROWN	1		TTI 110 /TT 120			IDK CERAMIQUE/POM 120
	1.5		TTI 110			IDK CERAMIQUE/POM 120
	2	AI 110 vs ou vp / AIC 110vs ou vp	TTI 110		ID 120	IDK CERAMIQUE 120
	3	AI 110 vs / AIC 110vs	TTI 110	AVI 110	ID 120	IDK CERAMIQUE 120
	4		TTI 110	AVI 110	ID 120	IDK CERAMIQUE 120
	5	AI 110 vs / AIC 110vs	TTI 110	AVI 110		
	6		TTI 110			
	7		TTI 110			
Calibre ISO, 06 GREY	1		TTI 110 /TT 120			
	1.5		TTI 110			
	2	AI 110vs / AIC 110vs	TTI 110		ID 120	
	3	AI 110vs / AIC 110vs	TTI 110		ID 120	
	4	AI 110vs / AIC 110vs	TTI 110		ID 120	
	5		TTI 110		ID 120	
	6		TTI 110			
	7		TTI 110			
Calibre ISO, 08 WHITE	1					
	1.5					
	2				ID 120	
	3				ID 120	
	4				ID 120	
	5				ID 120	

Minimal pressure needed for a normal and no riskless use of nozzles :
Conventional air induction nozzles :
*AI/AIC 110, AVI 110, ID 120, IDN 120, INJET 110 : Conventional air induction nozzles 3 bas minimum.

Low pressure air induction nozzles :
* IDK 120, MINIDRIFT 110, ADX : Low pressure air induction nozzles 1.5 bars minimum.
* TTI : low pressure air induction nozzles 2 bars miminum

Official list of nozzles approved of reducing untreated buffer zones (latest update dating to 4th june 2008) *(tab. 2)*

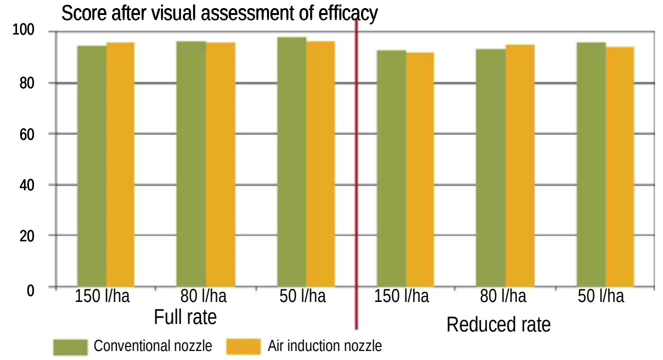
Calibre	Pressure	HARDI		LURMARK	NOZAL	AGROTOP	AIR BUBBLE JET
		Conventional air induction	Low pressure air induction	Low pressure air induction	Low pressure air induction	Low pressure air induction	Low pressure air induction
Calibre ISO, 0.15 GREEN	1		MINIDRIFT 110				
	1.5						
	2			DB F120	ADX		
	3				ADX		
	4						
	5						
Calibre ISO, 0.2 YELLOW	1		MINIDRIFT 110		ADX		
	1.5				ADX		
	2			DB F120			
	3	Injet 110					
	4	Injet 110					
	5						
Calibre ISO, 0.25 VIOLET	1		MINIDRIFT 110		ADX		
	1.5				ADX		
	2			DB F120			AIR BUBBLEJET 110 Résine
	3	Injet 110					
	4	Injet 110					
	5						
Calibre ISO, 0.3 BLUE	1		MINIDRIFT 110		ADX		
	1.5				ADX		
	2			DB F120			AIR BUBBLEJET 110 Résine
	3	Injet 110		DB F120			
	4	Injet 110					
	5						
Calibre ISO, 0.4 RED	1		MINIDRIFT 110		ADX		
	1.5				ADX		
	2			DB F120	ADX		AIR BUBBLEJET 110 Résine
	3	Injet 110		DB F120			
	4	Injet 110					
	5						
	6						
	7						
Calibre ISO, 05 BROWN	1		MINIDRIFT 110		ADX		
	1.5		MINIDRIFT 110		ADX		
	2			DB F120	ADX		AIR BUBBLEJET 110 Résine
	3	Injet 110		DB F120	ADX	TURBODROP TDXL/AIRMIX 110	
	4			DB F120	ADX		
	5			DB F120			
	6			DB F120			
	7						
Calibre ISO, 06 GREY	1						
	1.5						
	2			DB F120			AIR BUBBLEJET 110 Résine
	3	Injet 110		DB F120		TURBODROP TDXL	
	4			DB F120			
	5			DB F120			
	6			DB F120			
	7						
Calibre ISO, 08 WHITE	1						
	1.5						
	2			DB F120			
	3	Injet 110		DB F120			
	4						
	5						

Minimal pressure needed for a normal and no riskless use of nozzles :
Conventional air induction **nozzles** :
*AI/AIC 110, AVI 110, ID 120, IDN 120, INJET 110 : Conventional air induction **nozzles** 3 bars minimum.

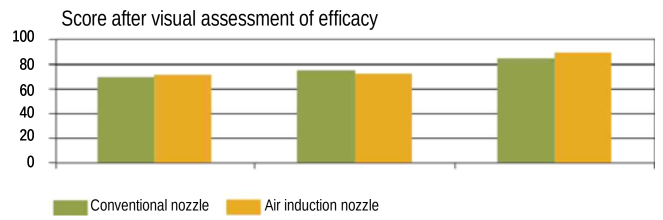
Low pressure air induction **nozzles** :
* IDK 120, MINIDRIFT 110, ADX : Low pressure air induction **nozzles** 1.5 bars minimum.
* TTI : low pressure air induction nozzles 2 bars miminum

Impact of nozzle type on the efficacy of Archipel on ryegrass – 4 year summary *(fig. 3a)* and of Roundup Flash (3 l/ha) *(fig. 3b)*

3a Archipel



3b Roundup Flash (3 l/ha) – Monsanto / ARVALIS-Institut du végétal 2006



Systemic herbicides are more dependent on the quality of the spray. Their efficacy is therefore less sensitive to the type of nozzle used and to reduced

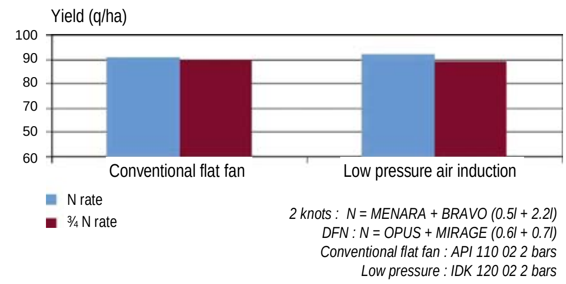
In all the trials that we have carried out, we have never observed any significant drop in the level of efficacy that could be attributed to the use of nozzles producing large droplets *(figure 3)*. Beware of using contact herbicides early (in the autumn), when targets are small, which could cause problems with air induction. Future trials will help us to confirm or invalidate this concern.

Non systemic products are most sensitive to a reduction in volume/ha and/or to larger droplets.

New low pressure air induction nozzles

This year, we carried out trials with a new generation of low pressure air induction nozzles. Trials carried out on the drift bench indicate that when the recommended working pressure is used (2 bars), those nozzles reduce drift in the same proportion as conventional air induction nozzles (3 bars minimum) *(figure 4)*. They are therefore as effective as the old models. In field trials, with herbicides and fungicides, those nozzles do not seem to result in significantly lower levels of efficacy when used with systemic products. With non systemic products, lower levels occur, similar to those noted with conventional air induction. Therefore, on the face of it, the reasoning which leads to using this new type of air induction nozzles is the same as for the old type, but further trials are being carried out to verify those observations.

Impact of nozzle type on septoria control *(fig. 4)*



The reasoning which leads to the using of low pressure air induction nozzles is the same as for the old type of air induction nozzles.

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