

Tecnología de boquillas

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CENTRO DE INVESTIGACIONES
CIENTÍFICAS Y TECNOLÓGICAS
DE EXTREMADURA
Investigación Agroalimentaria



JUNTA DE EXTREMADURA

Consejería de Medio Ambiente y Rural,
Políticas Agrarias y Territorio

Curso sobre Tecnologías de Aplicación de Fitosanitarios – Finca La Orden (Badajoz) Noviembre 2016



Unidad de Mecanización Agraria
<http://uma.deab.upc.edu>



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DE CATALUNYA**
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Funciones de la boquilla

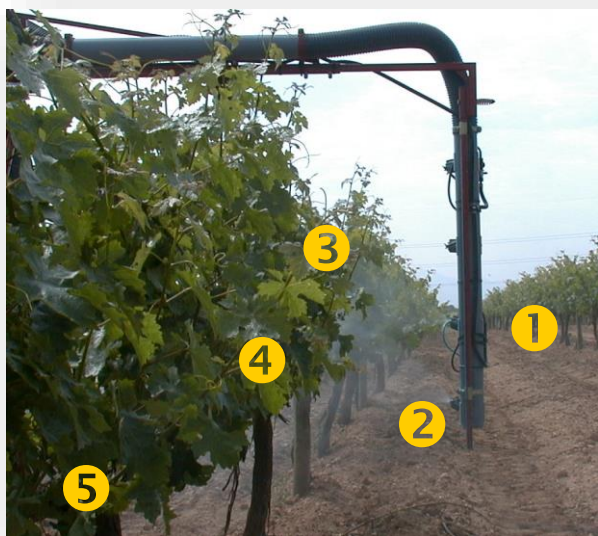
1. Control del caudal de líquido

2. Formación de las gotas

3. Distribución sobre el objetivo

4. Recubrimiento

5. Penetración

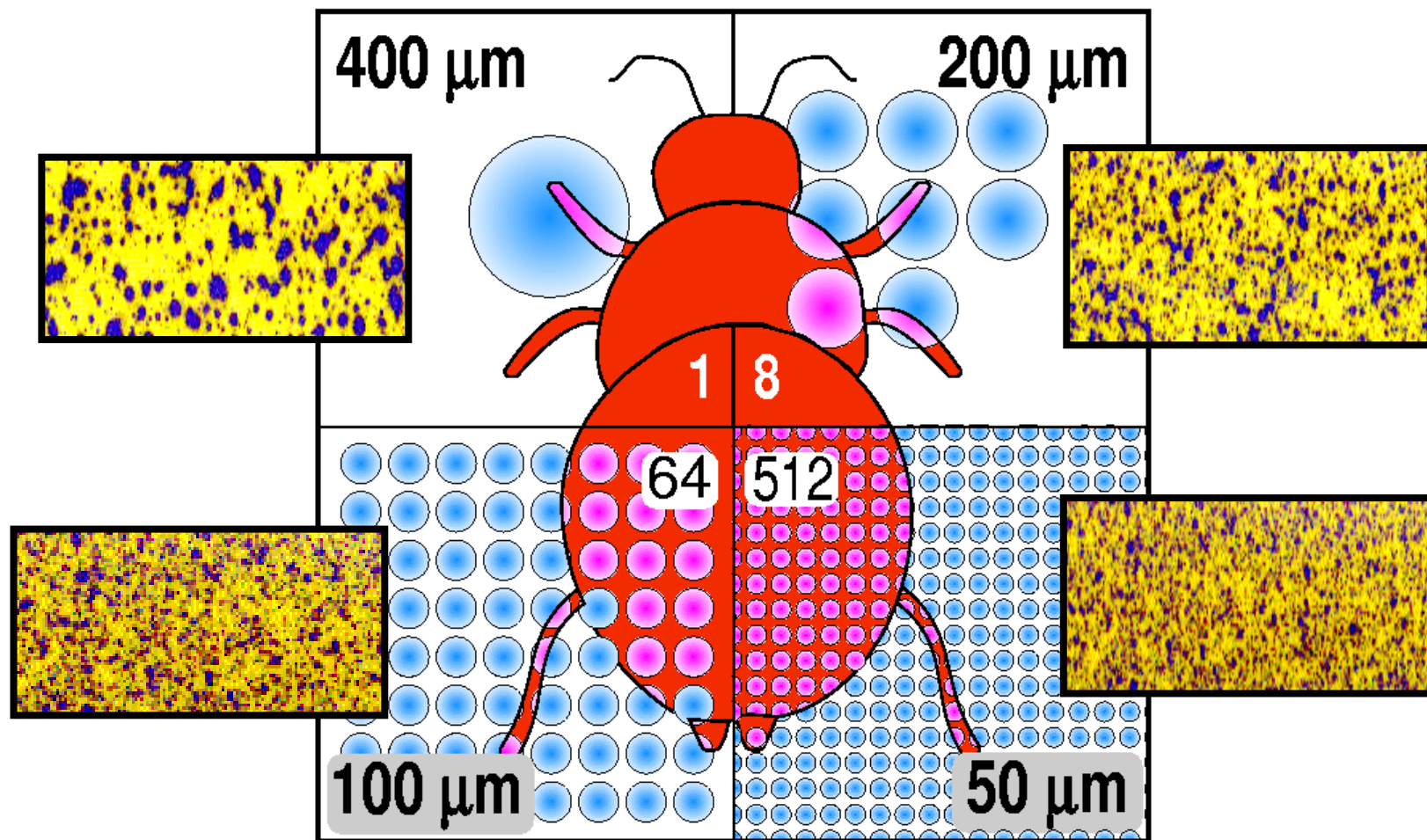


La eficacia y el riesgo de deriva de un tratamiento dependen de:

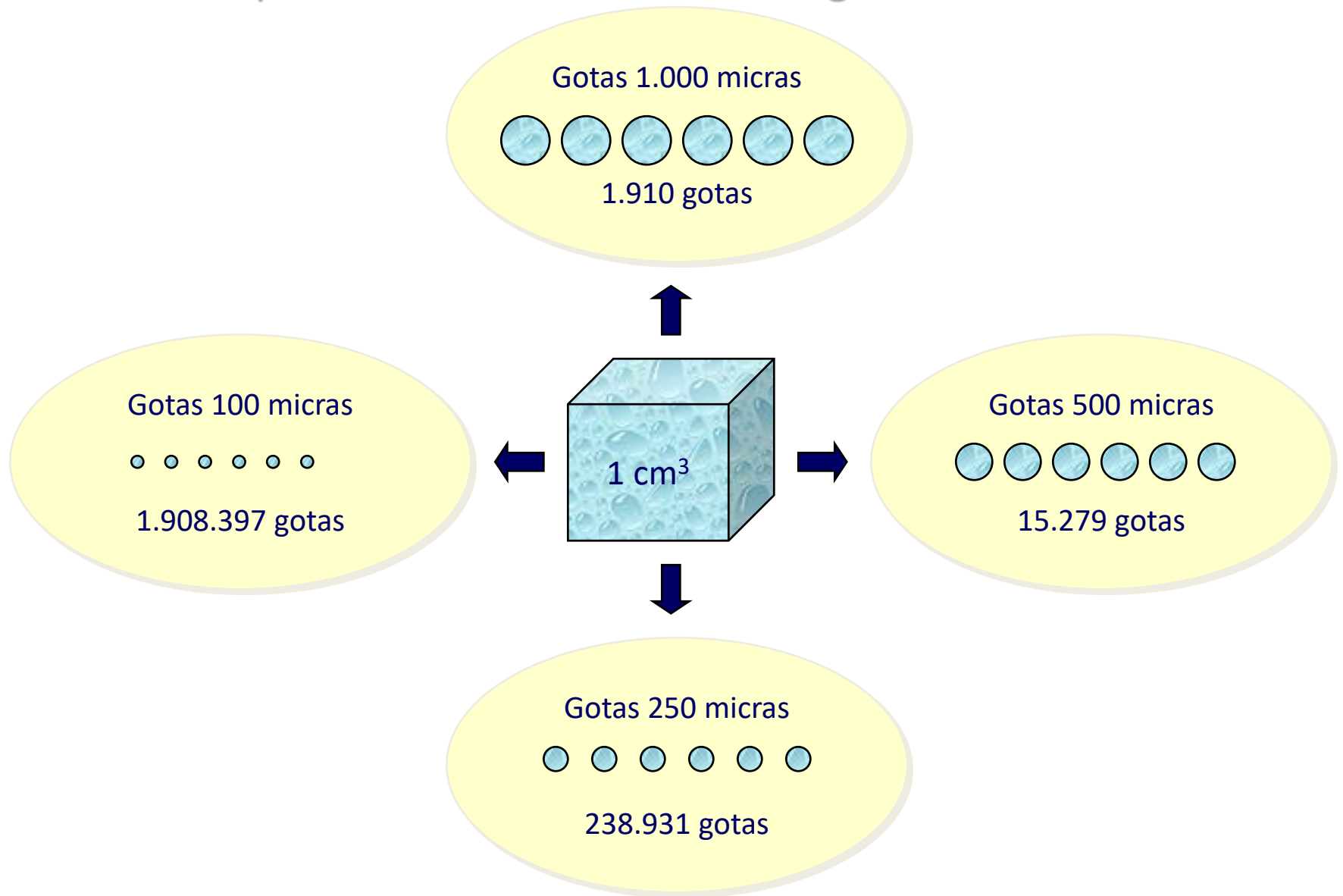


- El tamaño de gotas
Diámetro mediano en volumen (VMD)
- El espectro de gotas formado
Rango (% gotas gruesas-% gotas finas)

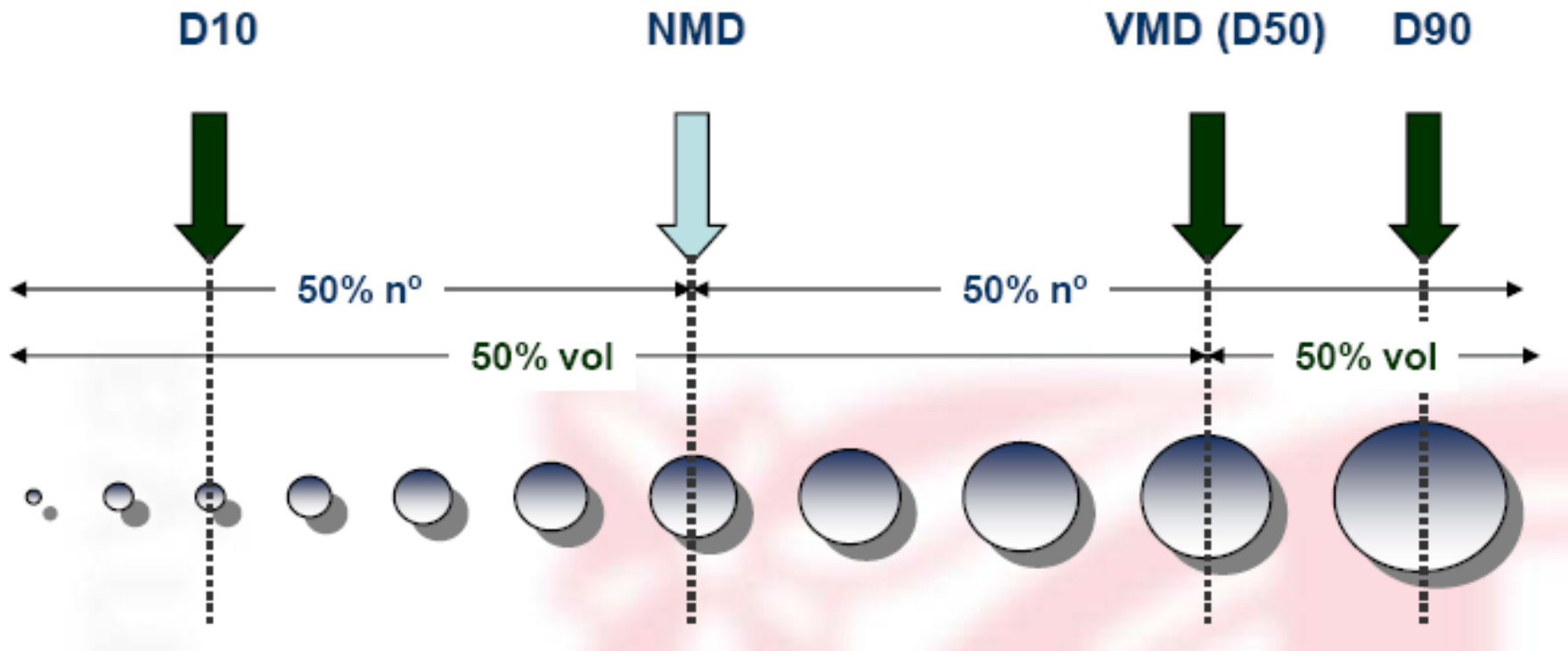




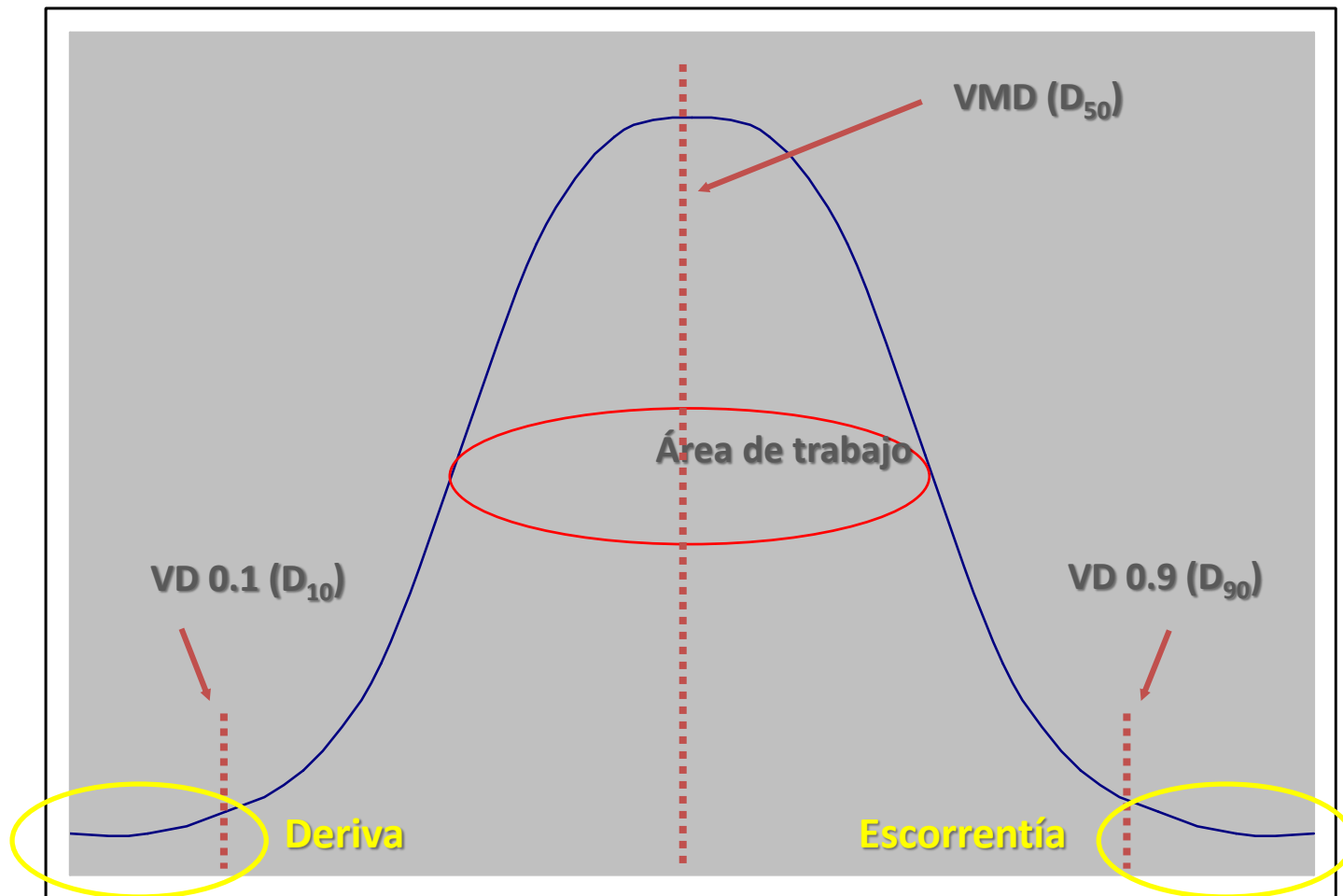
Elección de la pulverización: tamaño de las gotas



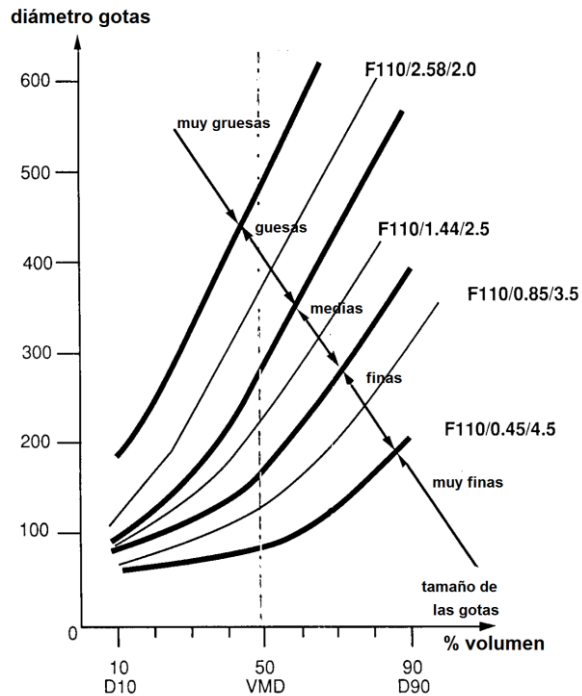
Población de gotas



Importancia del espectro de gotas



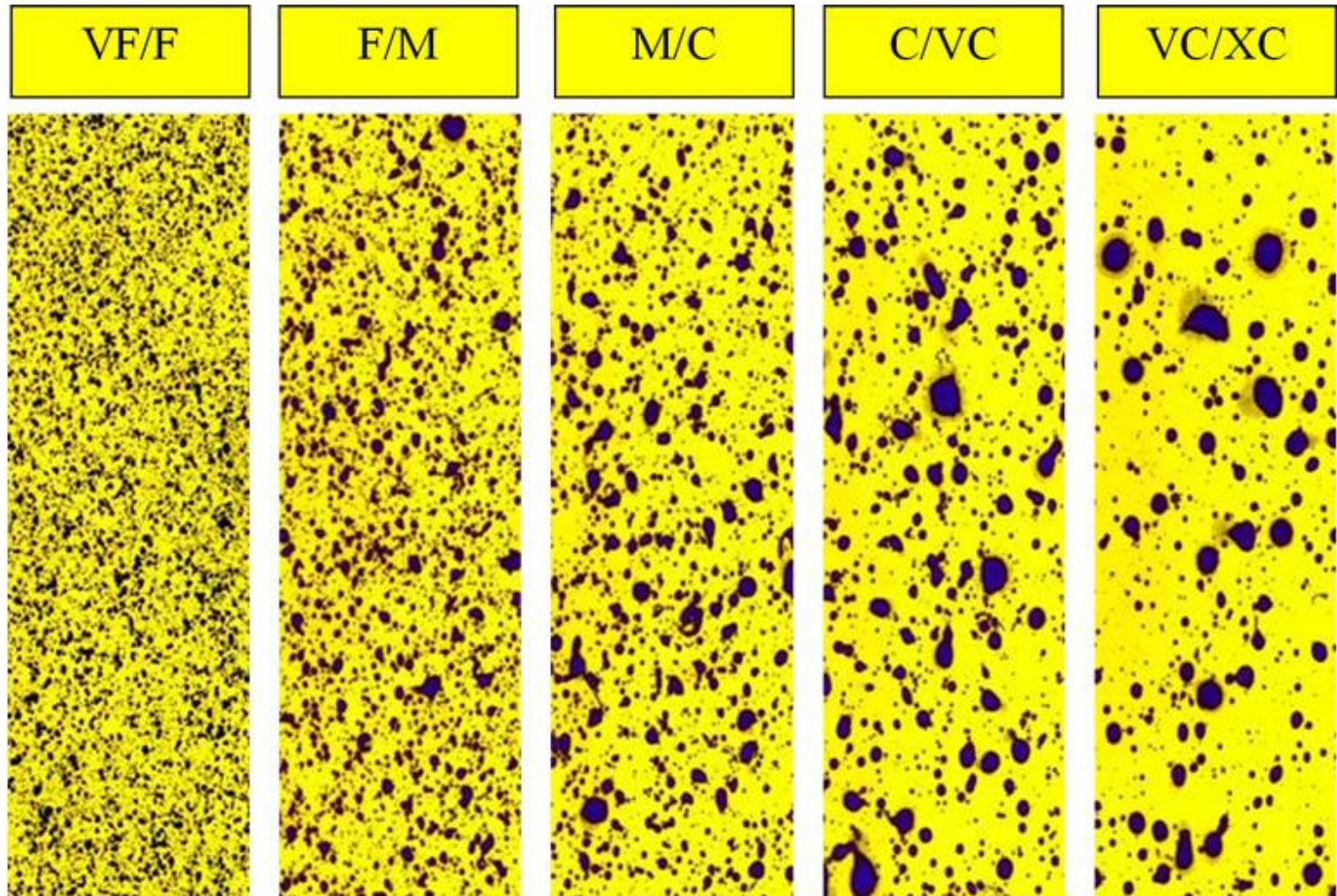
Clasificación del tamaño de gotas



Category	BCPC	ASABE S572
Muy fina (VF)	$< 90 \mu m$	$< 100 \mu m$
Fina (F)	$90 - 200 \mu m$	$100 - 175 \mu m$
Media (M)	$200 - 300 \mu m$	$175 - 250 \mu m$
Gruesa (C)	$300 - 450 \mu m$	$250 - 375 \mu m$
Muy gruesa (VC)	$> 450 \mu m$	$375 - 450 \mu m$
Extra gruesa (XC)		$> 450 \mu m$



Droplet category droplet sizes



<http://www.wilger.net/Drop%20cat%20drop%20sizes.jpg>

Image courtesy of Tom Wolf, Agriculture and Agri-Food Canada, Research Centre





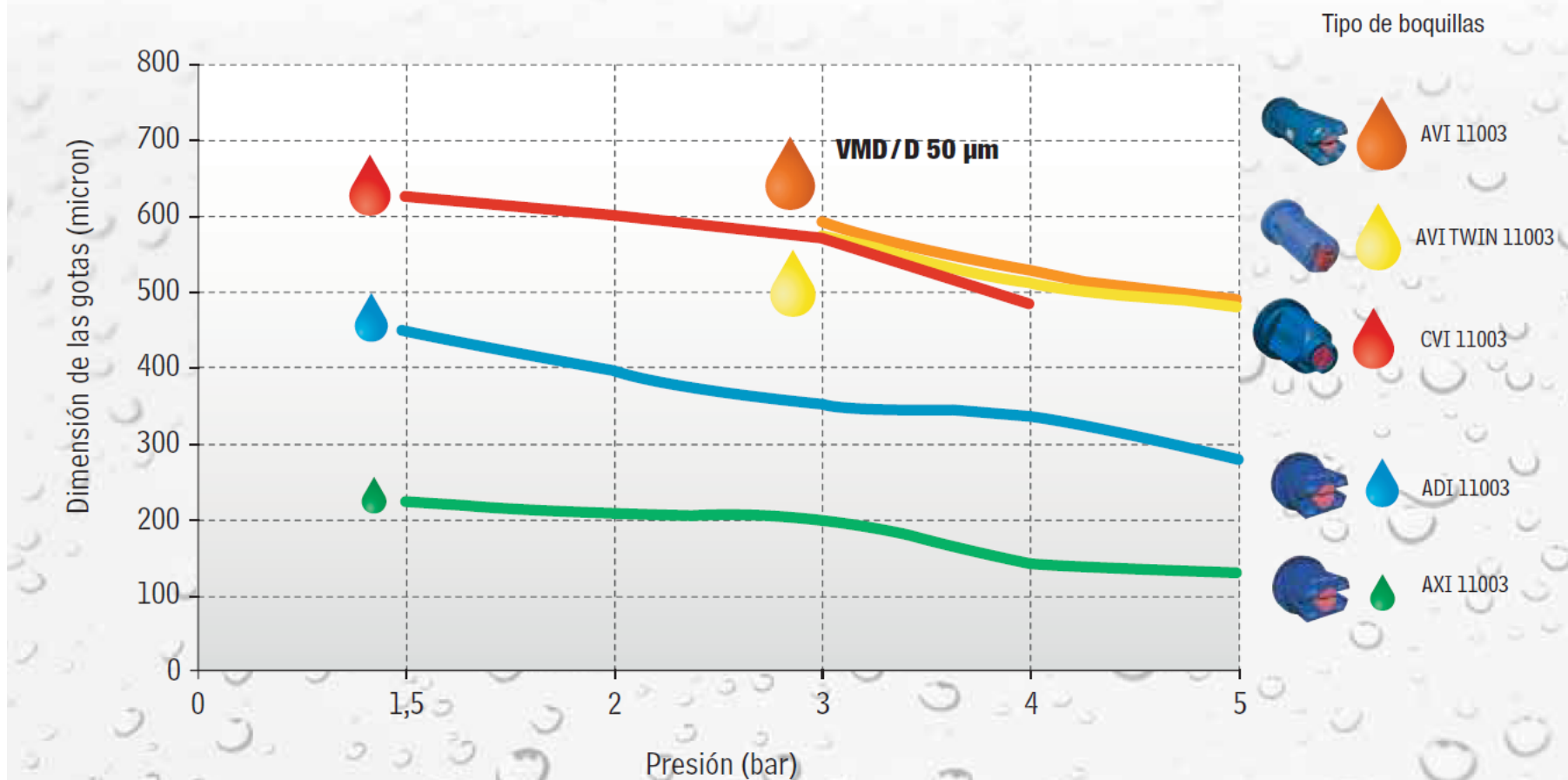
	 	bar	DROP SIZE		CAPACITY ONE NOZZLE IN l/min
			80°	110°	
XR8001 XR11001 (100)		1.0	M	F	0.23
		1.5	F	F	0.28
		2.0	F	F	0.32
		2.5	F	F	0.36
		3.0	F	F	0.39
XR80015 XR110015 (100)		4.0	F	VF	0.45
		1.0	M	F	0.34
		1.5	M	F	0.42
		2.0	F	F	0.48
		2.5	F	F	0.54
XR8002 XR11002 (50)		3.0	F	F	0.59
		4.0	F	F	0.68
		1.0	M	M	0.46
		1.5	M	F	0.56
		2.0	M	F	0.65
XR110025 (50)		2.5	M	F	0.72
		3.0	F	F	0.79
		4.0	F	F	0.91
		1.0		M	0.57
		1.5		M	0.70
XR8003 XR11003 (50)		2.0		F	0.81
		2.5		F	0.90
		3.0		F	0.99
		4.0		F	1.14
		1.0	M	M	0.68
XR8004 XR11004 (50)		1.5	M	M	0.83
		2.0	M	F	0.96
		2.5	M	F	1.08
		3.0	M	F	1.18
		4.0	M	F	1.36
		1.0	C	M	0.91
		1.5	M	M	1.12
		2.0	M	M	1.29
		2.5	M	M	1.44
		3.0	M	M	1.58
		4.0	M	F	1.82



	 	bar	DROP SIZE	CAPACITY ONE NOZZLE IN l/min
TTJ60-11002 (100)		1.5	C	0.56
		2.0	C	0.65
		3.0	C	0.79
		4.0	M	0.91
		5.0	M	1.02
TTJ60-110025 (100)		6.0	M	1.12
		1.5	VC	0.70
		2.0	C	0.81
		3.0	C	0.99
		4.0	C	1.14
TTJ60-11003 (100)		5.0	M	1.28
		6.0	M	1.40
		1.5	VC	0.83
		2.0	C	0.96
		3.0	C	1.18
TTJ60-11004 (50)		4.0	C	1.36
		5.0	C	1.52
		6.0	M	1.67
		1.5	VC	1.12
		2.0	C	1.29
		3.0	C	1.58
		4.0	C	1.82
		5.0	C	2.04
		6.0	M	2.23



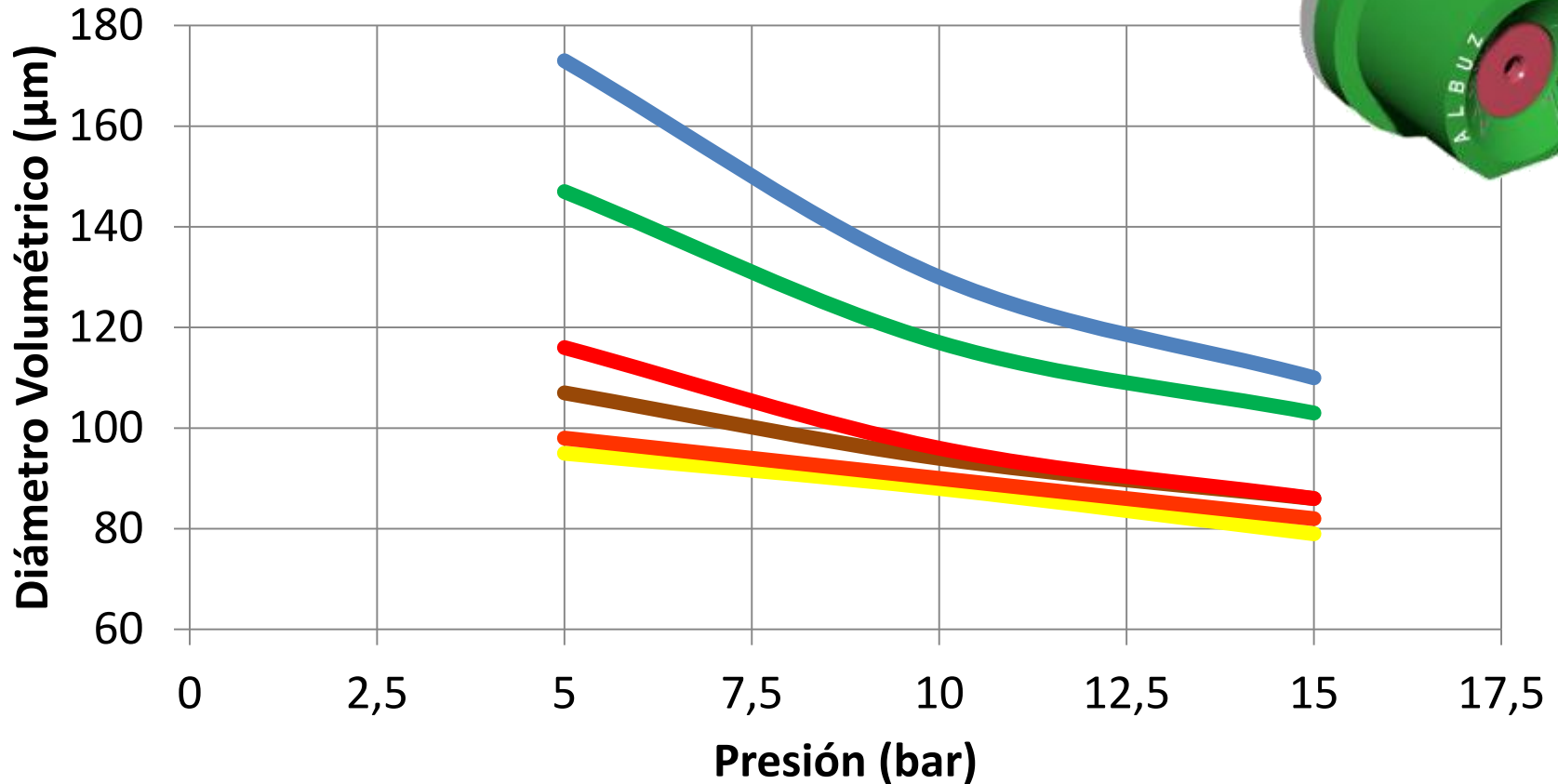
COMPARATIVA DEL TAMAÑO DE GOTAS: BOQUILLAS MODELO 03



Fuente: Catalogo Albuz 2013



Comparativa del tamaño de gotas según presión



— Marrón (0.67 l/min) — Amarillo (1.03 l/min) — Naranja (1.39 l/min)
— Rojo (1.92 l/min) — Verde (2.47 l/min) — Azul (3.40 l/min)





bar

DROP
SIZEAIXR110015
(100)

1.0	XC
2.0	VC
3.0	C
4.0	C
5.0	M
6.0	M

AIXR11002
(50)

1.0	XC
2.0	VC
3.0	C
4.0	C
5.0	C
6.0	M

AIXR110025
(50)

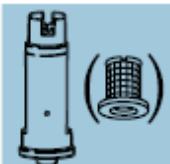
1.0	XC
2.0	XC
3.0	VC
4.0	C
5.0	C
6.0	C

AIXR11003
(50)

1.0	XC
2.0	XC
3.0	VC
4.0	C
5.0	C
6.0	C

AIXR11004
(50)

1.0	UC
2.0	XC
3.0	VC
4.0	VC
5.0	C
6.0	C

DROP
SIZE

110°

AI80015
AI110015
(100)

2.0	UC
3.0	XC
4.0	XC
5.0	VC
6.0	VC
7.0	C
8.0	C

AI8002
AI11002
(50)

2.0	UC
3.0	XC
4.0	XC
5.0	VC
6.0	VC
7.0	C
8.0	C

AI80025
AI110025
(50)

2.0	UC
3.0	XC
4.0	XC
5.0	VC
6.0	VC
7.0	C
8.0	C

AI8003
AI11003
(50)

2.0	UC
3.0	XC
4.0	XC
5.0	VC
6.0	VC
7.0	C
8.0	C

AI8004
AI11004
(50)

2.0	UC
3.0	XC
4.0	XC
5.0	VC
6.0	VC
7.0	C
8.0	C



bar

DROP
SIZETTI110015
(100)

1.0	UC
2.0	UC
3.0	UC
4.0	XC
5.0	XC
6.0	XC
7.0	XC

TTI11002
(50)

1.0	UC
2.0	UC
3.0	UC
4.0	UC
5.0	XC
6.0	XC
7.0	XC

TTI110025
(50)

1.0	UC
2.0	UC
3.0	UC
4.0	UC
5.0	XC
6.0	XC
7.0	XC

TTI11003
(50)

1.0	UC
2.0	UC
3.0	UC
4.0	UC
5.0	XC
6.0	XC
7.0	XC

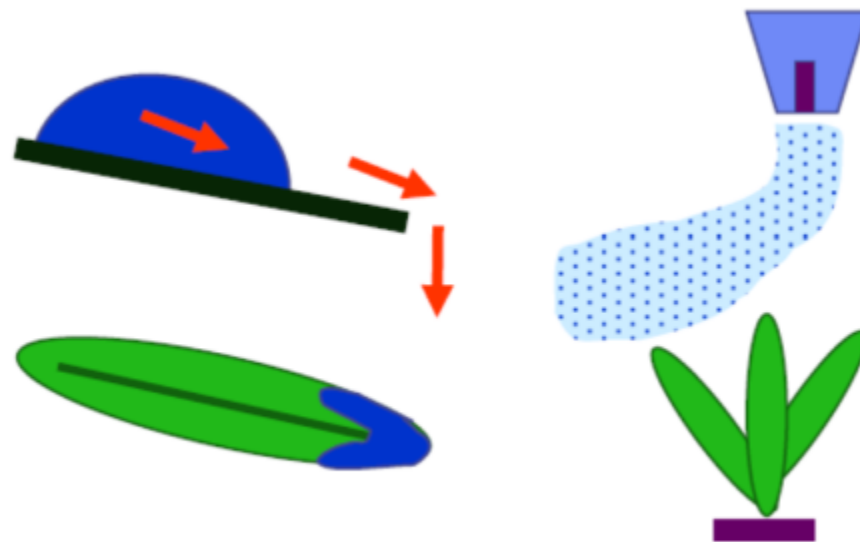
TTI11004
(50)

1.0	UC
2.0	UC
3.0	UC
4.0	UC
5.0	XC
6.0	XC
7.0	XC

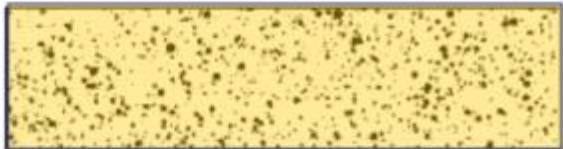
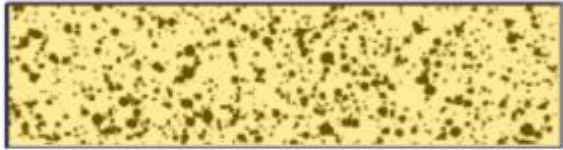
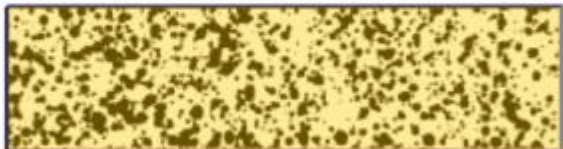
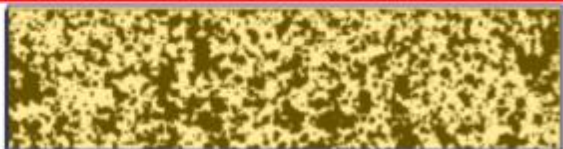
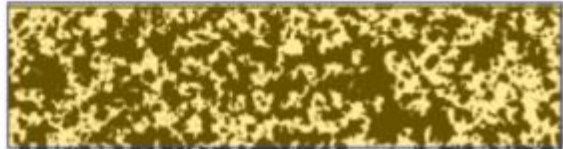
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Tamaño de las gotas

GOTAS PEQUEÑAS	GOTAS GRANDES
Buen recubrimiento	Espacios desprovistos de producto
Buena fijación	Peligro de escorrentía hacia el suelo
	Acumulación de materia activa en el borde de las hojas
Peligro de evaporación y deriva	Escaso peligro de evaporación y deriva



Tamaño de las gotas

	Gotas/cm ²	Porcentaje de cobertura	Tamaño de las gotas (VMD) µm	STP Referencias
	85	10 %	250	
Recubrimientos del 20-30% son suficientes en la mayor parte de los tratamientos	70	20 %	275	
	60	30 %	300	
	55	40 %	312	
	40	50 %	325	

Equipment for crop protection — Sprayer nozzles — Colour coding for identification

ISO/FDIS 10625

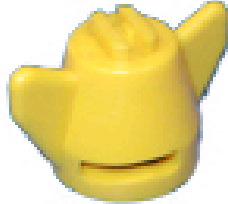
Matériel de protection des cultures — Buses de pulvérisation — Code de couleur pour l'identification

Caudal @ 3 bar / 40 psi		Color	Código	Tipo
l/min	GPM			
0.4	0.1	Naranja	01	F, LD
0.6	0.15	Verde	015	F, LD, AI
0.8	0.2	Amarillo	02	F, LD, AI
1.0	0.25	Rosa	025	AI
1.2	0.3	Azul	03	F, LD, AI
1.6	0.4	Rojo	04	F, LD, AI
2.0	0.5	Marrón	05	F
2.4	0.6	Gris	06	F
3.2	0.8	Blanco	08	F



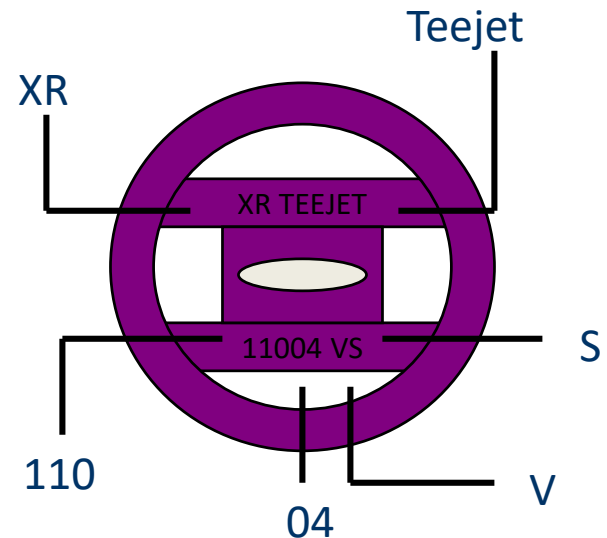
Nomenclatura ISO

S ISO F-02-110 CT Yellow



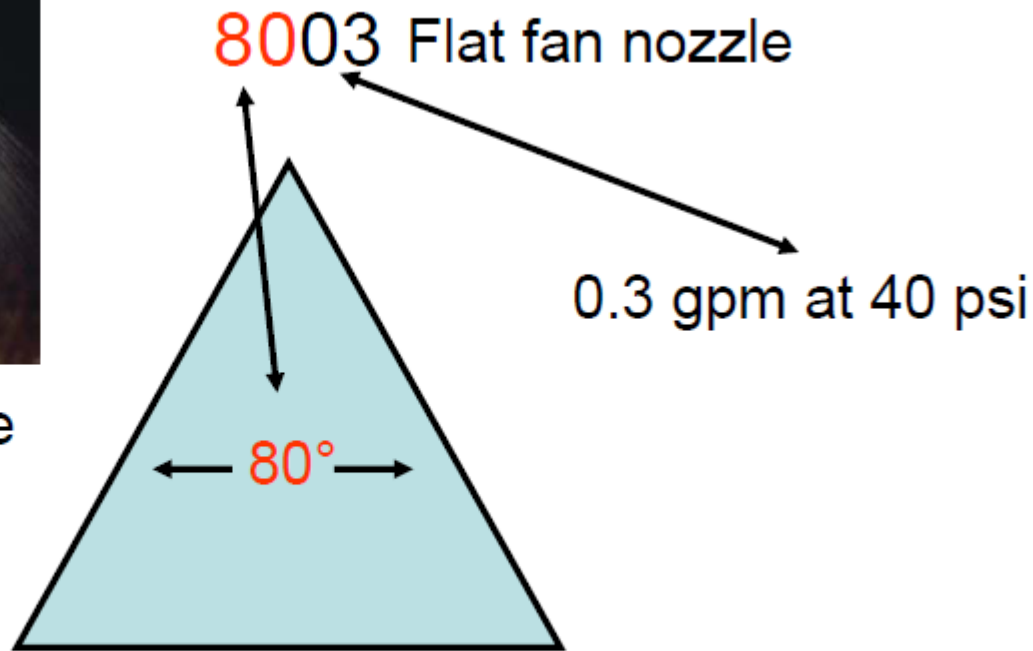
S:	Sintético
ISO:	Boquilla normativa ISO
F:	Abanico
02:	Caudal nominal (gal/min) a 3 bar
110:	Ángulo de pulverización

Teejet:	Fabricante
XR:	Tipo de boquilla
110:	Ángulo de pulverización
04:	Caudal nominal (gal/min) a 3 bar
V:	Codificación de colores "VisFlo"
S:	Tipo de material (acero inox.)





Flat fan nozzle
pattern



Numbering system for Teejet nozzles

			DROP SIZE	CAPACITY ONE NOZZLE IN l/min
bar				
AIXR110015 (100)	1.0	XC	0.34	
	2.0	VC	0.48	
	3.0	C	0.59	
	4.0	C	0.68	
	5.0	M	0.76	
	6.0	M	0.83	
AIXR11002 (50)	1.0	XC	0.46	
	2.0	VC	0.65	
	3.0	C	0.79	
	4.0	C	0.91	
	5.0	C	1.02	
	6.0	M	1.12	
AIXR110025 (50)	1.0	XC	0.57	
	2.0	XC	0.81	
	3.0	VC	0.99	
	4.0	C	1.14	
	5.0	C	1.28	
	6.0	C	1.40	
AIXR11003 (50)	1.0	XC	0.68	
	2.0	XC	0.96	
	3.0	VC	1.18	
	4.0	C	1.36	
	5.0	C	1.52	
	6.0	C	1.67	
AIXR11004 (50)	1.0	UC	0.91	
	2.0	XC	1.29	
	3.0	VC	1.58	
	4.0	VC	1.82	
	5.0	C	2.04	
	6.0	C	2.23	



			DROP SIZE	CAPACITY ONE NOZZLE IN l/min
		bar	110°	
AI80015 AI110015 (100)	2.0	UC	0.48	
	3.0	XC	0.59	
	4.0	XC	0.68	
	5.0	VC	0.76	
	6.0	VC	0.83	
	7.0	C	0.90	
	8.0	C	0.96	
AI8002 AI11002 (50)	2.0	UC	0.65	
	3.0	XC	0.79	
	4.0	XC	0.91	
	5.0	VC	1.02	
	6.0	VC	1.12	
	7.0	C	1.21	
	8.0	C	1.29	
AI80025 AI110025 (50)	2.0	UC	0.81	
	3.0	XC	0.99	
	4.0	XC	1.14	
	5.0	VC	1.28	
	6.0	VC	1.40	
	7.0	C	1.51	
	8.0	C	1.62	
AI8003 AI11003 (50)	2.0	UC	0.96	
	3.0	XC	1.18	
	4.0	XC	1.36	
	5.0	VC	1.52	
	6.0	VC	1.67	
	7.0	C	1.80	
	8.0	C	1.93	
AI8004 AI11004 (50)	2.0	UC	1.29	
	3.0	XC	1.58	
	4.0	XC	1.82	
	5.0	VC	2.04	
	6.0	VC	2.23	
	7.0	C	2.41	
	8.0	C	2.58	



	 bar	DROP SIZE		CAPACITY ONE NOZZLE IN l/min
		80°	110°	
XR8001 XR11001 (100)	1.0	M	F	0.23
	1.5	F	F	0.28
	2.0	F	F	0.32
	2.5	F	F	0.36
	3.0	F	F	0.39
	4.0	F	VF	0.45
XR80015 XR110015 (100)	1.0	M	F	0.34
	1.5	M	F	0.42
	2.0	F	F	0.48
	2.5	F	F	0.54
	3.0	F	F	0.59
	4.0	F	F	0.68
XR8002 XR11002 (50)	1.0	M	M	0.46
	1.5	M	F	0.56
	2.0	M	F	0.65
	2.5	M	F	0.72
	3.0	F	F	0.79
	4.0	F	F	0.91
XR110025 (50)	1.0		M	0.57
	1.5		M	0.70
	2.0		F	0.81
	2.5		F	0.90
	3.0		F	0.99
	4.0		F	1.14
XR8003 XR11003 (50)	1.0	M	M	0.68
	1.5	M	M	0.83
	2.0	M	F	0.96
	2.5	M	F	1.08
	3.0	M	F	1.18
	4.0	M	F	1.36
XR8004 XR11004 (50)	1.0	C	M	0.91
	1.5	M	M	1.12
	2.0	M	M	1.29
	2.5	M	M	1.44
	3.0	M	M	1.58
	4.0	M	F	1.82



bar	l/mn							
	MORADA 80-0050	ROSA 80-0075	NARANJA 80-01	VERDE 80-015	AMARILLA 80-02	LILA 80-025	AZUL 80-03	ROJA 80-04
5	-	0,39	0,52	0,77	1,03	1,29	1,55	2,07
6	-	0,42	0,57	0,85	1,13	1,41	1,70	2,26
7	0,31	0,46	0,61	0,92	1,22	1,53	1,83	2,44



SPECIFICAS

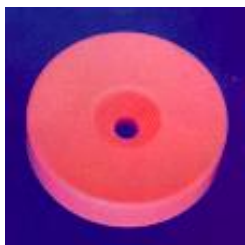
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Nozzle flow rate and color code ISO according ISO 10625

Pressure bar	Flow rate l/min at nozzle size ISO												
	-01	-015	-02	-025	-03	-04	-05	-06	-08	-10	-12	-16	-20
1.0	0.23	0.35	0.46	0.58	0.69	0.92	1.15	1.39	1.85	2.31	2.77	3.70	4.62
1.5	0.28	0.42	0.57	0.71	0.85	1.13	1.41	1.70	2.26	2.83	3.39	4.53	5.66
2.0	0.33	0.49	0.65	0.82	0.98	1.31	1.63	1.96	2.61	3.27	3.92	5.23	6.53
2.5	0.37	0.55	0.73	0.91	1.10	1.46	1.83	2.19	2.92	3.65	4.38	5.84	7.30
3.0	0.40	0.60	0.80	1.00	1.20	1.60	2.00	2.40	3.20	4.00	4.80	6.40	8.00
4.0	0.46	0.69	0.92	1.15	1.39	1.85	2.31	2.77	3.70	4.62	5.54	7.39	9.24
5.0	0.52	0.77	1.03	1.29	1.55	2.07	2.58	3.10	4.13	5.16	6.20	8.26	10.33
6.0	0.57	0.85	1.13	1.41	1.70	2.26	2.83	3.39	4.53	5.66	6.79	9.05	11.31
7.0	0.61	0.92	1.22	1.53	1.83	2.44	3.06	3.67	4.89	6.11	7.33	9.78	12.22
8.0	0.65	0.98	1.31	1.63	1.96	2.61	3.27	3.92	5.23	6.53	7.84	10.45	13.06
9.0	0.69	1.04	1.39	1.73	2.08	2.77	3.47	4.16	5.54	6.93	8.31	11.09	13.86
10.0	0.73	1.10	1.46	1.83	2.19	2.92	3.65	4.38	5.84	7.30	8.76	11.68	14.61
12.0	0.80	1.20	1.60	2.00	2.40	3.20	4.00	4.80	6.40	8.00	9.60	12.80	16.00
14.0	0.86	1.29	1.73	2.16	2.59	3.46	4.32	5.19	6.91	8.64	10.37	13.83	17.28
16.0	0.92	1.39	1.85	2.31	2.77	3.70	4.62	5.54	7.39	9.24	11.09	14.78	18.48
18.0	0.98	1.47	1.96	2.45	2.94	3.92	4.90	5.88	7.84	9.80	11.76	15.68	19.60
20.0	1.03	1.55	2.07	2.58	3.10	4.13	5.16	6.20	8.26	10.33	12.39	16.52	20.66
25.0	1.15	1.73	2.31	2.89	3.47	4.62	5.77	6.93	9.24	11.55	13.86	18.48	23.09



Baja deriva?



Angulo?



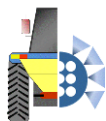
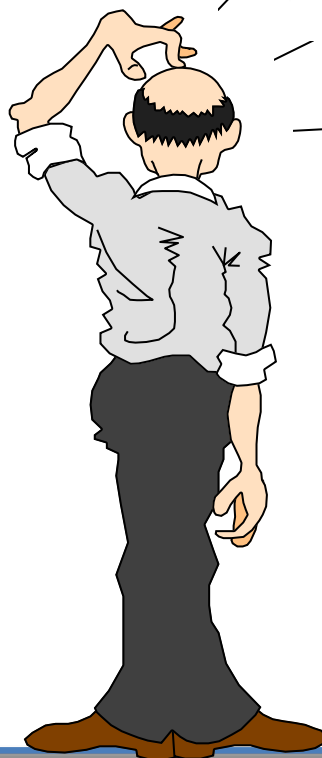
Abanico?



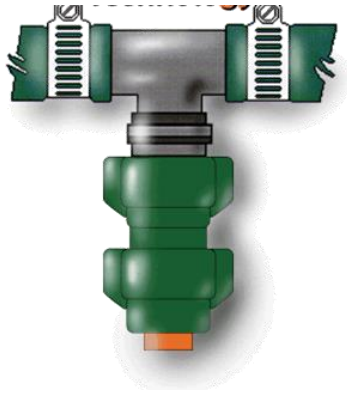
Conicas?



? * + ¿ !



La elección de la boquilla depende de ...



1. El caudal necesario
2. La presión de trabajo
3. La distribución
4. El ángulo de pulverización
5. El líquido a pulverizar
6. La calidad de la atomización
7. El material de la boquilla

Abanico o chorro plano



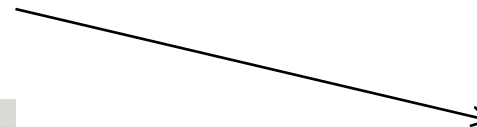
Turbulencia o cónicas



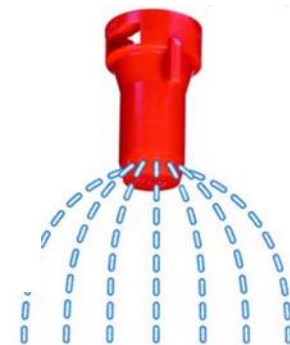
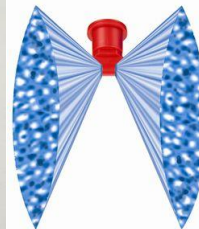
Deflectoras o de espejo



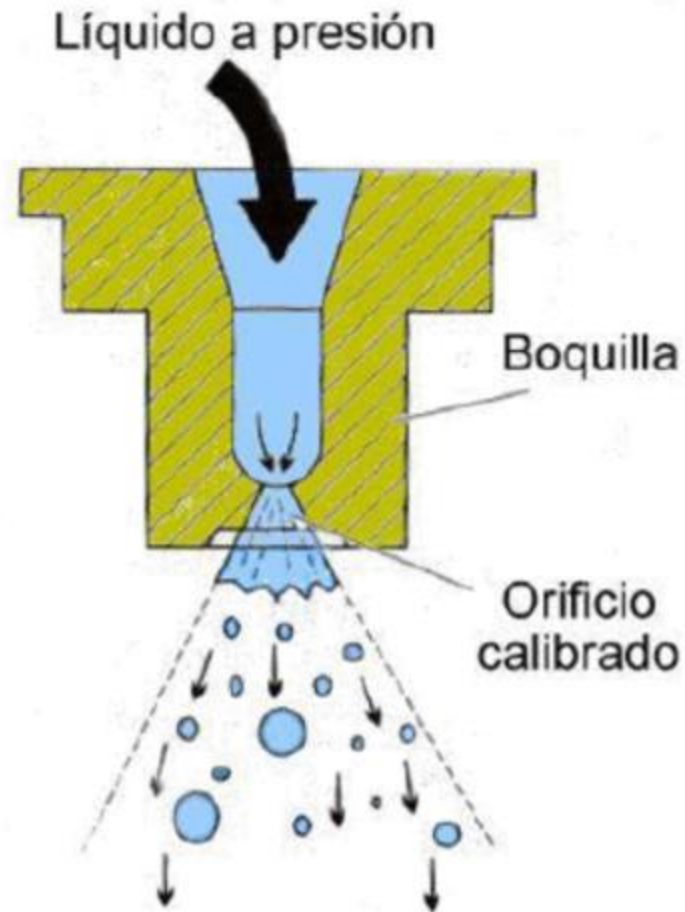
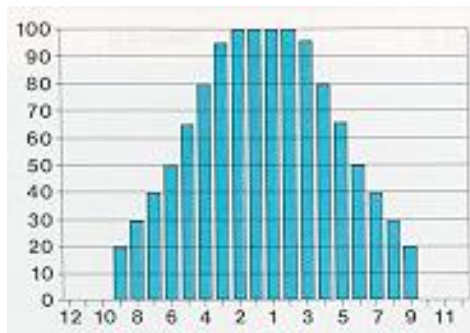
De chorros múltiples



Especiales

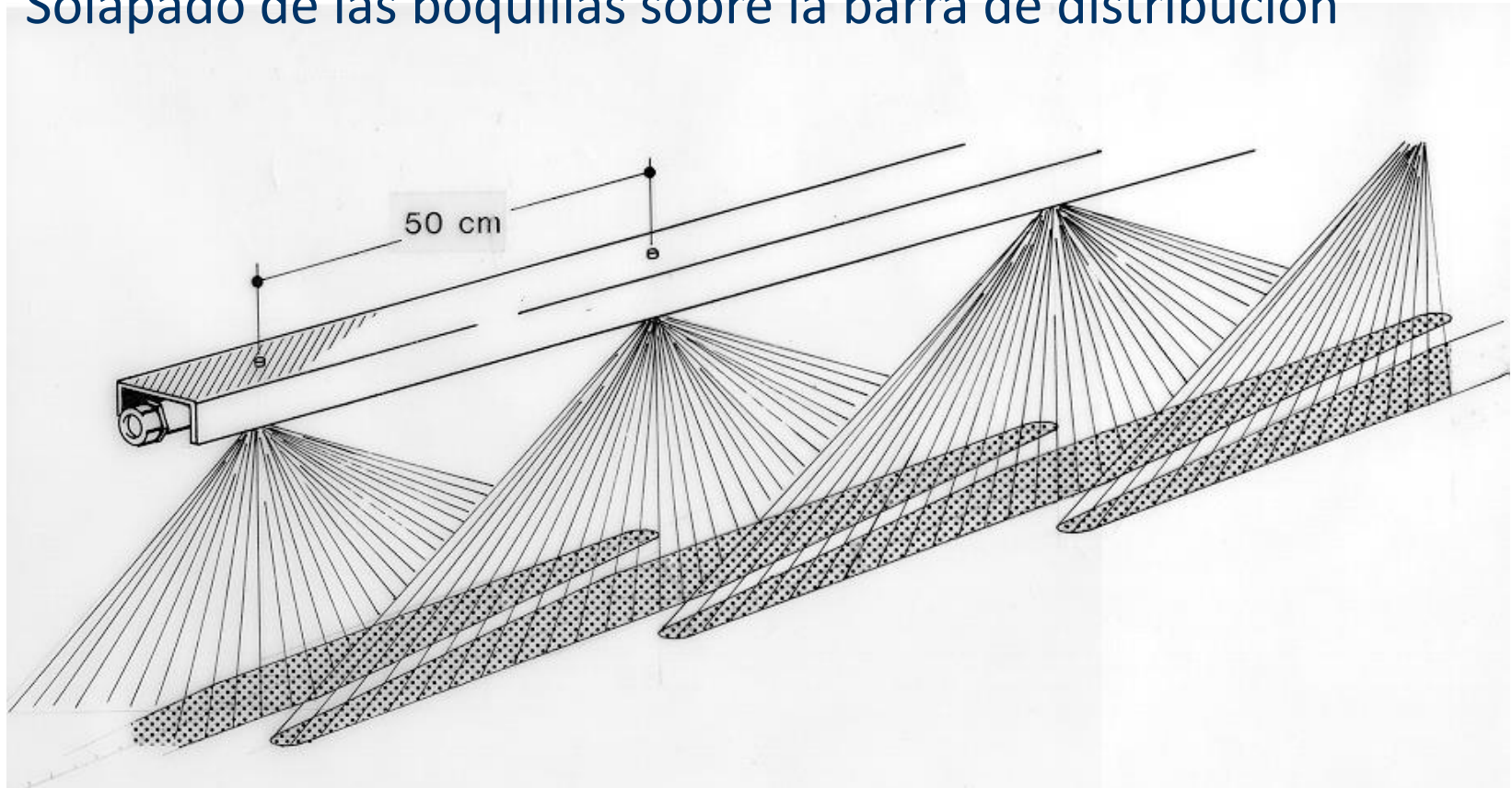


Abanico



Características Boquillas de Abanico

Solapado de las boquillas sobre la barra de distribución

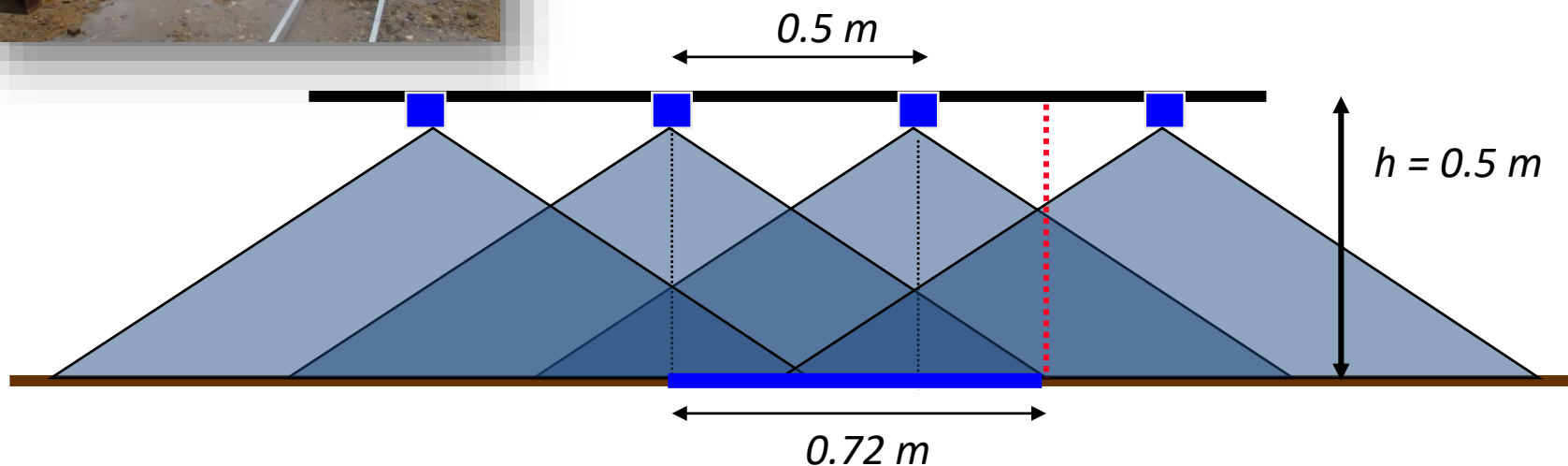


Colocación de las boquillas en la barra (II)

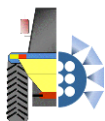
(Boquillas de 110°)



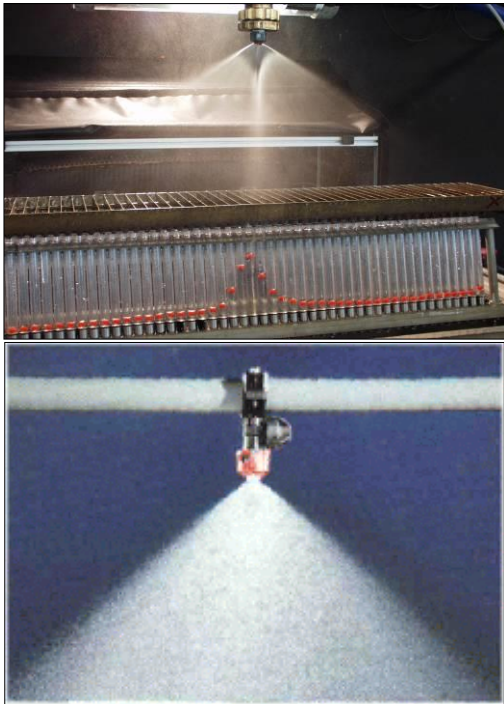
Es importante que los chorros de dos boquillas contiguas no choquen en el aire. De esta forma se garantiza un adecuado recubrimiento



Todos los puntos reciben líquido de tres boquillas



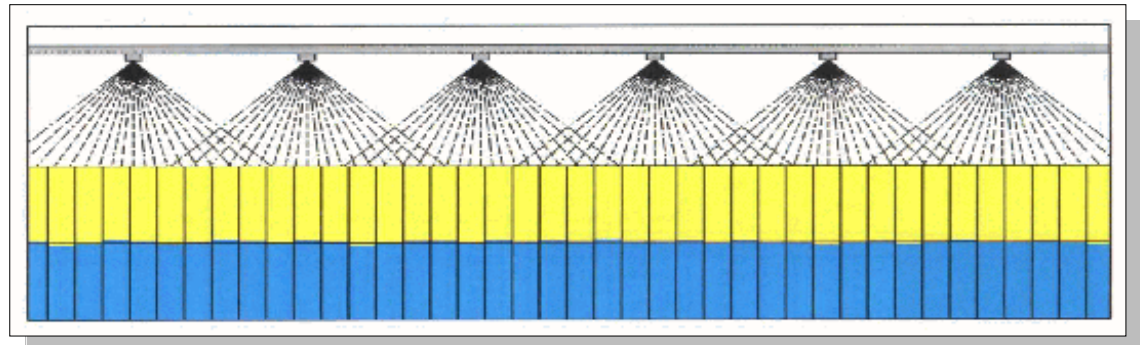
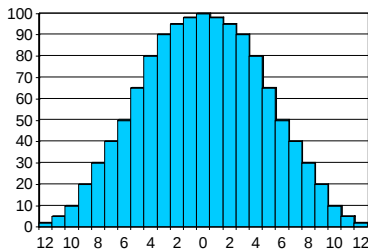
Uniformidad de distribución – factor clave

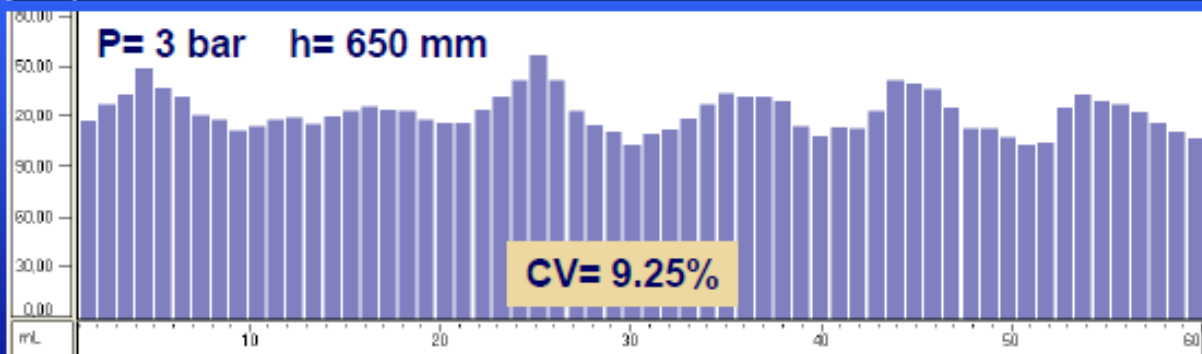
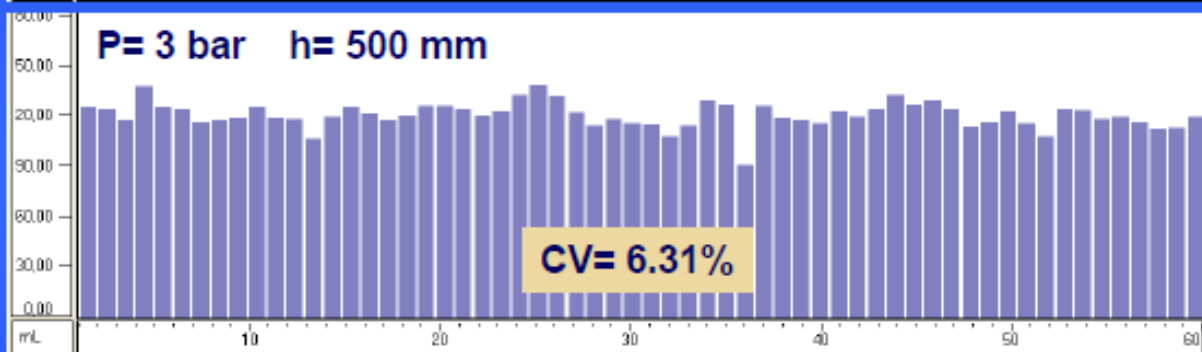
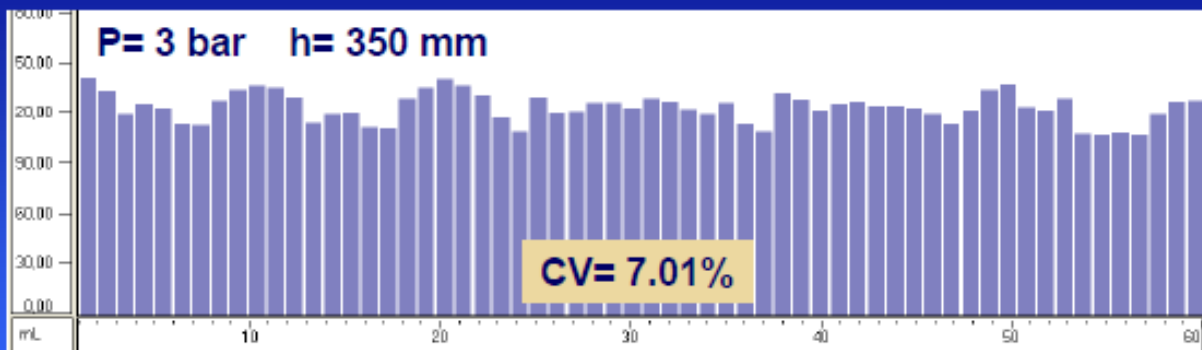


Las boquillas de abanico presentan una distribución triangular de dimensiones variables en función del ángulo de pulverización

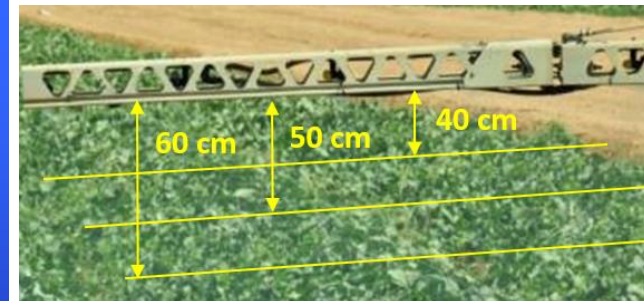
La altura de la barra es un factor clave para la consecución de una distribución uniforme en toda la superficie a tratar

Los sistemas de estabilidad de la barra permiten amortiguar errores de distribución debidos al mal estado de las parcelas

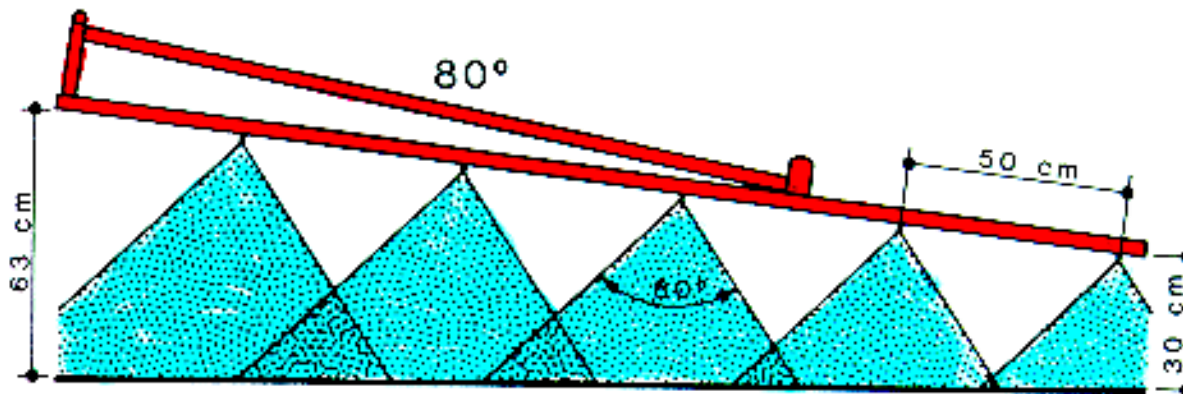
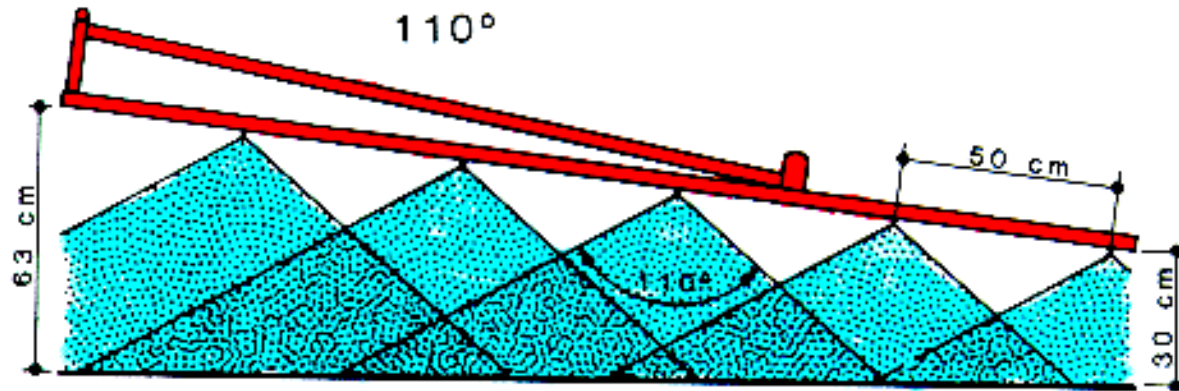




Abanico 110º

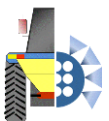


Las boquillas de 110° permiten mayores movimientos de la barra sin afectar gravemente a la distribución horizontal.



J.H. Camballack

Keith Turnbull Research Institute Victoria Australia

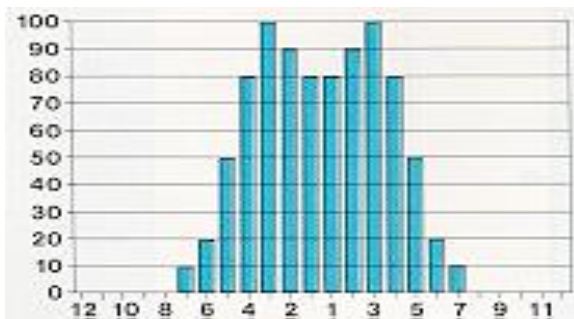




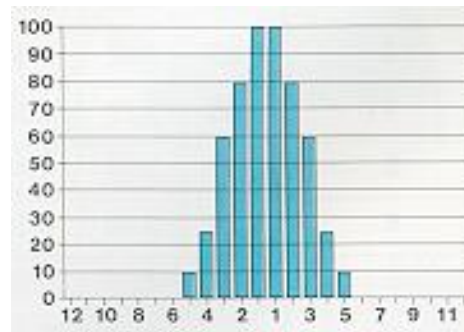
Striping caused by boom being too low or having insufficient pressure to develop spray pattern

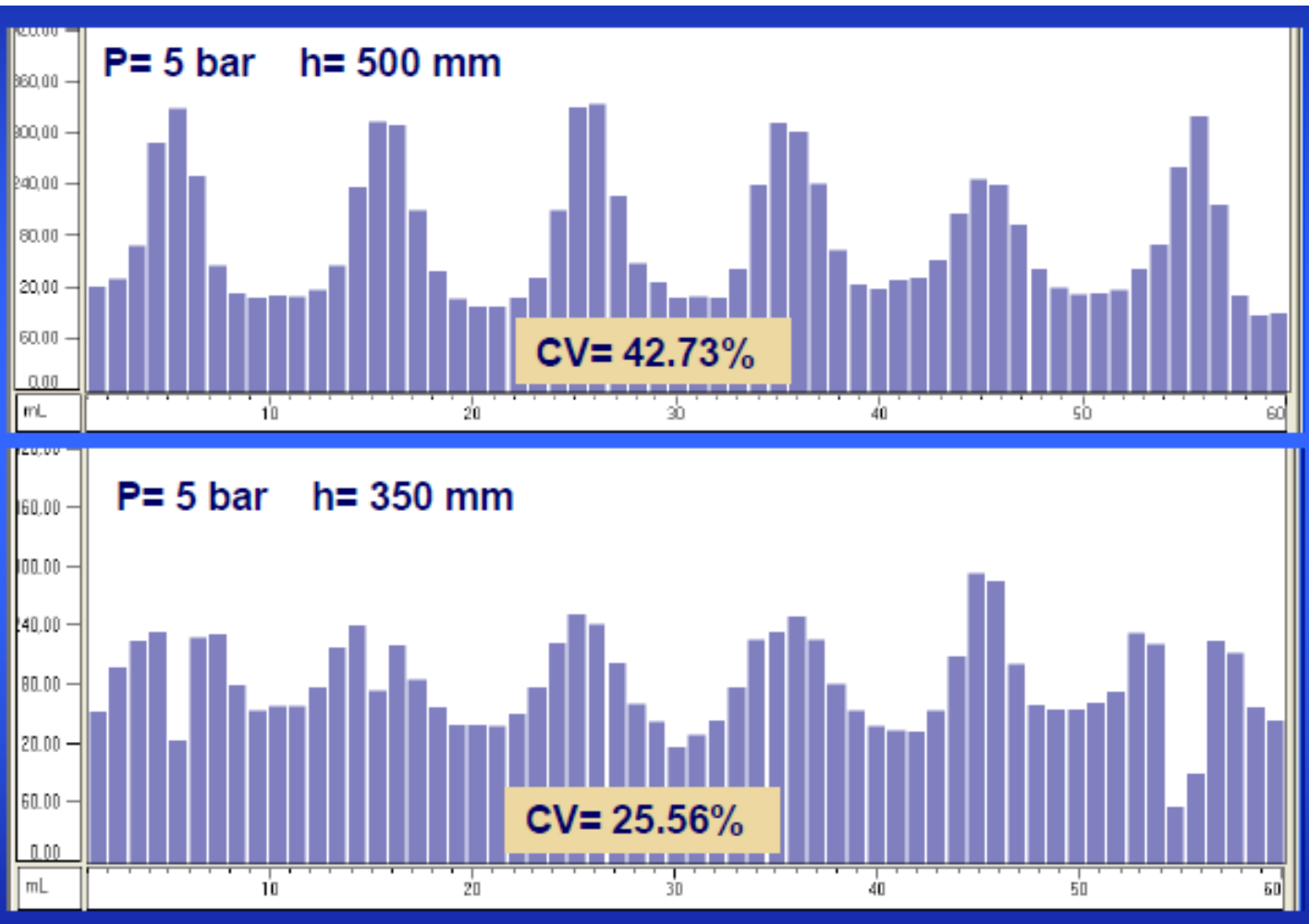


Cónica



Cono lleno



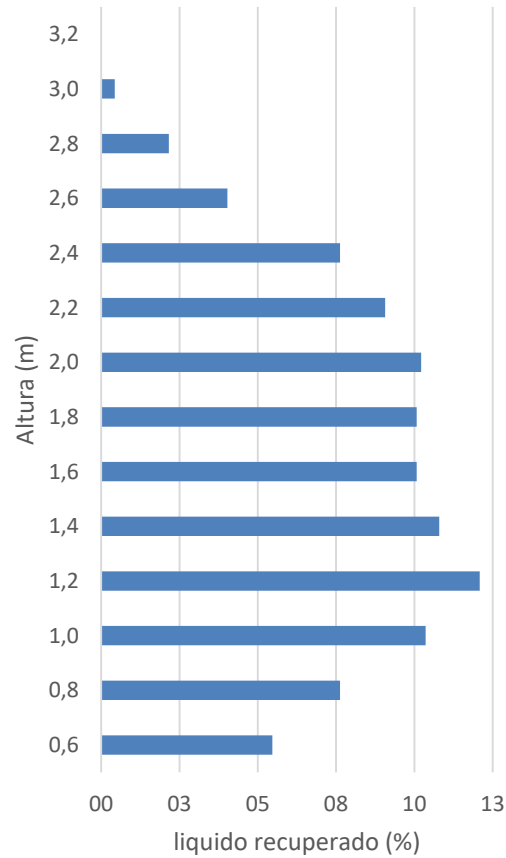


Cono hueco 80°

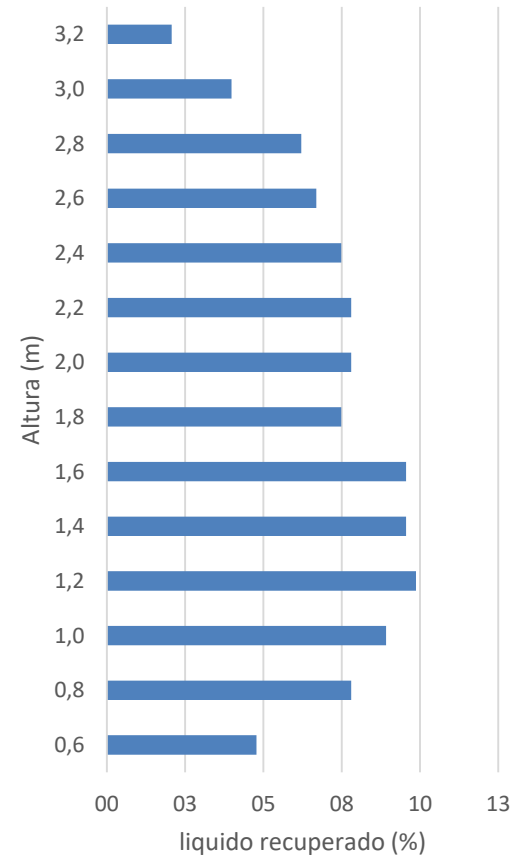




1.2 metros

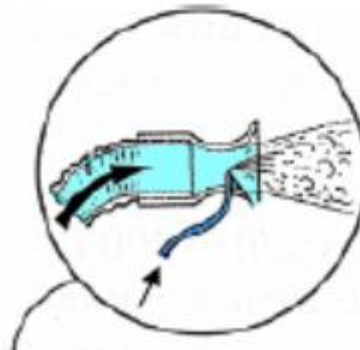
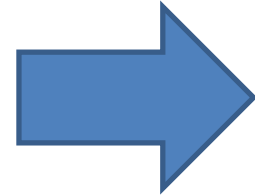
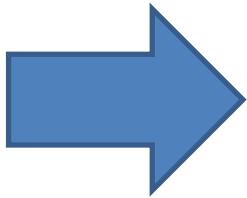


1.7 metros

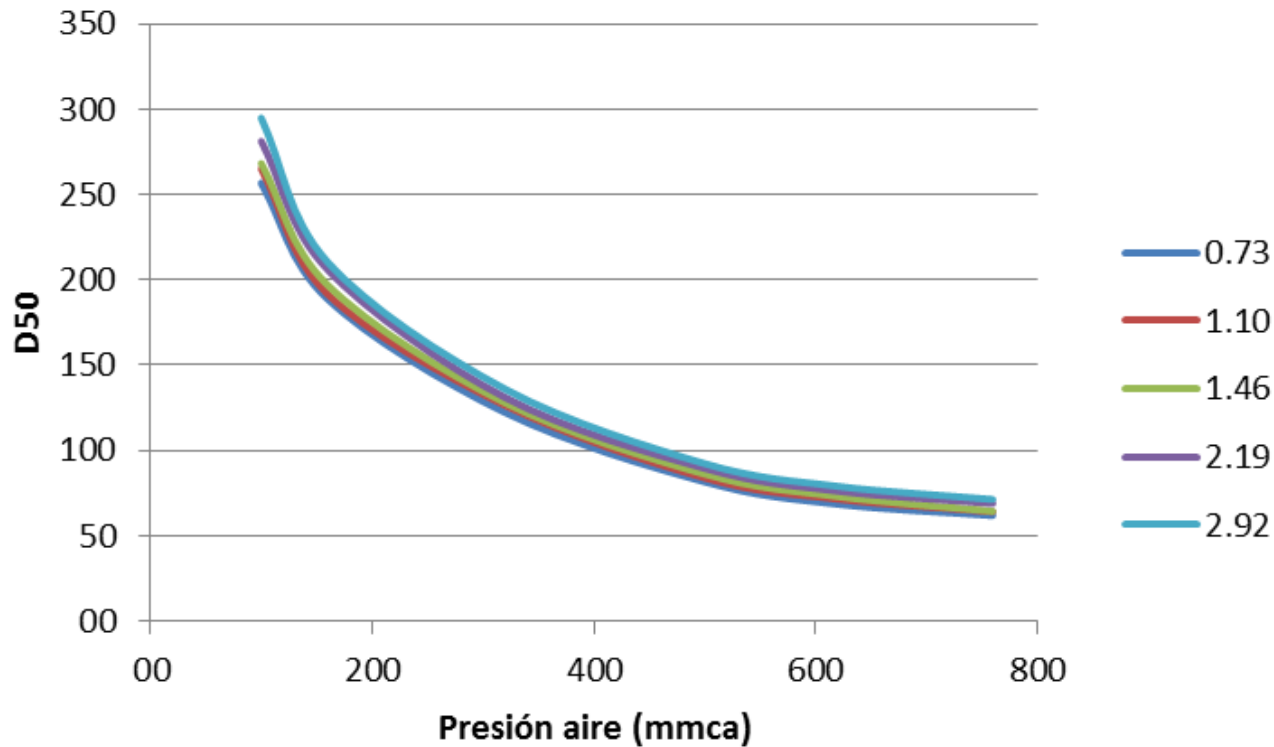


Pulverización neumática

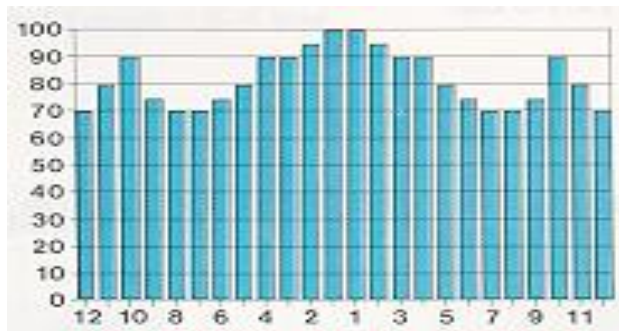
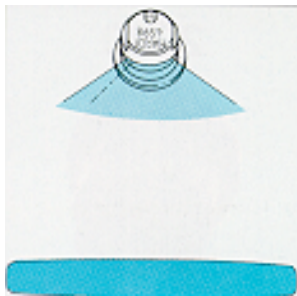
Caudal de agua (l/min)
Baja presión (1-3 bar)



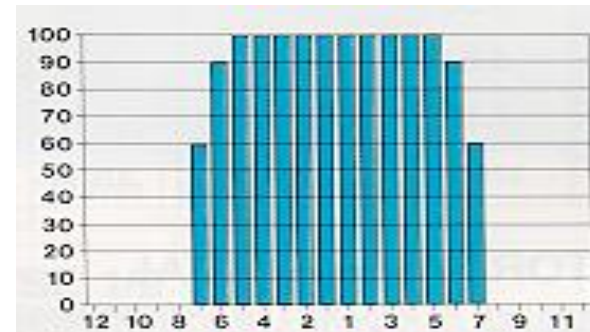
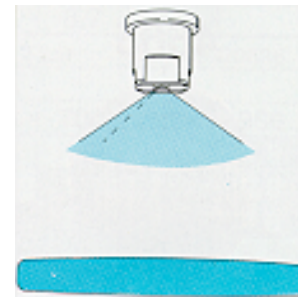
Boquillas neumáticas

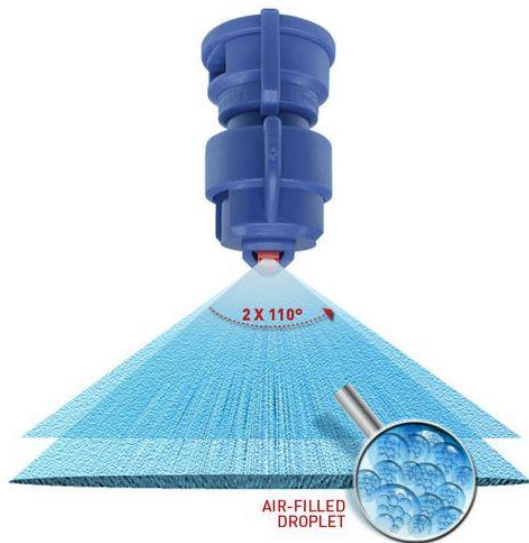
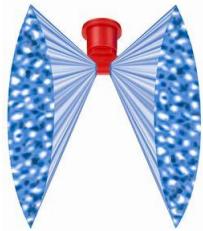


Espejo

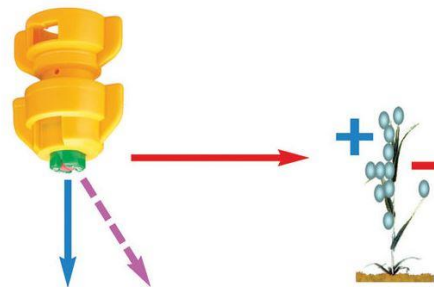


Abanico uniforme

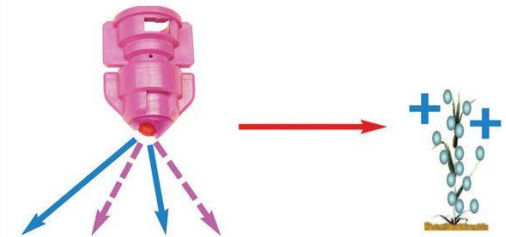




TurboDrop® HiSpeed Standard
Asymmetric high pressure double flat fan
venturi nozzle made from ceramic (coated with POM)

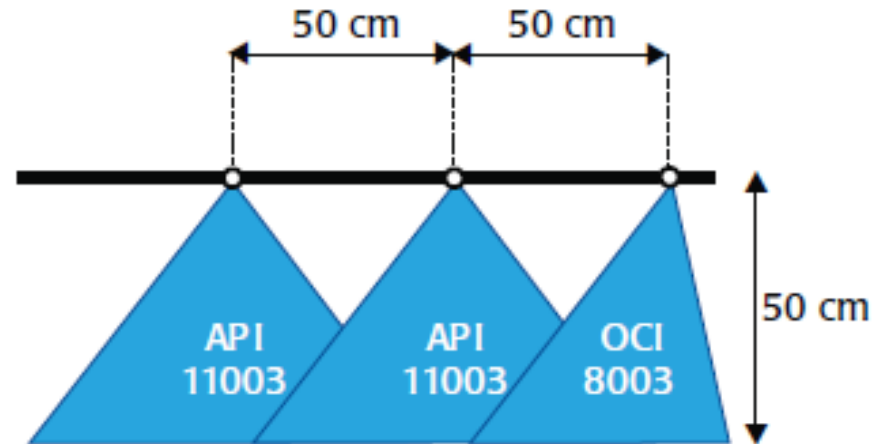
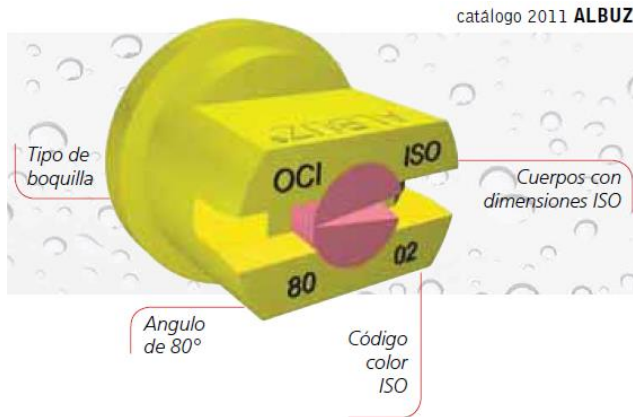


TurboDrop® TD

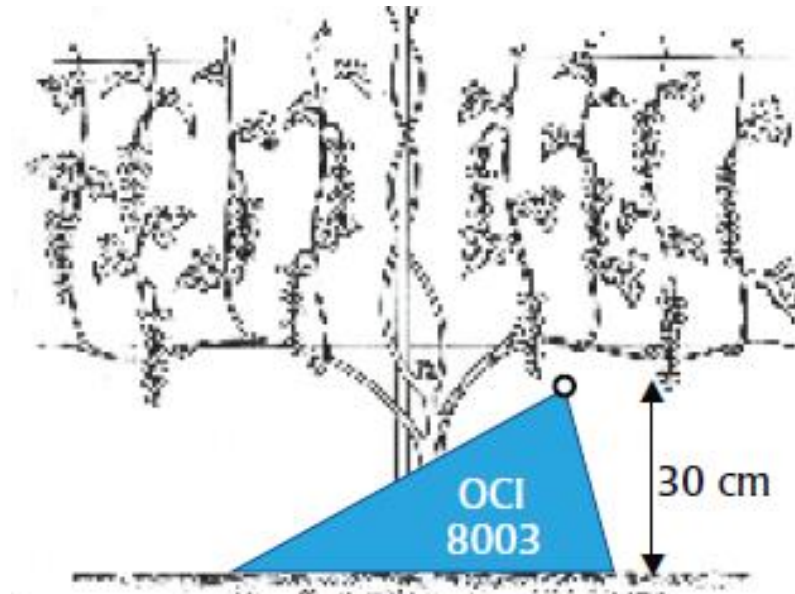
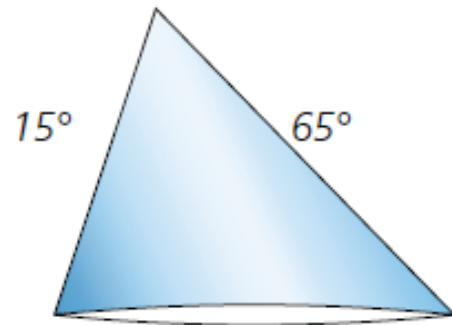


TurboDrop® HighSpeed

Boquillas especiales



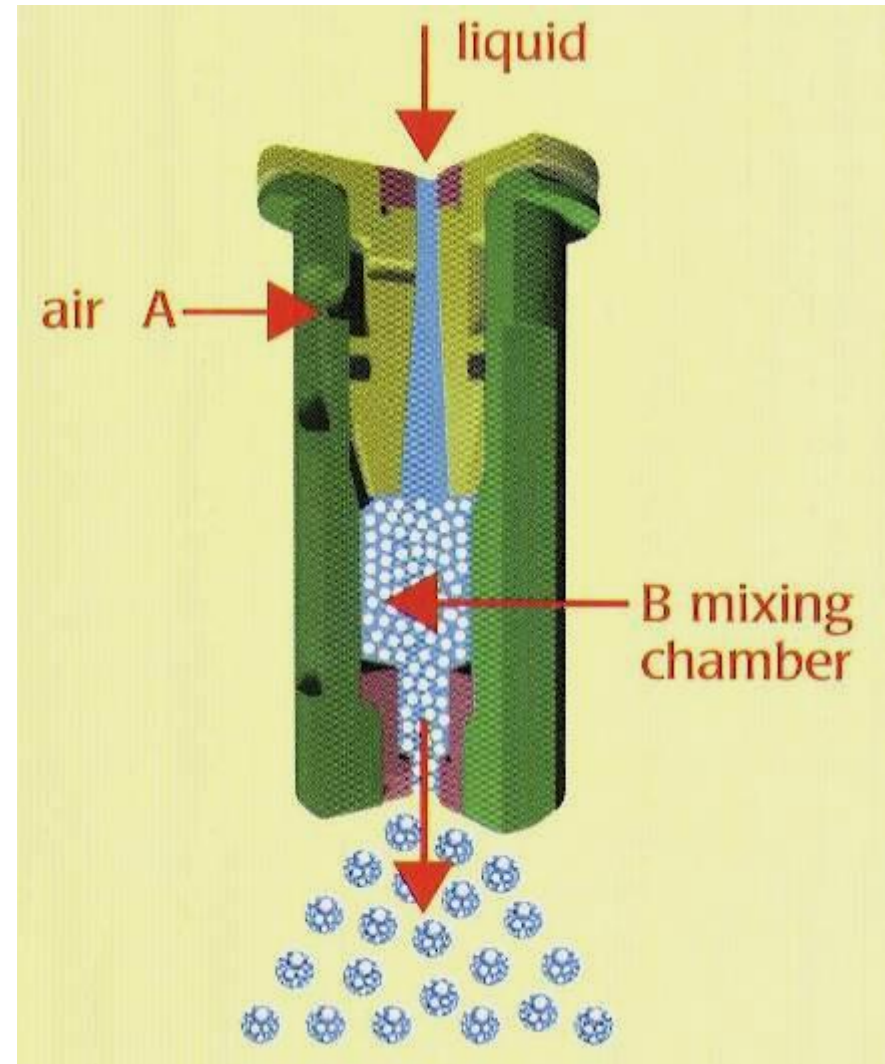
ÁNGULO DEL CHORRO



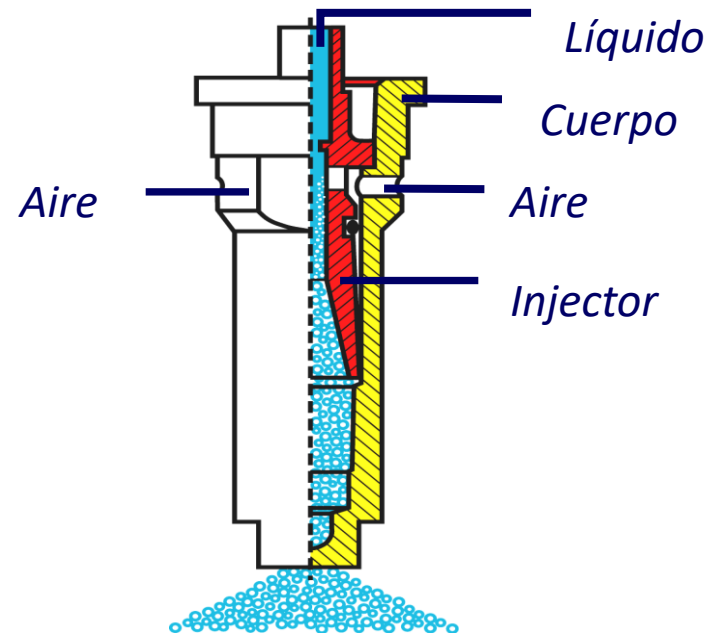
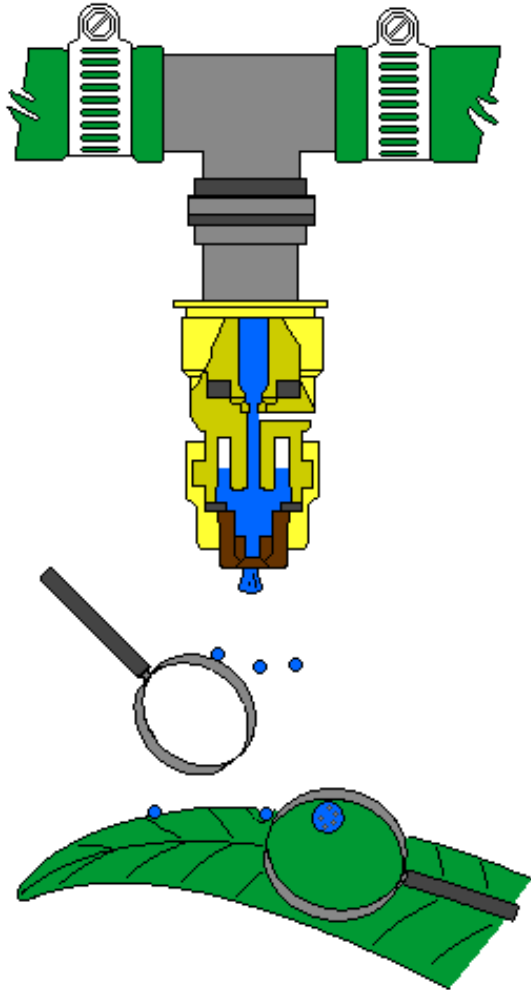
Boquillas antideriva

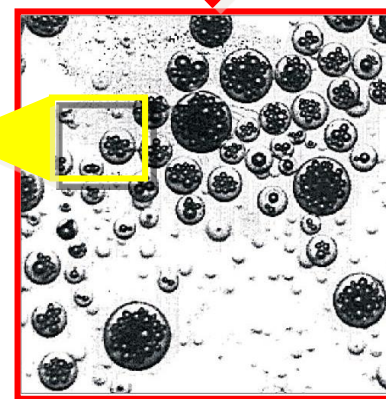
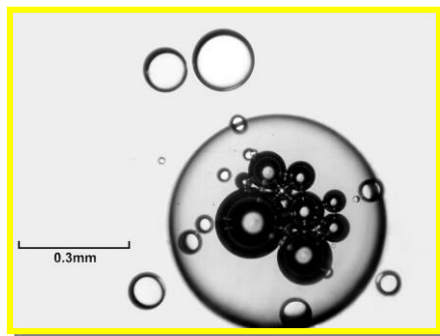
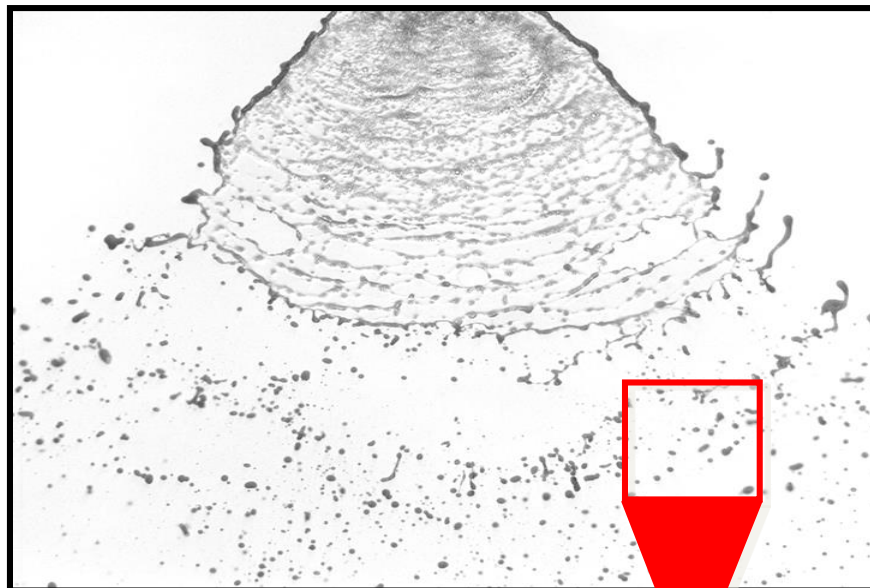
Existen 2 tipologías:

- Inyección de aire
- Con precámara



Utilizar boquillas de baja deriva

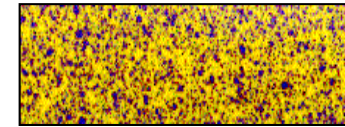




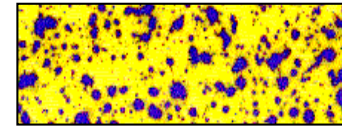
Boquillas antideriva: efecto en los tratamientos



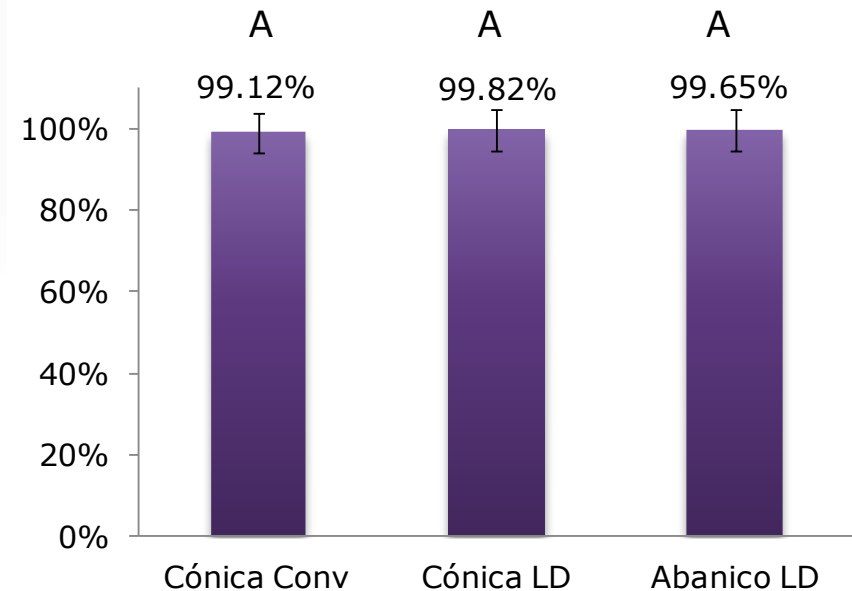
Convencional



Baixa deriva



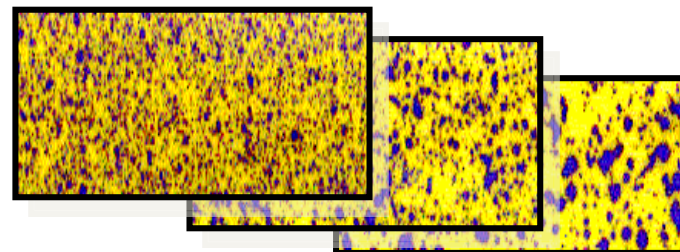
Resultats
Eficàcia biològica



Resultados presentados en GDPM, Vitoria - Gasteiz 2014

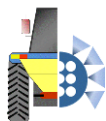


Desarrollo en las boquillas: Cambios y mejoras continuas

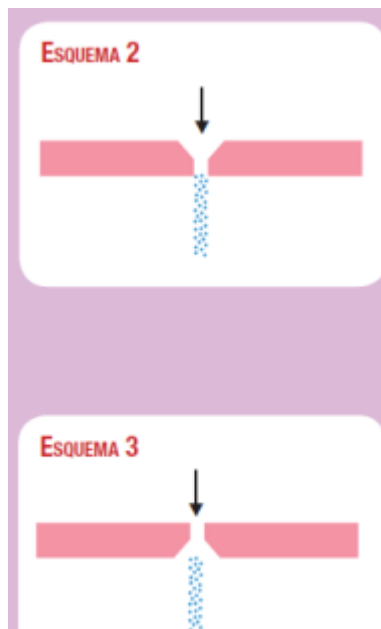


Boquillas “estándar” con:

- Cono vacío, cono lleno y abanico
- Ángulo 60 °, 80 ° y 110°
- Reducción deriva y convencional

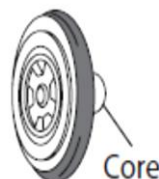


IMPORTANTE! Conocer la relación boquilla – caudal – presión



bar	Litres / mn				
	AMT ..007	AMT ..008	AMT ..010	AMT ..012	AMT ..015
2	0,42	0,54	0,91	1,14	1,88
3	0,51	0,66	1,10	1,39	2,27
4	0,59	0,75	1,25	1,60	2,60
5	0,65	0,83	1,38	1,78	2,89
10	0,91	1,15	1,89	2,51	3,99
15	1,10	1,39	2,27	3,06	4,82
20	1,27	1,59	2,59	3,52	5,51

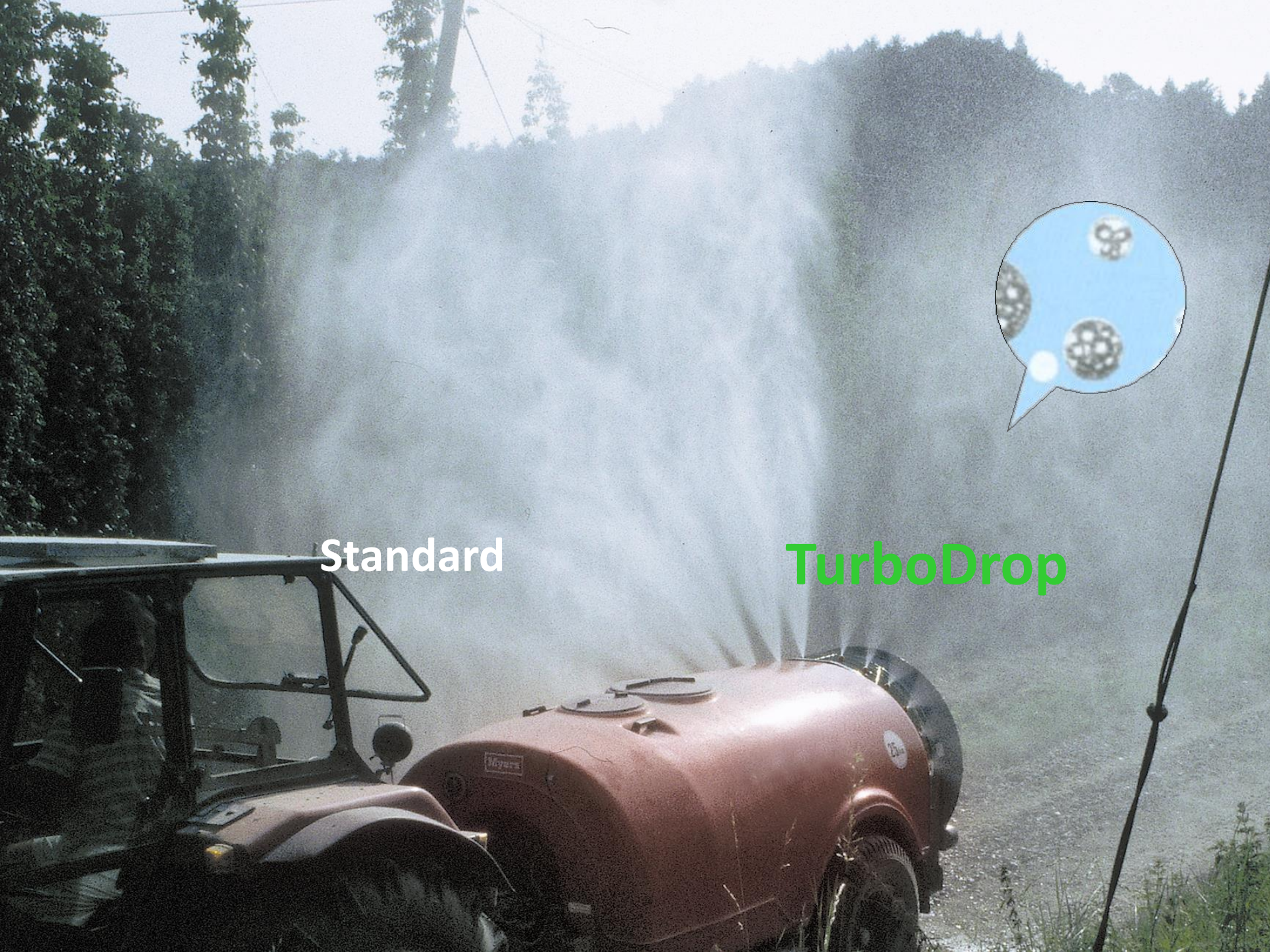
		mm	l/mn									
			0.7 bar	1 bar	2 bar	3 bar	4 bar	5 bar	6 bar	10 bar	15 bar	20 bar
D1	DC31	0.79	0.31	0.36	0.49	0.59	0.67	0.74	0.80	1.0	1.2	1.4
D1.5	DC31	0.91	0.39	0.45	0.63	0.76	0.86	0.95	1.0	1.3	1.6	1.8
D2	DC31	1.0	0.45	0.53	0.72	0.86	0.98	1.1	1.2	1.5	1.8	2.0
D3	DC31	1.2	0.49	0.58	0.80	0.95	1.1	1.2	1.3	1.6	1.9	2.2
D1	DC33	0.79	0.32	0.36	0.46	0.56	0.64	0.71	0.78	0.98	1.2	1.4
D1.5	DC33	0.91	0.42	0.47	0.63	0.75	0.85	0.95	1.0	1.3	1.6	1.9
D2	DC33	1.0	0.47	0.56	0.78	0.95	1.1	1.2	1.3	1.7	2.0	2.3
D3	DC33	1.2	0.57	0.68	0.95	1.1	1.3	1.5	1.6	2.0	2.5	2.8
D4	DC33	1.6	0.78	0.91	1.3	1.5	1.7	1.9	2.1	2.7	3.3	3.7





TurboDrop

Standard



Standard

TurboDrop

