Drift reducing nozzle systems for space cultures

[1]Zb. Czaczyk and [2]G. Bäcker
[1]Institute of Agricultural Engineering, Poznań University of Life Sciences
Wojska Polskiego 28, PL60-637 Poznań, Poland,
[2]Department of Viticultural Engineering, Geisenheim Research Center,
Von-Lade-Str. 1, D65366 Geisenheim, Germany.

Abstract

Lasting application technologies in the plant protection are not imaginable without drift reducing nozzle systems. In grapes, hop and orchards especially airs including nozzles comply with this requirement and so are more and more spreading in practical use. During development and qualifying of those drift reducing nozzle types, beside the investigations of suitability in practical use and drift behaviour quite a lot of droplet size measurement are required. In this case laser diffraction turned out as one of the most suitable methods. Recent developments of droplet size measuring equipment are easily to handle and distinguished on very comfortable software.

Beside the well known air including nozzle types like Albuz AVI 80 and Lechler ID 90 the recent recommendations for practical use also include types as Agrotop AIRMIX, which seems to be especially suited for the helicopter spraying. As air including nozzle type for space cultures also the recent development from Albuz, TVI 80 seem to be very interesting. This hollow cone type is distinguished on smaller flow rates in comparison with other types of air including nozzles.

The paper gives a view over the current supply of drift reducing nozzles types. Moreover it draws a comparison of droplet size distribution and makes an assessment of application quality, drift behaviour and practical suitability. As well it sums up experiences with the new easy manageable droplet size analyser ISITEC by Malvern.

Key words: spray nozzles, spray drift, viticulture, droplet size, laser diffraction, crop protection

*Corresponding author, Email address: czaczykz@up.poznan.pl

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Introduction

Drift reduced nozzles with different substantiation consequently year by year win the popularity in the agricultural practice. Usually nozzles used for application with these sprayers are working not single, but as set.

The user of new generation of nozzles should be completely and objective inform about his application know-how. It is not easy to prepare, but technical and field investigations are needed. The reduction of risk for environment, operator and agricultural products with introduce of new techniques and technologies is very important, but must guarantee also good biological efficacy of used chemicals. The biological efficacy can be achieve only through good distributions of spray liquid on the surface of canopies. Usually published results are made at low pressure according to field sprays (Harašta 2005, Nuyttens *et al*. 2006), but for spatial cultures protected by orchard or viticultural sprayers, the in practice used pressures are higher (1.0 – 1.5 MPa and more). With the aim to reduce the aerial drift potential and soil pollution also in space cultures, the working pressure should be reduce to less than 1.0 MPa.

Special technical solutions are used by mechanization of vineyards in the steep, where on the base of law exception also the helicopter application will be used. In this spraying equipment the low pressure flat fan air included nozzles are working successful. For different spatial cultures some sets from different nozzle sizes are completed and symmetric mounted on both sites of the sprayer. The spray characteristic of different completed sets will be investigated in next tests.

With this background in Department of Viticultural Engineering, at Geisenheim Research Center several investigations to develop a advise information were conduced. Part of them was made as first step, to determine a spray characteristics of these nozzles used in spatial cultures (mostly in viticulture).

Materials and Methods

The spray nozzles selected to this investigations were produced by manufacturers: Albuz, Lechler and Tee Jet, and recommended to use in spatial cultures for ground application. Different hollow-cone (standard and air included) and flat fan air included, covering various sizes and flow rates was represented (Table 1). Spray pressures: 0.5; 0.75; 1.0; 1.25 and 1.5 MPa were used.

Flat fan air included Agrotop AirMix plastic nozzles used in spatial cultures by helicopter applications at spray pressures 0.2; 0.4 and 0.6 MPa were investigated.

Droplet size spectra characteristics were conducted by ISITEC Malvern Particle Size Analyzer. Spray liquid was tap water with temperature ~20º C. Air humidity and temperature during investigations were respectively 65% and 18º C. Nozzle height was 50 cm above the measuring level of laser. Nozzle to floor distance was 1.8 m. Working speed of tested nozzles cross to laser light was 10 cm $\cdot$ s^{-1}. Four repetitions for each tested nozzle were conducted, and for each nozzle type three nozzles were tested.

The values of: D_{V10} [μm] (10% of the volume of produced droplets smaller than the value of D_{V10}), and D_{V50} [μm] (D_{V50} = VMD – Volume Median Diameter, 50% of the spray volume of produced droplets smaller than D_{V50} value). They are the most important coefficients used as statement of spraying characteristics (VMD), and drift potential (D_{V10}).

For the more detailed and unified calculation of drift potential, the ISO standard ISO-22369-1 will be in developing phase (ISO 2006). After publishing a last valid version of ISO-22369-1, we would to calculate our results to ISO drift calculations standards.

Results and Discussion

The results calculated during this investigations show large differences between drop sizes over the different nozzle types (Tab. 2.). The lowest VMD value (106.9 μm) for conventional hollow-cone nozzle Tee Jet TXVK yellow at 1.5 MPa was calculated. The coarsest droplets (VMD – 801.3 μm) produces at 0.5 MPa the flat fan air included Lechler ID 90015 nozzle. The reduction of spray pressure to less than 1.0 MPa significantly change the spray characteristic determined by VMD and D_{V10}. Values of both coefficients at lower pressures were higher, and on this way we can easy reduce the drift potential also by using the conventional hollow-cone nozzle. The results from simultaneously conducted investigations in viticulture show, that the biological efficacy of application with the air included nozzles was satisfied if the VMD was not higher than 400 μm. From other site, the reduction of drift potential is acceptable if the VMD is bigger as 300 μm.

The results of the droplet size for AirMix flat fan nozzles (for helicopter spraying) are listed in table 3. By aerial application the transport conditions are different as at ground application with the air assistance.

The coverage quality on the targets and the biological efficacy are also different. Very important is also the characteristics of air assistance fan (direction, homogeneity and speed of air). The spraying and drift potential characteristics of homogenous equipped sprayers, and with different nozzles (different sizes) completed sets should be also

evaluated on technical and biological way. With this background next experiments are conducted and the results should be published in short time.

Conclusions

- Reduction of drift potential with the aim of environment protection and with acceptable biological efficacy is possible with using of air included nozzles,
- first results suggest, that the spraying quality of tested nozzles between 300 and 400 μm VMD, have significantly reduced drift potential and acceptable biological efficacy,
- all results from this investigations should to be estimate with new drift reduction ISO standards,
- the unified measure and calculation method for spray characteristics are needed,
- influence of air assistance fan characteristics on the spray distribution and drift potential should be investigated,
- coding of nozzle sizes should be consequently by all producers adapted to one unified (e.g. ISO color code) international standard.

References

1. Bäcker, G., *Lasting Plant Protection Procedures by Innovative Technology*, KTBL – 456, 2007, pp. 34-46.
2. ISO - Standard – 22369-1, *Crop protection equipment – Drift classification of spraying equipment*, 2006.
3. Harašta, P., *The possibilities of droplet spectrum regulation at application of plant protection products*, Res. Agr. Eng., 51, 2005 (4): 125-133
4. Nuyttens, D., Baetens, K., De Schampheleire, M. & Sonck, B., *PDPA Laser-Based Characterisation of Agricultural Spray Nozzles*, Agricultural Engineering International: the CIGR Ejournal. Manuscript PM 06 024. Vol. VIII. December 2006: 1 – 18.

Table 1. Nozzles used to evaluate spray characteristics for space cultures.

Manufacturer	Nozzle type	Nozzle specification
Albuz	Hollow-cone standard	ATR lilac, brown, yellow, orange, red, green
	Hollow-cone air included	TVI 800075; 8001; 80015; 8002; 80025
	Flat-fan air included	AVI 8001; 80015; 8002; 80025; 8003
Lechler	Hollow-cone standard	TR orange; green; yellow; blue
	Hollow-cone air included	ITR 80015; 8002
	Flat-fan air included	ID 9001; 90015; 9002; 90025; 9003
Tee Jet	Hollow-cone standard	TXVK yellow; green; red
Agrotop	Flat fan air included	AirMix 11001; 110015; 11002; 110025;
	(for helicopter spraying only)	11003; 11004; 11005; 11006

Table 2. Characteristics of spraying quality for drift reduced nozzles used in space cultures.

Pressure	Value	Nozzle specification					
[MPa]	[μm]	ATR lilac	ATR brown	ATR yellow	ATR orange	ATR red	ATR green
0.5	D_{V10} / D_{V50}	106.3/202.5	95.7/172.2	100.4/173.4	110.5/204.2	117.8/228.9	119.9/285.0
0.75		91.1/164.0	89.9/163.8	85.2/153.3	100.2/193.5	102.1/293.3	109.4/261.9
1.0		87.4/158.6	82.4/151.3	81.8/149.9	95.2/184.7	95.2/192.5	103.0/246.7
1.25		80.1/145.3	84.7/156.7	84.7/156.9	86.9/162.4	92.5/182.4	99.7/236.6
1.5		75.4/136.4	85.9/158.2	84.6/154.2	83.3/159.3	90.3/181.5	90.4/204.7
	Albuz	TVI 800075	TVI 8001	TVI 80015	TVI 8002	TVI 80025	
0.5		144.1/307.5	196.4/536.5	165.0/378.4	185.3/514.7	185.8/410.0	
0.75		126.2/247.2	161.2/395.0	150.7/360.4	165.7/447.3	172.5/414.7	
1.0		114.5/235.7	145.6/364.7	129.2/305.3	191.0/506.3	143.9/367.7	
1.25		114.0/206.2	145.7/320.1	125.7/291.4	198.8/434.8	127.4/321.4	
1.5		112.6/203.0	123.9/276.9	111.4/248.0	187.9/411.5	143.3/370.0	
	Albuz	AVI 8001	AVI 80015	AVI 8002	AVI 80025	AVI 8003	
0.5		149.8/613.2	125.8/325.7	176.6/529.5	176.3/522.5	154.2/447.2	
0.75		113.0/259.0	105.4/262.3	140.5/398.5	137.4/396.7	135.5/382.1	
1.0		102.6/226.4	96.0/230.6	125.4/332.2	127.1/359.7	121.2/340.9	
1.25		92.7/191.1	89.8/214.9	116.1/312.5	117.0/322.6	109.4/308.5	
1.5		79.2/171.2	81.4/200.4	106.9/286.1	111.7/307.1	106.9/290.2	
	Lechler	ID 9001	ID 90015	ID 9002	ID 90025	ID 9003	
0.5		213.9/728.2	231.5/801.3	225.9/753.6	184.5/565.6	194.0/632.5	
0.75		170.0/631.9	196.2/768.8	174.6/584.5	153.3/459.0	169.5/556.5	
1.0		161.2/631.8	170.5/699.6	151.9/516.1	136.9/397.3	146.7/471.8	
1.25		138.9/518.1	154.9/599.4	140.7/437.1	125.8/358.1	135.6/428.0	
1.5		132.2/446.3	143.0/520.3	129.2/391.4	121.1/346.3	126.7/398.2	
	Lechler	TR orange	TR green		TR yellow	TR blue	
0.5		88.1/150.5	87.5/149.8		88.9/160.6	83.5/156.3	
0.75		80.6/135.5	80.4/140.2		81.6/151.6	78.6/151.0	
1.0		72.8/128.0	74.1/134.3		75.3/141.9	74.0/144.3	
1.25		71.7/124.0	72.6/129.4		74.8/143.5	70.9/139.0	
1.5		67.6/122.9	69.6/125.8		70.6/136.6	70.3/139.2	
	Tee Jet	TXVK yellow		TXVK green		TXVK red	
0.5		81.9/154.5		77.7/140.1		85.6/144.5	
0.75		68.9/131.4		64.7/126.4		78.6/136.6	
1.0		63.3/119.5		64.0/120.4		69.5/123.3	
1.25		59.2/111.7		59.0/112.2		67.3/119.5	
1.5		57.1/106.9		56.2/107.4		62.1/112.9	
	Lechler	ITR 80015			ITR 8002		
0.5		235.6/475.4			317.9/557.6		
0.75		224.1/570.1			241.5/534.1		
1.0		222.9/517.0			250.6/542.5		
1.25		161.1/380.9			257.3/589.9		
1.5		168.0/398.1			231.6/468.5		

Table 3. Characteristics of spraying quality for flat fan air included nozzles produced by Agrotop.

Nozzle type	Pressure [MPa]	D_{V10} [μm]	VMD [μm]
AirMix 11001	0.2	109.4	336.8
	0.4	92.8	296.1
	0.6	83.2	263.3
AirMix 110015	0.2	137.3	461.2
	0.4	116.2	301.6
	0.6	108.3	264.0
AirMix 11002	0.2	125.2	336.4
	0.4	110.1	276.5
	0.6	98.2	247.2
AirMix 110025	0.2	137.2	391.9
	0.4	119.4	312.8
	0.6	107.1	280.7
AirMix 11003	0.2	137.9	379.2
	0.4	119.4	311.9
	0.6	107.1	278.3
AirMix 11004	0.2	154.2	433.6
	0.4	131.1	357.1
	0.6	122.6	328.3
AirMix 11005	0.2	156.6	448.2
	0.4	132.7	356.2
	0.6	115.1	348.0
AirMix 11006	0.2	203.5	773.0
	0.4	136.0	418.2
	0.6	118.8	345.2