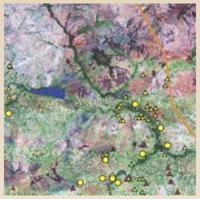

Wind Tunnel Testing of Nozzles for Reduction of Drift

Presented by:

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STONE ENVIRONMENTAL INC

Contents

Introduction

- In an effort to reduce the magnitude of drift from groundspray applications of a contact insecticide, a wind tunnel study was conducted to test different nozzle technologies known to reduce drift.
- There are a number controllable factors during an application that can affect drift and many of these already have restrictions on most pesticide labels:

  Droplet Size, Wind Speed, Boom Height

PRECAUTIONS AND RESTRICTIONS

Do not permit spray to contact auto vehicles as paint finish could be permanently damaged. If vehicles come into contact with spray, wash immediately.

Do not use this product for any uses other that those specified on this label.

For proper mixing, fill the spray tank at least ¾ filled with water before Cheminova Malathion 57% is added. Mechanical agitation or recirculation through the pump by-pass to the tank is usually sufficient for maintaining a good dispersion. Rinse empty container with water and drain into spray tank - repeat twice more. Repeat applications may be made as indicated. Consult your State Agricultural Experiment Station for proper timing of applications.

Spray Drift Requirements

Observe the following requirements when spraying in the vicinity of aquatic areas such as, but not limited to lakes; reservoirs; rivers; permanent streams; marshes or natural ponds; estuaries and commercial fish ponds.

Buffer Zones for Aerial Application

When making a Non-ULV application with aerial application equipment, a minimum buffer zone of 25 feet must be maintained along any water body.

Droplet Size

Use the largest droplet size consistent with acceptable efficacy. Formation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the air stream as much as possible, and by avoiding excessive spray boom pressure.

For groundboom and aerial applications, use only medium or coarser spray nozzles according to ASAE (S572) definition for standard nozzles, or a volume mean diameter (VMD) of 300 microns or greater for spinning atomizer nozzles. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.

Wind Direction and Speed

Make aerial or ground applications when the wind velocity favors on target product deposition (approximately 3 to 10 mph). Do not apply when wind velocity exceeds 15 mph. Avoid applications when wind gusts approach 15 mph. For all non-aerial applications, wind speed must be measured adjacent to the application site on the upwind side, immediately prior to application.

Temperature Inversion

Do not make aerial or ground applications into areas of temperature inversions. Inversions are characterized by stable air and increasing temperatures with increasing distance above the ground. Mist or fog may indicate the presence of an inversion in humid areas. Where permissible by local regulations, the applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.

Additional Requirements for Ground Applications

For groundboom applications, apply with nozzle height no more than 4 feet above the ground or crop canopy.

For airblast applications, turn off outward pointing nozzles at row ends and when spraying the outer two rows. To minimize spray loss over the top in orchard applications, spray must be directed into the canopy.

Introduction

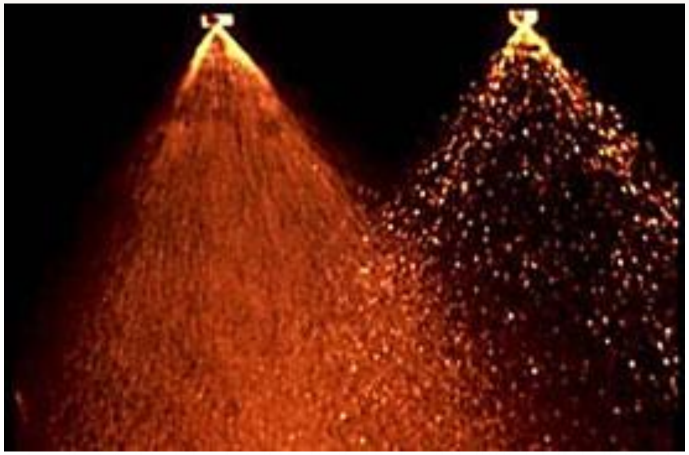
- The EPA is in the process adding another adjustment to labels: nozzle recommendation

- The DRT program will recommend different nozzles that have different levels of drift control and potential spray setbacks will vary depending on the nozzle type used by the applicator.

- The data in this presentation has been submitted to EPA and will hopefully inform that process of designating drift reducing nozzles.

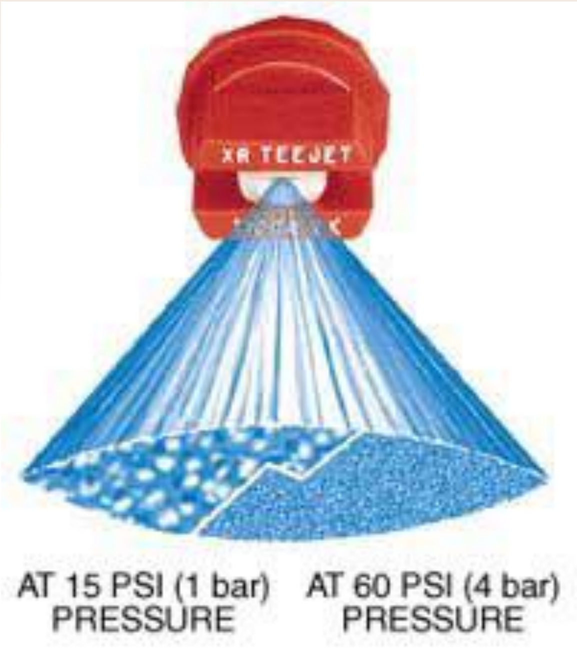
Terminology

- Drift – the physical movement of spray droplets through the air to any off-target site at the time of application
- Droplet spectrum – the physical make-up of droplet sizes exiting the nozzle, measured in microns, driftable droplets are generally considered to be <150 microns
- Contact pesticides – pesticides that must make direct contact with the target pest (insect, fungus, weed) to be efficacious
- Systemic pesticides – absorbed by plants and move to untreated parts of the plant. Efficacious without complete coverage



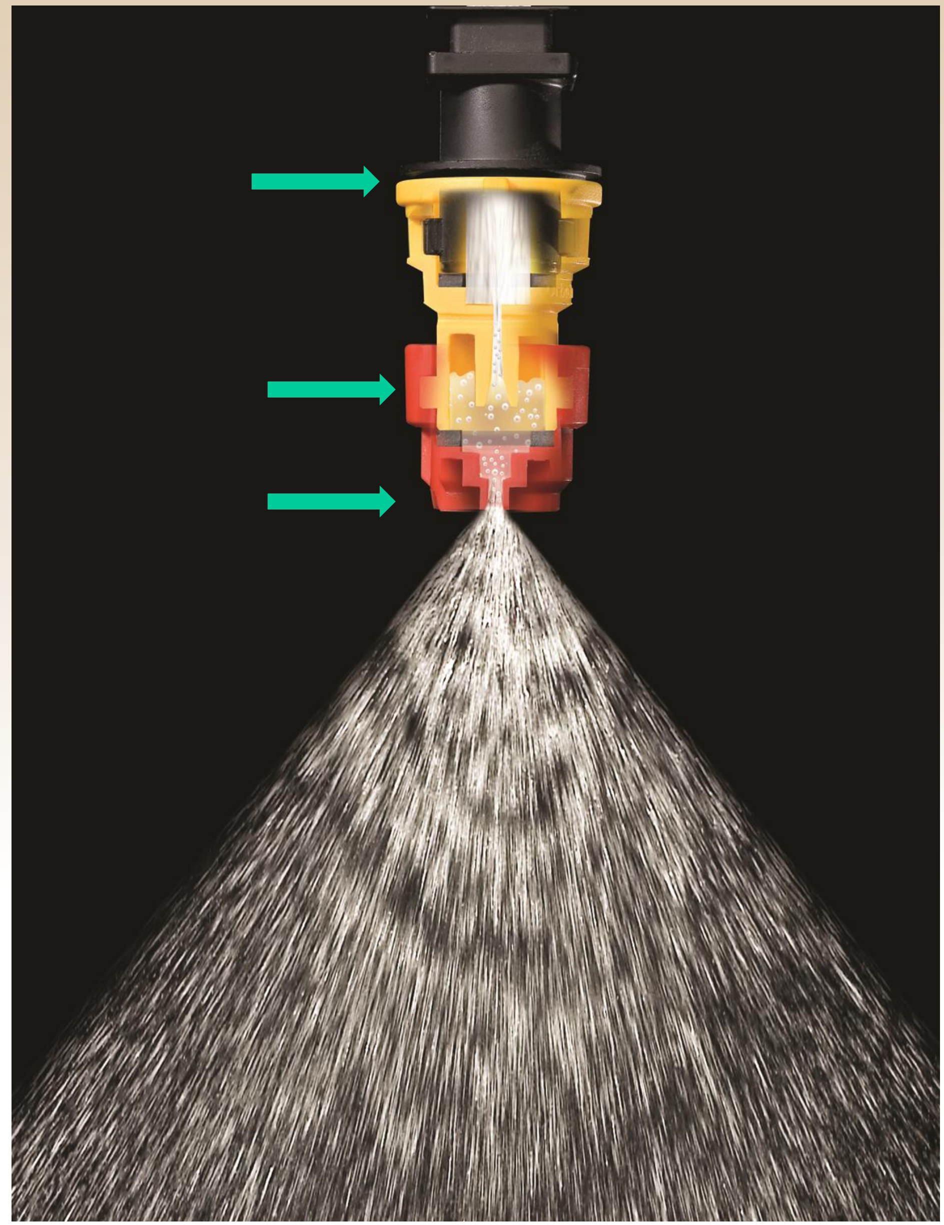
Spray Nozzles – Flat Fan

- Sprays in an inverted elliptical "V" pattern. Deposition is heaviest in the center and dissipates at the edges.
- Three basic types: standard, extended range, and pre-orifice
- Extended range (XR's) have a wider range of operating pressures
- Pre-orifice reduce pressures internally leading to larger droplets and better drift control



Spray Nozzles – Venturi or Air Induction

- Features two orifices; one meters the flow and the second forms the spray pattern. In between there is an air aspirator. Air mixes with the flow creating larger air filled droplets in a tighter range of droplets.



Background

- To make an efficient application that minimizes drift you first need to look at the type of chemical you are applying, the formulation, and the crop.
- A pre-emergent herbicide application to bare ground is a very different application than a contact insecticide application to crop foliage where coverage is key.
- Generally with herbicide applications you want to get the product to the ground as quickly and efficiently (large droplets) as possible to reduce off target drift.
- With a contact insecticide application you need coverage to be efficacious, that means coverage over and under the leaf surface. To reduce drift and be efficacious you have to hit the sweet spot between driftable droplets and droplets too large to get good coverage. Generally 300-400 micron droplet size.

Nozzles

- 9 nozzles tested
- 20 different configurations of nozzle, orifice size, and pressure
- Nozzles were chosen based on label restrictions for spray rate then manufacturer recommendations for efficacy and drift reduction
- Teejet has a catalogue, Greenleaf has a calculator tool on their website
- TeeJet, http://www.teejet.com/english/home/selection-guides/spray-nozzles.aspx
- Greenleaf, http://www.turbodrop.com/dynamic.php?pg=Choosing_the_Right_Nozzle/Nozzle_Calculator
- All nozzles were rated "very good" or "excellent" for efficacy with contact insecticides and drift

TeeJet Catalogue – Nozzle and Spray Parameters

	PSI	DROP SIZE	CAPACITY ONE NOZZLE IN GPM	CAPACITY ONE NOZZLE IN OZ./MIN.	20″ GPA 4 MPH	5 MPH	6 MPH	8 MPH	10 MPH	12 MPH	15 MPH	20 MPH
AIXR110015 (100)	15	XC	0.092	12	6.8	5.5	4.6	3.4	2.7	2.3	1.8	1.4
	20	XC	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6
	30	C	0.13	17	9.7	7.7	6.4	4.8	3.9	3.2	2.6	1.9
	40	C	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2
	50	C	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5
	60	M	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7
	80	M	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1
	90	M	0.23	29	17.1	13.7	11.4	8.5	6.8	5.7	4.6	3.4
AIXR11002 (50)	15	XC	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8
	20	XC	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1
	30	VC	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5
	40	C	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0	4.0	3.0
	50	C	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3
	60	C	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6
	80	M	0.27	35	20	16.0	13.4	10.0	8.0	6.7	5.3	4.0
	90	M	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5
AIXR110025 (50)	15	XC	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2
	20	XC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7
	30	XC	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3
	40	VC	0.25	32	18.6	14.9	12.4	9.3	7.4	6.2	5.0	3.7
	50	C	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2
	60	C	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6
	80	C	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0
	90	C	0.38	49	28	23	18.8	14.1	11.3	9.4	7.5	5.6

Nozzles Tested

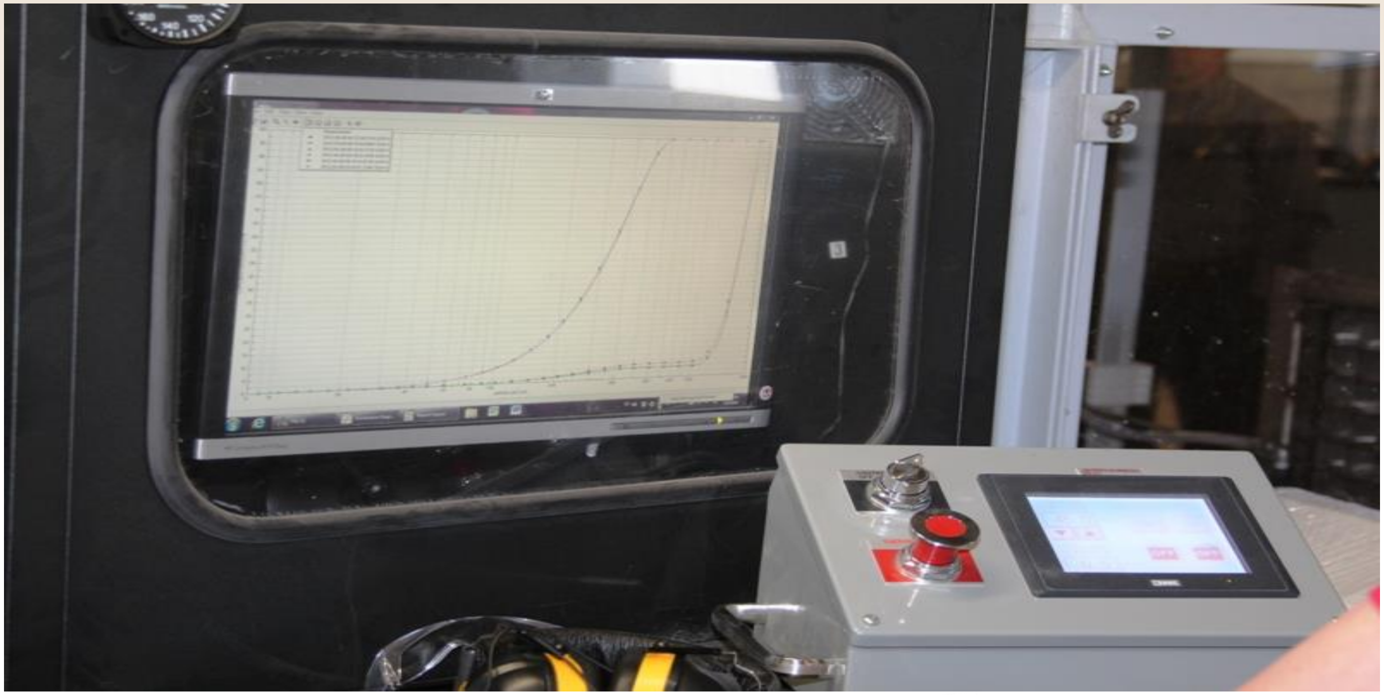
Nozzle	Nozzle Code	Orifice	Pressure (psi)
Air-Induction Extended Range TeeJet	AIXR110025	025	50
	AIXR11006	06	80
AirMix Low Pressure	AM11003	03	50
	AM11006	06	70
TurboDrop High Pressure	TDCFFC11005	05	70
TurboDrop Med Pressure XL	TDXL11002	02	80
	TDXL110025	025	70
	TDXL11005	05	80
Turbo Teejet Wide Angle Flat	TT11003	03	50
	TT11005	05	40
	TP9508	08	60
	TT11008	08	60
Turbo Twinjet Twin Flat	TTJ11003	03	50
	TTJ11006	06	80
	TTJ11006	06	90
TwinJet Flat	TF11008	08	40
	TF11008	08	60
XRC TeeJet Extended Range Flat	XR11003	03	50
	XR11008	08	50
	XR11010	10	40

Wind Tunnel

- University of Nebraska-Lincoln Wind Tunnel Testing Facility, located at the West Central Research & Extension Center in North Platte, NE

Wind Tunnel

- All tests conducted at 15 mph
- Droplet spectrum from each test was evaluated with a particle analyzer
- The Sympatec HELOS KR with the R7 lens laser diffraction instrument measures droplet sizes ranging 0.5 - 3,500 microns in diameter
- Statistics were Dv, percent less than, relative span

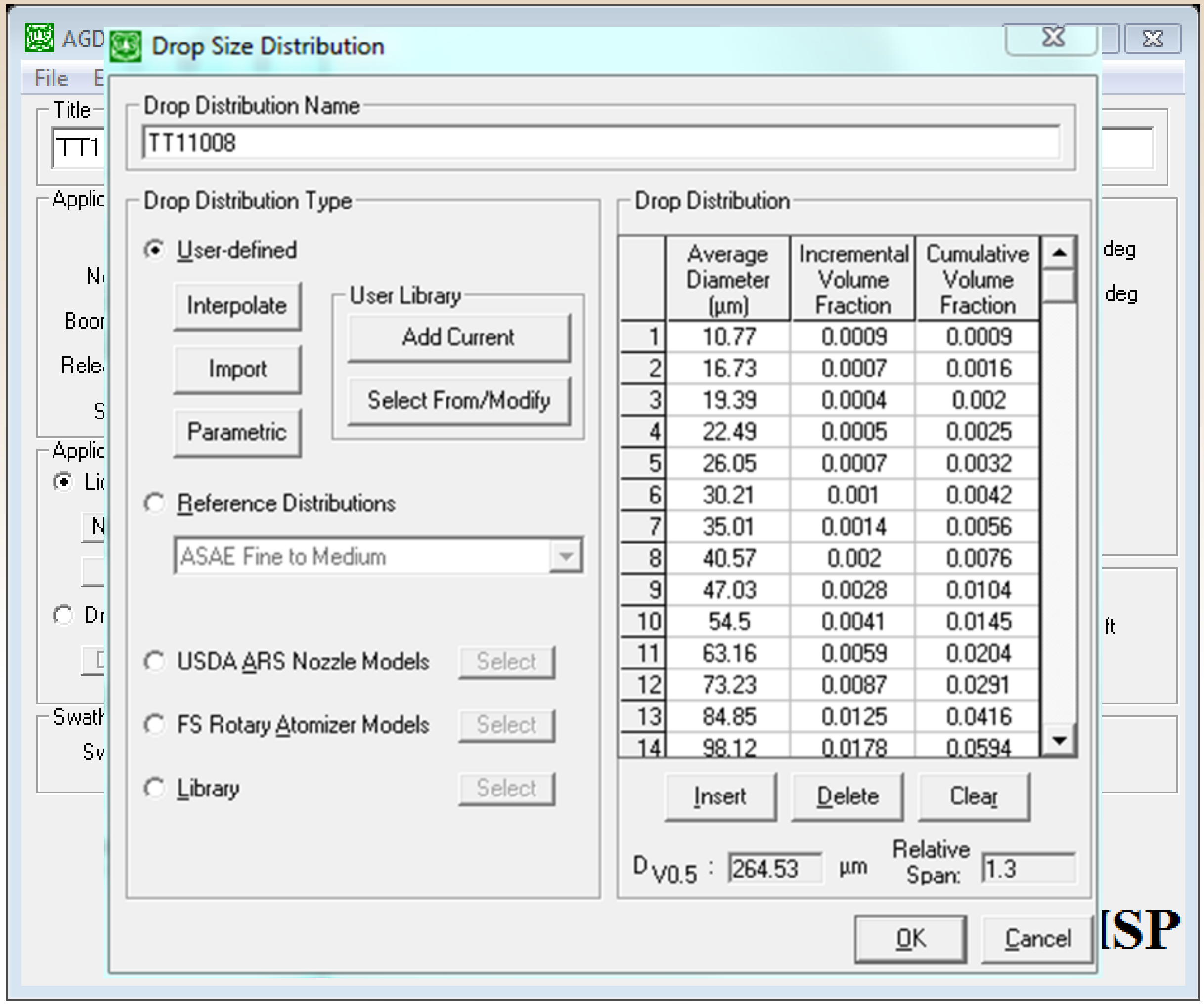


Droplet Spectrum Results

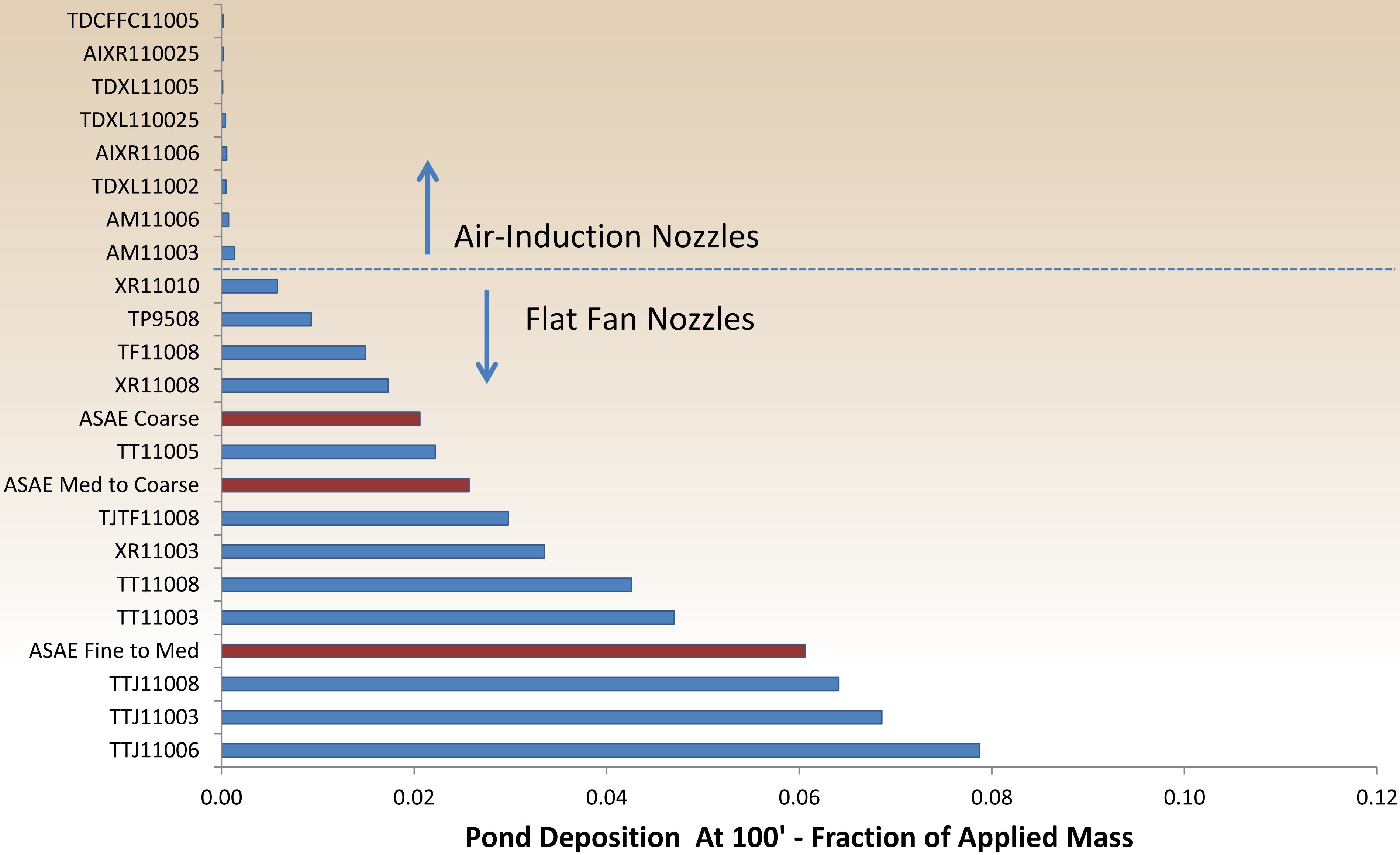
Nozzle	Nozzle Code	psi	% <105 µm	Dv10 (µm)	Dv50 (µm)	Dv90 (µm)	Relative Span
TurboDrop High Pressure	TDCFFC11005	70	0.56	266	520	786	1.00
TurboDrop Med Pressure XL	TDXL11005	80	0.75	242	471	703	0.98
Air-Induction Extended Range TeeJet	AIXR110025	50	1.08	217	412	596	0.92
AirMix Low Pressure	AM11003	50	1.18	209	403	734	1.29
XRC TeeJet Extended Range Flat	XR11010	40	1.31	204	396	601	1.00
TurboDrop Med Pressure XL	TDXL110025	70	1.52	190	369	564	1.02
Air-Induction Extended Range TeeJet	AIXR11006	80	1.66	200	404	640	1.09
Turbo Teejet Wide Angle Flat	TP9508	60	1.84	188	373	580	1.05
TurboDrop Med Pressure XL	TDXL11002	80	2.01	175	336	513	1.01
XRC TeeJet Extended Range Flat	XR11008	50	2.02	174	312	533	1.06
AirMix Low Pressure	AM11006	70	2.26	177	366	592	1.14
TwinJet Flat	TF11008	40	2.65	159	303	462	1.01
Turbo Teejet Wide Angle Flat	TT11005	40	3.33	154	322	539	1.20
TwinJet Flat	TF11008	60	4.88	135	268	416	1.06
Turbo Teejet Wide Angle Flat	TT11003	50	6.15	125	257	419	1.15
Turbo Teejet Wide Angle Flat	TT11008	60	6.20	125	263	456	1.26
XRC TeeJet Extended Range Flat	XR11003	50	6.56	121	233	356	1.02
Turbo Twinjet Twin Flat	TTJ11003	50	8.74	110	224	364	1.14
Turbo Twinjet Twin Flat	TTJ11006	80	12.55	97	201	343	1.24
Turbo Twinjet Twin Flat	TTJ11006	90	14.32	91	194	332	1.27

AGDISP 8.26 Drift Modeling

- Insecticide drift to a 1 hectare pond was modeled using AGDISP 8.26
- User-defined droplet spectra were used in AGDISP based on the summarized wind tunnel data for each nozzle
- Each nozzle was modeled at 15 mph, the wind speed used at the wind tunnel facility

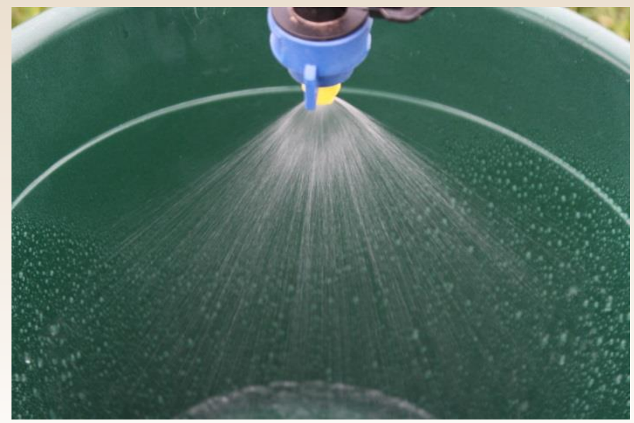


Nozzles Ranked by Drift using AGDISP 8.26



Conclusions

- The air induction nozzles tested were generally the best performers for the combination of drift and efficacy.
- Some of the flat fan nozzles may be acceptable for drift reduction if used at the correct pressure and orifice size.



Next Steps/Future Work

- Efficacy trials using the best performing nozzles
- Conduct field trials to test best performing nozzles
- Publish data in peer-reviewed journal
- Education of growers and professional applicators
- Bob Wolf; former Application Technology Specialist in the Biological and Agricultural Engineering Department at Kansas State University

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