
New Options for Low Drift Spray Application

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Introduction

Spray drift continues to be a major concern for producers and applicators. The increasing use of non-selective or highly active herbicides requires increased vigilance by applicators to ensure that sensitive areas are protected from damage. Several technologies are providing new opportunities for spray drift management. Most of these are inexpensive and compatible with existing spray equipment.

Nozzles represent an important yet inexpensive sprayer component. The droplet size spectrum emitted by a nozzle determines, to a large part, the effectiveness of the spray and its off-target behaviour. Spray quality can be controlled through pressure changes (lower pressures result in coarser spray) or nozzle flow rate (nozzles with higher flow rates produce coarser sprays). In addition to these adjustment opportunities, new nozzles specifically designed to emit coarser sprays at standard operating pressures, or those providing more adjustable spray qualities, are becoming valuable tools for drift management.

Objectives

- Identify new options for spray drift management;
- Evaluate drift characteristics of pre-orifice and venturi type nozzles;
- Initiate efficacy testing of low-drift spray methods with non-selective herbicides.

Materials and Methods

A. Drift-reducing Options

The following nozzles represent the major types currently available in Western Canada:

Extended Range Flat Fan: The standard nozzle for herbicide application. Produces acceptable spray patterns at pressures between 100 and 400 kPa. Pressure reduction decreases the proportion of the spray volume in driftable droplets (i.e., those less than 150 μm in diameter), reducing drift (e.g. XR8002).

Pre-Orifice Flat Fan: A pre-orifice reduces the internal operating pressure of a standard tip, producing a coarser spray between 200 and 400 kPa. Because of the transparent pressure drop in the nozzle body (the pressure gauge reads the external pressure only), the minimum pressure producing acceptable spray patterns is higher than that of a conventional flat fan tip (e.g. Spraying Systems Drift Guard DG8002, or Lurmark SD-02-1 10).

Turbo TeeJet: A turbulence chamber in a modified flooding tip produces a wide-angle, spray between 100 and 620 kPa. This wide pressure range makes these nozzles very compatible with automatic rate controllers which use pressure to adjust flow rate according to travel speed. The proportion of the spray volume in drift-prone droplets is reduced, making these tips suitable for low-drift application (e.g. TT11002).

Venturi Nozzles: Venturi (also known as air induction or foaming nozzles) represent a more sophisticated version of the flat fan nozzle. An internal venturi creates negative pressure inside the nozzle body. Air is drawn into the nozzle through aspiration holes, mixing with the spray liquid. The emitted spray contains large droplets filled with air bubbles, and virtually no fine, drift-prone droplets. The air-containing droplets may shatter on impact with the leaf, providing equivalent coverage to conventional, finer sprays. Pressure range varies with tip manufacturer, but is typically higher (e.g. 275 to 700 kPa) than standard flat fan tips. Venturis are available from most manufacturers (e.g. Greenleaf Technologies' TurboDrop (TD); Billerica Farm Systems' Air Bubble Jet (ABJ); Spraying Systems' Air Induction (AI); John Deere's Spraymaster Ultra, as well as models from Lurmark and Lechler).

Capstan "Synchro": Conventional nozzles are mounted on a nozzle body assembly which contains a small solenoid valve in place of the diaphragm check valve. The solenoid pulses at an adjustable duty cycle, creating an intermittent liquid flow rate through the nozzle whose rate is a function of the duty cycle. To change carrier volume, the operator adjusts the solenoid duty cycle - this has no effect on spray patterns or droplet size. An 8-fold reduction in flow rate can be achieved - essentially, an 8008 tip can deliver flow rates as low as an 8001 tip. To change droplet size, the operator changes pressure - the duty cycle of the solenoid adjusts so that the original travel speed and carrier volume are maintained. Because of electronic control, these nozzles are well suited to incorporation into GPS systems. Available from Ramboc.

Spraying Systems AirJet: "Twin-fluid" nozzles use a mixture of air and liquid to control droplet size and carrier volume. Air is supplied to the nozzle by a compressor at a rate up to 2.5 ft³/min, and mixes with the spray liquid inside the nozzle body. Both air and liquid exit through a flooding tip. Separate adjustment of air and liquid pressures gives control over volume rate and droplet size. At a single carrier volume, these nozzles can emit a range of spray qualities, selectable from the sprayer cab without changing nozzles. This system is not yet widely available.

Adjuvants: Low-drift adjuvants increase the viscosity of the spray liquid, resulting in coarser spray qualities from standard nozzles. Some low-drift adjuvants degrade under pump shear stress, and may not mix easily in the tank. These products can also modify spray patterns, so care must be taken prior to their use.

B. Spray Drift Measurement

Spray drift studies were carried out using two field methods:

Method A: Rotorod air samplers captured airborne off-target drift 5 m downwind of the sprayed swath. Spraying Systems Extended Range (XR8002 and XR11002) and Drift Guard (DG8002 and DG11002) were tested at 275 kPa and 100 L/ha over a range of wind speeds using a conventional 13 m wide tractor-drawn sprayer.

Method B: Roundup was applied to a barley cover crop at 440 g a.i./ha using 50 and 100 L/ha at speeds of 8 and 16 km/h. XR and TurboDrop tips were used at 275 kPa. A 20 km/h crosswind carried drift into an untreated strip. Drift damage in this strip was quantified with biomass samples.

C. Product Effectiveness

Roundup and Liberty were applied to 25 cm tall oat plants using five application methods, each at 100 L/ha:

- XR8002 tips at 275 kPa;
- TT11002 tips at 275 kPa;
- TD110015 tips at 400 kPa;
- AirJet (twin fluid) at 180 kPa liquid and 70 kPa air pressure;
- XR8002 with low drift adjuvant (AgRhô DR2000) at 1 g/L.

Herbicide effectiveness was assessed with visual ratings (0-9, where 0 = no effect and 9 = total control) when treatment differences appeared most pronounced.

Results

A. Spray Drift

- Spray drift losses were linearly related to wind speed (Figure 1; Table 1);
- Airborne drift at a 20 km/h wind ranged from 1.1 to 4.4% (Table 1);
- 110° fan angle tips drifted 26 to 50% more than their 80° counterparts;
- DG8002 tips drifted less than any other tip tested, reducing drift by 70 % from the XR8002;

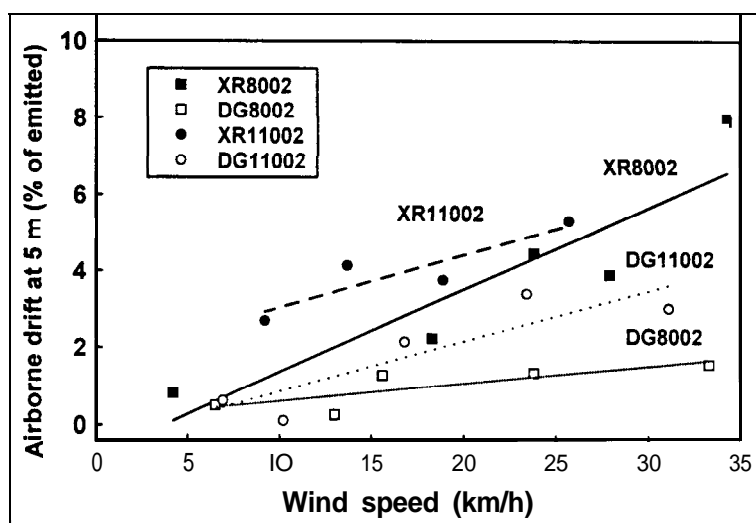


Fig. 1: Relationship between wind speed and airborne drift for four spray tips, each applying 100 L/ha

- DG11002 tips reduced drift by 50% from the XR11002 tips;
- Drift reductions were related to the droplet size spectrum emitted by the tips (data not shown).

Table 1: Regression parameters relating airborne spray drift (dependent variable) to wind speed (independent variable), as represented in Figure 1.

Nozzle Tip	Intercept (a)	Slope (b)	Correlation Coefficient (r)	Airborne drift at (km/b)		% of (XR8002) at 20 km/b
				10	20	
XR8002	-0.78	0.21	0.91	1.4	3.5	100
DG8002	0.15	0.05	0.83	0.6	1.1	31
XR11002	1.66	0.14	0.90	3.0	4.4	126
DG11002	-0.46	1.32	0.89	0.9	2.2	63

- The 110” venturi nozzles had narrower spray patterns than their 110” conventional counterparts, likely due to a pressure drop within the nozzle. Spray patterns remained acceptable, but should be checked carefully prior to operation and boom height set accordingly.
- Both the conventional flat fan and venturi nozzles provided good barley control with Roundup (Figure 2).
- Off-target damage was minimized with the venturi nozzles compared to the conventional flat fans.
- No direct drift comparison was made between venturi and other low-drift nozzle types. However, preliminary droplet size analysis suggest that drift-prone droplets are more effectively reduced from venturi tips than from pre-orifice or Turbo TeeJet tips.

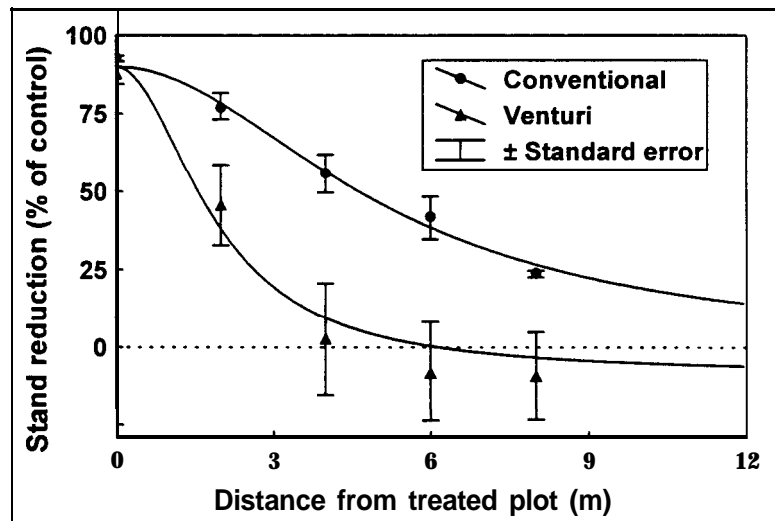


Fig. 2: Off-target Roundup damage with conventional flat fan tips (XR8004 at 275 kPa, 100 L/ha) and venturi tips (TD1 1004 at 275 kPa, 100 L/ha).

B. Product Effectiveness

- Overall weed control was better with Roundup than Liberty (Fig. 3, Fig. 4);
- All low drift nozzles provided equivalent weed control to the standard tip for both herbicides;
- The low-drift adjuvant (DR2000) enhanced Roundup effectiveness compared to the other treatments, an effect not observed with Liberty;

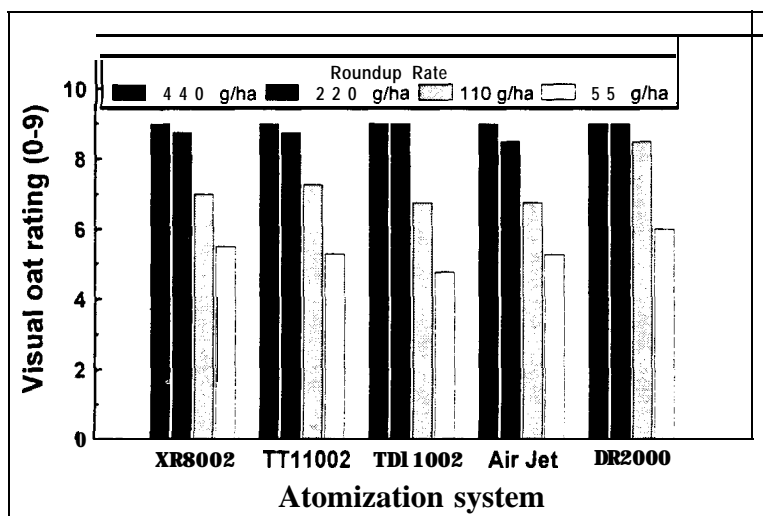


Fig. 3: Oat control with Roundup using various low-drift delivery systems.

Conclusions

- Applicators have several new, viable options for drift management;
- Pre-orifice tips reduced drift by 50 to 70% from conventional flat fans.
- 80° fan angles drifted less than 110" angles for both tip types. Venturi tips were highly effective at drift reduction;
- Initial results indicate that herbicides applied with low-drift sprays can be as effective as those applied with conventional sprays.
- To facilitate technology adoption, additional efficacy data are required, and these options should be identified on product labels and provincial guidelines.

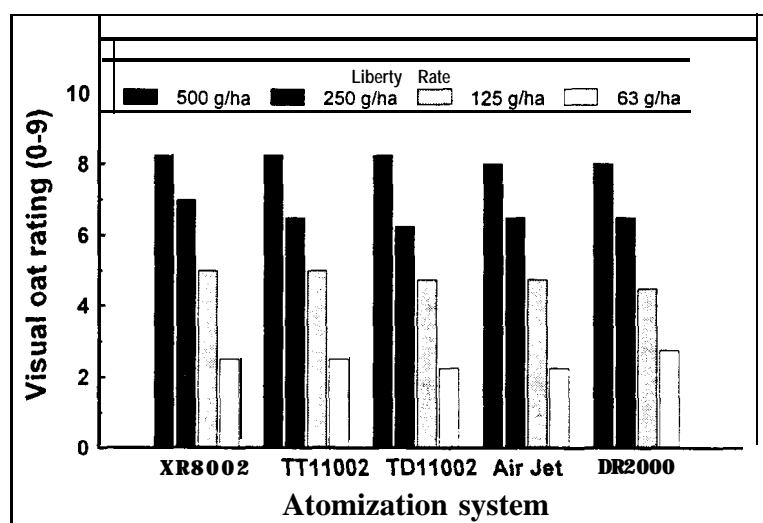


Fig. 4: Oat control with Liberty using various low-drift delivery systems.

Acknowledgments

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