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Spray Application Methods to Maximize Sclerotinia Control in Canola with Foliar Fungicide

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Final Project Report

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Abstract:

Sprays of Ronilan and Benlate were applied to canola with 4 application methods to determine the impact of nozzle type and pressure on sclerotinia stem rot suppression of canola. Both fungicides were highly effective, reducing stem rot in treated plots and increasing yield over the unsprayed check in two of three years. Variation in product performance among years indicated that environmental conditions have a major effect on the disease and subsequent yield loss. Overall, conventional flat fan nozzles (TeeJet XR) and low-drift venturi nozzles (Greenleaf TurboDrop) were equally effective at reducing disease. Both 40 and 80 psi provided similar performance although increasing the venturi nozzle pressure to 80 psi improved disease control and yield slightly. Investigation of spray retention showed that the majority (88%) of spray was intercepted by the top third of the canola canopy for all application systems. Flowers and buds retained nearly 20% of the total applied spray dose, and this amount was increased when pressure was increased. Stems retained a very minor proportion of the applied dose. Coarser sprays delivered more of their dose in the target area, but had lower retention values on flowers and buds than the finer sprays. These results indicate that venturi nozzle technology is appropriate for use with foliar fungicides for sclerotinia control in canola provided pressures are adjusted to optimize nozzle performance.

Background and Objectives:

Sclerotinia stem rot of canola caused by *Sclerotinia sclerotiorum* (Lib.) de Bary has long been a potential threat to canola production in the Parkland (Vanterpool 1957). Disease management consists of crop rotation and application of foliar fungicides at flowering. However the sclerotia produced by the pathogen survive for many years in soil, which limits the effectiveness of crop rotations of even 4 years (Morrall and Dueck 1982). Effectiveness of rotation is also limited because of the pathogen's ability to disperse air-borne inoculum. The introduction of other sclerotinia susceptible broadleaf crops in the rotation such as pulses and forage legumes further increases the risk of epidemic development. Resistant cultivars are not yet available, which leaves fungicide application as the most important control method for most producers.

Spray nozzle design has undergone significant advances over the past two years. Most notably, venturi nozzle technology is rapidly being adopted as a means of improving deposition of sprays under windy conditions. Custom applicators are leading users of the technology, and many are considering wholesale switches to these new nozzles for all their applications, including fungicides. Although spray drift has historically not been considered a major concern for fungicides, the advantages of improving on-target deposition under a wider window of application can improve the timeliness and effectiveness of the spray application.

In order to achieve effective disease control and maximum economic benefit from fungicide application, growers need to know the impact that application equipment has on various control products. With this goal in mind a study was undertaken at Melfort Research Farm in 1998 to 2000. The objectives were to determine the effect of low-drift nozzle technology on foliar fungicide application, to compare effectiveness of the products benomyl (Benlate) and vinclozolin (Ronilan) on disease suppression and to determine if there are interactions among application methods and products. In addition, the spray deposition of application methods was compared under lab conditions.

Experimental Method:

Field Trials: Five experiments were conducted over 3 years at Melfort, SK on Melfort silty-clay loam soil in fields where risk of stem rot infection was expected to be high. Experiments were conducted at Site 1 in 1998 to 2000, which had a history of hay and cereal production. Additional experiments were conducted at Site 2 in 1999 and 2000. This field had been previously cropped to cereals but had high levels of nitrogen due to manure application in previous years. Canola was direct-seeded into wheat stubble in each experiment, except for Site 2 in 1999, which was seeded into canola stubble. Details of the field operations are summarized in Table 1. Recommended fertilizer rates based on soil tests were applied at seeding, and weed control was obtained with applications of glyphosate (Roundup) on cv. Quest and glufosinate-ammonium (Liberty) on cv. Exceed. Benlate (benomyl) and Ronilan (vinclozolin) fungicides were applied to the canola crop at the 20-30% bloom stage of flowering each year using a Melroe Spra-Coupe 220 (Figure 1).

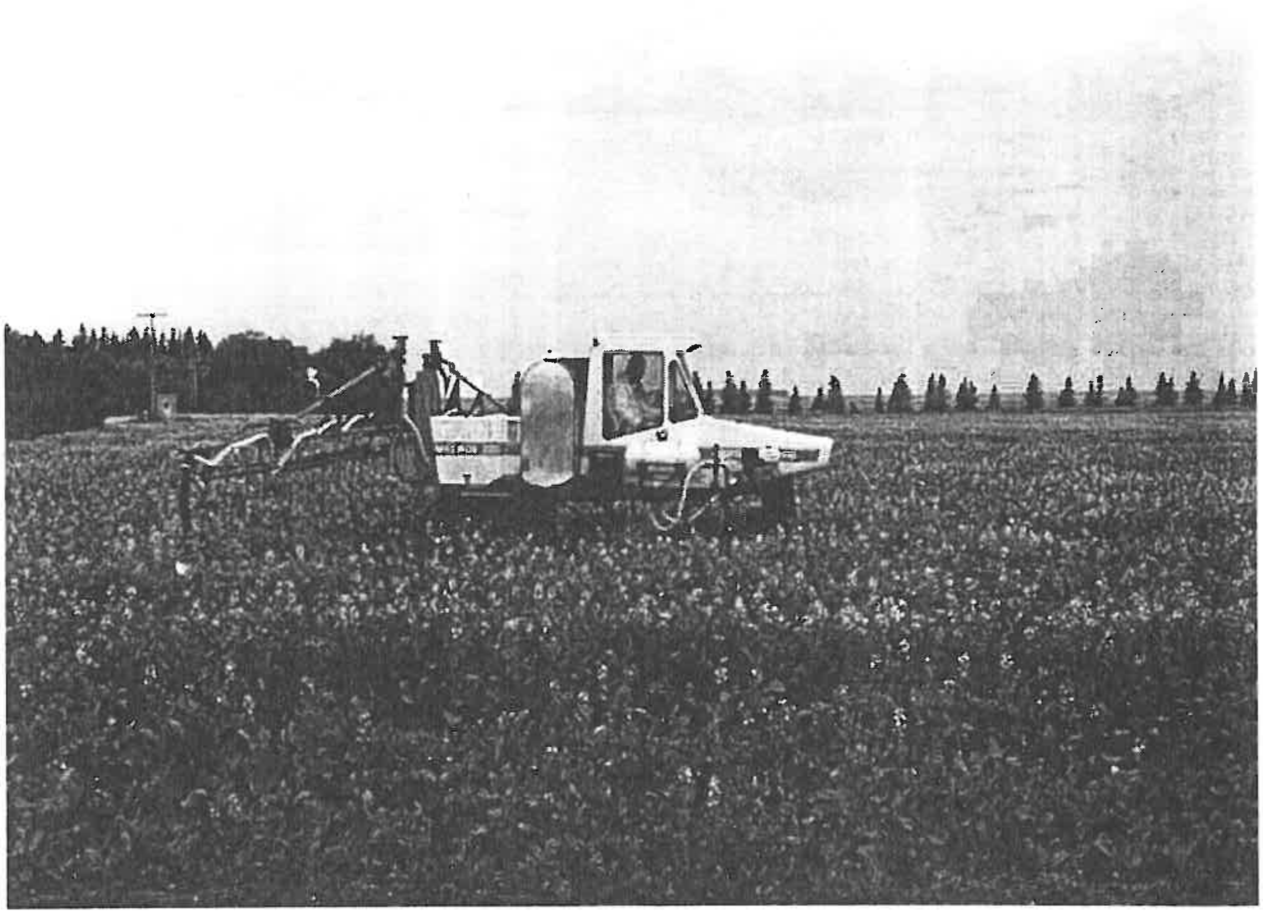


Figure 1. Melroe Spra Coupe 220 used in field study.

Both products were applied at 1.0 kg. ai./ha except in 1998 when Ronilan was applied at 0.75 kg. ai./ha. Spray treatments were applied at 100 L/ha using hollow cone, conventional flat fan, and venturi-type flat fan nozzles (Table 2). Plot size was 10 m wide by 25 m deep arranged in a split plot design on a 2.2 ha site. Main plots were fungicide treatments and sub-plots were application methods. Sclerotinia stem rot incidence (percentage of plants infected) and severity (Table 2) was assessed in 250 plant samples per treatment shortly before swathing (growth stage 5.0 to 5.2; Harper and Berkenkamp 1975). Plots were swathed and then combined with a Massey 550.

TeeJet TXVS-8 nozzles are hollow cone types, which produce an ASAE "Fine" spray at 85 psi. These are expected to provide the best coverage due to the small droplet size, but can have problems with poor patterns, spray drift and rapid evaporation. TeeJet XR8002 and XR80015 are "Extended Range" flat fan nozzles commonly used for spray application of the majority of pesticides in Canada. At 40 psi, XR8002 tips produce a "Medium" spray quality, whereas at 80 psi, XR80015 tips produce a "Fine" spray quality. Greenleaf TurboDrop TD11002 and TD110015 are venturi nozzles that emit a "Very Coarse" spray, even at higher pressures (Figure 2). This spray is noted for its extreme drift resistance, but little is known about impacts on fungicide efficacy.

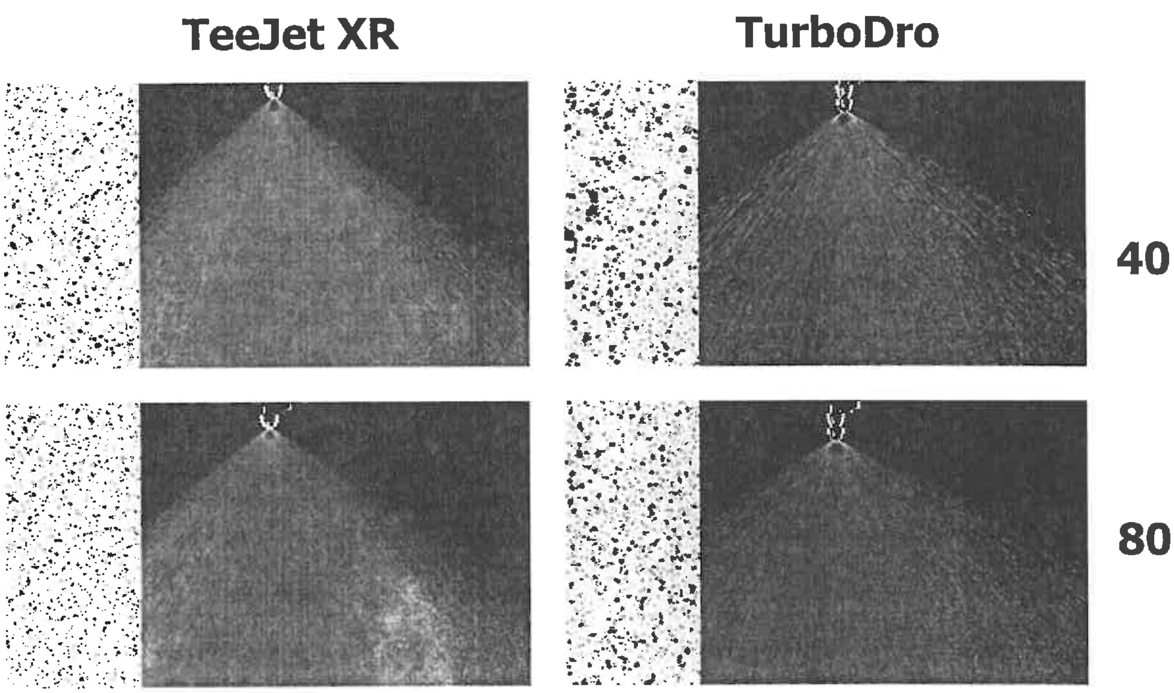


Figure 2. Flat fan sprays used in field and lab study (Hollow cone not depicted).

All nozzles were calibrated prior to spraying. Output from each nozzle was captured in a graduated cylinder for 30 seconds, and any nozzle whose output deviated more than 5% from the mean was replaced. Since nozzles from various manufacturers often vary slightly in output at the same pressure, maintaining a constant application volume necessitates travel speed adjustments. Adjustments of less than 1 km/h can not be done accurately under field conditions, therefore it was decided to adjust spray pressure slightly for each application system so that sprayer output became identical for all treatments. In this way, travel speed could be maintained at a constant value for all nozzles (Table 3).

Table 1. Cultivars, seeding rates and dates of seeding and harvest operations.

	1998	1999 Site 1	1999 Site 2	2000 Site 1	2000 Site 2
Cultivar	Quest	Quest	Exceed	Quest	Quest
Seed rate (kg/ha)	5.6	5.6	5.5	8.0	8.0
Seed date	May 10	May 19	May 24	May 15	May 15
Fungicide applic date	July 2	July 6	July 12	July 12	July 12
Stem rot assessment date	Aug 14	Aug 25	Sept 7	Aug 23	Aug 24
Swathing date	Aug 17	Sept 8	Sept 8	Aug 25	Aug 28
Combining date	Sept 2	Sept 22	Sept 22	Sept 14	Sept 14

Table 2. Sclerotinia stem rot severity assessment scale.

Disease Weighting	Symptoms
1.00	Main stem lesion affecting entire plant
0.75	Three or more major branches girdled (3/4 plant affected)
0.50	Two major branches girdled (1/2 plant affected)
0.25	One major branch girdled (1/4 plant affected)
0.10	A few pods infected
0	No symptoms

Assessments based on possible impact of an infection on yield. Lower stem lesions affect whole plant, plants with affected branches reduce total plant yield less than a main stem lesion and a few pod lesions have minimal impact on total plant yield (depending on the number of pods affected). Stem rot severity determined by recording the number of plants in each category, multiplying by the weighting and dividing by total number of plants rated multiplied by a weighting of 1. This value was changed to a percent and multiplied by 0.5 to give an expected yield loss value based on the 'rule of thumb' that 50% yield loss can be expected from each infected plant.

Table 3. Treatment list for fungicide application experiments

Nozzle	Pressure (psi)	Fungicide	Volume (L/ha)	Travel speed (km/h)
TeeJet TXVS-8	85	Benlate	100	9.0
TeeJet XR8002	40	Benlate	100	9.0
Greenleaf TD11002	46	Benlate	100	9.0
TeeJet XR80015	72	Benlate	100	9.0
Greenleaf TD110015	76	Benlate	100	9.0
TeeJet TXVS-8	85	Ronilan	100	9.0
TeeJet XR8002	40	Ronilan	100	9.0
Greenleaf TD11002	46	Ronilan	100	9.0
TeeJet XR80015	72	Ronilan	100	9.0
Greenleaf TD110015	76	Ronilan	100	9.0

Lab Trials: Canola plants were spayed under lab conditions to determine the effect of application method on spray retention by the plant. Canola was grown to the 20 to 30% flowering stage in 6-inch pots under greenhouse conditions. Potted plants were transferred to a track room for spray application. The track room, a facility which is 15 m long and 5 m wide, allows for the establishment of an entire plant canopy (i.e., a "mini-field") that can be sprayed with a 2.5-m wide boom at a range of pressures and travel speeds (up to 20 km/h, Figure 4). Nozzles, pressures, and travel speeds were set up as they had been for the field trials (Table 3). Forty canola plants were set up in a 8 x 5 matrix, simulating the field stand density. An individual target plant was placed into the middle of this stand, which was then sprayed with a mixture containing a surfactant (Agral 90) and a tracer dye (Rhodamine WT). The surfactant concentration was adjusted so the spray deposit on canola leaves (droplet size, spreading) matched that of a Benlate application from the same nozzle. In this way, Benlate did not need to be sprayed and handled by technical staff.

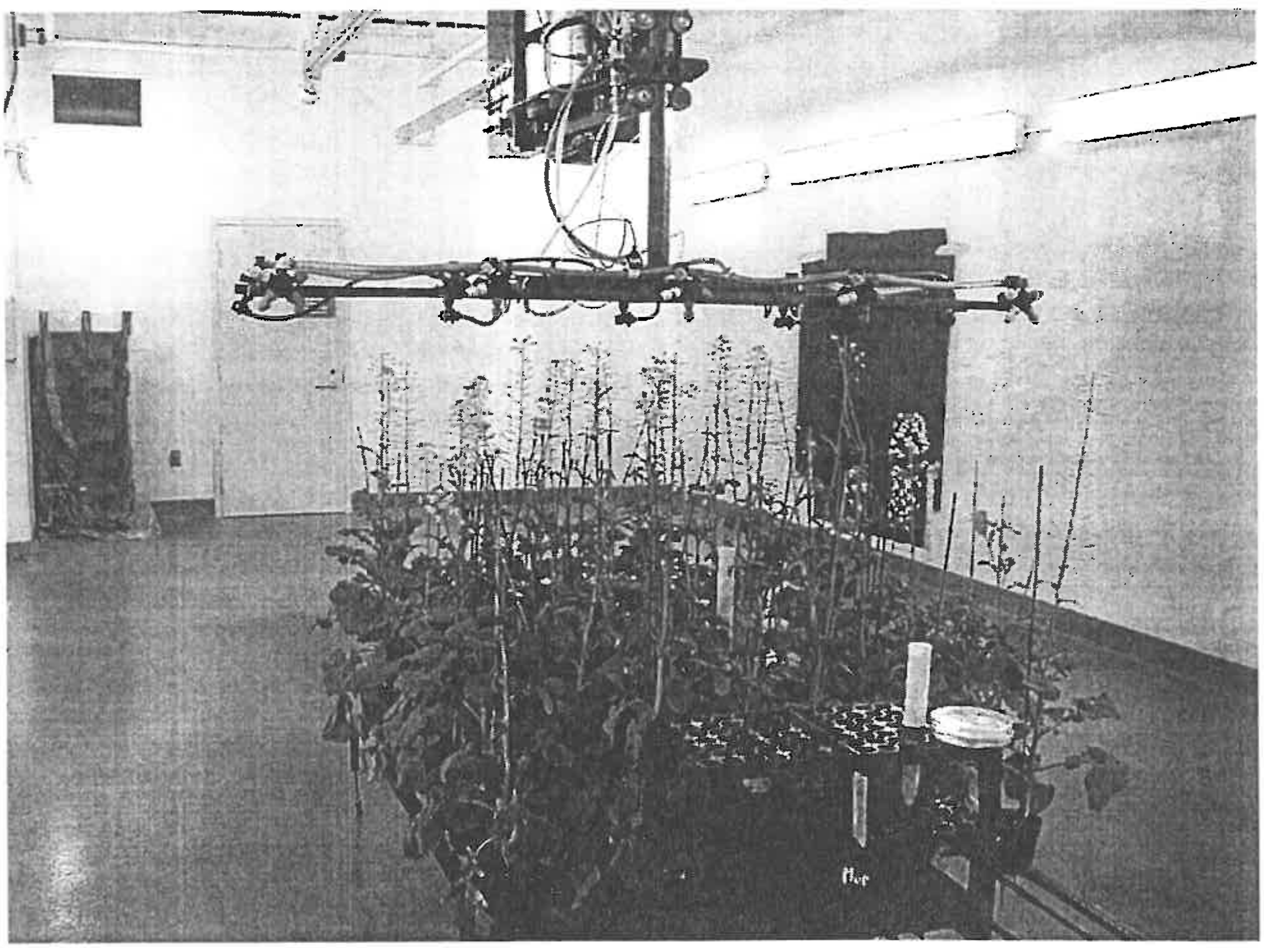


Figure 3. Boom setup in track room for deposition study.

Petri plates were placed in line with the target plant to determine total spray delivery to the plant region. This was done to account for spray displacement arising from a moving boom, which can be significantly greater for a finer than a coarser spray. Using the petri-plate data, the spray dose that was actually delivered to the plant could be calculated. The plant retention data was then normalized by this amount to make a fair comparison between application systems.

Immediately after spraying, the plant was carefully removed from the canopy, and brought into a work area where it was partitioned: first, the main plant stem was cut into three equal parts by height (top, middle, bottom, Figure 4). Second, each part was subdivided into components. For the top third, the components were unopened flower buds, flowers, leaves, and stems. For the middle and bottom third, leaves and stems were separated. Each component was placed in a container to which ethanol was added, capped, an agitated for 1 minute (Figure 5). After agitation, the ethanol was sub-sampled into 20 mL glass vials for analysis, and the plant parts were bagged and dried. The plant wash was analyzed for the dye using a fluorescence spectrophotometer. Spray capture was expressed as µL/g dry plant part weight.

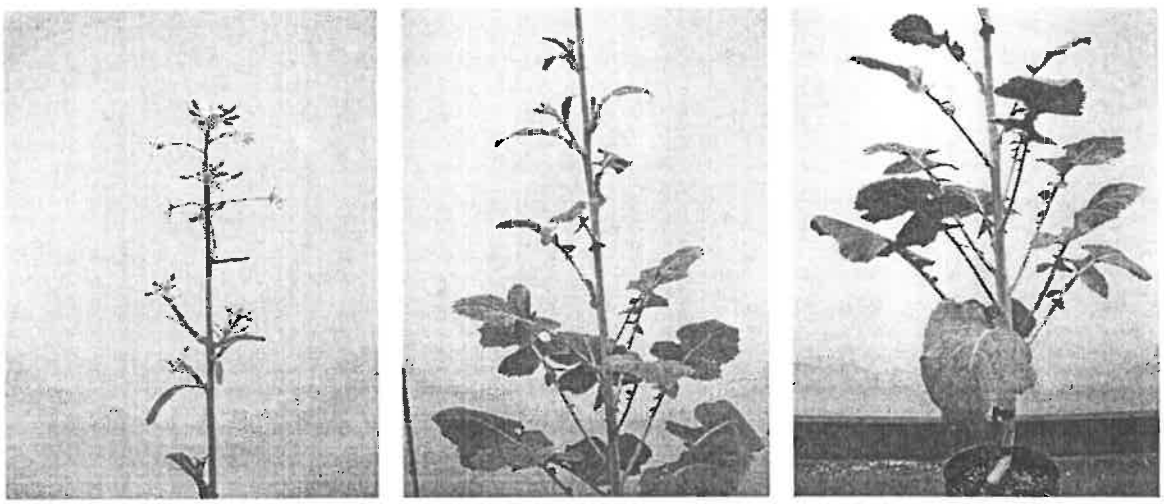
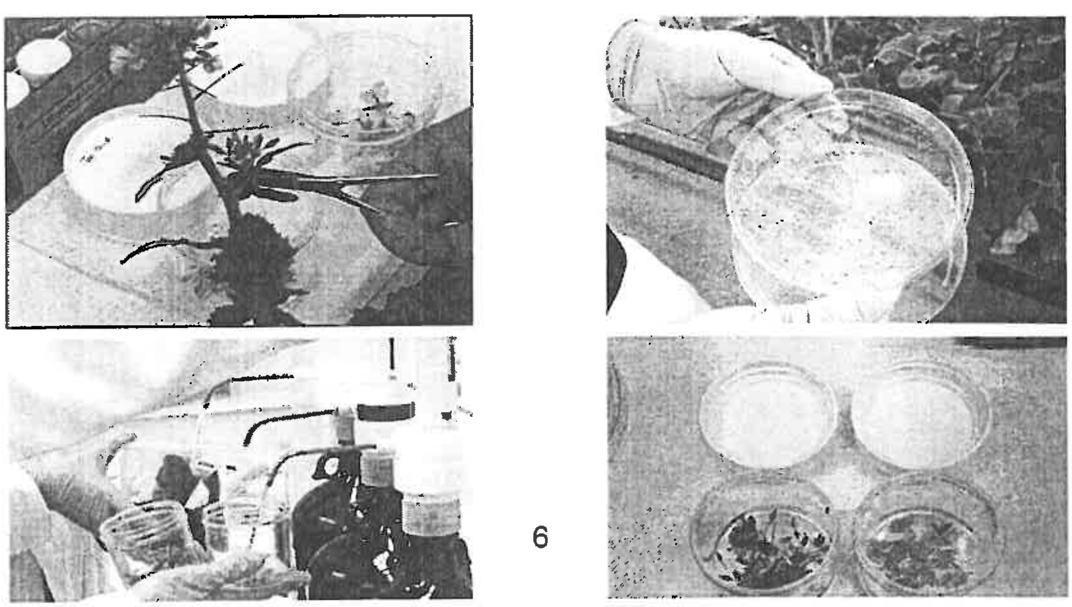


Figure 4. Canola plant partitions in lab study (top, middle, and bottom thirds of plant).

Figure 5. Spray retention methods used in lab study



Results and Discussion:

Field Trials: Sclerotinia stem rot was prevalent at Melfort in all three years of the study, in all experiments as indicated by the incidence of stem rot in the unsprayed controls which ranged from 30.6 to 55.1% of plants (Tables 4-8). Both Ronilan and Benlate were effective in reducing stem rot incidence and increasing yield from that of the control in 1998 and in both experiments in 2000 (Tables 4, 7 & 8; Figure 6). However stem rot incidence was not reduced or yield increased by fungicide application in either experiment in 1999 (Tables 5 & 6). Differences among years were attributed to variation in environmental conditions (Table 9). In 1998 all days with precipitation greater than 1.0 mm occurred in the first 3 weeks of July, which coincided with flowering of the crop. Warm dry conditions prevailed in the latter half of July and early August. These conditions put the crop at risk of stem rot infection in early flower, its most susceptible period. Application of fungicides at 20-30% bloom was very effective in reducing stem rot symptoms and increasing yield. The warm dry conditions in late July caused flowering to end somewhat prematurely, which reduced infection of the crop in late flower. In 1999 rainfall events were evenly spread with two events occurring per week in each of the first four weeks of July. This put the crop at risk of stem rot infection over a greater period than in 1998. Mean temperature during the flowering period in 1999 was much lower than in 1998 or 2000 causing the crop to flower an extra 7 to 10 days. These conditions increased the period of susceptibility of stem rot infection in 1999 compared to other years and was likely responsible for the lack of stem rot control and yield increase observed when fungicides were applied. In 2000, rainfall events occurred equally spaced throughout flowering and total precipitation was much greater than in previous years. Temperatures were similar to 1998 and warmer than in 1999 resulting in a flowering period of near normal length (21 days).

Quality of the harvested canola was also examined by evaluating the thousand kernel weight, bulk density and percentage green seed. Differences between Benlate and Ronilan were not observed in any experiment (Tables 4-8).

Table 4. Effect of application method and fungicide product on sclerotinia stem rot incidence, crop yield, thousand kernel weight (TKW), bushel weight (BW) and green seed at Melfort in 1998.

Treatment		N	Incidence (%)	Severity (%)	Yield (kg/ha)	TKW (grams)	BW (lbs)	Green seed (%)
Control								
Unsprayed		8	51.6	22.6	1730	2.97	54.4	0.75
Nozzle & Pressure								
XR8002	/ 40	8	3.9	1.6	2328	2.79	54.6	1.25
XR80015	/ 80	8	3.9	1.7	2265	2.83	54.5	0.63
TD 8002	/ 40	8	6.1	2.5	2215	2.86	54.8	0.38
TD 80015	/ 80	8	4.8	1.9	2352	2.73	54.7	0.63
$Lsd_{(0.05)}$			1.9	0.96	254	0.19	0.4	0.85
Fungicide								
Benlate		16	6.7	3.0	2308	2.82	54.6	0.81
Ronilan		16	2.6	0.9	2272	2.78	54.7	0.63
$Lsd_{(0.05)}$			6.4	2.45	582	0.12	0.7	1.85

There was no significant effect of application method on fungicide effectiveness. On the average, there was a trend to slightly less stem rot incidence and severity in plots treated with the XR tips than the TD treated plots at the same pressure (Figure 7). This slight nozzle effect depended on fungicide: for example, in 2000, Benlate performance was slightly better with XR nozzles, whereas Ronilan performance was slightly better with the TD nozzles (Figure 8). In all cases, increased spray pressure resulted in slightly less stem rot and sometimes marginally increased yield although differences were not statistically significant.

Table 5. Effect of application method and fungicide product on sclerotinia stem rot incidence, crop yield, thousand kernel weight (TKW), bushel weight (BW) and green seed on Quest canola on Site 1 at Melfort in 1999.

Treatment		N	Incidence (%)	Severity (%)	Yield (kg/ha)	TKW (grams)	BW (lbs)	Green seed (%)
Controls								
Unsprayed		8	30.6	4.9	1415	2.6	52.9	3.8
TXVS-8	/ 85	8	20.4	8.3	1314	2.7	52.8	2.9
Nozzle & Pressure								
XR8002	/ 40	8	26.3	6.8	1386	2.6	53.0	4.9
XR80015	/ 72	8	23.8	6.9	1320	2.6	52.9	4.0
TD 8002	/ 46	8	28.6	7.9	1368	2.6	53.1	3.3
TD 80015	/ 76	8	30.9	8.1	1433	2.7	52.8	5.1
$Lsd_{(0.05)}$			11.6	3.4	201	0.1	0.3	2.1
Fungicide								
Benlate		16	26.5	7.6	1359	2.6	53.0	4.9
Ronilan		16	28.3	7.2	1394	2.6	52.9	3.7
$Lsd_{(0.05)}$			10.6	3.6	571	0.1	0.3	2.6

Table 6. Effect of application method and fungicide product on sclerotinia stem rot incidence, crop yield, thousand kernel weight (TKW), bushel weight (BW) and green seed on Exceed canola on Site 2 at Melfort in 1999.

Treatment		N	Incidence (%)	Severity (%)	Yield (kg/ha)	TKW (grams)	BW (lbs)	Green seed (%)
Controls								
Unsprayed		8	55.1	25.6	1348	3.3	51.6	5.6
TXVS-8	/ 85	8	62.2	29.4	1275	3.2	51.2	6.9
Nozzle & Pressure								
XR8002	/ 40	8	57.3	26.3	1365	3.3	51.7	6.1
XR80015	/ 72	8	59.1	28.0	1478	3.2	51.7	6.4
TD 8002	/ 46	8	66.5	31.0	1339	3.1	52.0	6.8
TD 80015	/ 76	8	61.6	28.2	1435	3.3	51.6	6.9
$Lsd_{(0.05)}$			8.1	3.9	135	0.2	0.7	2.6
Fungicide								
Benlate		16	62.7	29.2	1387	3.2	51.7	6.3
Ronilan		16	59.5	27.5	1422	3.2	51.8	6.8
$Lsd_{(0.05)}$			12.2	8.2	261	0.2	0.9	3.4

Table 7. Effect of application method and fungicide product on sclerotinia stem rot incidence, crop yield, thousand kernel weight (TKW), bushel weight (BW) and green seed on Quest canola on Site 1 at Melfort in 2000.

Treatment		N	Incidence (%)	Severity (%)	Yield (kg/ha)	TKW (grams)	BW (kg/hl)	Green seed
Controls								
Unsprayed		8	50.8	22.6	1500	2.8	67.7	1.8
TXVS-8	/ 85	8	14.1	5.2	1746	2.7	67.6	1.6
Nozzle & Pressure								
XR8002	/ 40	8	16.8	6.2	1775	2.8	67.7	1.8
XR80015	/ 72	8	13.3	4.6	1722	2.7	67.9	2.5
TD 8002	/ 46	8	21.0	8.1	1725	2.7	67.7	3.1
TD 80015	/ 76	8	16.8	6.1	1625	2.8	67.8	2.6
$Lsd_{(0.05)}$			8.1	2.9	226	0.2	0.4	2.2
Fungicide								
Benlate		16	19.6	7.6	1654	2.8	67.8	2.4
Ronilan		16	14.3	5.0	1770	2.7	67.7	2.6
$Lsd_{(0.05)}$			25.0	10.7	240	0.2	0.4	1.4

Table 8. Effect of application method and fungicide product on sclerotinia stem rot incidence, crop yield, thousand kernel weight (TKW), bushel weight (BW) and green seed on Quest canola on Site 2 at Melfort in 2000.

Treatment		N	Incidence (%)	Severity (%)	Yield (kg/ha)	TKW (grams)	BW (kg/hl)	Green seed (%)
Controls								
Unsprayed		8	40.8	18.9	1548	2.7	68.0	2.1
TXVS-8	/ 85	8	13.4	5.6	1929	2.6	68.4	2.4
Nozzle & Pressure								
XR8002	/ 40	8	15.2	6.5	1948	2.7	68.4	2.1
XR80015	/ 72	8	11.0	4.5	2067	2.7	68.1	2.5
TD 8002	/ 46	8	16.0	7.0	1743	2.7	68.1	2.8
TD 80015	/ 76	8	14.0	6.1	1914	2.7	68.1	2.1
$Lsd_{(0.05)}$			7.6	3.3	279	0.1	0.4	1.7
Fungicide								
Benlate		16	18.3	8.5	1817	2.7	68.1	2.4
Ronilan		16	9.8	3.5	2019	2.7	68.2	2.3

$Lsd_{(0.05)}$	13.6	5.6	314	0.2	0.9	2.9

Table 9. Number of days of precipitation, total precipitation and average (minimum and maximum daily) temperature from July 1 to August 4 at Melfort, SK for the years 1998 to 2000.

	1998	1999	2000
Number of days precipitation > 1.0 mm	9	8	11
Total precipitation (mm)	43	58	125
Mean temperature (°C)	18.3	15.5	17.7

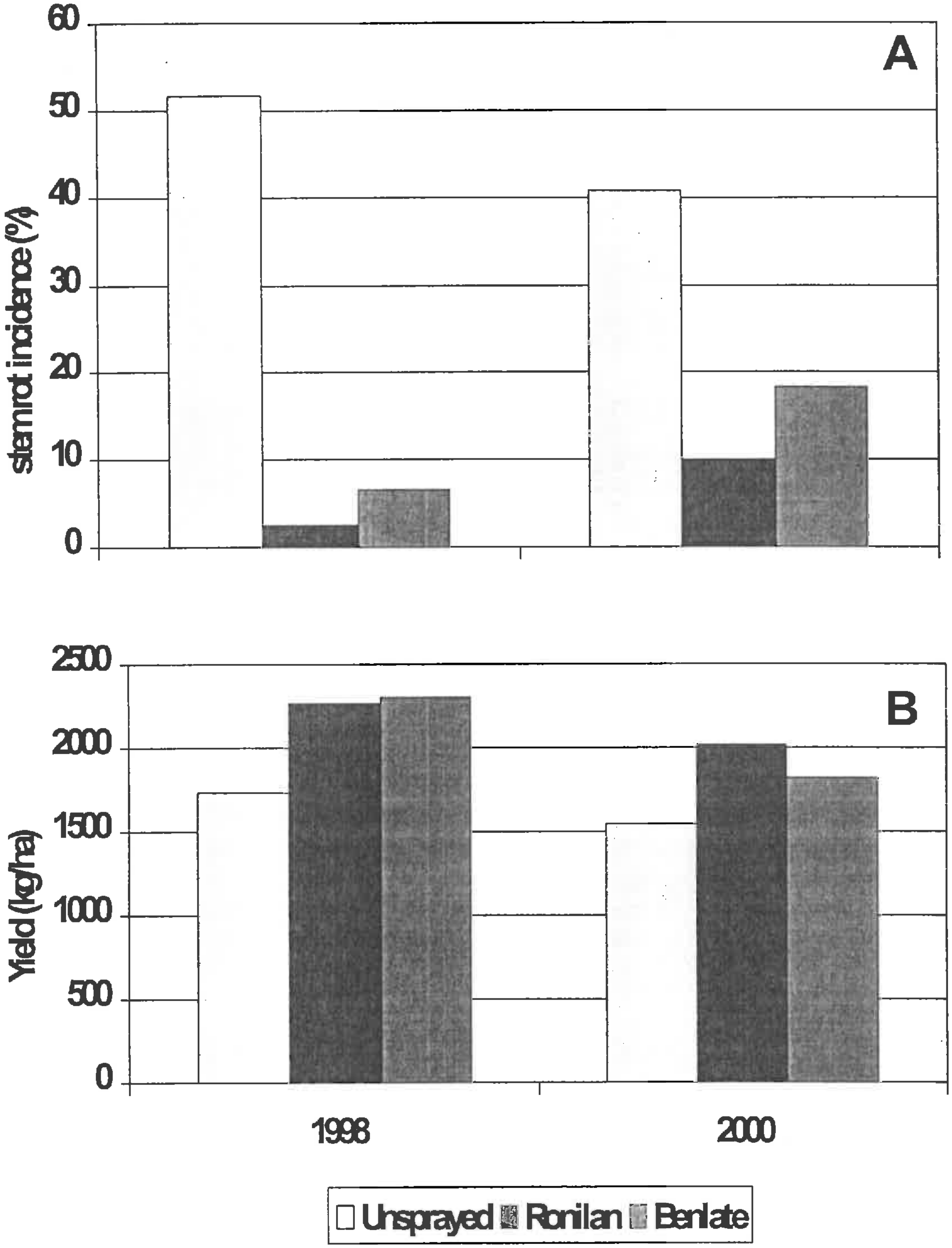


Figure 6. Effect of Ronilan and Benlate fungicides on: A - sclerotinia stem rot incidence (% of plants infected) and B - yield (kg/ha) of Quest canola at Melfort, SK in 1998 and 2000.

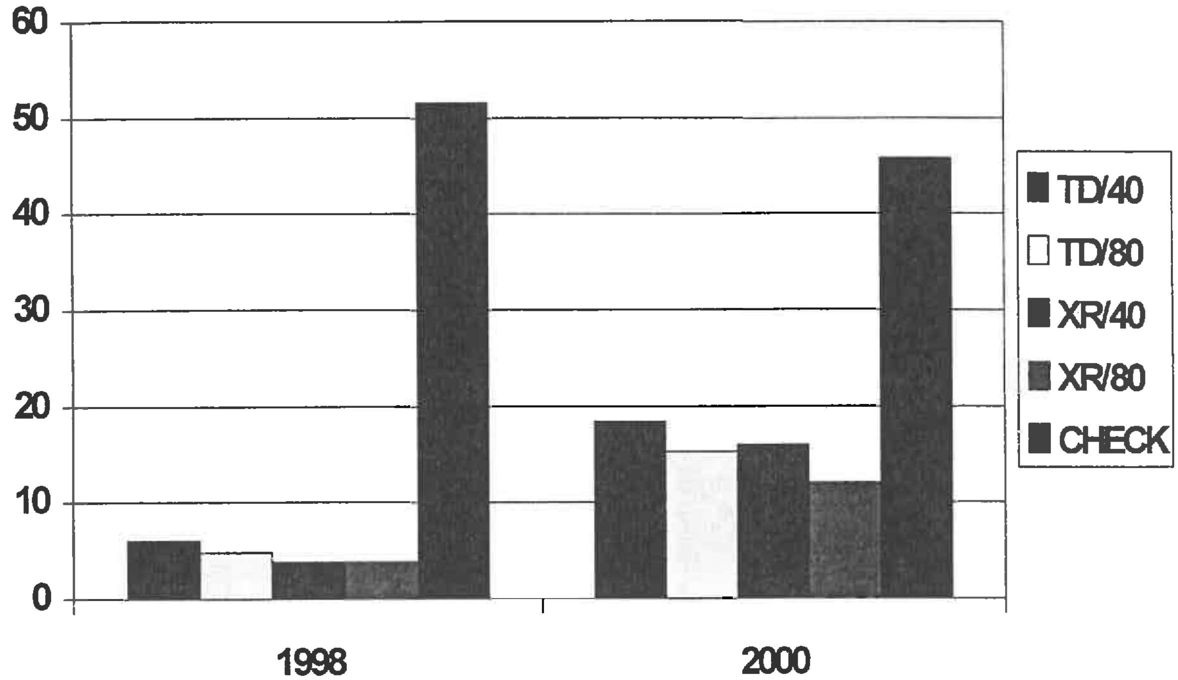


Figure 7. Sclerotinia stem rot incidence (% of plants infected) for Greenleaf TurboDrop venturi (TD) and conventional (XR) sprayer nozzles at 40 and 80 psi at Melfort, SK.

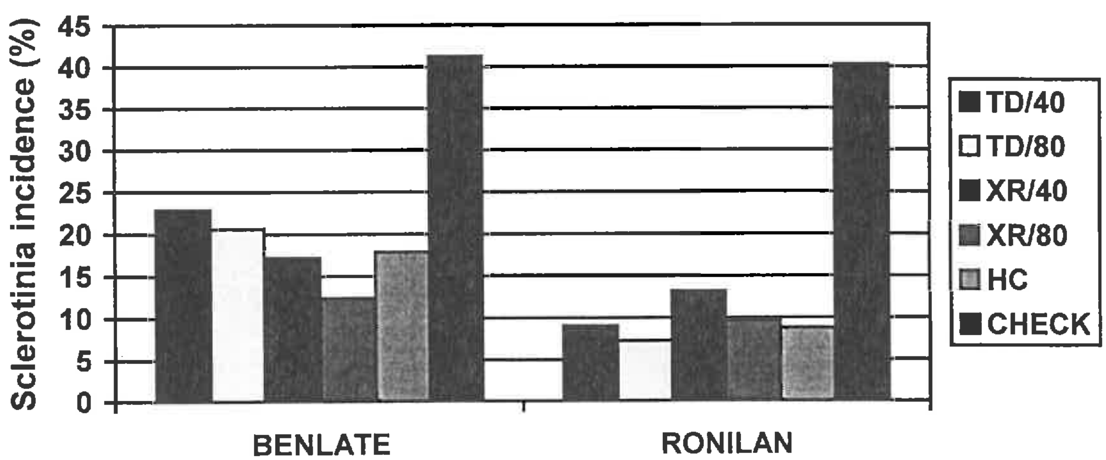


Figure 8. Sclerotinia stem rot incidence Benlate and Ronilan with five application methods at Melfort, SK in 2000.

Lab Trial: Spray retention data showed that at the site of application, all nozzles deviated significantly from their calibrated output of 100 L/ha (Table 10). In particular the fine hollow cone spray (TX-VS) had low deposition values (40 L/ha) on the petri plates compared to the coarser sprays. The low-drift sprays had the highest deposit values (73 to 78 L/ha). Deviations from intended output are not uncommon during a spraying operation, and these effects are likely due to redistribution of the spray cloud with a moving boom. Larger droplets resist such displacement and provide more accurate targeting to the canopy. In addition, a petri plate is a good collector of larger droplets, but a poor collector of small droplets, which tend to resist capture by large horizontal targets. To compare nozzles fairly, these values were taken into account and all subsequent retention values were expressed as a proportion of the delivered (petri plate) amount.

The effect of application method was more likely to be significant in the top of the plant canopy compared to the bottom. At the top of the canopy, application method had a significant effect on bud (p=0.025), flower (p=0.049), and leaf (p=0.049) deposits. The coarser sprays typically provided lower deposits than the finer sprays, although the finer deposits were typically more variable.

In the middle of the canopy, spray deposits were much lower than those at the top of the canopy (one tenth of the top canopy values). Although stem deposits were very low overall, nearly twice as much could be deposited using a finer spray than coarser sprays (p=0.014).

In the lower canopy, deposits were marginally lower than they had been in the middle canopy. No significant effects of application method were detected.

Taken on the whole, sprays were partitioned in a similar fashion for all application methods (Figure 9). The majority of the total spray was recovered from leaves for all sprays. Stems contributed the least to the spray deposit. A surprisingly large proportion of the total spray dosage was recovered from the flower petals and buds (11-14% and 7%, respectively). Application systems did not differ in this respect. Even the coarser sprays were effectively retained by these plant structures.

Table 10. Mean spray retention (µL/g dry weight, adjusted with petri plate contents, ± standard deviation) on various canola plant parts, in response to application method. *, **, and ns denote application method effects that are significant at 5%, 1%, and not significant, respectively.

			Location								
	Pressure		Top				Middle		Lower		Total
Nozzle	(psi)	Petri **	Bud *	Flower *	Stem *	Leaf ns	Stem *	Leaf ns	Stem ns	Leaf ns	All ns
TX-VS	85	40 ± 8	31 ± 7	249 ± 94	9 ± 8	104 ± 19	0.6 ± 0.2	24 ± 25	0.5 ± 0.4	12 ± 7	0.5 ± 0.2
XR8002	40	67 ± 4	24 ± 4	266 ± 31	4 ± .7	91 ± 24	0.4 ± 0.1	13 ± 4	0.5 ± 0.3	10 ± 2	0.3 ± 0.1
TD02	46	73 ± 12	15 ± 3	167 ± 37	3 ± 1	57 ± 8	0.3 ± 0.1	10 ± 7	0.3 ± 0.1	7 ± 0.4	0.3 ± 0.1
XR80015	72	57 ± 30	30 ± 12	274 ± 56	4 ± 1	145 ± 59	0.7 ± 0.2	12 ± 5	0.4 ± 0.3	8 ± 2	0.4 ± 0.4
TD015	76	78 ± 20	20 ± 3	178 ± 50	4 ± 2	77 ± 51	0.3 ± 0.1	10 ± 3	0.3 ± 0.1	7 ± 2	0.3 ± 0.2

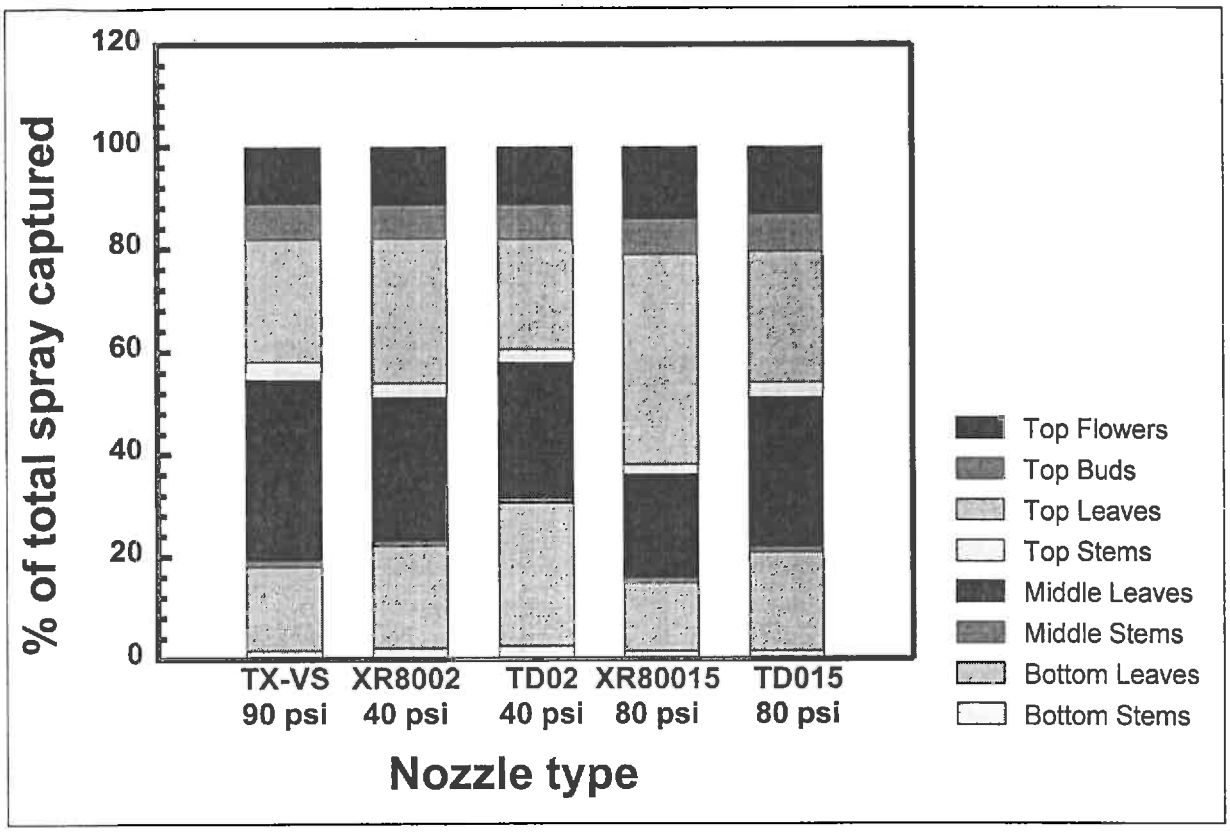


Figure 9. Mass Balance of spray deposited on canola plant parts (% of total spray retained).

Impact:

Results from this study indicate that the products Benlate and Ronilan were equally effective in the control of sclerotinia stem rot and the protection of yield. Low-drift nozzle technology was appropriate and as effective as conventional nozzles for stem rot control although spray pressure should be increased from 40 psi to 80 to optimize performance. Neither product or application method improved thousand-kernel weight, bushel weight or % green seed over the unsprayed check.

Spray retention was affected by application method, particularly in the top third of the canopy. Finer sprays had slightly higher retention values on buds, flowers, and stems in this part of the plant. The top third retained 88% of the total spray that was captured by the plant, with the mid- and lower regions of the canopy together capturing the remaining 12%. Coarser sprays had similar distribution patterns of total retained spray dosage as the finer sprays.

Applicators seeking low-drift spray technology to protect non-target areas and extend their window of application with respect to wind can be advised to use coarse sprays such as those in this study. Additional information on these nozzles can be obtained from the fact sheet "Making Sense of New Nozzle Choices", available at provincial extension agrologist offices.

Acknowledgments

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MAKING SENSE
of New Nozzle Choices

Introduction

Spray drift is becoming an increasingly important aspect of every spray operation. With greater diversification of crops, more highly active or non-selective herbicides, and a greater awareness of pesticides in the environment, spray drift management has become everybody's business. Nozzles can play an important role in drift management. They are inexpensive but could be the most important sprayer components because the range of droplet sizes in a spray determines how effective the spray deposit is, and how much spray will drift.

Figure 1: Conventional spray at 40 psi

Whether or not a low-drift nozzle has a fit on your farm depends on how you currently spray. Most applicators are under time pressure, and struggle to achieve the correct staging under typical weather conditions. Some have had a drift complaint, and want to avoid future problems. Many need to protect sensitive areas down-wind, including shelterbelts or neighbouring fields. For those, and others, low drift spray methods provide an important option that can mean the difference between spraying in a timely manner or causing drift damage.

Figure 2: Venturi nozzle spray at 70 psi

Are Low-Drift Nozzles for You?

- Struggle to get spraying done
- Have had drift complaint
- Have diversified farm
- Worry about environment, exposure
- Farm near urban areas

Since there are more nozzle types on the market now than ever before, applicators may have trouble deciding which nozzle best fits their needs. This fact sheet summarizes the main characteristics of major low-drift nozzles, and shows each nozzle overlayed on the image of the spray deposit produced by that nozzle. Deposit images were produced using water volumes of 40 L/acre (9 gal./acre) for all nozzles. For XR, DG, and TT tips, pressure was approximately 35 psi at a standard flow rate designation of 02 (0.2 US gal./min. or 0.75 L/min.). For the venturi tips, pressure was approximately 60 psi at a standard flow rate designation of 015 (0.15 US gal./min. or 0.56 L/min.). Standard flow rates are established at 40 psi. Quoted prices are approximate, per nozzle tip.

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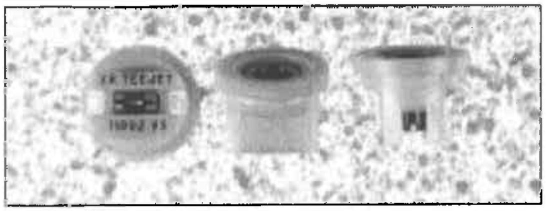
Conventional Nozzles

Extended Range Flat Fan:



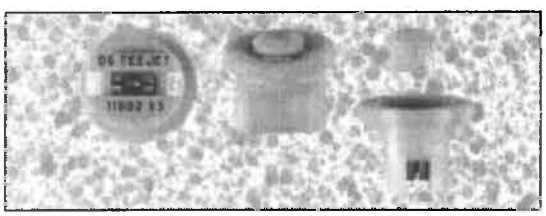
Technology: Standard nozzle currently used for pesticide application in western Canada. Available in a wide range of sizes and fan angles to fit most application needs. Nozzles with an 80° angle pattern produce coarser droplets than those that produce a 110° angle at the same flow rate. Minimum effective height of 80° tips is 18" above the target, whereas 110° tips can be operated at 14".

Pressure / Spray Quality: Spray quality is Fine to Medium. Produces a uniform spray pattern between 15 to 60 psi. Lower pressures and higher flow rates produce coarser spray that reduces drift. Optimum pressure is 40 psi.

Price: Costs between $5.00 and $6.00 for TeeJet (e.g. XR8002) or ComboJet (e.g. ER 80-02) or $1.57 for Lurmark (e.g. 02 F 80) and are widely available from a variety of suppliers.

Pros / Cons: Main drawback of these nozzles is that they are very prone to drift at higher pressures and in the smaller sizes.

Pre-Orifice Flat Fan:



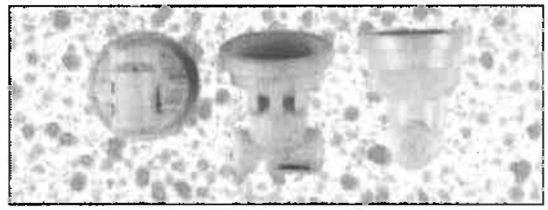
Technology: A pre-orifice reduces the internal operating pressure of a standard tip, producing a coarser spray at standard pressures. The pressure gauge on the sprayer reads the external pressure, but the pressure drop in the nozzle body reduces the amount of fine droplets exiting the spray tip. Sizes range from 80015 to 8005 - also available in 110 ° angles.

Pressure / Spray Quality: Spray quality: Medium to Coarse. Narrower pressure range compared to a conventional flat fan tip - pressures should not drop below 30 psi nor exceed 60 psi. Optimum pressure is 40 psi.

Price: Costs $7.75 for TeeJet (Drift Guard, e.g., DG8002), or $3.57 for Lurmark (e.g. SD-02-110).

Pros / Cons: Reduce drift by 50% from extended range flat fans, but are more difficult to clean.

Turbo TeeJet:



Technology: A unique flooding-type nozzle with a turbulence chamber produces a wide-angle (150 °) spray. Sizes range from 11001 to 11008.

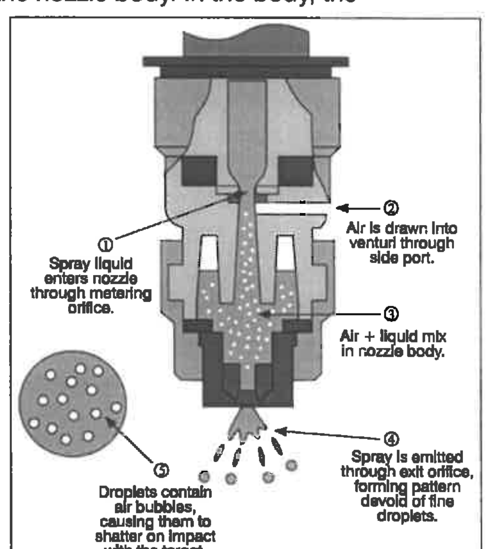
Pressure / Spray Quality: Spray quality: Medium to Coarse. A wide pressure range (15 to 90 psi) makes these nozzles very compatible with automatic rate controllers that use pressure to adjust flow rate in response to travel speed. Optimum pressure is 40 psi.

Price: $5.00 from Spraying Systems dealers. (e.g. TT11002)

Pros / Cons: Produce coarser spray, reducing drift by 50% compared to extended range tips. Can be difficult to unplug, so carry a few extras in the field.

Venturi Nozzles:

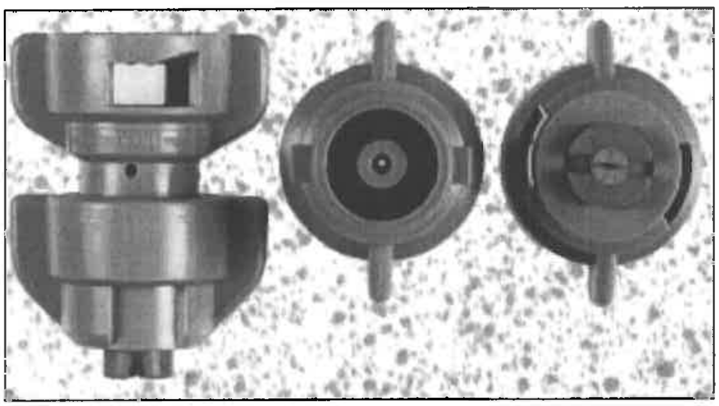
There are currently eight different venturi nozzles on the market. All have the same basic design feature: they have two orifices, one to meter liquid flow, the other, somewhat larger, to form the pattern. In between these two orifices is a venturi or jet, used to draw air into the nozzle body. In the body, the air mixes with liquid and forms an air-amended spray. The resulting spray pattern is low pressure and can be described as a very coarse spray containing large, air-filled droplets and virtually no small, drift



prone droplets. Venturi nozzles differ from conventional low pressure sprays by being coarser and containing fewer fines.

Venturi nozzles are also known as "air induction", "air inclusion" or "foaming" nozzles. Dramatic drift reductions have been observed with these tips while good spray coverage has generally been maintained. The reason is that the droplets are filled with air bubbles which cause the droplets to shatter on impact with the leaf, providing similar coverage to finer, conventional sprays. But getting the maximum benefit from these nozzles requires careful selection of the right nozzle for your needs, and proper operation. Features to watch are pressure range, ease of cleaning, and the ability to fit onto existing hardware.

Greenleaf TurboDrop:



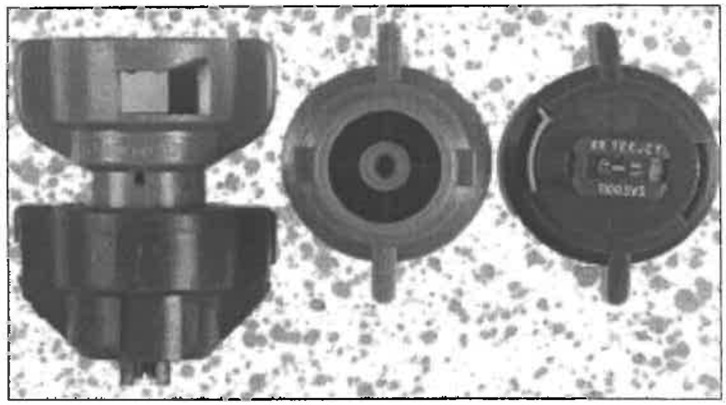
Technology: The first and most proven venturi nozzle. The exit tip is separate from the nozzle body and can be exchanged with other tips to fit specific needs. For example, a Turbo TeeJet exit tip can be used to increase spray coarseness, widen the spray angle, and improve pressure range. Exit tips must conform to the manufacturer's flow rate recommendations, and be extended range 110° models. Sizes range from 110005 to 11010.

Pressure / Spray Quality: Produces intermediate spray coarseness among the venturi tips. Good patterns are achieved between 30 and 150 psi. Optimum pressures for pesticide effectiveness are 60 to 80 psi.

Price: $25.00 for complete nozzle from Westward Parts dealers.

Pros / Cons: Integrated nozzle cap fits Spraying Systems QuickJet adapters. Long-lasting ceramic metering orifice is easily detachable for cleaning.

Greenleaf TurboDrop XL:



Technology: A lower pressure, all plastic version of the TurboDrop. Sizes range from 110005 to 11010.

Pressure / Spray Quality: Good patterns are produced between 15 and 120 psi. Pressures up to 75 psi provide a coarser spray than the original TurboDrop, while pressures over 75 psi create a somewhat finer spray. Optimum pressures are 60 to 80 psi.

Price: $12.00 for complete nozzle from Westward Parts dealers.

Pros / Cons: Integrated nozzle cap fits Spraying Systems QuickJet adapters. Best suited for those sprayers requiring a lower, wider pressure range.

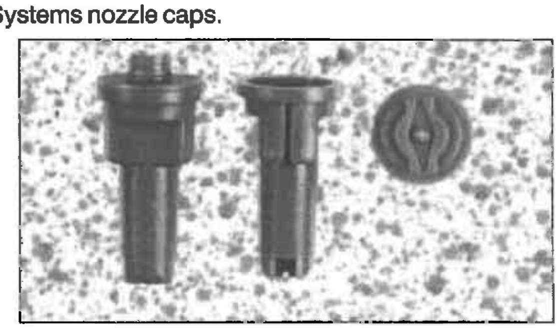
Billericay Farm Systems Air Bubble Jet:

Technology: All plastic construction. Less air induction than other venturi nozzles, with a removable metering orifice for easy cleaning. Sizes range from 110015 to 11005.

Pressure / Spray Quality: Good patterns are produced between 20 and 90 psi. Unlike most other venturi nozzles, optimum pressures are 30 to 45 psi. Emits a finer spray than other venturi nozzles, but still offers good drift protection.

Price: $8.95 from ABJ Agri Products, Brandon, MB (204) 726-9201.

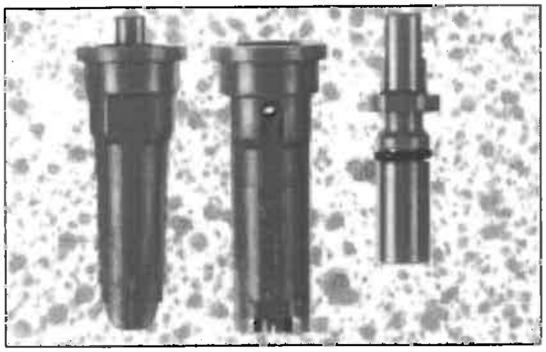
Pros / Cons: Due to slightly finer spray quality compared to other venturi nozzles, this nozzle offers an intermediate solution for applicators. Fits Spraying Systems nozzle caps.



Lechler ID:

Technology: All-plastic construction, with a removable venturi insert. Sizes range from 110015 to 11004. Also available under the Hardi Injet name.

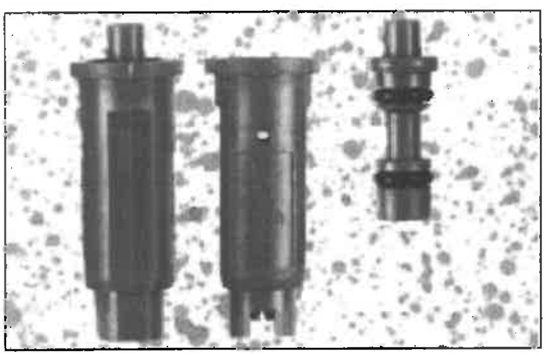
Pressure / Spray Quality: Good patterns are produced between 40 and 100 psi. Generates intermediate spray coarseness compared to other venturi nozzles. Optimum pressures are 60 to 80 psi.



Price: $10.54 from AgDepot

Pros / Cons: Has a wider body than a standard nozzle and requires a special nozzle cap ($0.70). Removal of insert requires needle-nosed pliers. Narrow pattern may require raising of boom.

TeeJet Air Induction (AI):



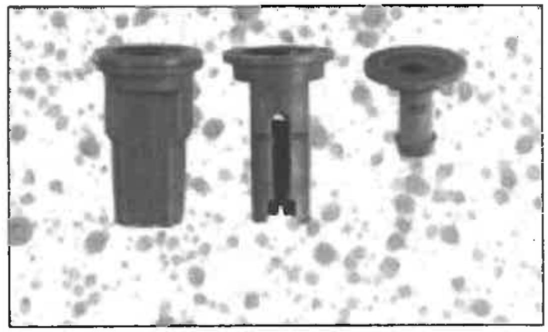
Technology: Similar in design to the Lechler ID, but utilizes a steel exit tip. Available in an "Even" pattern for banding applications. Sizes range from 110015 to 11005.

Pressure / Spray Quality: Good patterns are produced between 40 and 100 psi. Optimum pressures are 60 to 80 psi. Generates intermediate to slightly coarser spray quality compared to other venturi nozzles.

Price: $10.90 from Spraying Systems dealers.

Pros / Cons: A special nozzle cap is required to accommodate its wider body ($0.70). Removal of venturi insert requires needle-nosed pliers.

SprayMaster Ultra:



Technology: Plastic body and steel exit tip. Re-designed in early 1999, with no technical information available at time of printing. An earlier version of this tip is depicted.

Pressure / Spray Quality: Good patterns are produced between 40 and 100 psi. Optimum pressures are 60 to 80 psi. Generates the coarsest, lowest-pressure spray of the venturi type nozzles, and spray patterns need close attention to maintain proper nozzle overlap.

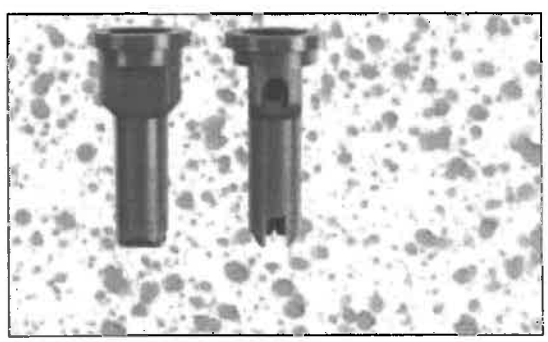
Price: $9.73 from John Deere Dealers.

Pros / Cons: Venturi-orifice is removable for cleaning. Fits Spraying Systems nozzle caps.

Sprays International:

Technology: This nozzle has not yet been widely adopted in North America. Sometimes called the "Kematal" tip because of the material it's made of.

Pressure / Spray Quality: Good patterns are produced between 40 and 100 psi. Optimum pressures are 60 to 80 psi. Similar in appearance to the Air Bubble Jet, but produces a coarser spray.



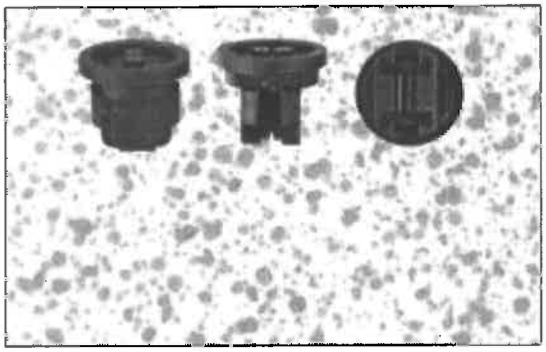
This nozzle has the narrowest fan angle of the venturi tips. Patterns and overlaps must be watched closely to ensure good coverage.

Price: $9.22 from Sprayer Parts Warehouse dealers.

Pros / Cons: Single-piece construction; venturi is not removable. Fits Spraying Systems nozzle caps.

Lurmark Ultra-Lo-Drift:

Technology: The most compact of the venturi tips, it closely resembles a conventional spray nozzle. All plastic construction, with two pre-orifice holes to meter the liquid through the body of the nozzle.



Pressure / Spray Quality: Good patterns are produced between 30 and 100 psi. Optimum pressures are 60 to 80 psi. Spray quality is intermediate compared to other venturi nozzles. Produces a wider angled spray and slightly wider pressure range than most other venturi tips.

Price: $9.79 from Retail Co-op outlets.

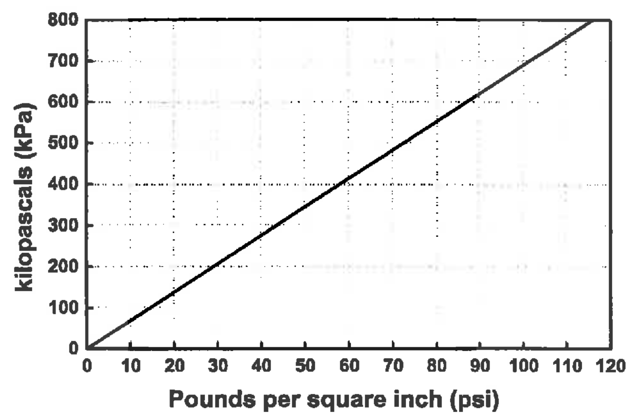
Pros / Cons: This tip can be disassembled for cleaning if necessary using a nozzle cap or screwdriver. Fits Spraying Systems nozzle caps.

Issues to Consider

Spray Pressure with Venturi Tips: Although most venturi tips are rated at minimum pressures of 30 to 40 psi, they need to be operated at higher than normal pressures to give optimum performance over a range of conditions. The exception is the Air Bubble Jet, which is designed to work at conventional pressures. Even at pressures of 60 to 80 psi, the remaining venturi nozzles still provide excellent drift protection. Using lower than the recommended pressures may cause the pattern to collapse, and will reduce the activity of the air-induction mechanism. Without the inclusion of air in the droplets, the ability to maintain proper coverage can be reduced. Check the boom pressure of your sprayer and the ability of your pump to operate at high pressures. If your system has trouble exceeding 50 psi, consider the TurboTeeJet, Air Bubble Jet or the Greenleaf TurboDrop XL. When using an automatic flow regulator, monitor your boom pressure and sprayer output closely when you change speeds. Poor patterns are the number one reason for performance complaints.

Nozzle Size Selection: Since venturi nozzles should be operated at higher pressures, you may need to choose a nozzle with a lower flow rate from the one you are currently using to maintain the correct water volume without increasing travel speeds. For example, if you currently use a conventional 02 size nozzle at 40 psi, a venturi 015 tip operated at 70 psi will provide the same flow rate, drift less, and give you some pressure latitude if you need to slow down. If you use a 03 tip at 40 psi, conversion to a 025 nozzle at 60 psi, or a 02 nozzle at 90 psi will give the same flow rate. The smallest size for most venturi nozzles is 015, except for the Greenleaf TurboDrop and TurboDrop XL, which come in sizes as small as 005 and 01. Check manufacturer guidelines for recommended pressures, and calibrate your sprayer at the start of every season.

Boom Height: Although venturi nozzles are sold as 110° fan angles, their spray pattern is closer to 80°, and quickly becomes narrower at lower pressures. This is because the exit tip has a greater flow rate than the metering orifice, causing a significant pressure drop. Even at a gauge pressure of 80 psi, the exit tip pressure may only be 20 or 30 psi. The lower spray pressure at the exit tip causes a narrowing of the fan. Watch patterns carefully, and place your boom at the height needed to achieve proper overlap.



Nozzle Wear: Most venturi nozzles are constructed of plastic. Plastic has very good wear characteristics, and can outlast stainless steel. Plastic is, however, prone to deformation if handled with hard objects, so care must be taken during cleaning.

Nozzle Plugging: Even with clean water and screens, nozzles will occasionally plug. A venturi nozzle should present less plugging problems than conventional nozzles because the metering orifice is round, allowing larger particles to pass through. The exit orifice typically has about twice the flow rate of the metering orifice, reducing the likelihood of plugging. If this orifice plugs, the nozzle will have to be taken apart for cleaning.

Adjuvants: Air bubble inclusion in droplets is a function of formulation and pressure. Air bubbles may not form without a surfactant or at lower pressures. Remember that almost all post-emergent pesticides sold in western Canada either have surfactants in the formulation, or call for them to be added. No special additives are required. Low-drift adjuvants such as Nalcotrol or 38-F should not be used with venturi tips, as the spray will not atomize properly. Always check your patterns after adding any adjuvant.

Efficacy: Venturi tips are best known for their dramatic ability to reduce drift. Many of these tips are new to western Canada, and information on pesticide efficacy when they are used is still scarce. Initial data suggest that these tips perform well at conventional carrier volumes, travel speeds, and product rates.

Some weeds are more difficult targets than others, particularly the difficult-to-wet weeds, such as lambsquarters, cleavers, wild oats, and green foxtail. These weeds generally require finer sprays to maintain effective coverage. When using venturi nozzles on these weeds, make sure your pressure is high enough to achieve good coverage. Larger weeds and reduced product rates typically make chemical control more difficult, and these conditions may also reveal some performance differences between nozzles.

According to preliminary results, herbicides that belong to herbicide Groups 2, 4, 9 and 22 perform well with venturi nozzles, even at normal pressures (40 psi). Application of herbicides in resistance groups 1, 6, 8, and 10 may require higher pressures with venturi nozzles to maintain good performance, especially under challenging conditions. Studies are continuing, and more information will be available at the end of 1999.

Check with your chemical representative to see if the manufacturer supports the use of low-drift nozzles with their products.

The Bottom Line

As with any new technology, venturi nozzles should be introduced carefully. They have tremendous promise for reducing drift while maintaining good efficacy, and have been used successfully by hundreds of western Canadian applicators under a variety of conditions. But they can be used improperly - make sure you pay attention to pressure and your herbicide / weed combination before you spray.

You may not want to or need to use venturi nozzles under all conditions. Start thinking in terms of using the ***"right spray for the conditions"***. This means that you may want to use conventional tips under good conditions, but choose low-drift tips for the outside rounds or when winds come up.

Finer sprays are also more appropriate for most insecticides and fungicides, and for grassy weeds. Coarser sprays will work well for broadleaf weeds, and when penetrating a cereal canopy. You may also want to consider having two different flow rates available – for example, 5 gallons/acre (23 L/acre) will improve performance for glyphosate, and 10 gallons/acre (45 L/acre) is required for Liberty and most contact products.

Nozzle Selection Guidelines

Coarser Sprays

- Easy-to-wet broadleaf weeds (pigweed, smartweed, thistles, etc.)
- Cereal canopy penetration
- Group 2, 4, 9, 22 or products with soil activity
- Outside rounds and windy conditions

Finer Sprays

- Grassy weeds (wild oats green foxtail, etc.)
- Difficult-to-wet broadleaf weeds (lambsquarters, cleavers, kochia, etc.)
- Broadleaf canopy penetration
- Group 1,6, 8, 10
- Insecticides
- Good weather conditions

Remember that nozzles are still the most important parts of your sprayer. It makes sense to invest in them to make sure the job gets done right.

For More Information: This Fact sheet will be available at the provincial Web Sites for updated information when it becomes available.

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