Alberta Farm Machinery
Research Centre

Printed: January 1990
Tested at: Lethbridge
ISSN 0383-3445
Group 8 (b)

Evaluation Report 623

Bourgault Model 850 Field Sprayer

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

BOURGAULT MODEL 850 FIELD SPRAYER

Manufacturer and Distributor:
F.P. Bourgault industries Ltd.
P.O. Box 39
St. Brieux, Saskatchewan
S0K 3V0
PH: (306) 275-2300

Retail Price: $14,903.00 (Jan. 1990, f.o.b. Lethbridge, Alberta, Set-up included, optional equipment; BEE monitor $821.00, Swivel-Jet nozzle body assemblies $540.00).

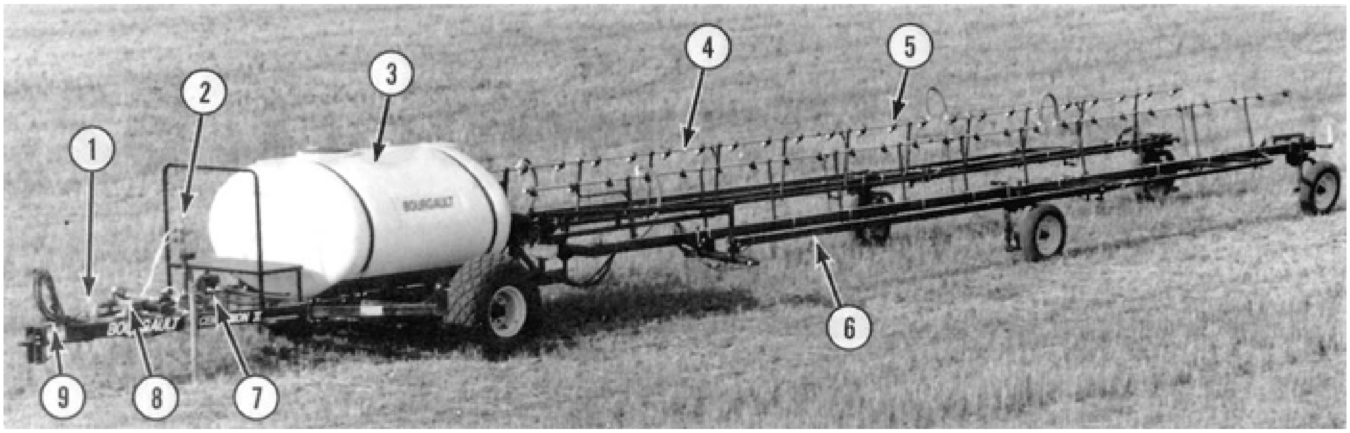

FIGURE 1. Bourgault Model 850 Field Sprayer: (1) Hydraulic Motor and Pump, (2) Chem-Ease Chemical Wand, (3) Spray Tank, (4) Spray Boom, (5) Nozzle Body, (6) Boom Radius Arm, (7) Solenoid and Pressure Regulating Valves, (8) Reload and Agitation Plumbing System, and (9) Hydraulic Hoses.

SUMMARY AND CONCLUSIONS

Rate of Work:

Operating at speeds between 5.4 and 7.7 mph (8.7 and 12.4 km/h) resulted in instantaneous work rates between 48 and 78 ac/h (19 and 32 ha/h). At an application rate of 10 gal/ac (112 L/ha), about 85 ac (34 ha) could be sprayed with a full tank.

Quality of Work:

Application rate accuracy was very good using the BEE sprayer monitor. The BEE monitor flow sensor was accurate to 2% of the displayed reading. The desired application rate could always be kept constant by adjusting nozzle pressure and forward speed. The application rate using XR110015 and XR11003 stainless steel nozzles was 5 and 10 gal/ac (56 and 112 L/ha), respectively, at a forward speed of 7.6 mph (12.2 km/h) and with a nozzle pressure of 40 psi (276 kPa).

Measured nozzle delivery rate was good. The new Tee Jet XR110015 and XR11003 nozzle deliveries were about 3% higher than specified by the nozzle manufacturer. Nozzle wear was minimal and rated as excellent. The Tee Jet XR110015 and XR11003 nozzles were used in the field for 46 and 37 hours, respectively. Variability among individual nozzle deliveries was very good before and after testing. The CV for the XR110015 and XR11003 nozzles was 1.6 and 1.2%, respectively.

Nozzle spray distribution patterns for Spraying Systems extended range nozzles were very good at Bourgault's recommended nozzle operating height of 15 in (381 mm) and nozzle forward angle of 35 degrees. Spray patterns were very uniform above 14 psi (100 kPa) using the XR11003 nozzles. Spray patterns were acceptable above 17 psi (120 kPa) and very uniform between 20 and 40 psi (138 and 276 kPa) using the XR110015 nozzles.

AFMRC conducted no tests to evaluate spray drift. However, using the extended range Tee Jet XR11003 nozzle tips at a nozzle pressure of 20 psi (138 kPa) and at a nozzle height of 10 in (254 mm) would in fact minimize spray drift during windy conditions.

System pressure losses were rated as fair. The pressure loss from the remote control pressure tap to the nozzles was about 8 psi (55 kPa) using the XR11003 nozzle tips. As a result, the remote control pressure guage did not indicate true nozzle tip pressure. The remote control pressure gauge was very good and reliable.

The strainers were good in preventing nozzle plugging. The small XR110015 nozzle tips plugged frequently when using lake and dugout water.

Boom stability was very good. The 4 in (102 mm) square tubing, front boom truss system and suspension system on the castor wheels reduced boom bounce. Reduced boom movement improved spray distribution patterns and application rate uniformity.

Crop damage was minimal and rated as very good. Trailer and inner castor wheel soil contact pressure was 45 and 21 psi (310 and 145 kPa) respectively.

Ease of Operation and Adjustment:

Ease of adjusting application rate was very good with the optional BEE sprayer monitor and Swivel-Jet dual nozzle body assemblies. The tractor forward speed or nozzle pressure could be adjusted until the desired application rate,was displayed on the monitor.

Ease of operating the controls was very good. Spraying Systems remote control and the BEE monitor made it easy to adjust and monitor application rate from the tractor seat. The BEE monitor speed and flow sensors had to be calibrated before spraying. Adjusting the agitator and throttle valves was difficult since the remote control pressure gauge was not readily visible from the sprayer hitch. The chemical inductor and reloading valves were accessible and easy to adjust.

Ease of adjusting the end castor wheels was good. The adjustments were a trial and error procedure and took about 2 hours before the booms trailed or unfolded satisfactory. The castor wheel camber bolts were easier to adjust with the castor wheel assembly raised off the ground.

Sprayer maneuverability was good in both transport and field position. Care had to be exercised when turning into narrow farmyard approaches since the inside boom turned sharply. Backing the sprayer in transport position resulted in the booms gradually unfolding to field position.

Ease of boom positioning was very good. The operator could place the booms into transport position in about 10 s by driving forward while engaging the tractor hydraulics to raise the wet booms. Placing the booms into field position took about a minute and required the operator to back the sprayer until the booms completely unfolded. It took about 100 to 150 ft (30 to 46 m) for the booms to completey unfold. The procedure got easier with experience.

Ease of adjusting nozzles was very good. Nozzle angle was factory set at a forward angle of 35 degrees and was manually adjustable. Nozzle height was adjusted with the hydraulic ram stop from about 8 to 23 in (203 to 584 mm). The Swivel-Jet dual nozzle assemblies made nozzle changing fast.

Ease of filling the spray tank was very good when utilizing the sprayer pump. It took about 20 minutes to fill the 850 gal (3864 L) spray tank. The reloading valves had to be opened and closed in the recommended sequence to prevent chemical solution from entering the water supply source or running the pump dry.

Ease of adding chemical to the spray tank was very good using the Chem-Ease chemical extractor. Normally, it took less than one minute to extract chemical from a typical 2.2 gal (10 L) chemical container. Extracting chemical during reloading allowed the operator to rinse the chemical containers with clean water.

Ease of hitching was very good. The hitch jack was safe and the hitch clevis adjustable for leveling the sprayer trailer to the tractor hitch. The four hydraulic lines and two electronic couplers were easy to hook-up.

Ease of cleaning was good. Removing the nozzle caps for nozzle and strainer cleaning was quick, however, the strainers were difficult to remove. Removing the main line strainer was safe and easy.

Ease of draining was very good. The drain line valve was near the outside of the trailer and easily accessible. The spray tank sump allowed for complete draining. The Swivel-Jet diaphragm nozzle assemblies were difficult to drain.

Ease of lubrication was good. All 34 grease fittings were accessible. Sixteen grease fittings were located on the boom and castor wheel assemblies and required greasing daily. The other 18 grease fittings required greasing annually.

Pump Performance:

The Hypro 9303C-HM4 pump output was very good. At the maximum hydraulic flow the pump delivered 17.8 gal/min (81 L/min) at a 40 psi (276 kPa) nozzle pressure. This was adequate to apply 21 gal/ac (236 L/ha) at a forward speed of 5 mph (8 km/h).

Agitator output exceeded recommended agitation rates.

Operator Safety:

The operator's manual emphasized operator safety. The sprayer was safe to operate if normal safety and chemical precautions were taken. The Chem-Ease chemical extractor and Swivel-Jet dual nozzle tips reduced operator contact.

Operator's Manual:

The operator's manual was very good, providing complete information and illustrations on safety, sprayer operation, maintenance and adjustments.

Mechanical History:

A few mechanical problems occurred during testing. The outer radius arm bolts loosened frequently, the boom breakaway shear pins failed in rough field conditions and the castor wheel camber adjustment bolts bent.

RECOMMENDATIONS

It is recommended that the manufacturer consider:.

1. Modifying the nozzle pressure line to indicate true nozzle pressure at the remote control pressure gauge.
2. Modifying the boom radius arms to prevent the bolts from loosening.
3. Modifying the boom breakaway assembly to prevent the shear bolts from failing in rough field conditions.
4. Modifying the castor wheel camber adjustment assembly to prevent the bolts from bending.

THE MANUFACTURER STATES THAT:

With regard to recommendation number:

1. The nozzle pressure line has been relocated to indicate true nozzle pressure at the remote control pressure gauge. All Centurion II's manufactured will be modified to correct this problem, at no cost to the owner.
2. The boom radius arm is now connected to the boom by a ball and socket arrangement to eliminate this problem. All Centurion II's will be modified to correct the problem, at no cost to the owner.
3. The boom breakaway assembly is now controlled by a spring loaded, releasable link. The release force can be adjusted as desired by the operator. If the boom breaks away it can easily be reconnected by backing up. All Centurion II sprayers not equipped with the shear pin system will have their sprayer updated at no cost to the owner.
4. The castor wheel camber adjustment tabs have been modified to correct this problem. This problem will be checked on all Centurion II sprayers built before the problem was corrected, and if necessary, changes will be made, at no cost to the owner.

THE MANUFACTURER FURTHER STATES THAT:

1. A number of changes have been made to the castor wheel assembly. All Centurion II sprayers manufactured after July 1, 1989 will have these changes. The changes will improve the rate at which the booms fold or unfold, reduce the turning radius in transport and simplify the camber adjustment. All sprayers manufactured prior to this date will be modified to this format, at no cost to the owner.
2. The number of grease nipples has been reduced from 34 to 26 of which 10 require annual greasing.

GENERAL DESCRIPTION

The Bourgault Model 850 is a trailing, boom-type field sprayer. The trailer consists of a single axle with floatation turf tires. Two castor wheels with a suspension system support each boom. The booms automatically fold back for transport. The 856 gal (3891 L) plastic tank has four jet agitators, fluid level indicator, drain hose, and a filler opening with strainer.

The Bourgault sprayer has 50 Swivel-Jet dual nozzle assemblies with diaphragm check valves spaced at 20 in (508 mm) intervals, giving a spraying width of 83.3 ft (25.4 m). Nozzle height is hydraulically controlled. Nozzle angle is adjustable and remains constant throughout the height range.

The Bourgault Model 850 has a Chem-Ease chemical wand, tank access platform, remote control and bottom reload systems. The bottom reload system utilizes the inboard centrifugal pump. The pump is hydraulically driven and operates at speeds between 4000 and 5000 rpm. The Spraying Systems remote control console mounts on the tractor and contains a pressure gauge and control switches to operate the pressure regulating and boom solenoid valves. An optional BEE monitoring system is available that indicates application rate, forward speed, nozzle flow rate, volume and area sprayed.

FIGURE 1 shows the location of the sprayer's major components while detailed specifications are given in APPENDIX 1.

SCOPE OF TEST

The Bourgault Model 850 sprayer was operated for 83 hours in the conditions shown in TABLES 1 and 2 while spraying about 3830 ac (1551 ha). The Alberta Farm Machinery Research Centre (AFMRC) evaluated the sprayer for rate of work, quality of work, ease of operation and adjustment, pump performance, operator safety and suitability of the operator's manual.

Spraying Systems extended range TeeJet flat fan XR110015VS and XR11003VS stainless steel nozzle tips were used during the test. Both nozzle tips were tested in the laboratory at various spraying heights and at a forward angle of 35 degrees.

TABLE 1. Operating Conditions

CHEMICAL APPLIED	FIELD	HOURS	SPEED mph	(km/h)	FIELD AREA ac	(ha)
Target	Barley	3.25	6.2	(10.0)	160	(65)
Target	Wheat	8.50	6.2	(10.0)	305	(123)
Buctril M/	Wheat	4.00	6.6	(10.6)	168	(68)
MCPA Fusilade	Canola	1.50	7.0	(11.3)	61	(25)
Poast	Canola	2.00	7.0	(11.3)	87	(35)
Poast/Buctril M	Flax	2.00	7.0	(11.3)	85	(34)
2,4-D/Amitrol	Summerfallow	14.25	6-7	(9.7-1.3)	650	(263)
2,4-D/Banvel	Summerfallow	4.00	7.0	(11.3)	186	(75)
2,4-D/Tordon	Summerfallow	20.50	6.9-7.5	(11.1-12)	982	(398)
Tordon	Wheat	23.00	5.4-7.7	(8.7-12.2)	1146	(464)
TOTAL		83.00			3830	(1551)

TABLE 2. Topography

TOPOGRAPHY	HOURS	FIELD AREA ac	(ha)
Level	15	689	(279)
Undulating	60	2790	(1130)
Rolling	8	351	(142)
TOTAL	83	3830	(1551)

RESULTS AND DISCUSSION

Rate of Work

During field testing, the Bourgault Model 850 sprayer was operated between 5.4 and 7.7 mph (8.7 and 12.4 km/h) (TABLE 1) resulting in instantaneous workrates between 48 and 78 ac/hr (19 and 32 ha/hr). Actual workrates were less depending on operator skill and reloading time. The quick folding of the boom made tank reloading from a central location convenient. With a full spray tank, about 85 ac (34.4 ha) could be sprayed at 10 gal/ac (112 L/ha).

Quality of Work

Application Rate: Application rate accuracy was very good using the optional BEE sprayer monitor. The application rate accuracy of the BEE monitor depended on the flow and speed sensor accuracy. The BEE flow sensor was accurate to about 2 percent of the indicated reading when calibrated as instructed in the operator's manual. The flow sensor calibration number for the XR110015 and XR11003 nozzle tips was 267. The same calibration number could be used for other nozzle tips with flowrates between 3 and 30 gal/min (14 and 136 L/min).

The speed sensor was accurate, but depended on the sprayer wheel circumference. The sprayer wheel circumference varied, depending on field conditions and spray tank fluid volume. As a result, the application rate varied about 4 percent from a full to near empty tank. For greater accuracy, the speed sensor was calibrated in actual field conditions, with the spray tank half full of water and sprayer tires properly inflated.

Application rate depended on tractor speed, nozzle size and pressure. The application rate using XR110015 and XR11003 nozzles was 5 and 10 gal/ac (56 and 112 L/ha), respectively, at a forward speed of 7.6 mph (12.2 km/h) and nozzle pressure of 40 psi (276 kPa). Changes to forward speed or nozzle pressure resulted in different application rates as shown in FIGURE 2. However, with the BEE monitor the desired application could easily be kept constant when changes to pressure and speed were desired. For example, reducing nozzle pressure from 40 to 20 psi (276 to 138 kPa) reduced the application rate from 10 gal/ac (112 L/ha) to 7.2 gal/ac (81L/ha) using the 11003 nozzles at 7.6 mph (12.2 km/h). The operator could decrease forward speed until the desired application of 10 gal/ac (112 L/ha) was shown on the monitor display. As a result, the operator didn't require nozzle application rate charts or graphs.

Nozzle Calibration: Measured nozzle delivery was good. FIGURE 3 shows the average delivery of Spraying Systems extended range TeeJet XR110015 and XR11003VS nozzle tips over a range of nozzle pressures.

Measured delivery of the new extended range nozzle tips was about 3 percent greater than specified by Spraying Systems rated output. The TeeJet XR110015 and XR11003 nozzle tips were used for 46 and 37 hours, respectively. Both showed no signs of increased delivery, indicating minimal nozzle wear. Some researchers indicate that a nozzle needs replacement once delivery has increased by more than 10%. Nozzle wear depends on the type of chemicals sprayed and water cleanliness.

Variability among individual nozzle deliveries for the Tee Jet XR110015 and XR11003 nozzles was low and rated as very good. A low coefficient of variation (CV) indicates similar delivery rates for all nozzles. A high CV indicates large variations among individual nozzle delivery rates. The CV of nozzle deliveries was 1.6% for the XR110015 nozzles and 1.2% for the XR11003 nozzles.

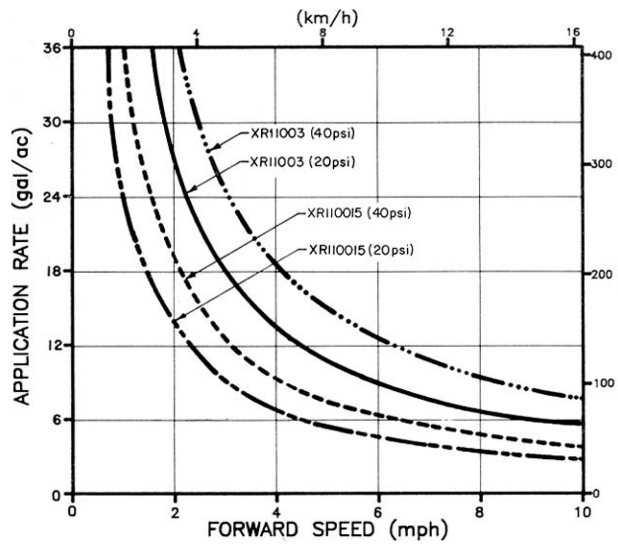

FIGURE 2. Application Rates at Various Forward Speeds and Pressures Using Spraying Systems Extended Range Tee Jet XR110015VS and XR11003VS Nozzles.

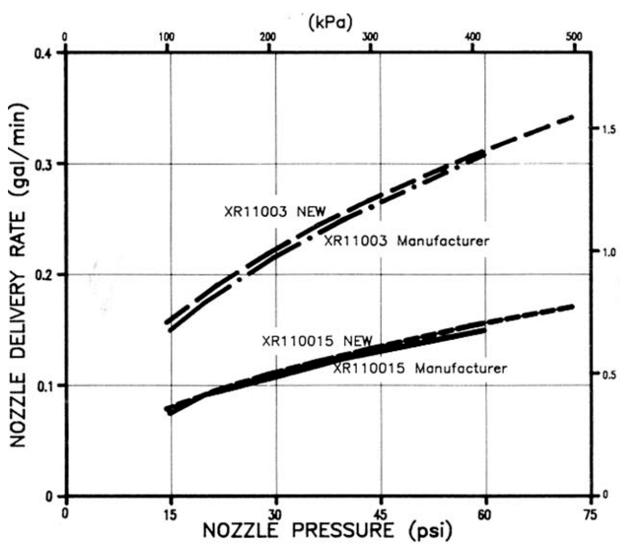

FIGURE 3. Delivery Rates for Spraying Systems Extended Range Tee Jet XR110015VS and XR11003VS Stainless Steel Nozzle Tips.

Distribution Patterns: Nozzle spray distribution patterns were very good at Bourgault's recommended nozzle height of 15 in (381 mm) and nozzle forward angle of 35 degrees. FIGURES 4 and 5 show spray distribution patterns along the boom with the extended range Tee Jet XR110015 nozzles operated at nozzle pressures of 22 and 44 psi (150 and 300 kPa). The coefficient of variation (CV)[1] at 22 psi (150 kPa) (FIGURE 4) was 8.31%, with application rates along the boom varying from 3.5 to 5.0 gal/ac (39 to 56 L/ha) at 7.0 mph (11 km/h). At 44 psi (300 kPa) (FIGURE 5) the CV was 11.0% with application rates along the boom varing from 4.2 to 7.2 gal/ac (47 to 81 L/ha) at 7 mph (11 km/h).

FIGURE 6 shows a typical spray distribution pattern along the boom with the extended range Tee Jet XR11003 nozzle tips operated at a nozzle pressure of 22 psi (150 kPa). The CV was 6.8%, with application rates along the boom varying from 7.0 to 10 gal/ac (79 to 112 L/ha) at a 7 mph (11 km/h) forward speed. The CV was similar at 44 psi (300 kPa). As shown, Spraying Systems extended range nozzles could be used at both manufacturer's recommended pressures of 22 and 44 psi (150 and 300 kPa) and produce acceptable spray distribution patterns.

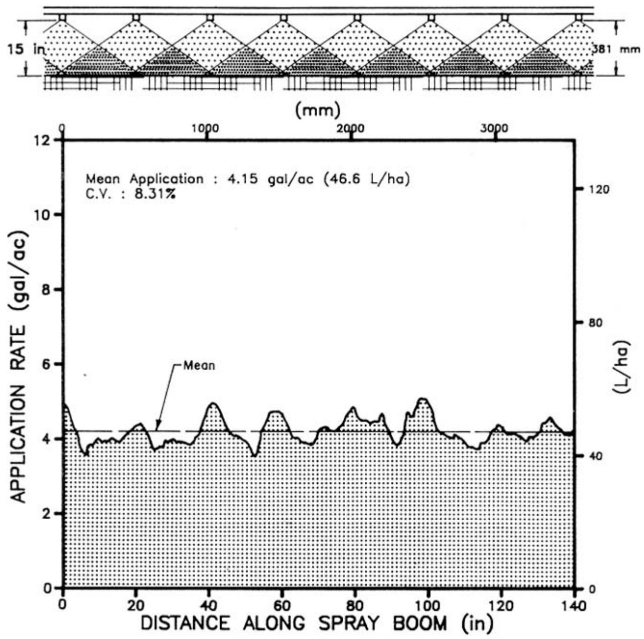

FIGURE 4. Typical Distribution Pattern Along the Boom at 22 psi (150 kPa) with Spraying Systems Extended Range Tee Jet XR110015VS Stainless Steel Nozzle Tips, at a 15 in (381 mm) Nozzle Height, 35 Degree Forward Spray Angle and 7 mph (11 km/h).

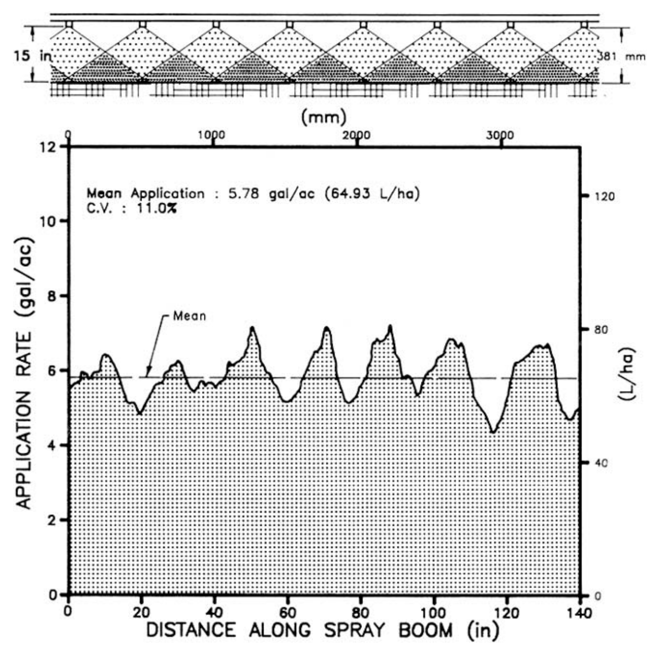

FIGURE 5. Typical Distribution Pattern Along the Boom at 44 psi (300 kPa) with Spraying Systems Extended Range TeeJet XR110015VS Stainless Steel Nozzle Tips, at 15 in (381mm) Nozzle Height, 35 Degree Foeward Spray Angle and 7 mph (11 km/h).

Spraying Systoms extended range nozzles were designed to spray at pressures between 15 and 60 psi (100 and 415 kPa). FIGURE 7 shows how nozzle pressure affected pattern uniformity for the extended range TeeJet XR110015 and XR11003VS nozzles. The larger XR11003 nozzles produced very uniform patterns at all pressures tested. The XR110015 nozzles produced acceptable spray distribution patterns above 17 psi (120 kPa) and very uniform patterns between 20 and 40 psi (138 and 276 kPa). The spray distribution patterns did not change after the nozzles were used in the field.

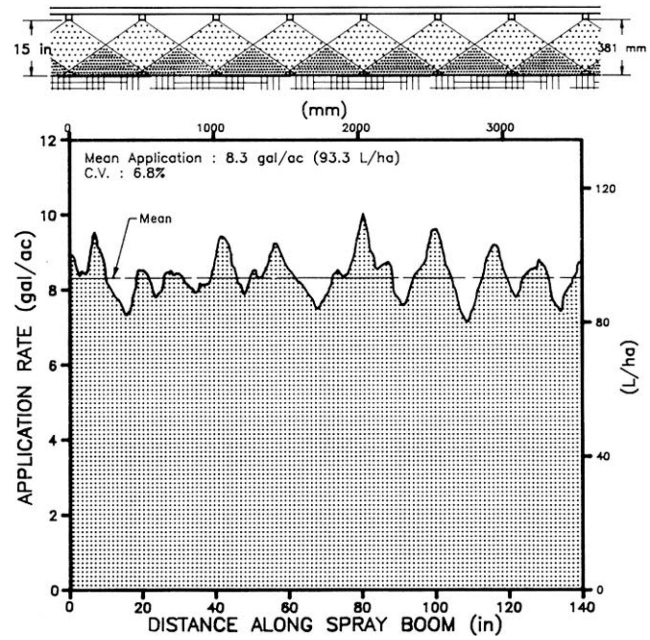

FIGURE 6. Typical Distribution Pattern Along the Boom at 22 psi (150 kPa) with Spraying Systems Extended Range Tee Jet X R11003VS Stainless Steel Nozzle Tips, at a 15 in (381 mm) Nozzle Height, 35 Degree Forward Spray Angle and 7 mph (11 km/h).

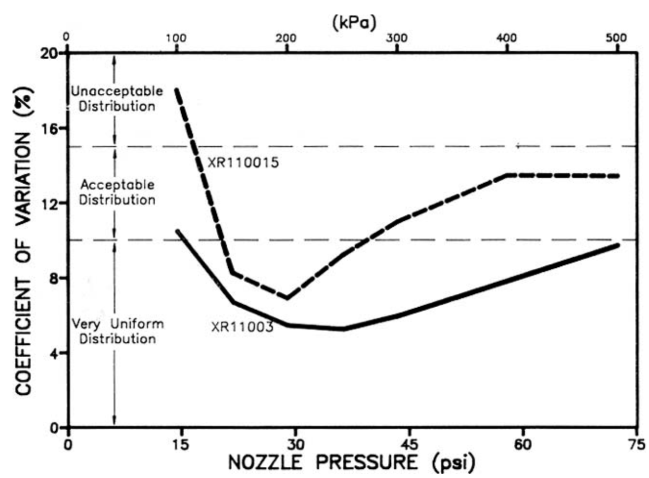

FIGURE 7. Spray Pattern Uniformity for Spraying Systems Extended Range Tee Jet XR110015 and XR11003 Stainless Steel Nozzles Operated at a 15 in (381 mm) Nozzle Height and 35 Degree Forward Spray Angle.

Spray Drift: AFMRC conducted no tests to evaluate spray drift. Previous work by AFMRC and Saskatchewan Research Council indicates that off-swath drift from large nozzles operated at low pressures and heights is less than small nozzles operated at standard nozzle pressures and heights. The Bourgualt sprayer could effectively reduce spray drift with the large XR11003 nozzles operated at low nozzle pressures and heights.

FIGURE 8 shows how nozzle heights affected spray pattern uniformity for the extended range TeeJet XR110015 and XR11003VS nozzles. Both nozzles produced very uniform spray patterns at the low nozzle heights shown. Therefore, off-swath spray drift could be minimized by operating the extended range nozzles at a nozzle height of 10 in (254 mm).

Studies have shown that 110 degree nozzles produce smaller droplets that are more susceptible to drift than 80 degree nozzles of the same size. However, operating the 110 degree nozzles at heights

[1]The coefficient of variation (CV) is the standard deviation of application rates for successive 0.63 in (16 mm) sections along the boom expressed as a percent of the mean application rate. The lower the CV, the more uniform is the spray coverage. A CV below 10 percent indicates very uniform coverage while a CV above 15 percent indicates inadequate uniformity. The CV's above were determined in stationary laboratory tests. In the field, CV's may differ due to boom vibration and wind. Different chemicals vary as to the acceptable range of application rates. For example, 2,4-D solutions have a fairly wide acceptable range while other chemicals may have a narrow range.

lower than the standard 18 in (457 mm) could minimize the smaller droplets susceptibility to drift.

Current studies have shown small spray droplets produced at high nozzle pressures is a more effective way to control weeds. Therefore, reduced weed control may result when spraying at low pressures in windy conditions.

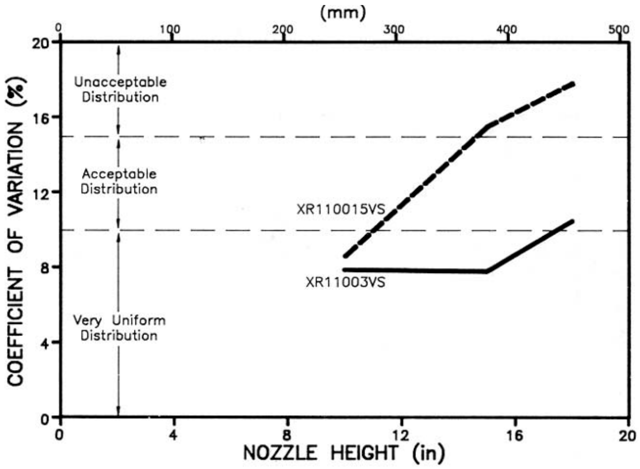

FIGURE 8. Spray Pattern Uniformity for Tee Jet XRI10015 and XRI1003 Stainless Steel Nozzles Operated at a Nozzle Pressure of 36 psi (248 kPa) and a Nozzle Forward Angle of 35 Degrees.

Pressure Losses: Pressures in the plumbing system were measured at the pump, remote control pressure gauge, flow sensor and nozzles using different sized nozzles. Pressure losses were rated as fair since true nozzle pressure was not indicated. The pressure loss from the remote control pressure top to the nozzle tip was about 8 psi (55 kPa) using the XR11003 nozzle tips. As a result, the remote control pressure gauge did not indicate true nozzle pressure. The true nozzle pressure was measured at the nozzle tip with a calibration gauge provided by the manufacturer. The measurement was done for each change in desired spraying pressure. This was inconvenient and unnecessary. It is recommended that the manufacturer consider modifying the nozzle pressure line to indicate true nozzle pressure at the remote control pressure gauge.

Pressure losses occurred across the flow sensor and solenoid valves, limiting the capacity of the sprayer. However, the losses were insignificant since sprayer capacity could easily be increased by increasing the speed of the pump or closing the agitator valve slightly.

The remote console pressure gauge was accurate and rated as very good. The calibration gauge indicated about 1.5 psi (10 kPa) low when new and about 3 psi (20 kPa) low at the end of the test.

Use of Optional Nozzles: The Swivel-Jet dual nozzle body assembly (FIGURE 9) accepted a wide range of standard nozzle tips.

System Strainers: The Bourgault sprayer system strainers were good. The tank filler opening and pump inlet hose were equipped with 16 and 50 mesh strainers, respectively. Both strainers effectively removed large foreign material. The 50 mesh nozzle strainers effectively prevented the TeeJet XR11003 nozzles from plugging. The Tee Jet XR110015 nozzles plugged frequently since the 100 mesh strainers were not effective when using lake or dugout water.

Boom Stability: The Bourgault sprayer boom stability was very good. Field observations indicated that the booms remained stable in the field conditions encountered (TABLE 2). The 4 in (102 mm) square tubing used for boom rail construction and suspension system on the castor wheels reduced boom bounce on rough fields. In addition, the front truss reduced horizontal boom end movement. Reduced boom movement in the field improved spray distribution pattern and application rate uniformity. Boom operation across gullies was also very good since the boom pivoted near the middle.

Soil Compaction and Crop Damage: Soil contact pressure beneath the castor wheels was less than that of an unloaded one-half ton truck. The soil contact pressure beneath the sprayer trailer wheels was about 45 psi (310 kPa). Crop damage in the sprayer wheel tracks was minimal. The average soil contact pressures under the sprayer wheels with a full tank are given in TABLE 3.

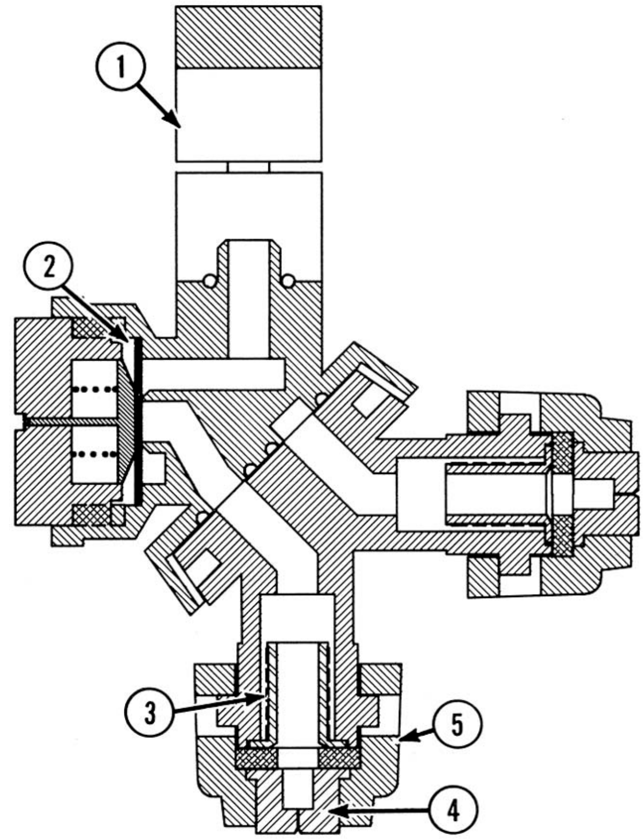

FIGURE 9. Swivel-Jet Diaphragm Dual Nozzle Body Assembly: (1) Split-Eyelet Clamp, (2) Diaphragm Check Valve, (3) Strainer, (4) Nozzle Tips, and (5) Quick-Disconnect and Self-Aligning Nozzle Cap.

Crop damage was minimal and rated as very good. The trailer and castor wheels travelled over about 2.8 and 1.5 percent of the total field area sprayed, respectively. No crop damage was observed in the trailer or castor wheel tracks when spraying in young crops less than 7 in (178 mm) tall. The only noticeable damage was when the sprayer trailer wheel tread was adjusted to run outside the tractor wheel tread.

TABLE 3. Soil Contact Pressure by Sprayer Wheels

	TIRE TRACK WIDTH*		AVERAGE SOIL CONTACT PRESSURE	
	in	(mm)	psi	(kPa)
Trailer Wheels	8.1	(206)	45	(310)
Boom Wheels - Inner	4.3	(108)	21	(138)
- Outer	3.2	(81)	16	(111)

*For comparative purposes, an unloaded one-half ton truck has a soil contact pressure of about 30 psi (207 kPa).

EASE OF OPERATION AND ADJUSTMENT

Application Rate: Ease of adjusting application rate was very good. The dual nozzle body assemblies and BEE monitor system made changing application rates very easy. Adjusting application rate within a 20 percent range with the same nozzles was easily done. The ground speed and nozzle pressure was adjusted until the desired application was displayed on the BEE monitor. There was no need to use nozzle charts and graphs.

The Swivel-Jet diaphragm dual nozzle body assembly housed two nozzle tips. This was convenient when the desired application rate had to be adjusted more than 20 percent.

Controls: Ease of operating the controls was very good. The Bourgault sprayer was equipped with Spraying Systems remote control console to operate sprayer controls from the tractor seat and a BEE monitor (FIGURE 10) to monitor application rate, ground speed, area and volume sprayed.

The remote control console included a pressure gauge to indicate nozzle pressure, boom solenoid valve switches to control flow to the booms and a pressure regulating switch to adjust nozzle pressure.

The pressure regulating switch was small and at times difficult to use in rough field conditions. Depending on the butterfly valve position, small adjustments of the pressure switch resulted in small or large pressure changes. With experience, nozzle pressure became easier to adjust.

The BEE sprayer monitor included 5 push button switches and a 3-digit LED display screen that was easy to read unless it faced direct sunlight. The push buttons were small and at times difficult to use in rough field conditions. The push buttons were easy to use to turn the power on and enter the three calibration numbers. The spraying width of the Bourgault sprayer, wheel and flow sensor calibration numbers had to be entered before spraying.

The wheel calibration number was the sprayer tire circumference in actual soil conditions with the spray tank half full of water. The sprayer wheel circumference measurement required another operator to count the wheel revolutions. The wheel circumference was recalibrated when soil conditions varied.

The flow from each nozzle tip had to be measured in order to determine the flow sensor calibration number. This was time consuming and inconvenient. A faster calibration procedure was to adjust the monitor until the flow indicated on the monitor matched the total flow of the nozzles. Total nozzle flow was determined from a nozzle tip catalogue.

The agitator and throttle control valves were mounted on the sprayer hitch frame. Therefore, it was difficult to adjust the desired maximum operating pressure since the remote control pressure guage was not easily visible from the hitch. The agitator valve was fully open during spraying and only had to be opened once. The throttle valve was also left opened and the tractor hydraulic flow adjusted to set the maximum operating pressure.

Tank liquid level indicator was not used since the BEE monitor accurately displayed the amount of fluid sprayed.

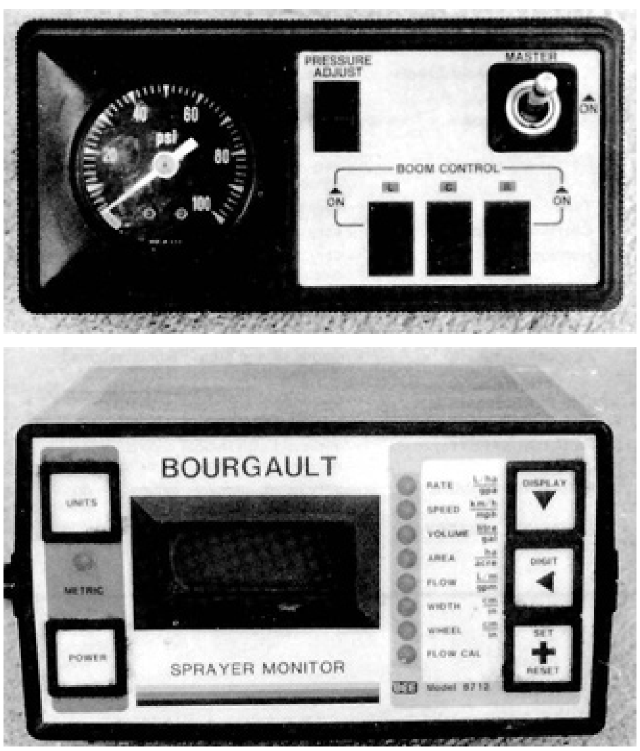

FIGURE 10. Top: Spraying Systems Remote Control Console, Bottom: BEE Sprayer Monitor.

Castor Wheel Adjustments: Ease of adjusting the end castor wheels was good. The end castor wheels had to camber and toe-in slightly for proper boom performance. The adjustments took about 2 hours before the boom trailed satisfactory and unfolded quickly to field position.

The castor wheel camber bolts were difficult to turn and eventually bent. The bolts were easier to adjust with the castor wheel assembly raised off the ground. Once adjusted, the castor wheels did not normally have to be readjusted. However, the camber bolts bent and slipped from the stop brackets, thus requiring re-adjustment.

Maneuverability: Sprayer maneuverability was good. The sprayer towed very well in both field and transport position. The sprayer had a turning radius of 68 ft (21 m) in transport position. Although the turning radius was adequate, care had to be exercised when turning into narrow farmyard approaches since the inside boom turned sharply into the ditch (FIGURE 11).

Backing up the sprayer in transport position for a short distance was possible, until the booms started unfolding into field position. Operators should avoid circumstances requiring backing up long distances.

FIGURE 11. Inside Boom Position During A Sharp Turn.

Boom Positioning: Ease of boom positioning was very good. Positioning the booms from the tractor seat allowed getting in and out of fields quickly and conveniently. The sprayer booms were placed into transport position in less than 10 seconds by driving forward with the wet booms raised.

Placing the booms in field position was done by backing up the sprayer until the boom radius arms snapped into the sprayer trailer arm. The procedure took about one minute and a distance of 100 to 150 ft (30 to 46 m) depending on operator experience, reverse speed and rear castor wheel camber adjustment. The booms unfolded faster when the castor wheel camber was set at a high inclination. However, adjusting the camber greater than 10 degrees caused the castor wheels to plow.

The transport width was 13.4 ft (4.1 m) (FIGURE 12) providing safe high speed road transport.

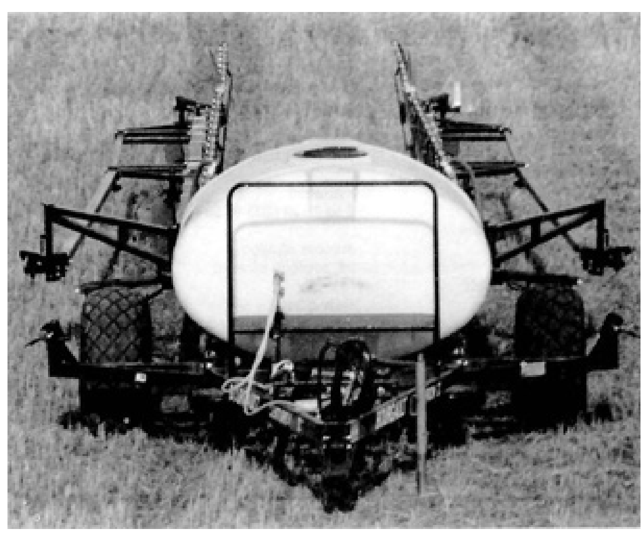

FIGURE 12. Bourgault in Transport Position.

Nozzle Adjustments: Ease of adjusting nozzle height and angle was very good. Nozzle angle was factory set at a 35 degree forward angle. However, nozzle angle could be adjusted by loosening 6 clamps and rotating the wet spray booms. Spray interference with the castor wheels resulted when nozzle angle was adjusted more than 37 degrees forward. Nozzle angle remained constant at all boom heights.

Nozzle height was conveniently controlled hydraulically from the tractor. Nozzle height could be adjusted from about 8 to 23 in (203 to 584 mm) using the hydraulic ram stops. This was adequate using the 110 degree extended range nozzles. The Bourgault boom could be adjusted higher than 23 in (584 mm), but required the hydraulic line valves to be closed to prevent the booms from shifting from the desired height. The nozzles could be raised to 37 in (940 mm) before the castor wheel lock assemblies engaged and folded the booms to transport position.

The sprayer was delivered with the booms level from end to end. The Swivel-Jet dual nozzle tip assemblies made nozzle changing very easy.

Tank Filling: Ease of filling the spray tank was very good. The 850 gal (3864 L) spray tank could be filled utilizing the filler opening or reloading system. The reloading system was convenient and safe, since less foaming and splashing occurred. All reloading valves were easily accessible from the reloading side of the sprayer. The time required to fill the spray tank averaged about 20 minutes, regardless of the power take-off speed. A 2 in (51 mm) transfer hose was needed to connect the nurse tank to the reloading coupler.

Care had to be exercised in operating the reloading valves to prevent chemical solution from the spray tank entering the water supply source or running the sprayer pump dry during reloading. It was important to open and close the valves in the recommended sequence.

Chemical Inducting: Ease of adding chemical to the spray tank was very good. The Bourgault sprayer was equipped with a Chem-Ease chemical extractor (FIGURE 13). The Chem-Ease chemical extractor was near the reloading valves making chemical inducting and reloading water one operation. Chemical could also be extracted during agitation with the spray tank nearly full, thus reducing solution foaming. Both were convienent, but the former provided for rinsing of chemical containers with clean water. Preference depended on operator skill, time and amount the chemical foamed.

Rate of chemical extraction varied depending on the type of chemical being extracted, pump speed and reloading valve position. Increasing pump speed and slightly closing the reloading valve resulted in faster extraction rates. Normally, it took less than one minute to extract chemical from a typical 2.2 gal (10 L) chemical container. PAMI Evaluation Report #556 provides detailed test information on the Chem-Ease Chemical Extractor.

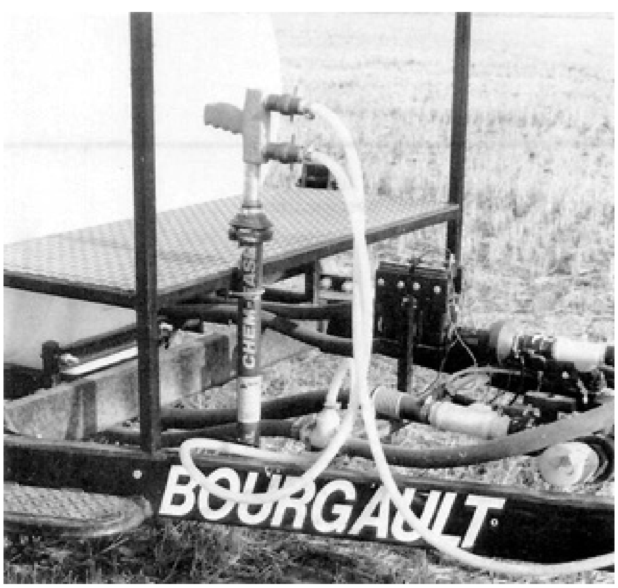

FIGURE 13. Chem-Ease Chemical Extractor.

Hitching: Ease of hitching was very good. The hitch jack provided was safe. The hitch jack handle was long and easy to crank. The hitch clevis was adjustable to level the spray tank trailer. Hitching included the hook-up of four hydraulic lines for the pump orbit motor and height adjustment of the spray booms, plus two electronic couplers for the remote control and monitor systems.

Cleaning: Ease of cleaning was good. Removing nozzle caps from the Swivel-Jet nozzle assemblies for cleaning was quick. The nozzle orifices should be unplugged using a soft bristle toothbrush to prevent orifice damage.

Removing the strainers from the Swivel-Jet nozzle assemblies was difficult at times. The top of the nozzle assemblies had to be tapped or the strainer pried with a screwdriver, causing chemical solution to splatter on the operator.

The pump inlet hose strainer was easy and safe to remove. The strainer was positioned horizontally which reduced operator contact with the chemical during removal.

Draining: Ease of draining the spray tank was very good. The spray tank completely drained through the sump at the bottom of the tank. The drain valve was near the sprayer trailer frame and easily reached.

The pump cavity was easily drained by opening the cock at the bottom of the pump. Draining the hoses was done by loosening the ring clamps and removing the hose ends. The spray booms were drained by removing the end plugs. The Swivel-Jet diaphragm nozzle body assemblies were difficult and inconvenient to drain since the diaphragm had to be removed to completely drain the body assembly.

Lubrication: Ease of lubricating the sprayer was good. The Bourgault sprayer had 34 pressure grease fittings. The sixteen grease fittings located in the castor wheel brackets required greasing daily. The other eighteen required grease annually. All grease fittings were easily accessible.

PUMP PERFORMANCE

Output: The Hypro 9303C-HM4 centrifugal pump output was very good. The pump operated about 5000 rpm at the maximum rated hydraulic flow of 5.8 gal/min (26.5 L/min). At the maximum rated flow the pump delivered 17.8 gal/min (81 L/min) to the Bourgault sprayer booms at a 40 psi (276 kPa) nozzle pressure. This was adequate to apply 21 gal/ac (236 L/ha) at a forward speed of 5 mph (8 km/h).

Higher application rates could be obtained by closing-off the agitator valve.

Agitation: Agitation output was very good. The Bourgault sprayer was equipped with four horizontally mounted, hydraulic agitators. TABLE 4 shows agitator outputs during various operating conditions using the 0.19 in (4.8 mm) diameter orifices. Agitation rates varied depending on pump speed and the amount that throttle, regulator and agitator valves were opened. Maximum agitation rates occurred with the agitator valve fully opened and the throttle valve closed.

Agitator output was over 22 gal/min (100 L/min) in all spraying and reloading conditions encountered. This exceeded the recommended agitation rates for emulsifiable concentrates and wettable powders. Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 1.5 gal/min per 100 gal of tank capacity (1.5 L/min per 100 L of tank capacity). For wettable powders such as Atrazine, recommended agitation rates are 3.0 gal/min per 100 gal of tank capacity (3.0 L/min per 100 L of tank capacity).

At high agitation rates, foaming may occur with some chemicals. However, the agitation rate could easily be reduced by partially closing the agitator valve.

TABLE 4. Agitator Outputs

OPERATING CONDITION	PUMP SPEED	AGITATOR OUTPUT gal/min	(L/min)
Reloading	5000	66	(300)
Field Spraying (XR110015)	5000	48	(220)
Field Spraying (XR11003)	5000	53	(240)

OPERATOR SAFETY

The first few pages of the operator's manual emphasized operator safety. The Bourgault sprayer had warning decals to indicate dangerous areas. The sprayer was equipped with a Chem-Ease chemical extractor that reduced operator exposure to chemical during chemical inducting. The Swivel-Jet dual nozzle body assemblies also reduced operator exposure to chemical during changing nozzle tips. The sprayer was equipped with a slow moving vehicle sign.

Caution: Operators are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with chemicals. Although many commonly used agricultural chemicals may be relatively harmless to humans, others they may be deadly. In addition, little is known about the long-term effects of human exposure to many commonly used chemicals. In some cases, the effects may be cumulative, causing harm after continued exposure over several years.

OPERATOR'S MANUAL

The operator's manual was very good. It was clearly written and well illustrated. It provided useful information on safety, machine specifications, sprayer operation, maintenance, adjustments, trouble shooting and optional equipment.

MECHANICAL PROBLEMS

TABLE 5 outlines the mechanical history of the Bourgault during 83 hours of operation while spraying about 3830 ac (1551 ha). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

ITEM	OPERATING HOURS	EQUIVALENT FIELD AREA ac	(ha)
Plumbing			
- several plumbing components were loose and tightened at	beginning of test		
Boom			
- the right outer radius arm bolt failed and was replaced at	11	395	(160)
- the outer radius arm bolts were loose and tightened at	23, 67	940, 2655	(381, 1075)
- a nozzle body assembly leaked and the diaphragm was replaced at	32	1335	(540)
- the radius arm shear bolts failed and were replaced at	62, 83	2495, 3830	(1010, 1551)
- the top camber adjustment bolt at the end castor wheel slipped off and was readjusted at	62	2495	(1010)
- the end castor wheel camber angles changed and were readjusted at	63, 83	2495, 3830	(1010, 1551)
- right end castor wheel cotter pin sheared and was replaced at	end of test		
Console			
- Bee monitor fuse was blown and replaced at	7	225	(91)
- two wires on the remote control cord were severed at the hitch and repaired at	28	1090	(441)
- the remote console right boom switch was not working and the console was replaced at	62	2495	(1010)

DISCUSSION OF MECHANICAL PROBLEMS

Plumbing: Several plumbing components near the sprayer pump and wet spray boom were loose when the sprayer was delivered to AFMRC. A majority of the components leaked and were removed, teflon put on and retightened.

Booms: The outer boom radius arm bolts loosened (FIGURE 14) throughout the test. It is recommended the manufacturer consider modifying the boom radius arms to prevent the bolts from loosening.

The boom break-away shear bolts failed due to excessive boom vibration in rough field conditions. It is recommended the manufacturer consider modifying the boom break-away assembly to prevent the shear bolts from failing in rough field conditions.

The rear castor wheel camber adjustment bolts bent from the force on the bolt during adjustment. Eventually, the bolts slipped from the castor wheel stop brackets (FIGURE 15). It is recommended the manufacturer consider modifying the end castor wheel camber adjustment assembly to prevent the bolts from bending.

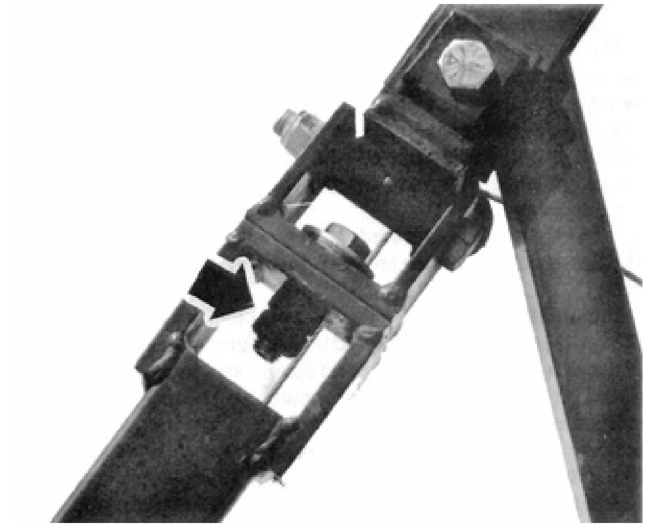

FIGURE 14. Loose Outer Boom Radius Arm Bolts.

FIGURE 15. Bent Castor Wheel Camber Adjustment Bolts.

APPENDIX I
SPECIFICATIONS

MAKE:	Bourgault Centurion II
MODEL:	850
SERIAL NUMBER:	S1069
MANUFACTURER:	F.P. Bourgault Industries P.O. Box 39 St. Brieux, Saskatchewan S0K 3V0 PH: (306) 275-2300
OVERALL DIMENSIONS:	
- wheel tread	
- trailer	
- minimum	7.5 ft (2.29 m)
- maximum	9 ft (2.74 m)
- transport height	6.0 ft (1.83 m)
- transport length	58.2 ft (17.7 m)
- transport width	13.4 ft (4.1 m)
- field height	6.0 ft (1.83 m)
- field length	20.0 ft (6.1 m)
- field width	82.5 ft (25.1 m)
- clearance height	11 in (279 mm)
- turning radius	68 ft (21 m)
TIRES:	
- trailer	two, 16.5L X 16.1, 6 ply
- boom	four, 5.9L X 15, 4 ply

WEIGHT:	TRANSPORT POSITION Empty		Loaded
- left trailer wheels	1555 lb	(705 kg)	5390 lb (2445 kg)
- right trailer wheels	1460 lb	(662 kg)	5500 lb (2495 kg)
- inner boom wheels - left	560 lb	(254 kg)	570 lb (259 kg)
- right	570 lb	(259 kg)	570 lb (259 kg)
- outer boom wheels - left	270 lb	(122 kg)	260 lb (118 kg)
- right	270 lb	(122 kg)	260 lb (118 kg)
- hitch	60 lb	(27 kg)	640 lb (290 kg)
Total	4745 lb	(2152 kg)	13190 lb (5983 kg)

	FIELD POSITION Empty		Loaded
- left trailer wheels	1305 lb	(592 kg)	5150 lb (2336 kg)
- right trailer wheels	1240 lb	(562 kg)	5380 lb (2440 kg)
- inner boom wheels - left	550 lb	(249 kg)	570 lb (259 kg)
- right	570 lb	(259 kg)	570 lb (259 kg)
- outer boom wheels - left	270 lb	(122 kg)	260 lb (118 kg)
- right	270 lb	(122 kg)	270 lb (122 kg)
- hitch	540lb	(245 kg)	990 lb (449 kg)
Total	4745 lb	(2152 kg)	13190 lb (5983 kg)

SPRAY TANK:	
- material	plastic
- capacity	850 gal (3864 L)
- agitation	hydraulic, 0.19 in (4.8 mm) orifice agitators
FILLER OPENING:	
- shape	round
- size	
- small	4.75 in (121 mm) I.D.
- large	15.75 in (400 mm) I.D.
- location	top, front
- height above ground	71 in (1803 mm)
CHEMICAL INDUCTOR:	
- type	Chem-Ease
STRAINERS:	
- pump inlet hose	1, 50 mesh
- nozzle assembly	
- XRI10015	50, 100 mesh
- XRI1003	50, 50 mesh
- spray tank	1, 16 mesh
PUMP:	
- make	Hypro
- model	9303C-HM4
- type	centrifugal
- operating speed	@ maximum hydraulic flow - 5063 rpm @ 5.8 gal/min (26.5 L/min)
- type of drive	hydraulic orbit motor
CONTROL CONSOLE:	
- make	Spraying Systems Co.
- model	744
- pressure gauge	dial, 0-100 psi (0-690 kPa)
MONITOR:	
- make	Baker Electronic Enterprises Inc.
- model	8712
- displays	application rate, forward speed, nozzle flowrate, total volume and area sprayed
- flow sensor	multi-jet turbine
- speed sensor	magnetic
SOLENOID VALVES:	
- make	Spraying Systems Co.
- model	18605-1
- size	two, 1 in (25.4 mm) NPT, 12 VDC, 35 watt
SPRAY BOOM:	
- material	aluminum
- size	1 in (25.4 mm) Schedule 80
- height adjustment	
- type	hydraulic
- range	8 to 23 in (203 to 584 mm)
- angle adjustment	
- type	manual rotation
- range	35 degrees forward
- nozzle assembly	
- make	Swivel-Jet
- type	split-eyelet diaphragm dual nozzle
- number	50
- spacing	20 in (508 mm)
- cap	quick-connect, color coded, self-aligning
- effective spraying width	83.3 ft (25.4 m)

SUMMARY CHART
BOURGAULT MODEL 850 FIELD SPRAYER

RETAIL PRICE:	$14,903.00 (Jan 1990, f.o.b. Lethbridge)
RATE OF WORK:	- 78 ac/hr (32 ha/hr) @ 7.7 mph (12.4 km/hr)
QUALITY OF WORK:	
Application Rate	- **very good;** BEE monitor flow sensor accurate to 2% of reading
Nozzle Calibration (XR110015)	
- delivery	- **good;** 3% high
- wear	- **excellent;** minimal after 46 hours
- coefficient of variation	- **very good**; about 1.6%
Nozzle Calibration (XR11003)	
- delivery	- **good;** 3% high
- wear	- **excellent;** minimal after 37 hours
- coefficient of variation	- **very good;** about 1.2%
Spray Distribution	
- XR110015	- **very good;** uniform above 14 psi (100 kPa)
- XRI1003	- **very good;** uniform between 20 and 40 psi (138 and 276 kPa)
Spray Drift	- minimized using XR11003 nozzles at low pressures and heights
Pressure	
-loss	- **fair;** true nozzle pressure not indicated
- gauge	- very good, reliable
Straining	- **good;** 100 mesh nozzle strainer ineffective using lake water
Boom Stability	- **very good;** with suspension castor wheels and boom end truss
Soil Contact Pressure	
- trailer	- 45 psi (310 kPa)
- castor	- 21 psi (138 kPa)
Crop Damage	- **very good;** minimal
EASE OF OPERATION AND ADJUSTMENT:	
Application Rate	- **very good;** easy with BEE monitor and dual nozzles
Controls	- **very good;**
Castor Wheel Adjustments	- **good;** took about 2 hours
Maneuverability	- **good;**
Boom Positioning	- **very good;** transport - 10 s field - 1 min
Nozzle Adjustments	- **very good;** 8 to 23 in (203 to 584mm) @ 35 degrees forward
Tank Filling	- **very good;** 20 minutes
Chemical Inducting	- **very good;** Chem-Ease extractor
Hitching	- **very good;** hitch jack was safe and hitch clevis was adjustable
Cleaning	- **good;** strainers difficult to remove and messy
Draining	- **very good;** tank drain accessible
Lubrication	- **good**; sixteen grease fittings required greasing daily
PUMP PERFORMANCE:	- **very good**; adequate capacity for nozzles and agitation
OPERATOR SAFETY:	- improved with remote control, dual nozzles and Chem-Ease extractor
OPERATOR'S MANUAL:	- **very good;** complete information on safety and operation
MECHANICAL HISTORY:	- problems with radius arm bolts loosening and shear pins failing

ALBERTA FARM MACHINERY RESEARCH CENTRE
3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080

This report is published under the authority of the minister of Agriculture for the Provinces of Alberta, Saskatchewan and Manitoba and may not be reproduced in whole or in part without the prior approval of the Alberta Farm Machinery Research Centre or The Prairie Agricultural Machinery Institute.