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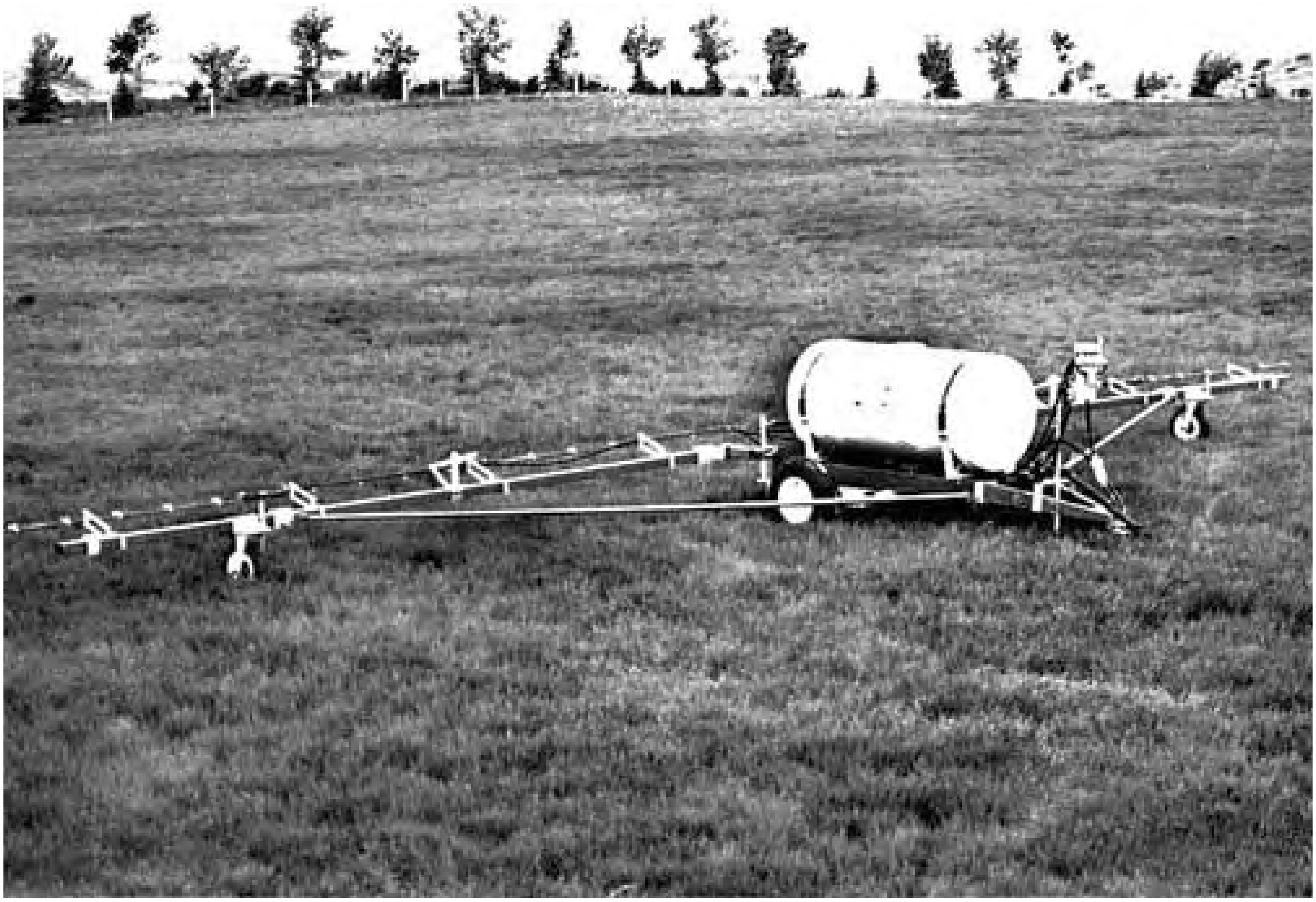
Evaluation Report 172



Demco Model LPW 560 Field Sprayer

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

DEMCO MODEL LPW 560 FIELD SPRAYER

MANUFACTURER:
Dethmers Manufacturing Company
Boyden, Iowa 51234
U.S.A.

DISTRIBUTOR:
Can-Am Farm Supply Ltd.
P.O. Box 3801, Postal Station B
Winnipeg, Manitoba
R2W 3R6

RETAIL PRICE:
$5,495.85 (March, 1980, f.o.b. Regina, complete with electric boom control valves, Hypro Model C9006 centrifugal pump and two 11L x 15SL 8-ply trailer tires.)

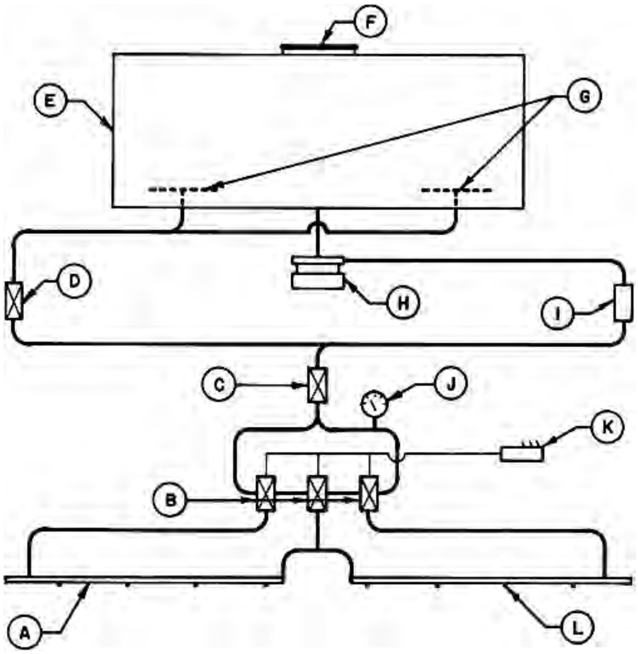


FIGURE 1. Flow Diagram for Demco Model LPW 560: (A) Boom, (B) Electronic Boom Valves, (C) Pressure Regulator, (D) Agitator Control, (E) Tank, (F) Lid, (G) Agitators, (H) Pump, (I) Line Strainer, (J) Pressure Gauge, (K) Boom Control Switch, (L) Nozzle.

SUMMARY AND CONCLUSIONS

Functional performance of the Demco Model LPW 560 sprayer was good. Functional performance was reduced by interference between the tank and middle boom ends during transport, difficulty in adjusting boom height, inconvenient tank filling height, difficulty in adjusting boom pressure, poorly positioned and supported hoses and difficulty in keeping the boom height adjusting assembly tight. Nozzle distribution patterns were acceptable at pressures above 205 kPa (30 psi) with the Delavan LF-2 (80°) stainless steel nozzle tips used during the test. Nozzle delivery increased 3.5% after 86 hours of field use. Variability among individual nozzle deliveries was low. The nozzle assembly accepted a wide range of standard nozzle tips.

The Demco LPW 560 performed well at field speeds up to 13 km/h (8 mph) resulting in a maximum field capacity of 24 ha/h (59 ac/h). The castor wheel assemblies performed well.

Output of the Hypro C9006 centrifugal pump was lower than the manufacturer's total output. Pump suitability was reduced by its sensitivity to plumbing system restrictions and to tractor engine speed. The pump was adequate to apply and agitate emulsifiable concentrates such as 2,4-D but was not adequate for applying wettable powders since sufficient agitation to keep the tank solution properly mixed was not possible.

Plumbing system pressure loss was minimal from the control valves to the end nozzles. The pressure gauge was accurate and clearly visible from the tractor. Nozzle plugging occurred frequently until nozzle strainers were added.

Application rate was controlled by adjusting ground speed and boom pressure. The control and agitator valves were inconvenient to operate, making boom pressure difficult to adjust. Boom height was difficult to adjust and nozzle angle could not be adjusted. Hitching was convenient and grease fittings were readily accessible. The blunt tow bar pins made folding and unfolding the sprayer inconvenient. Care had to be exercised when turning due to boom interference. The tank was difficult to fill by gravity from a nurse tank since the filler opening was over 1700 mm (67 in) above the ground. The tank was not supplied with a drain, making draining and cleaning the tank inconvenient.

The operator's manual adequately outlined sprayer operation.

Several mechanical problems occurred during the 86 hours of field operation. The line strainer leaked throughout the test. Interference occurred between the tank and middle boom inlet hoses, between the transport bar brackets and the transport bar pin clips, and between the left transport bar bracket and the transport bar. The control valve outlet barbed connectors and tank level indicator tubing were undersized. Most hoses buckled, sagged and wore on sprayer surfaces due to insufficient support. The right castor wheel bracket, hitch clevis, tow bar bracket, transport bar brackets and control panel upright bent during field operation. Several of the nuts and bolts on the boom height adjustment mechanism, pump hanger and hitch loosened and were lost.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a metric or dual calibrated pressure gauge or suitable conversion chart to facilitate sprayer operation after conversion to the metric (SI) system.
2. Supplying a suitable strainer at the tank filler opening.
3. Supplying nozzle strainers as standard equipment to prevent nozzle plugging or alternatively recommending the use of nozzle strainers in the operator's manual.
4. Modifications to supply sufficient agitation for wettable powders.
5. Modifications to simplify pressure adjustment.
6. Modifications to the tow bar pins to simplify pin insertion.
7. Modifications to eliminate rear safety stand and boom interference during transport.
8. Modifying the tank platform to provide for safer and more convenient filler opening access.
9. Modifications to the boom height adjusting mechanism to make height adjustment more convenient.
10. Modifications to permit nozzle angle adjustment.
11. Modifications to simplify securing the free end of the power take-off shaft for transport.
12. Modifications to the castor wheel assemblies to permit easier lubrication of the support carrier plates.
13. Providing the optional sump as standard equipment to permit convenient tank draining.
14. Supplying a slow moving vehicle sign.
15. Expanding the operator's manual by providing calibration charts in both Imperial and metric (SI) units.
16. Modifications to prevent the line strainer from leaking.
17. Modifications to prevent inner boom end nozzle damage caused by interference between the tank and boom inlet hoses during transport.
18. Modifications to secure hoses to prevent wear, sagging and buckling.
19. Modifications to prevent the boom height adjusting locknuts from loosening during field use.
20. Informing the operator to lock both castor wheels during transport to prevent castor wheel damage.
21. Modifications to prevent transport bar and bracket interference when positioning the transport bar to field position.

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Senior Engineer: E. H. Wiens
Project Technologist: L. B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. Dual calibrated gauge will be supplied as standard equipment.
2. A strainer is available and may be ordered as an option with all Demco sprayers.
3. Nozzle strainers are optional equipment and available with each sprayer.
4. Agitation is sufficient as provided with standard pump at recommended maximum rates per acre. Agitation is venturi boosted which was not considered by the test crew.
5. An optional electric pressure regulator is available which can be easily installed on the tractor for the operator's convenience.
6. Pins will be tapered.
7. The safety stand will be shortened to eliminate interference.
8. No modifications are planned. Customers rate platform as very adequate.
9. Modifications are under development.
10. An optional bracket is available to allow nozzle angle adjustment. Consideration is being given to replacing the square dry boom with round tubing.
11. Modification has been made.
12. An additional grease fitting has been added opposite the existing fitting for easier lubrication.
13. The sump is standard on polyethylene tanks, but will remain an option on fiberglass tanks.
14. The responsibility of providing slow moving vehicle emblems will remain with the customer.
15. Metric calibration charts will be provided in future printings of instructions.
16. Consideration is being given to a different strainer for the sprayer.
17. Modifications will be made.
18. Hoses must be cut to correct length from the bulk hose provided and secured with the nylon hose ties provided.
19. The operating instructions indicate that the locknuts should be set, after tightening, with a hammer and punch to prevent loosening during field use. (PAMI NOTE: This was done but the locknuts still loosened.)
20. Changes will be, made to the operating instructions as suggested.
21. The hairpin has been replaced with a cotter pin to prevent interference.

NOTE: This report has been prepared using SI units of measurement. A conversion table is given in APPENDIX III.

GENERAL DESCRIPTION

The Demco Model LPW 560 is a trailing, boom type field sprayer. The trailer is mounted on a single axle while each boom is supported by a castor wheel. The 1900 L (420 gal) fiberglass tank is equipped with hydraulic agitation and a fluid level indicator.

The Demco LPW 560 has 36 nozzles spaced at 508 mm (20 in) giving a spraying width of 18.3 m (60 ft). Boom height is adjustable while nozzle angle is not adjustable. The booms fold back for transport. The pressure regulator, agitator control, pressure gauge and boom control valves are mounted on a stand near the front of the trailer hitch. The test machine was equipped with optional electric boom control valves. Valve switches were mounted on the tractor. The trailer mounted, planetary gear drive centrifugal pump is driven from a 540 rpm tractor power take-off.

FIGURE 1 presents a flow diagram for the Demco LPW 560 while detailed specifications are given in Appendix I.

SCOPE OF TEST

The Demco LPW 560 was operated for 86 hours in the conditions shown in TABLE 1 while spraying about 1371 ha (3386 ac). It was evaluated for quality of work, pump performance, ease of operation, operator safety and suitability of the operator's manual.

TABLE 1. Operating Conditions

Chemical Applied	Hours	Speed	Spraying Rate	Field Area
		km/h	ha/h	ha
2, 4-D	39	8	15	585
2, 4-D, Banvel mixture	27	9	16.5	456
Picloram/2,4D mixture	20	9	16.5	330
TOTAL	86			1371

RESULTS AND DISCUSSION

QUALITY OF WORK

Distribution Patterns: No nozzle tips were supplied with the Demco LPW 560. The sprayer was equipped with 80° Delevan LF 2 stainless steel nozzles for the test. FIGURES 2 and 3 show spray distribution patterns along the boom with these nozzles. The coefficient of variation (CV)[1] at 140 kPa (20 psi) was 24.2%, with application rates along the boom varying from 42 to 133 L/ha (3.8 to 12.0 gal/ac) at 8 km/h (5 mph). High spray concentration occurred below each nozzle with inadequate coverage between nozzles. Although pressures this low are not recommended, the distribution pattern at the 140 kPa (20 psi) nozzle pressure is shown to illustrate the poor patterns typical at low pressure. At 275 kPa (40 psi) the distribution pattern improved, reducing the CV to 13.8%. Application rates along the boom varied from 76 to 140 L/ha (6.8 to 12.6 gal/ac) at 8 km/h (5 mph). Higher pressure improved distribution by increasing the overlap among nozzles. Higher pressure, however, usually causes more spray drift.

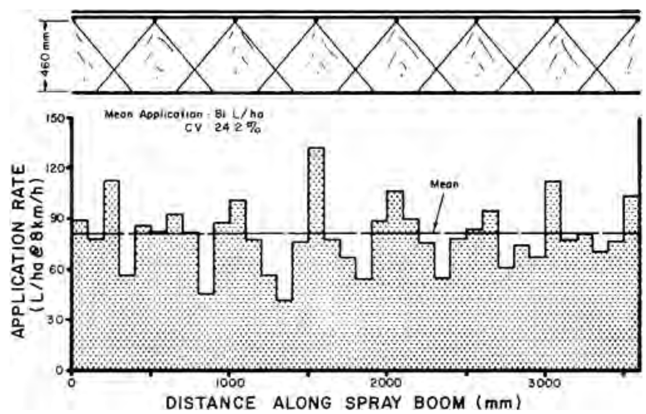

FIGURE 2. Typical Distribution Pattern along the Boom at 140 kPa with Delavan LF-2 (80°) Nozzles, at a 460 mm Nozzle Height.

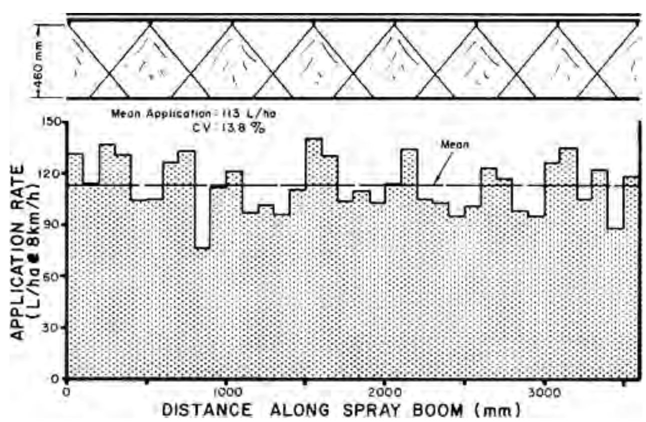

FIGURE 3. Typical Distribution Pattern along the Boom at 275 kPa with Delavan LF-2 (80°) Nozzles, at a 460 mm Nozzle Height.

FIGURE 4 shows how nozzle pressure and wear affect spray pattern uniformity. New Delavan LF-2 (80°) stainless steel nozzles

[1]The coefficient of variation (CV) is the standard deviation of application rates for successive 100 mm sections along the boom expressed as a per cent of the mean application rate. The lower the CV, the more uniform is the spray coverage. A CV below 10% indicates very uniform coverage while a CV above 15% indicates inadequate uniformity for chemicals having a narrow application range. The CV's above were determined in stationary laboratory tests. In the field CV's may be up to 10% higher 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 (±14%) while chemicals such as Buctril M have a very narrow range.

produced acceptable distribution patterns at pressures above 205 kPa (30 psi), while after 86 hours of field use, a pressure of 268 kPa (39 psi) was required to produce an acceptable distribution pattern. These nozzles were not capable of producing a very uniform distribution at any pressure.

FIGURE 4 also shows spray pattern uniformity results for three different batches of new 80° Tee Jet 8002 stainless steel nozzles tested by PAMI in previous years. One batch of new nozzles produced acceptable distribution patterns at pressures above 150 kPa (22 psi) and very uniform patterns at pressures above 172 kPa (25 psi), while another batch produced acceptable distribution only at pressures above 160 kPa (23 psi) and very uniform distribution at pressures above 240 kPa (35 psi). A third batch did not produce a very uniform distribution pattern at any pressure.

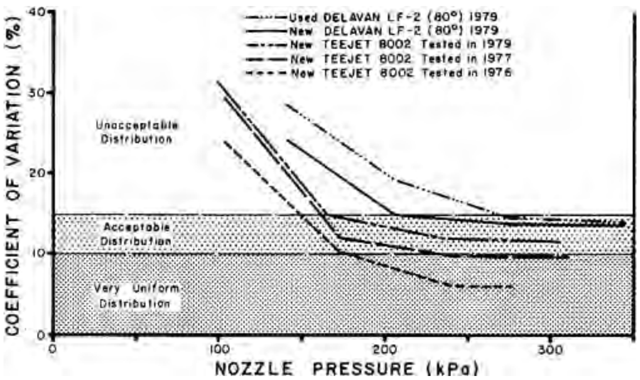

FIGURE 4. Spray Pattern Uniformity for New and Used Delavan LF-2 (80°) Stainless Steel Nozzles and for Three Different Batches of New Tee Jet 8002 Stainless Steel Nozzles, Operated at a 460 mm Nozzle Height.

FIGURE 5 shows the effect of nozzle pressure on spray pattern uniformity for 65°, TeeJet 6502 brass nozzles. These nozzles have the same capacity as the Delavan LF-2 and Tee Jet 8002 nozzles but have a 65° spray angle rather than an 80° angle. Two batches, representing two different nozzle manufacturing times, are shown. Both batches produced acceptable distribution patterns at pressures above 175 kPa (25 psi) while one batch produced very uniform distribution at pressures above 205 kPa (30 psi) and the other at pressures above 240 kPa (35 psi). Although researchers have reported that 800 nozzles usually produce better spray distribution than 650 nozzles, it can be seen that the variation among different batches of 80° nozzles is greater than the variation between 65 and 80° nozzles.

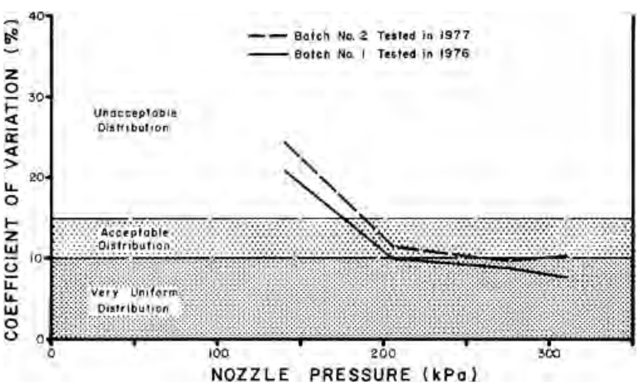

FIGURE 5. Spray Pattern Uniformity for Two Different Batches of New Tee Jet 6502 Brass Nozzles, Operated at a 560 mm Nozzle Height.

Spray Drift: To obtain acceptable spray distribution, the Demco had to be operated above 205 kPa (30 psi) with the Delavan LF-2 nozzles. As can be seen from FIGURE 4, large variations are possible in stainless steel nozzles and for some nozzle batches acceptable distribution patterns may be possible with nozzle pressures as low as 150 kPa (22 psi).

Work by the Saskatchewan Research Council[2] indicates that drift at the edge of the spray pattern is less with wide angle and high capacity spray nozzles operating at low pressure to produce coarse droplet sizes. For example, drift at the edge of the spray pattern is usually less than 1% of the amount sprayed when using Tee Jet 8002 nozzles at 205 kPa (30 psi). Drift from sprayers using lower capacity 65° nozzles is about 3% of the amount sprayed at 170 kPa (25 psi) and 6% at 275 kPa[3] (40 psi). The Delevan LF-2 (80°) nozzles used on the Demco sprayer could result in drift in excess of 1% since the lowest nozzle pressure to obtain an acceptable distribution pattern was 205 kPa (30 psi). The 80° nozzle angle permitted operating the boom lower to the ground than with 65° nozzles.

Nozzle Calibration: FIGURE 6 shows the delivery of the Delavan LF-2 (80°) stainless steel nozzles used on the Demco sprayer.

Nozzle delivery increased 3.5% after 86 hours of field use. Some researchers indicate that a nozzle needs replacement once delivery has increased by more than 10%. Nozzle wear depends or the type of chemicals sprayed and water cleanliness.

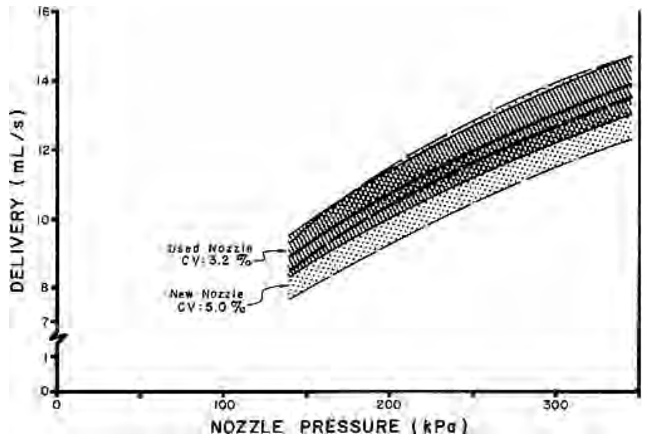

FIGURE 6. Delivery Rates of the Delavan LF-2 (80°) Stainless Steel Nozzles - New and Used 86 Hours.

FIGURE 6 also shows the variability among individual nozzles. The shaded area represents the variation in delivery rates for 10 nozzles before and after field use. A narrow range and low CV indicate similar discharge rates for all nozzles while a wide range indicates larger variability among individual nozzle deliveries. Variability among individual nozzle deliveries was higher when the nozzles were new than when used. The CV of nozzle deliveries was 5% when new and 3.2% after 86 hours of use.

The delivery from the new nozzles used on the Demco LPW 560 was 3.5% lower than the manufacturer's specified delivery. After 86 hours field use, the nozzles delivered at the manufacturer's rated output.

Use of Optional Nozzles: The nozzle assembly (FIGURE 7) accepted a wide range of standard nozzle tips. The nozzle height was adjustable permitting the use of flat fan, flood or cone nozzles. Flood nozzles, which operate other than vertical would however not function normally, since the nozzle angle was not adjustable.

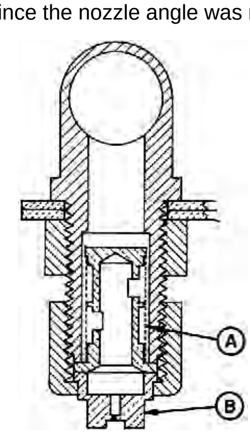

FIGURE 7. Cross Section of Nozzle. (A) Strainer, (B) Nozzle Tip.

[2]*Maybank, J., Yoshida, K., Shewchuk, S.R., "Comparison of Swath Deposit and Drift Characteristics of Ground-Rig and Aircraft Spray Systems -- Report of the 1975 Field Trials", Saskatchewan Research Council Report No. P76-1, January, 1976, p. 17.*

[3]*Maybank, J., Yoshida, K., "Droplet Deposition and Drift from Herbicide Sprays -- Analysis of the 1973 Ground-Rig Trials", Saskatchewan Research Council Report No. P.73-16, December, 1973, p. 65.*

Booms: The Demco 560 was driven over a series of standard obstacles[4] to assess boom stability. At 9 km/h (5.6 mph) the maximum boom end movement was a 144 mm (5.7 in) lift and a 76 mm (3.0 in) drop. This resulted in a boom height variation from 384 to 604 mm (15.1 to 23.8 in), compared to the correct 460 mm (18 in) boom height. FIGURE 8 compares nozzle overlap at these three boom heights.

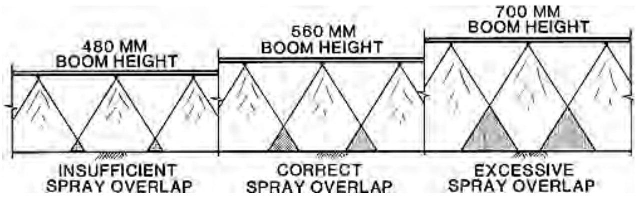

FIGURE 8. The Effect of Boom Lift and Drop on Spray Overlap.

The lift and drop at the center of the boom was about one-third that at the boom end. Boom bounce at 6 and 12 km/h (3.7 and 7.4 mph) was similar to that at 9 km/h (5.6 mph) when driving over 40 and 65 mm (1.6 and 2.6 in) high obstacles. Vertical boom bounce increased slightly with speed when driving over a 105 mm (4.1 in) high obstacle.

Driving over obstacles with the boom wheels also causes the forward boom speed to vary in relation to the tractor speed, since the boom initially deflects rearward and then springs forward. Boom speed determines the application rate. Higher application occurs as the boom deflects rearward and lower application occurs as it swings forward. Large variations in application rate can result from horizontal boom movement on rough ground. For example, driving over a 65 mm (2.6 in) high obstacle at 9 km/h (5.6 mph) caused boom end speed to vary from 4.8 to 15.0 km/h (3.0 to 9.3 mph). Resulting application rates could vary from 184 to 59 L/ha (16.6 to 5.3 gal/ac). These variations in boom end speed occurred in only 0.2 seconds while the sprayer travelled 500 mm (20 in). Boom end speed variation at 6 km/h (3.7 mph) was two-thirds less than at 9 km/h (5.6 mph). At 12 km/h (7.4 mph) speed variations were about 1.5 times larger.

Field Speeds: The Demco LPW 560 performed satisfactorily at speeds up to 13 km/h (8 mph) resulting in a field capacity of 24 ha/h (59 ac/h).

Pressure Losses in Plumbing System: Pressures in the plumbing system were measured at the pump outlet, boom control, boom inlet and boom end. Although there was a pressure loss from the pump outlet to the boom control, this did not affect system operation. Pressure losses from the boom control to the rest of the system were negligible.

Pressure Gauge: The pressure gauge was accurate in the normal operating range at the beginning of the test. At the end of the test the pressure gauge read 3.5 kPa (0.5 psi) high. This was a negligible error.

The pressure gauge was calibrated only in psi. To facilitate conversion to the metric (SI) system, a pressure gauge calibrated in kPa should be supplied with the sprayer.

Tank Strainer: No strainer was provided at the tank filler opening. It is recommended that a suitable strainer be provided to remove foreign particles before they enter the sprayer tank.

Line Strainer: A 40 mesh screen was located in the pump discharge line. Although no protection was provided for the pump, centrifugal pumps are less susceptible to damage by foreign materials than roller pumps. The plastic strainer bowl was dif. cult to remove for cleaning.

Nozzle Strainers: The Demco was not equipped with nozzle strainers. It is recommended that nozzle strainers be supplied, since the 40 mesh line strainer was not effective in removing impurities such as rust particles which may plug nozzle orifices. The nozzle assembly (FIGURE 7) had sufficient space for various types of nozzle strainers. Fifty mesh nozzle strainers were installed for field testing and successfully prevented nozzle plugging.

Soil Compaction and Crop Damage: The trailer and boom wheels travelled over about 3% of the total field area sprayed. The wheel tread of the trailer could be adjusted from 1510 to 2050 mm (59.5 to 80.7 in) to match tractor wheel tread. The only crop damage, in addition to that caused by the tractor wheels, was that caused by the castor wheels. This was only 0.9% of the total area sprayed. Soil contact pressure beneath the castor wheels was about 70% that of an unloaded pickup truck. The average soil contact pressures under the sprayer wheels with a full tank are given in TABLE 2.

[4]*PAMI T764-R78, Detailed Test Procedures for Field Sprayers.*

TABLE 2. Soil Compaction by Sprayer Wheels

	Average Soil Contact Pressure* With Tank Full	Tire Track Width
	kPa	mm
Trailer Wheels	230	193
Castor Wheels	142	83

**For comparative purposes, an unloaded one half ton truck has a soil contact pressure of about 200 kPa (30 psi).*

PUMP PERFORMANCE

Priming: The Hypro C9006 centrifugal pump supplied with the Demco sprayer was not self-priming. The pump was mounted near the bottom of the sprayer tank, automatically providing the positive inlet pressure required for pump priming. The manufacturer warned that the pump not be run dry to avoid damaging pump seals.

The location of the pump supply hose in the tank bottom was adequate to provide the pump with liquid in all the topographic conditions encountered during the test. Operating the sprayer on steep hills with the tank nearly empty could, however, result in the pump being starved, causing lost prime or seal damage.

Noise: The planetary gear pump drive was quite noisy throughout the test. Inspection of the planetary gears after 86 hours of field use showed no damage to the planetary gears. Although pump performance was not affected, the noise was irritating to the operator.

Agitation Capability: Pump output, as is characteristic of centrifugal pumps, was very sensitive to restrictions created by hose friction, valves, nozzles and other accessories. The manufacturer's rated pump output was 6.4 L/s (85 gal/min) at 275 kPa (40 psi), but the maximum pump delivery (FIGURE 9) through the sprayer system when equipped with Delavan LF-2 (80°) nozzles was only 1.08 L/s (14.3 gal/min). Of this total delivery, 0.64 L/s (8.5 gal/min) was Supplied to the tank agitators. Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 0.48 L/s (6.3 gal/min) for a 1900 L (420 gal) tank. For wettable powders such as Atrazine and Sevin, recommended agitation rates are 0.95 L/s (12.5 gal/min) for a 1900 L (420 gal) tank. At 275 kPa (40 psi) the pump output was therefore adequate for applying emulsifiable concentrates but was not adequate for applying wettable powders since sufficient agitation to keep the tank solution properly mixed was not possible. It is recommended that modifications be made to provide sufficient agitation for applying wettable powders.

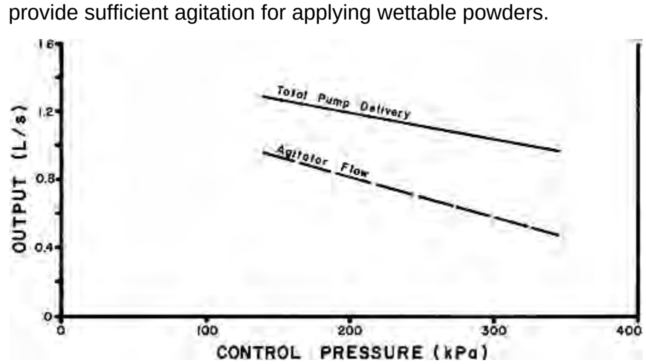

FIGURE 9. Pump Output Through the Sprayer System and Resulting Agitation Flow, when Equipped with Delavan LF-2 (80°) Nozzles.

Output: FIGURE 10 gives the pump performance curves for the Hypro C9006 pump when operating at a power take-off speed of 540 rpm. Pump output was lower than indicated by the manufacturer's curve. For example, at a pump outlet pressure of 200 kPa (30 psi), actual output was 5.8 L/s (76.5 gal/min) as opposed to the manufacturer's stated output of 7 L/s (92.4 gal/min). Pump wear was negligible after 86 hours of operation.

Pump output was very dependent on pump speed. It was difficult to maintain a constant pressure when operating in the field. For example, in typical herbicide application, a 10% variation in tractor engine speed, as could commonly occur in hilly fields, caused a 16% variation in control pressure with a resulting 9% variation in application rate.

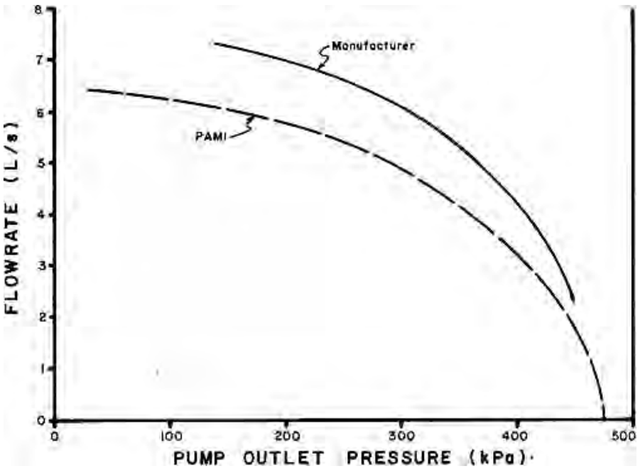

FIGURE 10. Pump Performance Curves at 540 rpm.

EASE OF OPERATION

Controls: Application rate was controlled by adjusting ground speed and nozzle pressure. Pressure could be controlled with either the boom control valve or the agitator valve (FIGURE 11). Flow to the three boom sections was easily controlled with the electric solenoid switches mounted on the tractor. The tank shut-off valve was conveniently located at the front of the tank.

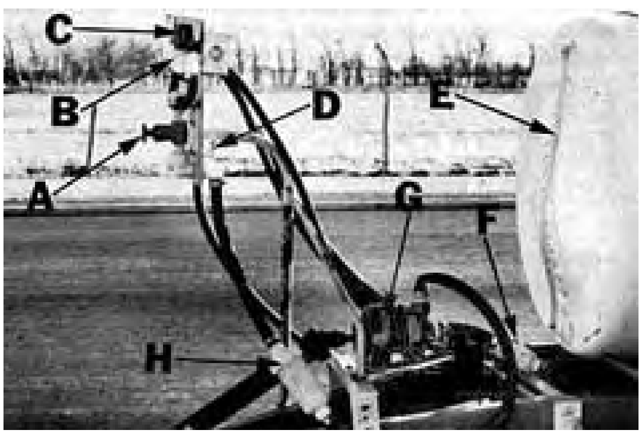

FIGURE 11. Controls: (A) Boom Control Valve, (B) Solenoid Valves, (C) Pressure Gauge, (D) Agitator Valve, (E) Liquid Level Indicator, (F) Shut-off Valve, (G) Pump, (H) Line Strainer.

The pressure gauge was visible from the tractor seat. The boom control valve was easily reached from the seat of smaller tractors but difficult to reach from large tractors. The agitator valve could not be reached from the tractor seat. Relocation of the agitator valve so it could be conveniently adjusted from the tractor seat would be desirable since it was easier to obtain the desired spraying pressure with the agitator valve than with the boom control valve. Small adjustments of the boom control valve resulted in large pressure changes. The boom and agitation control valves became very difficult to turn after about 30 hours of field use. This added to the difficulty of obtaining the desired spraying pressure with the boom control valve. Modifications are recommended to simplify pressure adjustment.

The tank liquid level indicator was easy to read when the sprayer was new or if the solution in the tank was opaque. With clear solution such as Banvel, the liquid level was difficult to, see after the tube became clouded with chemical. The gauge gave only a rough indication of liquid level since operation on hills and movement of liquid in the tank caused the indicator reading to fluctuate.

Transport: The Demco LPW 560 could be folded into transport or placed into field position in less than four minutes. The ends of the tow bar pins were blunt, requiring perfect alignment with tow bar holes before they could be inserted. This was especially difficult in rough fields, as the castor wheels rocked back and forth depending on soil contour. Modifications are recommended to simplify pin insertion.

The Demco had a turning radius of 7 m (23 ft) in transport position, which provided sufficient maneuverability. The turning radius was limited by boom interference (FIGURE 12). Backing the sprayer in transport position was difficult. The sprayer towed well at all normal road transport speeds.

FIGURE 12. Boom Interference when Making Sharp Turns.

Rear Safety Stand: Interference occurred between the rear safety stand and right boom end (FIGURE 13) when making left turns during transport. It is recommended that modifications be made to eliminate this interference.

FIGURE 13. Interference Between Rear Safety Stand and Right Boom End.

Tank Filling: The tank filler opening was over 1700 mm (67 in) above the ground, which made the tank difficult to fill by gravity from a nurse tank on a farm truck. The nurse tanks could only be completely emptied by driving the farm truck on higher ground or driving the sprayer in a ditch. This was time consuming and awkward. A plumbing package designed to utilize the sprayer pump to fill the sprayer tank from a nurse tank is available as optional equipment but was not evaluated. The 255 mm (10 in) filler opening was adequate for adding chemicals and water.

The platform provided for use in adding chemicals to the tank was too low, resulting in the operator standing on the trailer wheel. It is recommended that the platform be modified to provide for safer and more convenient filler opening access.

Nozzle Adjustment: Nozzle height could be adjusted without the use of tools. However, this was awkward since the operator had to simultaneously hold the boom support rail in position, pull the adjusting pin and align the adjusting bar hole with the pin (FIGURE 14). Modifications are recommended to make boom height adjustment more convenient.

Nozzle angle could not be adjusted. Modifications are recommended to provide nozzle angle adjustment for spraying with floodjet nozzles and for spraying Carbyne.

Nozzle Cleaning: The nozzles were easily removed for cleaning without the use of tools.

Hitching: The sprayer could be hitched to a tractor when the tank was empty without the use of the provided hitch jack. The jack was required when the tank was full. The sprayer, when empty, had a tendency to tip backwards. An adjustable safety stand was provided at the rear of the sprayer to prevent the sprayer from tipping backwards.

The tank sloped rearwards when hitched to most tractors. Since the pump suction hose was located at the center of the tank, it was important to keep the tank level to ensure a supply of liquid to the pump inlet. The hitch had to be inverted to level the tank for most tractors.

The power take-off shaft was equipped with a quick-disconnect coupling. The power leads for the solenoid boom valves connected to the tractor battery with alligator clamps.

FIGURE 14. Operator Aligning Nozzle Height, Adjusting Bar with his Knee.

Power Take-Off Shaft Transport Support: A clip was provided on the control stand to hold the power take-off shaft during transport. The clip was inconvenient to use since the control stand height had to be adjusted to attach the shaft. The stand height was dif. cult to adjust. Once it had been positioned to make the controls accessible from the tractor seat, readjusting it, to suit the power take-off shaft for transport, was inconvenient. Modifications are recommended to simplify securing the free end of the power take off shaft for transport.

Servicing and Cleaning: Lubricating the sprayer was easy since all grease fittings were accessible. No grease fitting was provided on the castor wheel support carrier and the manufacturer recommended that grease be applied manually. The fork had to be turned manually to place grease on top of the wheel carrier plate. This was difficult and inconvenient since the weight on the wheel was over 130 kg (290 lb). It is recommended that grease fittings be added to the castor wheel support carrier to improve servicing.

No drain plug was provided on the tank. The tank was cleaned and drained by disconnecting the suction hose from the pump. This was not satisfactory since the suction hose was attached at the centre of the tank making removal of all liquid difficult. It is recommended the optional sump be provided as standard equipment so the tank can be conveniently and completely drained.

OPERATOR SAFETY

Slow Moving Vehicle Sign: The sprayer was not equipped with a slow moving vehicle sign. This item should be standard equipment to comply with safety regulations.

Height Adjusting Bar: The boom height adjusting bar extended in front of the boom and could cause injury to an operator by accidentally walking into it while servicing.

Caution: Operators of all spraying equipment are cautioned to wear suitable eye protection, respirators and clothing to minimize operator contact with chemicals. Although many commonly used agricultural chemicals appear to be relatively harmless to humans, 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 a number of years.

OPERATOR'S MANUAL

The operator's manual clearly outlined sprayer installation, operation, calibration, nozzle selection, parts, lubrication and safety tips.

The calibration charts supplied with the sprayer were prepared only in Imperial units. To accommodate the present changeover to the metric (SI) system, calibration charts should be supplied in both Imperial and metric (SI) units.

MECHANICAL PROBLEMS

TABLE 3 outlines the mechanical history of the Demco LPW 560 during 86 hours of field operation while spraying about 1371 ha (3386 ac). Since the intent of the test was evaluation of functional performance, the following failures represent only those, which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History

Item	Hours	Field Area ha
Plumbing Assembly		
-The 13 mm control valve barbed connectors were replaced with 19 mm barbed connectors to .t the boom hoses at	beginning of test	
-The pump outlet hose buckled flat when not under pressure	throughout the test	
-The middle boom inlet hoses sagged and buckled flat during transport	throughout the test	
-The line strainer leaked, requiring frequent tightening	throughout the test	
-Additional gaskets were installed at	16, 22	240, 330
-The outer section inlet hose fasteners were lost and replaced at	22	330
-Nozzles plugged and 50 mesh nozzle screens were installed at	32	480
-The right inner end nozzle assembly broke off during transport and was repaired at	43	645
-The outlet hose from the left solenoid valve developed two holes from rubbing on the power take-off support and was repaired at	59	888
-The left inner end nozzle assembly bent during transport and was repaired at	80	1269
-Both left and right inner end nozzle assemblies had bent again at	end of test	
-The rear agitator hose was slightly worn from resting on a metal strap under the trailer frame at	end of test	
Tank and Trailer Assembly		
-The 19 mm level indicator tubing was replaced by 10 mm tubing to fit the barbed connections provided at	beginning of test	
-A hole for the control panel brace was drilled at	beginning of test	
-A bolt was lost from the right side of the pump hanger and replaced at	66	1038
-The control panel upright bent when the set screws loosened at	79	1253
-A hitch bolt was lost and replaced at	79	1253
-The hitch bolts loosened and were tightened at	86	1368
-The right tow bracket was bent slightly at	end of test	
-The hitch clevis was bent at	end of test	
Boom Assembly		
-The locknuts on the boom height adjustment linkage loosened frequently	throughout the test	
-Several of the bolts and locknuts were lost and replaced	throughout the test	
-The nuts and setscrews on the bottom end of the boom height adjustment linkage loosened, causing the boom ends to sag and 38, 66, were tightened at	38, 66, 79, 86	570, 1038, 1253, 1368
-The locknut on the right height adjusting bar loosened and was tightened at	59	888
-The bolt on the right height adjusting bar broke causing the entire boom to drag on the ground. The bolt and locknut were replaced a	60	906
-The transport tie bar pin clips bent at	62	942
-the transport bar brackets bent and the holes were worn at	62	942
-The right wheel bracket bent and was straightened at	66	1038
-The right transport tie bar hairpin was lost at	end of test	
-The left end of the transport bar interfered with the left transport bar bracket at	end of test	

DISCUSSION OF MECHANICAL PROBLEMS

PLUMBING ASSEMBLY

Strainer: The line strainer could not be sufficiently tightened by hand to prevent leaking. Additional gaskets and tightening with a wrench stopped the leaking temporarily but made it difficult to remove by hand. Modifications are recommended to prevent the strainer from leaking.

Inner End Nozzle Assemblies: Interference between the tank and middle boom inlet hoses (FIGURE 15), when travelling through depressions in transport position, resulted in bent and broken inner end nozzle assemblies. Modifications are recommended to prevent interference and nozzle damage.

FIGURE 15. Interference Between Tank and Middle Boom Inlet Hose Causing End Nozzle Damage.

Hoses: The hoses were soft and often sagged and buckled flat due to inadequate support (FIGURES 16 and 17). The boom inlet hose fasteners broke off during field operation, causing the hoses to drag on the ground. It is recommended that the hoses be properly secured to eliminate buckling, sagging and wear.

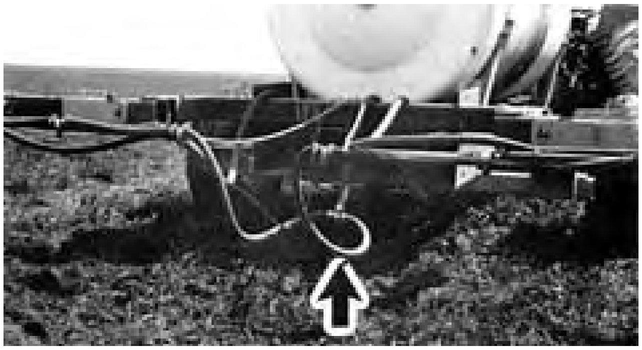

FIGURE 16. Sagging Middle Boom Inlet Hoses.

FIGURE 17. Buckled Pump Outlet Hose.

BOOM ASSEMBLY

Boom Height Adjusting Linkage: The locknuts on the boom height adjustment linkage provided resistance to the boom falling down completely while being adjusted. These locknuts loosened frequently during field operation resulting in lost nuts and bolts, excessive bouncing of the boom support rails and difficulty in adjusting boom height. It is recommended that the manufacturer make modifications to prevent the boom adjustment linkage locknuts from loosening during field use.

Right Castor Wheel: The right castor wheel outer bracket bent causing the wheel spindle to pull out of the inner bracket when the unlocked castor wheel went through a small dip on the road while being towed in transport. When towing the sprayer in transport, the manufacturer recommended that only one castor wheel be locked to allow for some wheel misalignment and to keep the sprayer from wobbling. To avoid castor wheel damage it is recommended that the manufacturer specify that both castor wheels be locked during transport.

Transport Tie Bar: The transport tie bar pin clips, used to keep the transport bar in place, interfered with the transport tie bar brackets when turning in transport position and bent (FIGURE 18) making them difficult to remove. The left end of the transport bar also wedged within the left transport bar bracket when transporting through depressions, making it difficult to remove the bar.
Modifications are recommended to prevent these problems.

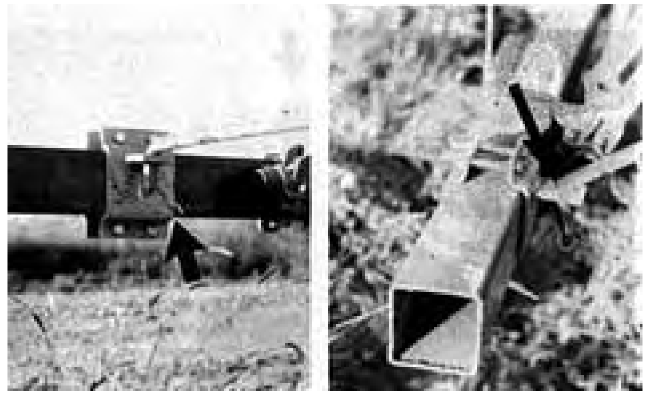

FIGURE 18. Bent Transport Pin Clip (left) and Wedging of Transport Bar in Bracket (right).

APPENDIX
SPECIFICATIONS

MAKE:	Demco Field Sprayer	
MODEL:	LPW 560	
SERIAL NUMBER:	594	
	Field Position	**Transport Position**
OVERALL WIDTH:	17,760 mm	2500 mm
OVERALL LENGTH:	4800 mm	12,440 mm
OVERALL HEIGHT:	1730 mm	1730 mm
TRAILER BOOM WHEEL TREAD:	2050 mm (max) 1510 mm (min)	12,580 mm
TIRES:	2, 11L x 15SL 2, 4.80 x 12 8-ply rib implement	
WEIGHTS: (Field Position)	**Tank Empty**	**Tank Full**
-- left trailer wheel	315 kg	1150 kg
-- right trailer wheel	330 kg	1140 kg
-- left boom wheel	136 kg	136 kg
-- right boom wheel	136 kg	136 kg
-- hitch	23 kg	290 kg
TOTAL	940 kg	2852 kg
TANK:		
-- material	fiberglass	
-- capacity	1900 L	
FILTERS:		
-- line strainer	40 mesh	
-- nozzle strainer	none	
PUMP: (540 rpm PTO driven)	Hypro C9006	
AGITATION:	hydraulic	
PRESSURE GAUGE:	USG (0 to 60 psi)	
BOOM SOLENOID VALVES:	Spraying Systems Model 14810-1 12 volt DC, 30 watt, 1/2" NPT	
BOOMS:	19 mm rubber hose attached to 31 mm square tube	
NOZZLES: (Optional)		
-- number	36	
-- spacing	508 mm	
SPRAYING WIDTH:	18.3 m	
BOOM ADJUSTMENT:		
-- height		
-maximum	952 mm	
-minimum	351 mm	
HITCH HEIGHT ADJUSTMENT:		
-- maximum	467 mm	
-- minimum	244 mm	
LUBRICATION POINTS:		
-- suction shut off valve	1	
-- castor wheel pivots	2	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports,

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX III
CONVERSION TABLE

1 kilometer per hour (km/h)	= 0.6 miles per hour (mph)
1 hectare (ha)	= 25 acre (ac)
1 litre per hectare (L/ha)	= 0.09 Imperial gallons per acre (gal/ac)
1 kilopascal (kPa)	= 0.15 pounds per square inch (psi)
1 kilogram (kg)	= 2.2 pounds mass (lb)
1 litre per second (L/s)	= 13.2 Imperial gallons per minute (gal/min)
1 litre (L)	= 0.22 Imperial gallons (gal)
1 metre (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)

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