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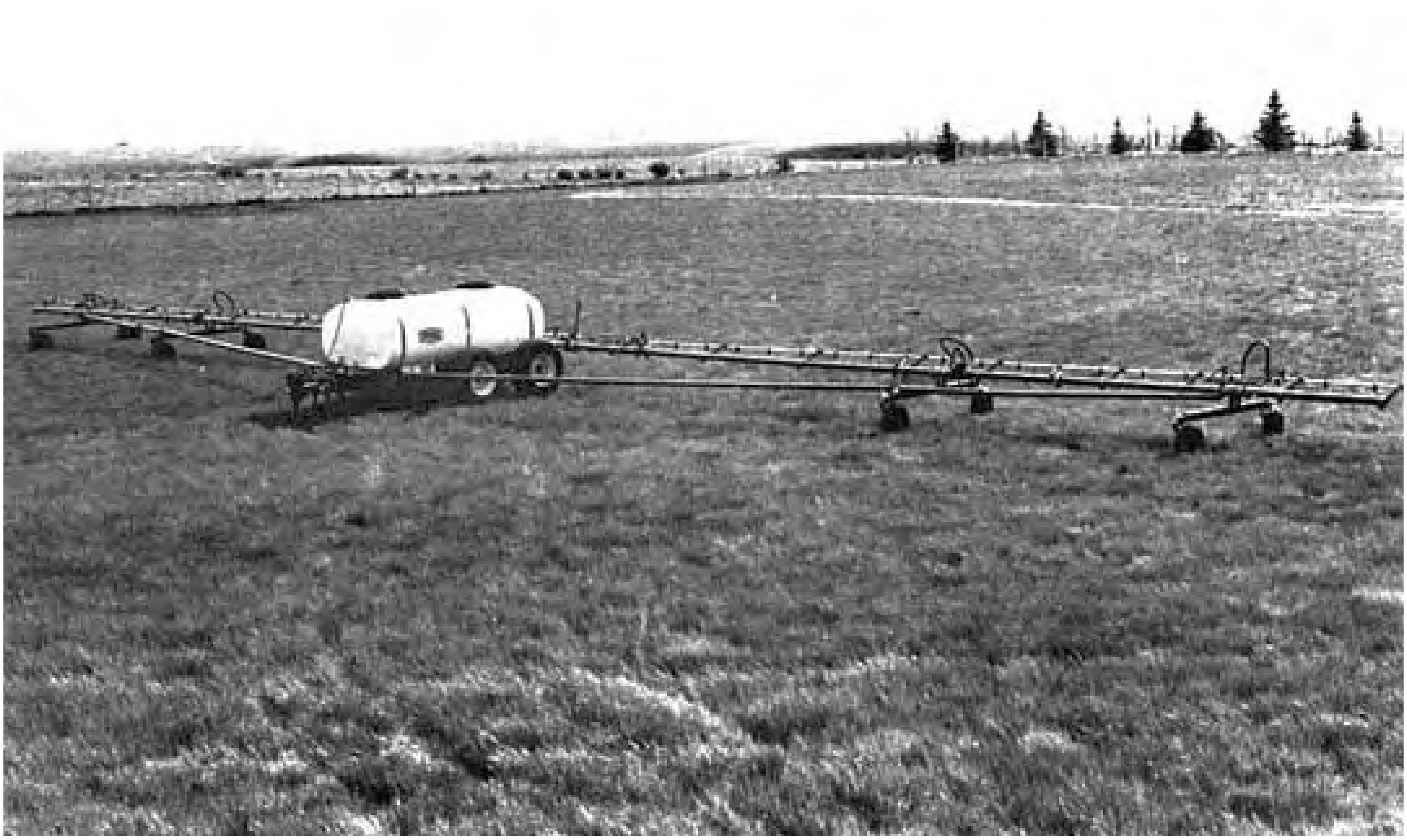
Evaluation Report 273



George White Model T610 Field Sprayer

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

GEORGE WHITE MODEL T610 FIELD SPRAYER

MANUFACTURER:
White - McKee Inc.
P.O. Box 70
Elmira, Ontario
N3B 2Z9

DISTRIBUTOR:
Saskatchewan Wheat Pool
2625 Victoria Avenue
Regina, Saskatchewan
S4T 1K2

RETAIL PRICE: (January, 1982, f.o.b. Elmira, Ontario)

a. T610 sprayer complete with Hypro Model C9006 centrifugal pump, Spraying Systems TeeJet 8002 stainless steel flat fan nozzle tips, quick attach diaphragm check valves and 24.9 m (82 ft) boom. $7150.00
b. Electronic sprayer monitor, automatic rate controller and remote boom controller. $1590.00

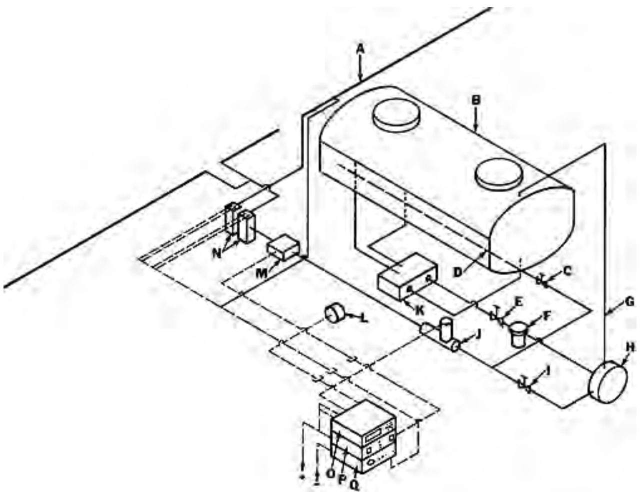


FIGURE 1. System Schematic for George White Model T610: (A) Booms, (B) Tank, (C) Agitator Valve, (D) Agitation Pipe, (E) Inlet Valve, (F) Strainer, (G) Positive Inlet By-Pass Line, (H) Pump, (I) Discharge Valve, (J) Flow Sensor, (K) Sump, (L) Speed Sensor, (M) Motorized Control Valve, (N) Boom Solenoid Valves, (O) Spray Monitor, (P) Automatic Rate Controller, (Q) Boom and Pressure Controller.

SUMMARY AND CONCLUSIONS

Functional performance of the George White Model T610 field sprayer was fair. Functional performance was reduced by interference between the tandem beam weldments and castor wheel forks, castor fork spindle failures, poorly fastened outer front and rear radius rods, rotation of radius rod mounts around the boom rail and inadequately fastened hitchjack.

Nozzle distribution patterns were acceptable at pressures above 95 kPa (14 psi) with the 80 degree LP Flat Fan TeeJet 8001 stainless steel nozzle tips and above 190 kPa (28 psi) with the 80 degree standard TeeJet 8002 stainless steel nozzle tips. Delivery of new LP8001 and standard 8002 nozzle tips was 3.3 and 2.3% higher, respectively, than specified by the manufacturer. Variability among individual nozzle deliveries was low. The nozzle assembly accepted a wide range of standard nozzle tips.

Output of the Hypro C9006 centrifugal pump was similar to the manufacturer's output. Pump capacity was reduced by its sensitivity to plumbing system restrictions. As a result the pump was not adequate to apply certain chemicals since sufficient agitation to keep the tank solution properly mixed was not possible.

Operating pressure was measured at the middle boom, giving the operator a good indication of nozzle spraying pressure. Plumbing system pressure losses did not affect sprayer operation at normal prairie application rates. Application rates up to 290 L/ha (26 gal/ac) were possible with available nozzles at acceptable nozzle pressures. The pressure gauge read 10 kPa (1.5 psi) high in the normal operating range. The 50 mesh nozzle cup strainers and LP 8001 nozzles plugged frequently.

The George White sprayer was equipped with a monitor, automatic rate controller and boom controller. Application rate was automatically maintained by the motorized control valve, which adjusted flow to the booms when changes in ground speed, engine speed and pressure occurred. The boom controller indicated boom pressure and operated the solenoid valves, which controlled flow to the three boom sections. All consoles could be conveniently placed on the tractor within the operator's reach. The system functioned well when properly calibrated.

Nozzle height and angle were adjustable. Hitching was convenient but unsafe due to an inadequately fastened hitch jack. Grease fittings were readily accessible. Grease to the trailer spindles was inadequate. Difficulty in holding the height adjustment lever with one hand and interferences between the outer radius rods, boom rail and tandem beams made folding and unfolding the sprayer inconvenient. Rotation of the radius rod mounts around the boom rail also made folding and unfolding the sprayer inconvenient.

Caution had to be exercised when transporting the sprayer due to its 3.9 m (12.8 ft) width. Backing the sprayer was inconvenient.

The sump was supplied with a drain for convenient tank draining and cleaning.

The operator's manual adequately outlined sprayer operation. Information on the compatibility of the automatic rate controller, boom controller and sprayer monitor with the sprayer was inadequate.

Several mechanical problems occurred during the 87 hours of field operation. Interference between the castor forks and tandem beam weldments caused the tandem beams to rotate about the boom rail causing damage to the nozzle bodies, radius rod mounts, slow moving vehicle sign, radius rod connecting bars, castor forks, boom uprights and collars. Interference between the connecting bars and linch pins resulted in the loss of the linch pins. Several of the vertical castor fork spindles failed. The hex bolts and retainer pins joining the outer front and rear radius rods were lost due to field vibration. The bolts on the hitch bracket and mounting plates loosened frequently. The tank saddle tore away from the trailer at the weld and the hitch frame twisted.

RECOMMENDATIONS:

It is recommended that the manufacturer consider:

1. Modifications to provide more convenient cleaning of the strainer bowl.
2. Providing 100 mesh nozzle strainers for use with LP 8001 nozzles.
3. Modifications to supply sufficient agitation.
4. Modifications to eliminate outer radius rod pins and boom rail interference when positioning and removing the radius rods from the holder clips.
5. Modifications to eliminate outer radius rod and tandem beam assembly interference when folding and unfolding the outer booms.
6. Modifications to prevent the radius mounts from rotating around the boom rails to eliminate binding when placing in transport and to prevent nozzle angle from changing during field operation.
7. Modifications to prevent the booms from colliding and spreading apart during transport or backing.
8. Providing a safer and more convenient way to add chemical to the spray tank.
9. Modifications to make boom height adjustment more convenient.
10. Attaching the hitchjack to the sprayer hitch more securely.
11. Modifications to ensure adequate lubrication of the trailer spindles.
12. Providing complete information on the compatibility of the automatic rate controller, boom controller and sprayer monitor with the George White sprayer.
13. Providing a longer electrical cable for the solenoid valves.
14. Modifications to prevent the tank saddle from tearing away

at the weld.
15. Modifications to prevent hitch frame from twisting and the bolts on the hitch bracket and mounting plates from loosening.
16. Modifications to prevent the vertical castor fork spindles from failing.
17. Modifications to prevent the outer front and rear radius rods from separating during field operation.

Senior Engineer: E. H. Wiens

Project Technologist: L. B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The filter is now mounted vertically to prevent build up at the inlet.
2. 100 mesh screen is recommended for use with LP8001 nozzles and are available.
3. The sprayer plumbing will be investigated in an attempt to increase agitation and still retain the required volume to the booms. This report has concluded that the agitation is insufficient based solely on an "old rule of thumb" rather than as a result-of any actual measurements to show that "certain chemicals" would or would not stay properly mixed.
4. Outer radius rod pins and boom rail interference when positioning and removing the radius rods from the holder clips has not been reported as a problem on any 1981 production units. This is under investigation.
5. Interference between the outer radius rod and tandem beam has not been reported as a problem on any 1981 production units. This is under investigation.
6. A stop has been added to prevent the radius mounts from rotating around the boom rails.
7. A tie bar will be supplied to connect booms in transport.
8. An optional step is available to facilitate adding chemicals to the tank.
9. A redesign of the handle locking mechanism is being investigated.
10. A tube mount jack now bolts directly to the tongue.
11. A more effective lubrication system is being investigated.
12. Manuals for the controllers and monitor are being provided.
13. An extension electrical cable is now being provided.
14. The frames have been modified to eliminate weld failures on the tank saddle.
15. The hitch frame has been modified.
16. A new design of outrigger tandem beams has eliminated failures of castor forks.
17. Welding on radius rods have been improved.

Manufacturer's Additional Comments

1. The new sealing arrangement of nozzles will prevent leakage.
2. The tank below the sprayer is more effective than a "sump" and is referred to as a suction header as it eliminates air from the system.
3. The method of attaching radius rods to the centre tandem has been modified and should remove the problem of losing lynch pins.
4. The boom uprights have a small protrusion in their radius to help prevent rotation on the boom pipe.
5. All attaching bolts for radius rods will have lock nuts in the future.

GENERAL DESCRIPTION

The George White Model T610 is a trailing, boom type field sprayer. The trailer is mounted on tandem axles while each boom is supported by two tandem walking beam castor assemblies, one near the center and one near the outer end. The low profile 2400 L (528 gal) plastic tank is equipped with hydraulic agitation, fluid level indicator and two filler openings with strainers.

The George White T610 has 49 nozzles spaced at 508 mm (20 in) giving a spraying width of 24.9 m (81.7 ft). Nozzles are equipped with diaphragm check valves to prevent spray drip when the boom control valves are closed. Boom height and spray angle are adjustable. The booms fold back for transport. The test machine was equipped with an optional electronic control system. The electronic control system included three remote consoles, which mounted on the tractor, a spray monitor, a boom and pressure controller and an automatic application rate controller. The planetary gear drive centrifugal pump is driven from a 540 rpm tractor power take-off.

FIGURE 1 presents a flow schematic for the George White T610 while detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The George White T610 was operated for 87 hours in the conditions shown in TABLE 1 while spraying about 1325 ha (3273 ac). It was evaluated for quality of work, pump performance, ease of operation, operator safety and suitability of the operator's manual.

Both 80 degree LP 8001 and standard 8002 .at fan Tee Jet stainless steel nozzle tips were supplied with the sprayer. During the test, the LP 8001 tips were used for 72 hours and the standard 8002 tips were used for 15 hours.

Table 1. Operating Conditions

Chemical Applied	Field	Hours	Speed km/h	Field Area ha	Workrate ha/h
Sweep/Banvil	Bladed Stubble	14.6	9	256	18
Sweep/Banvil/2, 4-D	Bladed Stubble	24	9	407	17
Banvil/2, 4-D	Wheat	4	9	65	16
Buctril M	Wheat	13	9	180	14
Buctril M	Barley	13	10.5	228	18
Buctril M	Wheat	4.5	6.5	71	16
Round-Up	Summerfallow	1	6.5	16	16
Hoegrass/Torch	Wheat	9.5	7	102	10.5
TOTAL		87		1325	

RESULTS AND DISCUSSION

QUALITY OF WORK

Distribution Patterns: The LP TeeJet nozzles were designed for use over a pressure range from 70 to 200 kPa (10 to 30 psi). FIGURES 2 and 3 show spray distribution patterns along the boom with LP TeeJet 8001 nozzles when operated at a 460 mm (18 in) nozzle height. The coefficient of variation (CV)[1] at 70 kPa (10 psi) (FIGURE 2) was 29.3%, with application rates along the boom varying from 32 to 83 L/ha (2.9 to 7.5 gal/ac) at 8 km/h (5 mph). High spray concentration occurred below each nozzle with inadequate coverage between nozzles. At 150 kPa (22 psi) (FIGURE 3) the distribution pattern improved considerably, reducing the CV to 7.7%. Application rates along the boom varied from 61 to 85 L/ha (5.5 to 7.7 gal/ac) at 8 km/h (5 mph). Higher pressures improved distribution by increasing the overlap and capacity among nozzles.

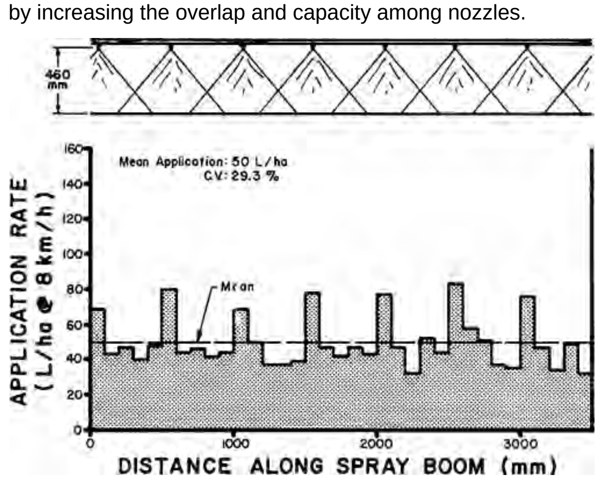


FIGURE 2. Typical Distribution Pattern along the Boom at 70 kPa with Spraying Systems LP Tee Jet 8001 Stainless Steel Nozzles, at a 460 mm Nozzle Height.

[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 rate. 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 other chemicals may have a narrower range.*

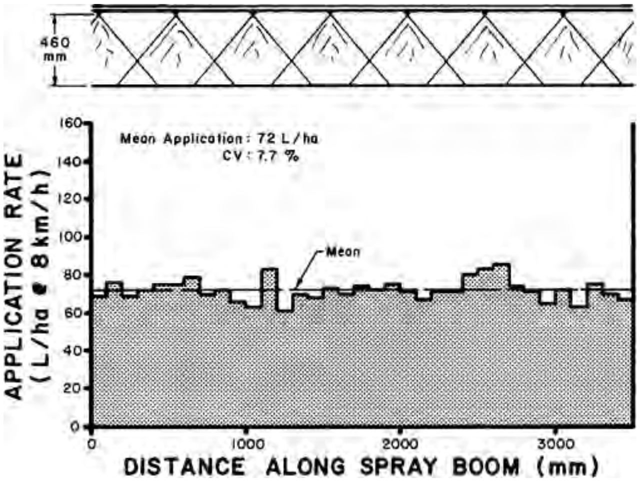


FIGURE 3. Typical Distribution Pattern along the Boom at 150 kPa with Spraying Systems LP TeeJet 8001 Stainless Steel Nozzles, at a 460 mm Nozzle Height.

The standard 8002 TeeJet nozzles were designed for use over a pressure range from 150 to 400 kPa (22 to 58 psi). FIGURES 4 and 5 show spray distribution patterns along the boom with these nozzles when operated at a 460 mm (18 in) nozzle height. The coefficient of variation (CV) at 150 kPa (22 psi) was 22.0% with application rates along the boom varying from 55 to 123 L/ha (5.0 to 11.1 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 for the standard flat fan TeeJet nozzles, the distribution pattern at the 150 kPa (22 psi) nozzle pressure is shown to illustrate the poor patterns typical at low pressures. At 300 kPa (44 psi) the distribution pattern improved, reducing the CV to 7.8%. Application rates along the boom varied from 101 to 136 L/ha (9.1 to 12.2 gal/ac) at 8 km/h (5 mph). Higher pressures improved distribution by increasing the overlap and capacity among nozzles. High pressure with standard TeeJet nozzles, however, usually causes more spray drift.

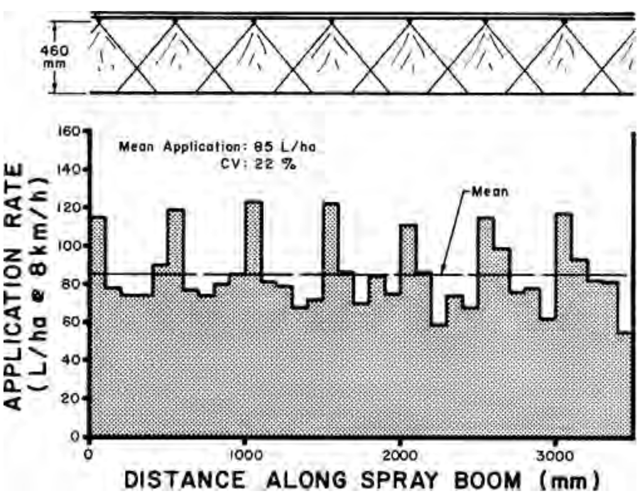


FIGURE 4. Typical Distribution Pattern along the Boom at 150 kPa with Spraying Systems Tee Jet 8002 Stainless Steel Nozzles, at a 460 mm Nozzle Height.

FIGURE 6 shows how nozzle pressure and wear affected spray pattern uniformity for the low pressure 8001 and standard 8002 flat fan nozzles. New LP 8001 stainless steel nozzles produced acceptable distribution patterns at pressures above 95 kPa (14 psi) and very uniform patterns at pressures above 120 kPa (17 psi). After 72 hours of field use, a pressure of 140 kPa (20 psi) was required to produce an acceptable distribution pattern and a pressure of 225 kPa (33 psi) was required to produce a very uniform distribution. Pressures above 200 kPa (30 psi) are not recommended due to excessive spray drift. New 8002 stainless steel nozzles produced acceptable distribution patterns at pressures above 190 kPa (28 psi) and very uniform patterns at pressures above 240 kPa (35 psi). After 15 hours of field use, a pressure of 220 kPa (32 psi) was required to produce an acceptable distribution pattern and a pressure of 310 kPa (45 psi) was required to produce a very uniform distribution.

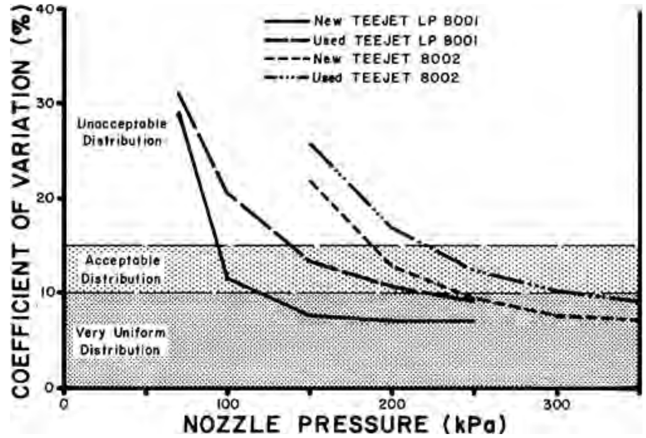


FIGURE 5. Typical Distribution Pattern along the Boom at 300 kPa with Spraying Systems TeeJet 8002 Stainless Steel Nozzles, at a 460 mm Nozzle Height.

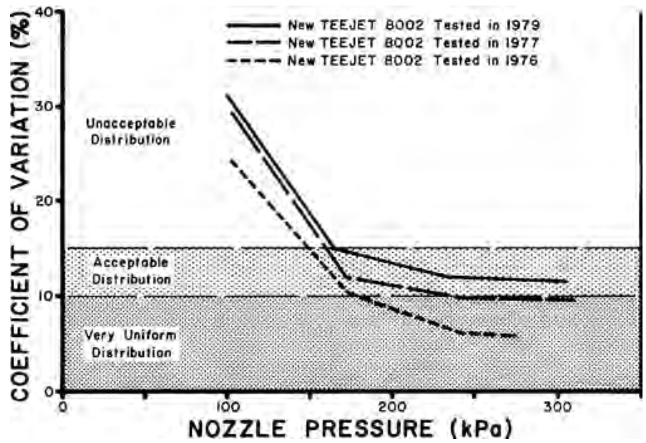


FIGURE 6. Spray Pattern Uniformity for New and Used Spraying Systems Tee Jet Standard 8002 and Low Pressure 8001 Stainless Steel Nozzles, Operated at a 460 mm Nozzle Height.

FIGURE 6 also shows that the low pressure TeeJet nozzles produce better spray pattern uniformity throughout their designed pressure range than the standard TeeJet nozzles. Observations of spray patterns indicated that the LP Tee Jet nozzles produced fewer small droplets than the standard TeeJet nozzles at the upper end of their respective pressure ranges.

FIGURE 7 shows spray pattern uniformity results for three different batches of new standard TeeJet 8002 stainless steel nozzles tested by PAMI in previous years. As can be seen from FIGURE 7, large variations in spray pattern uniformity are possible in stainless steel nozzles. For example, 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 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.

Spray Drift: 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 pressures since booms can be operated lower to the ground and fewer small droplets are produced. The low pressure LP8001 nozzles supplied with the George White were effective in minimizing drift, since they could be operated at low pressures, resulting in larger droplet sizes.

Nozzle Calibration: FIGURE 8 shows the average delivery of Spraying Systems LP TeeJet 8001 and standard TeeJet 8002 stainless steel nozzles over the normal range of operating pressures. The delivery of new LP8001 and 8002 nozzles was 3.3

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[2]*Maybank, J; Yoshida, K; Shewchuk, S.R., "Comparison of Swath Deposit and Drift Characteristics of Ground-Rig and Aircraft Herbicide Spray Systems" (Report of the 1975 Field Trials, Saskatchewan Research Council Report No. P76-1, January, 1976, p. 16.)*

and 2.3% higher, respectively, than specified by the manufacturer. The delivery rate of used LP8001 and 8002 nozzles increased less than 1.5% after 72 and 15 hours of field use, respectively. 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 both the LP8001 and 8002 was low. A low CV indicates similar discharge rates for all nozzles while a high CV indicates larger variability among individual nozzle deliveries. The CV of nozzle deliveries of the LP8001 and 8002 nozzles was 2.7 and 2.0%, respectively, for both new and used nozzles.

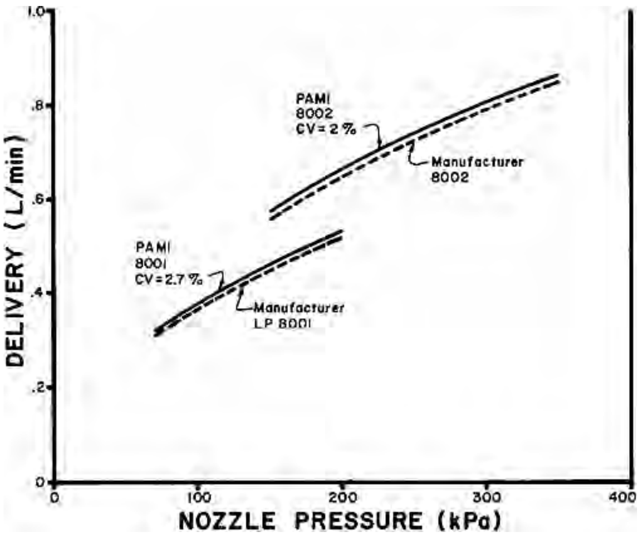

FIGURE 7. Spray Pattern Uniformity for Three Different Batches of New Spraying Systems Tee Jet 8002 Stainless Steel Nozzles, Operated at a 460 mm Nozzle Height.

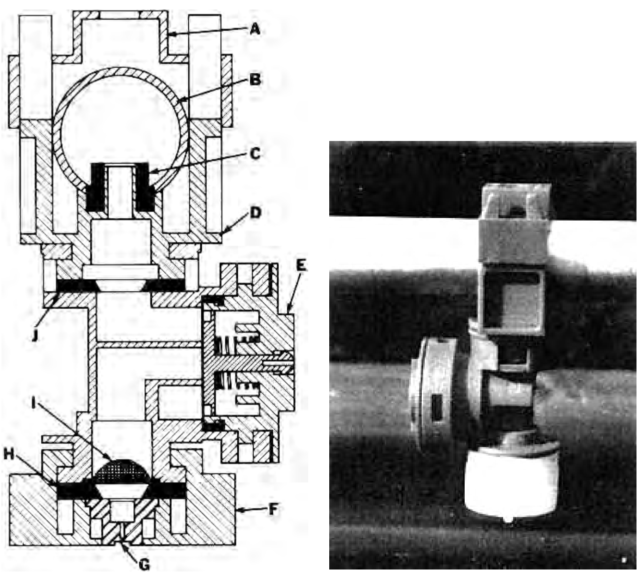

FIGURE 8. Delivery Rates for Tee Jet LP8001 and 8002 Stainless Steel Nozzles.

Use of Optional Nozzles: The nozzle assembly (FIGURE 9) accepted a wide range of standard nozzle tips. The quick attach, plastic nozzle caps and diaphragm check valves made nozzle changing quick and easy. Leaking around the nozzle clamp body occurred at the beginning of field testing. After several hours of field spraying, the leaking stopped. The plastic nozzle clamp body was easily broken when struck by an object.

Pressure Losses in Plumbing System: Pressures in the plumbing system were measured at the pump outlet, after the flow sensor, after the motorized control valve, at the boom inlet, at the boom end, and at the nozzle (FIGURE 1). At a typical prairie application rate of 100 L/ha (9 gal/ac), a pressure loss of approximately 50 kPa (7 psi) occurred from the pump outlet to the nozzles. Pressure losses were due mainly to restrictions caused by solenoid valves, elbows and hoses. Since the operating pressure was read at the middle boom, these pressure losses did not affect sprayer operation at normal spraying rates.

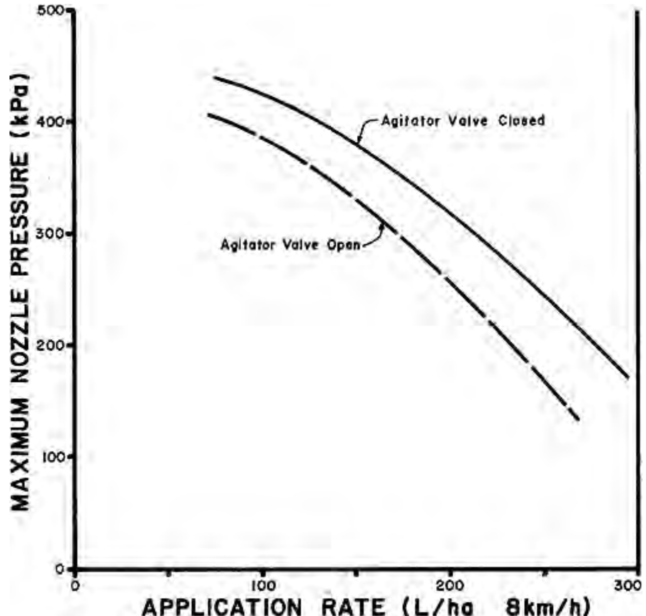

FIGURE 9. Cross Section of Nozzle Assembly: (A) Clamp Top, (B) Spray Boom, (C) Clamp Seal, (D) Clamp Body, (E) Diaphragm Check Valve, (F) Nozzle Cap, (G) Nozzle Tip, (H) Nozzle Seal, (I) Cup Strainer, (J) Check Valve Seal.

FIGURE 10 shows the maximum pressures available at the nozzle at various application rates when travelling at 8 km/h (5 mph). For example, with the agitator valve fully open, at a typical prairie application rate of 100 L/ha (9 gal/ac), the maximum nozzle pressure obtainable was 383 kPa (56 psi). Nozzle pressures below 200 kPa (29 psi) are not recommended due to poor distribution patterns that occur at low pressures when using standard flat spray nozzles. The maximum application rate obtainable with the George White T610 at a pressure of 200 kPa (29 psi) was 233 L/ha (21 gal/ac). At 100 kPa (15 psi), the lowest pressure at which low pressure flat fan spray nozzles produce a good distribution pattern, the maximum obtainable application rate was 285 L/ha (26 gal/ac).

Closing the agitator valve resulted in increased nozzle pressure at the various application rates. However, for most chemicals, the agitator valve had to be fully opened to obtain the required agitation.

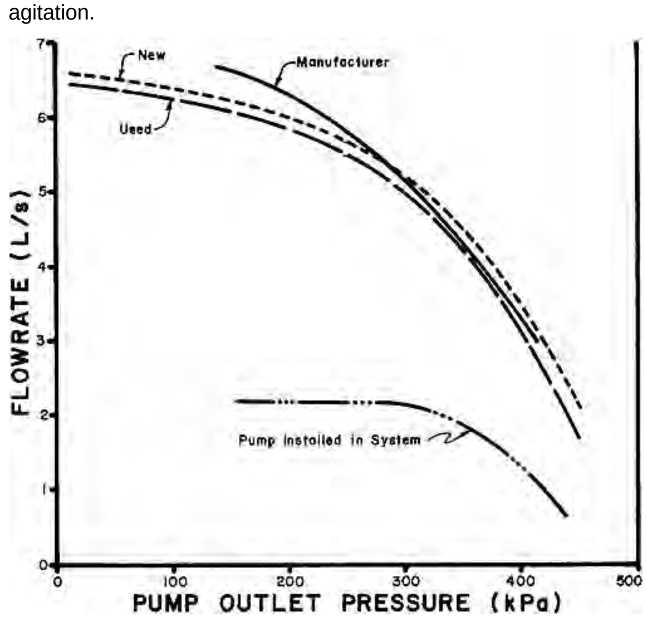

FIGURE 10. Maximum Available Nozzle Pressures at Various Application Rates at 8 km/h.

Pressure Gauge: The pressure gauge read 10 kPa (1.5 psi) high in the normal operating range throughout the test. This was considered a negligible error. Tank Strainer: The two 16 mesh tank strainers effectively removed large foreign particles from the water during tank filling.

Line Strainer: A combination 16/50 mesh screen was located in the pump inlet line and effectively kept foreign material from entering the spray system. The plastic strainer bowl was tilted upwards causing the debris to settle at the inlet line. This made it difficult to clean out the debris and could cause inlet line restrictions. It is recommended that the strainer bowl be repositioned to make strainer bowl cleaning more convenient.

Nozzle Strainers: The 50 mesh nozzle cup strainers effectively prevented the larger 8002 flat spray nozzles from plugging. Considerable plugging of the LP8001 nozzles occurred during the test. It is recommended that 100 mesh strainers be provided for use with the LP8001 nozzles. The cup strainers required frequent cleaning since the strainers themselves would plug up.

Soil Compaction and Crop Damage: The trailer and boom wheels travelled over about 1.9% of the total field area sprayed. The wheel tread of the trailer was 1800 mm (71 in), corresponding to the wheel tread on most tractors. The only crop damage, in addition to that caused by the tractor wheels, was that caused by the castor wheels. This was only 0.6% of the total area sprayed. Soil contact pressure beneath the castor wheels was about 20% greater than that of an unloaded pickup truck. The average soil contact pressure under the sprayer wheels with a full tank are given in TABLE 2.

TABLE 2. Soil Compaction by Sprayer Wheels

	Average Soil Contact Pressure* kPa	Tire Track Width mm
Trailer Wheels	196	154
Front Inner Boom Wheels	182	45
Rear Inner Boom Wheels	239	32
Outer Boom Wheels	239	32

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

RATE OF WORK

Field Speeds: The George White field sprayer operated well at speeds up to 12 km/h (7.5 mph). Speeds had to be reduced considerably on most corners due to excessive castor wheel bouncing which occasionally resulted in the beams rotating about the boom rails (FIGURE 22). Spraying during a turn is not recommended due to poor distribution patterns that occur at low pressure and erratic application rates that result along the boom due to different ground speeds of the boom.

The automatic rate controller permitted operating the tractor engine at speeds slightly above and below the rated engine speed. This permitted herbicide spraying in rough and hilly terrain where engine speed was usually reduced or increased.

Average Workrates: Field work rates indicated on the sprayer monitor varied from 17 to 27 ha/h (42 to 67 ac/h). However, actual average workrates, considering variations in field size, shape, topography and tank refill time varied from 10.5 to 18 ha/h (26 to 45 ac/h).

PUMP PERFORMANCE

Priming: The Hypro C9006 centrifugal pump supplied with the George White sprayers was not self-priming. The pump was secured to the tractor power take-off shaft. The positive inlet pressure needed for pump priming was automatically provided when the spray tank was full. The manufacturer warned that the pump not be run dry to avoid damaging pump seals. The sump below the spray tank provided the pump with liquid in all topographic conditions encountered.

Output: FIGURE 11 gives the pump performance curves for the Hypro C9006 pump when operating at a power take-off speed of 540 rpm. Pump output was similar to the manufacturer's curve. Pump wear was negligible after 87 hours of operation.

FIGURE 11 also shows the pump performance curve for the Hypro C9006 pump when installed in the George White sprayer plumbing system. Even though the rated pump output was 6.6 L/s (87 gal/min), the maximum pump delivery available to the booms was only 2.2 L/s (29 gal/min) due to plumbing restrictions.

Agitation Capability: Normally recommended agitation rates for emulsifiable concentrates such as 2,4-D are 1.8 L/min per 100 L of tank capacity (1.5 gal/min per 100 gal of tank capacity). For wettable powders such as Atrazine, recommended agitation rates are 3.0 L/min per 100 L of tank capacity (3.0 gal/min per 100 gal of tank capacity). Agitation with the George White sprayer occurred through the agitation pipe in the spray tank and through the pump by pass hose (FIGURE 1). FIGURE 12 shows agitator and pump by pass flows at various application rates with the agitator valve fully open. For example, at a typical prairie application rate of 110 L/ha (10 gal/ac), 8 L/min (1.8 gal/min) and 35 L/min (7.7 gal/min) of agitation were supplied through the bypass and agitation pipe respectively, resulting in a total agitation flow of 43 L/min (9.5 gal/min).

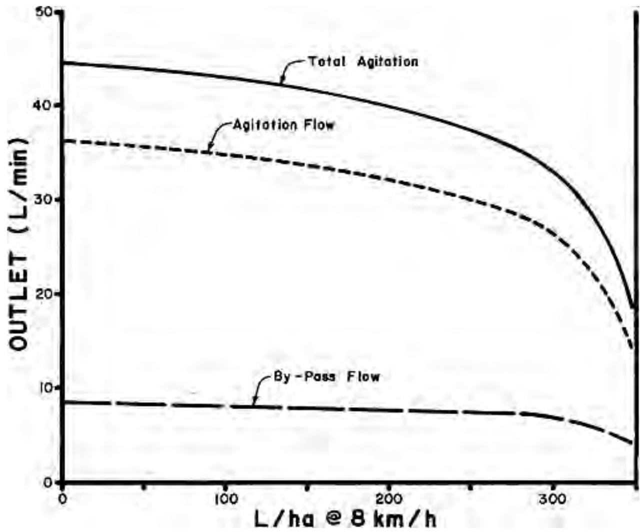

FIGURE 11. Pump Performance Curves at 540 rpm.

FIGURE 12. Agitation Output at Various Application Rates.

Agitation output was just adequate for applying emulsifiable concentrates at application rates below 110 L/ha (10 gal/ac) 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.

During road transport at rated engine speed, 36.4 L/min (8 gal/min) were delivered through the spray tank agitator and 8.5 L/min (1.9 gal/min) through the pump bypass. During stationary engine idle, a maximum of 17 L/min (3.7 gal/min) was delivered to the agitator and by-pass hose. At these low agitation rates it is recommended that the operator agitate the chemical solution in the tank at least one half hour before spraying to insure sufficient chemical mixing.

EASE OF OPERATION AND ADJUSTMENT

Controls: The George White T610 sprayer was equipped with a sprayer monitor, automatic rate controller and remote boom controller (FIGURE 13). These components were manufactured by SED Systems Inc. and their performance is described in PAMI evaluation report E1781C. The units could be mounted on the tractor to provide maximum convenience for the operator. The sprayer monitor could be switched to display ground speed, application rate, area sprayed, rate of work, solution pumped or distance travelled either in metric (SI) or in Imperial units. The automatic rate controller automatically maintained the application rate at a predetermined rate by opening or closing the motorized control valve when changes in ground speed, engine speed or pressure occurred. Chemical flow to each boom was controlled with the remote boom controller. The remote boom controller contained a pressure gauge, allowing the operator to monitor system pressure. The switches on the sprayer monitor were small and difficult to position in rough field conditions. The tank shut-off valve was conveniently located at the front of the tank. The agitator control valve could not be controlled from the tractor seat. Since the valve had to be operated fully open at all times it only had to be opened once.

FIGURE 13. Monitoring and Control System. (Upper: Remote Boom Controller and Pressure Gauge, Lower: Sprayer Monitor and Automatic Rate Controller).

The tank liquid level indicator was difficult to read. The level indicator gave only a rough indication of liquid level since operation on hills and movement of liquid in the tank caused the reading to fluctuate. The sprayer monitor indicated the amount of solution pumped if proper calibrations were made.

Transport: The George White sprayer could be folded into transport (FIGURE 14) or placed into field position in about 15 minutes with the use of a wrench. The weight on the spray boom height adjustment handle was too heavy to support by one person and two people were needed to adjust the boom height. The following interferences also made folding the sprayer into transport or placing into field position inconvenient. The outer radius rod pins and bolts interfered with the boom rail (FIGURE 15), making the radius rods difficult to position and remove from the holder clips. Interference between the outer radius rod pins and outer tandem beam pins and connecting bars (FIGURE 16) made it difficult to fold and unfold the outer booms. It is recommended that modifications be made to eliminate these interferences. The weight of the outer radius rods on the rod mounts caused the mounts to rotate downwards (FIGURE 17) making it difficult to place the radius rods in the holder clips due to the binding that occurred. It is recommended that modifications be made to eliminate the radius mounts from rotating downwards.

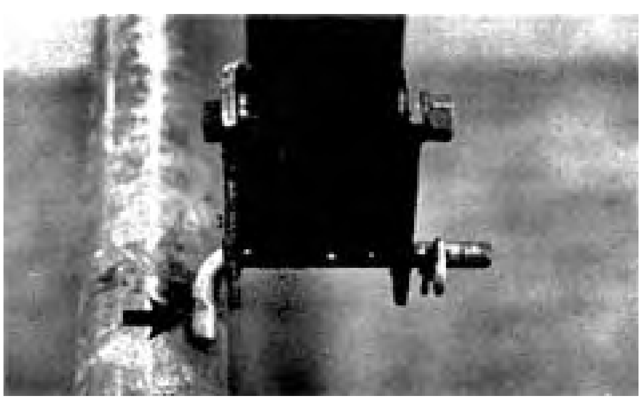

FIGURE 14. George White T610 in Transport Position.

The George White had a turning radius of 6.3 m (20.7 ft) in transport position, which provided sufficient maneuverability. The turning radius was limited by boom rail interference (FIGURE 18). Backing the sprayer in transport position was extremely difficult.

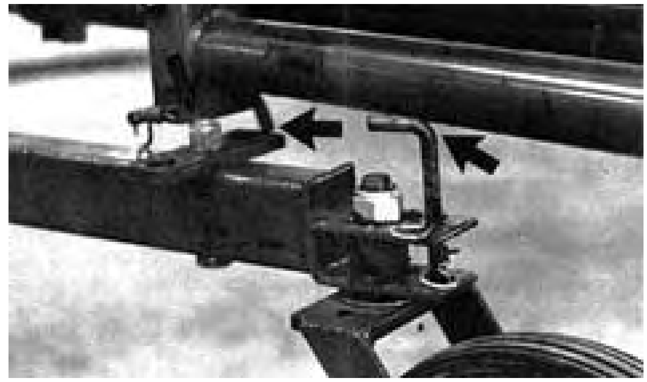

FIGURE 15. Interference Between Boom Rail, and Outer Radius Rod Pins.

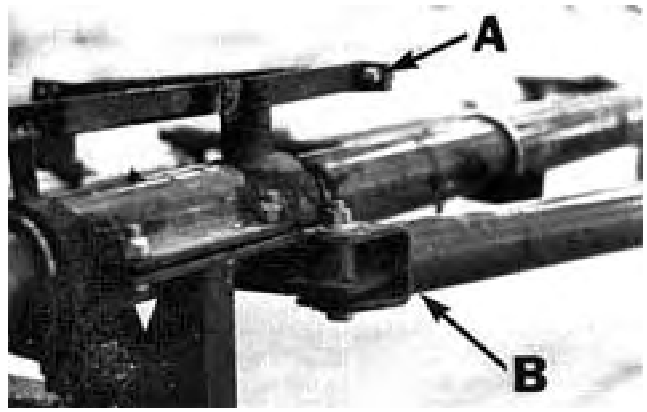

FIGURE 16. Interference Between Outer Radius Rod and Outer Tandem Beam Assembly.

FIGURE 17. Rotation of Radius Rod Mounts Around the Boom Rail: (A) Rod Mounts, (B) Outer Radius Rod. (Upper: Normal Position, Lower: Rod Mount Rotated Downward).

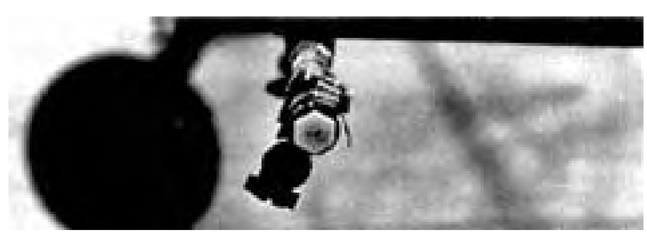

Figure 18. Boom Rail Interference when Making Sharp Turns.

Transporting the sprayer on side slopes and roads with a crown in the middle resulted in the booms spreading apart or colliding together. The booms also had a tendency to spread apart while backing. The sprayer otherwise towed well at all normal transport speeds. Modifications are required to prevent the booms from colliding and spreading apart during transport and while backing.

The front set of castor wheels were locked during transport to eliminate castor wheel vibrations during high speed road transport. However, locking the front castor wheels resulted in the front wheel skidding and deforming during turns.

The 3.9 m (12.8 ft) transport width caused some difficulty when going through narrow gates and travelling along roads.

Tank Filling: The tank filler opening was 1370 mm (4.5 ft) above the ground. The spray tank could be easily filled by gravity from nurse tanks on a farm truck. The two 380 mm (15 in) tank openings were adequate for adding chemicals and water and were easily accessible. However, the operator had to stand on either the trailer wheels, hitch or spray tank, making adding chemicals unsafe and inconvenient. It is recommended that modifications be made to provide for a safer and more convenient way to add chemical to the spray tank.

Nozzle Adjustment: Nozzle height was adjusted with the use of a wrench. The operator had to simultaneously adjust the height adjustment screw, rotate and hold the boom rails by means of the handle provided. This was difficult since the operator had to support the entire weight of the booms with one hand. Using the knee to rest the boom helped a little. Modifications are recommended to make boom height adjustment more convenient. Nozzle angle remained constant at all boom heights between 350 and 750 mm (14 and 30 in). Nozzle angle was conveniently changed by loosening five U-bolts and rotating the boom. In the field, the weight of the outer radius rods on the radius rod mounts caused the mounts to rotate downwards (FIGURE 17), which in turn caused the outer boom nozzle angle to change (FIGURE 19). It has already been recommended that modifications be made to eliminate this problem.

FIGURE 19. Nozzle Angle Pointing Back After Radius Mounts Shifted Downwards.

Nozzle Cleaning: The nozzles were easily and quickly removed for cleaning without the use of tools. The cup strainers had to be centered on the nozzle cap to prevent the strainers from being crushed. The cup strainers plugged frequently. This was inconvenient.

Hitching: The sprayer could be hitched to a tractor when the tank was empty without the use of the jack provided. The jack was required when the tank was full. The setscrews securing the jack to the trailer hitch were inadequate, allowing the jack to slip outwards (FIGURE 20) when the tank was full. This was unsafe and it is recommended that modifications be made to insure a stronger and safer hitch jack bracket.

The pump was connected directly to the tractor power take off shaft.

Boom Adjustments: The inner yoke weldments, pivot yoke weldments and outer front and rear radius rod joints fit very loosely, making initial boom alignment and nozzle height adjustments inconvenient.

Servicing and Cleaning: All 18 grease fittings were readily accessible. The trailer spindles could not be sufficiently lubricated with the one grease fitting provided and as a result wear on the spindles was evident at the end of the test. Modifications are required to provide the spindles with sufficient lubrication.

The tank could be easily drained through the drain plug located in the tank sump.

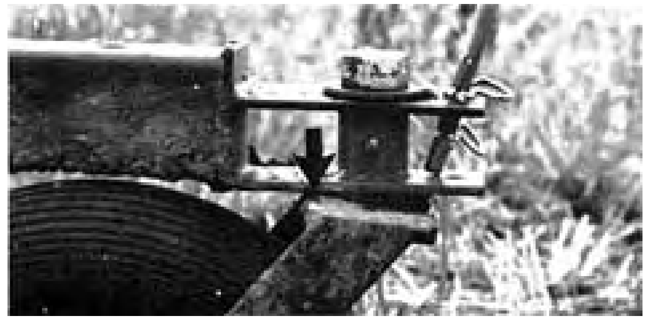

FIGURE 20. Hitch Jack Inadequately Secured.

OPERATOR SAFETY

Slow Moving Vehicle Sign: The sprayer was equipped with a slow moving vehicle sign to comply with safety regulations.

Transport: Since the width of the sprayer in transport position was 3.9 m (12.8 ft), caution had to be exercised when transporting the sprayer on roads and highways.

Tank Filling: Care had to be exercised when standing on the trailer tires or spray tank when adding chemical to the spray tank.

Caution: Operators 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 outlined sprayer operation, maintenance, servicing, calibration, parts, nozzle selection, lubrication and safety tips. Although an operator's manual was provided for the sprayer monitor, no manual was provided for the automatic rate controller. It is recommended that the manufacturer provide complete information on the compatibility of the boom controller, sprayer monitor and automatic rate controller with the George White T610 sprayer.

MECHANICAL PROBLEMS

TABLE 3 outlines the mechanical history of the George White T810 field sprayer during 87 hours of field operation while spraying about 1325 ha (3273 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 no conducted.

DISCUSSION OF MECHANICAL PROBLEMS

PLUMBING ASSEMBLY

Nozzle Assemblies: The top and bottom nozzle clamps had to be positioned in the boom perfectly straight to prevent any leaking.

TANK AND TRAILER ASSEMBLY

Electrical Cable: The electrical cable for the solenoid valves was too short. The cable length was adequate for solenoid valves located in front of the spray tank. However, the valves were located at the rear of the tank and additional cable was required. It is recommended that a longer electrical cable be provided when the solenoid valves are located at the rear of the sprayer tank.

Tank Saddle: The tank saddle tore away from the trailer frame at the weld. The thin material used for the tank saddle was inadequate. It is recommended that modifications be made to prevent the tank saddle from tearing away at the weld.

Hitch: The hitch frame was inadequate to resist twisting and the hitch jack bracket pulled away from the hitch when the tank was full of liquid. The bolts securing the hitch bracket and mounting plate to the hitch frame loosened frequently due to vibration. It is recommended that the manufacturer make modifications to prevent the hitch frame from twisting and the hitch bracket and mounting plate bolts from loosening.

TABLE 3. Mechanical History

Item	Hours	Field Area ha
Plumbing Assembly		
-The majority of the nozzles leaked. The leaking stopped after the nozzle assemblies were properly positioned at	beginning of test	
-The pressure gauge hose cracked near the boom and was repaired at	37	647
Tank and Trailer Assembly		
-The sump leaked at the hose connections and a new sump was installed at	beginning of test	
-The clamps that secure the sump to the sprayer were weak and twisted when the sump was being removed at	beginning of test	
-The cord for the solenoid valves was too short and additional cord was purchased and installed at	beginning of test	
-Bolts on the hitch and mounting plates loosened and were tightened at	37, 86	647, 1310
-The tank saddle tore away from the frame at the weld at	end of test	
-The hitch frame was twisted at	end of test	
-The hitch jack slipped outwards when the tank was full	throughout the test	
Boom Assembly		
-The right universal tube assembly was lost and a new one installed at	12	212
-Interference occurred between the castor fork and tandem beam assembly on all castor wheels	throughout the test	
-The interference was eliminated by inserting washers between the castor fork and tandem beam at	66	1010
-The hex bolts and retainer pins joining the front and outer rear radius rods were lost and replaced at	15, 22, 37, 53	256, 414, 647, 840
-The vertical castor fork spindles welded to the castor forks failed and were reinforced at	15, 57, 66, 71	256, 908, 1010, 1136
-The linch pin on the right inner radius rod was bent at	15	256
-The right boom lock bracket turned on the boom rail and was adjusted at	37, 40	647, 663
-Both outer radius rod mounts broke and were rewelded at	37, 87	647, 663
-The outer left front castor fork assembly was bent and straightened at	40	663
-The first boom upright on the left boom broke and was welded at	40	663
-The carriage bolt on the right inner radius rod holder clip was lost at	42	666
-The boom uprights turned on the boom rail and were repositioned at	37, 40, 86	647, 663, 1310
-The saddle clamps securing the tandem assemblies moved on the boom rail and were adjusted at	36, 65, 87	630, 990, 1325
-The outer left front castor wheel bearing failed and was replaced at	87	1325
-The four linch pins securing the outer and inner radius rods to the middle tandem assembly connecting bars were lost at	87	1325
-All top castor wheel spindle bushings were worn at	end of test	
-All castor wheel assemblies were sloppy	throughout the test	
-The middle tandem assembly connecting bars were worn at	end of test	
-The ends of the inner radius rod were worn at	end of test	

BOOM ASSEMBLY

Castor Fork and Tandem Beam Weldment: Interference occurred between the castor fork and tandem beam weldment on all castor wheel assemblies (FIGURE 21). This resulted in the wheels not castoring properly and caused the tandem beam to rotate about the boom rail (FIGURE 22). When the tandem wheel rotated about the boom rail, damage occurred to the nozzle bodies, radius rod mounts, slow moving vehicle sign, radius rod connecting bars, castor forks, boom uprights and collars. The interference was eliminated by inserting washers on the vertical castor fork spindles between the castor forks and tandem beams.

At the end of the test the manufacturer supplied a new castor fork and tandem beam weldment assembly (FIGURE 23). The new assembly worked well and only on one occasion did the tandem beam weldment rotate about the boom rail. This happened during a turn to the outer inside tandem beam when travelling over a rough cultivated field.

FIGURE 21. Interference between Castor Fork and Tandem Beam Weldment.

Castor Fork Spindles: The vertical castor fork spindles fit the tandem beam assemblies loosely, causing the castor wheels to vibrate. The welds, securing the vertical castor fork spindles to the castor forks, failed on several castor assemblies (FIGURE 24). The spindles were repaired by inserting new bolts and welding around the bolt head. It is recommended that modifications be made to prevent the vertical castor fork spindles from failing.

FIGURE 22. Rotation of Tandem Beam Assembly Around the Boom Rail.

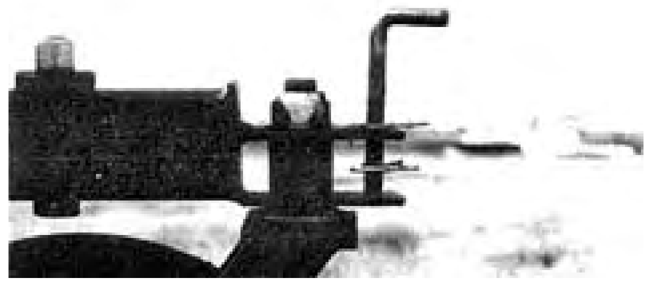

FIGURE 23. Modified Tandem Beam Assembly.

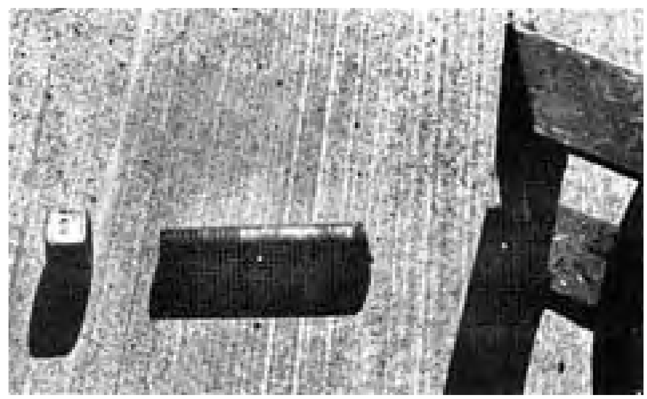

FIGURE 24. Typical Castor Fork Spindle Failure.

Outer Radius Rods: The hex bolts and the retainer pins joining the outer front and outer rear radius rods were lost several times on both sides. Also, the weld on the right outer front radius rod failed. When this occurred, the outer boom folded back resulting in damage to nozzles and booms. The failures were attributed to excessive field vibration due to loose fitting radius arm joints. It is recommended that the manufacturer make modifications to prevent the outer front and outer rear radius rods from separating during field use.

U-Bolts and Clamps: The boom uprights, tandem beam saddle clamps and lock brackets moved and turned on the boom rail. The U-bolts and clamps were tightened frequently during the test but movement still resulted. Further tightening caused damage to the U-bolt threads and clamps.

Pins: All four linch pins securing the radius rods to the middle tandem beam connecting bar were lost. The connecting bars turned in the field, causing the linch pins to bend and eventually get squeezed out.

Castor Wheel Assembly: The top bushings on all castor wheel assemblies were worn because the threads on the vertical castor spindles extended into the bushing. The modified castor wheel tandem assembly supplied at the end of the test eliminated this problem.

APPENDIX I
SPECIFICATIONS

MAKE:	George White Field Sprayer	
MODEL:		
-- boom	T80	
-- trailer	T610	
SERIAL NUMBER:	38218257	
	Field Position	**Transport Position**
OVERALL WIDTH:	25,095 mm	3915 mm
OVERALL LENGTH:	4740 mm	10,340 mm
OVERALL HEIGHT:	1480 mm	1480 mm
WHEEL TREAD:		
-- trailer	1800 mm	
-- boom		
-inside	13,770 mm	
-outside	20,760 mm	
WHEEL BASE:		
-- trailer	1015 mm	
-- boom	1635 mm	
TIRES:		
-- trailer	4, 11L x 155L, 6-ply, rib implement	
-- boom	8, 4.80/4.00 x 8	

WEIGHTS: (Field Position)	**Tank Empty**	**Tank Full**
-- left trailer wheels	270 kg	1305 kg
-- right trailer wheels	265 kg	1295 kg
-- inner boom wheels		
-left	95 kg	95 kg
-right	95 kg	95 kg
-- outer boom wheels		
-left	80 kg	80 kg
-right	80 kg	80 kg
-- hitch	25 kg	360 kg
TOTAL	910 kg	3310 kg

TANK:	
-- material	plastic
-- capacity	2400 L
FILTERS:	
-- tank	16-mesh
-- line	16/50 mesh
-- nozzle	50-mesh
PUMP:	Hypro C9006 (540 rpm PTO driven)
AGITATION:	hydraulic
PRESSURE GAUGE:	Marsh (0-700 kPa)

CONTROLS:	**Make**	**Model**	**Serial Number**
-- spray monitor	SED 333	943A	IMP 3113752A
-- rate controller	SED 333	948	GWR 11008
-- remote controller	SED 333	944	GW 860092
-- boom solenoid valves	Spraying Systems Model 144 12 volt DC, 30 watt, 3/4 NPT		
-- motorized control valve	Spraying Systems Model 244 - 3/4 NPT		

BOOMS:	19 mm I.D. aluminum pipe
NOZZLES:	
-- number	49
-- type	Spraying Systems Tee Jet flat fan 8002 and low pressure 8001 nozzles
-- spacing	508 mm
SPRAYING WIDTH:	24,892 m
BOOM ADJUSTMENT:	
-- height	
-maximum	750 mm
-minimum	350 mm
-- angle	360°
HITCH HEIGHT ADJUSTMENT:	
-- maximum	465 mm
-- minimum	375 mm
LUBRICATION POINTS:	
-- main axle	2
-- castor wheel spindles	8, 20 hour service
-- boom rail bearings	2, 100 hour service
-- boom rail tandem beam weldment bearings	4, 20 hour service
-- universal joint shafts	2
-- wheel bearings	repack annually

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 kilometre/hour (km/h)	= 0.6 miles/hour (mph)
1 hectare (ha)	= 2.5 acres (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 meter (m)	= 3.3 feet (ft)
1 millimetre (mm)	= 0.04 inches (in)

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