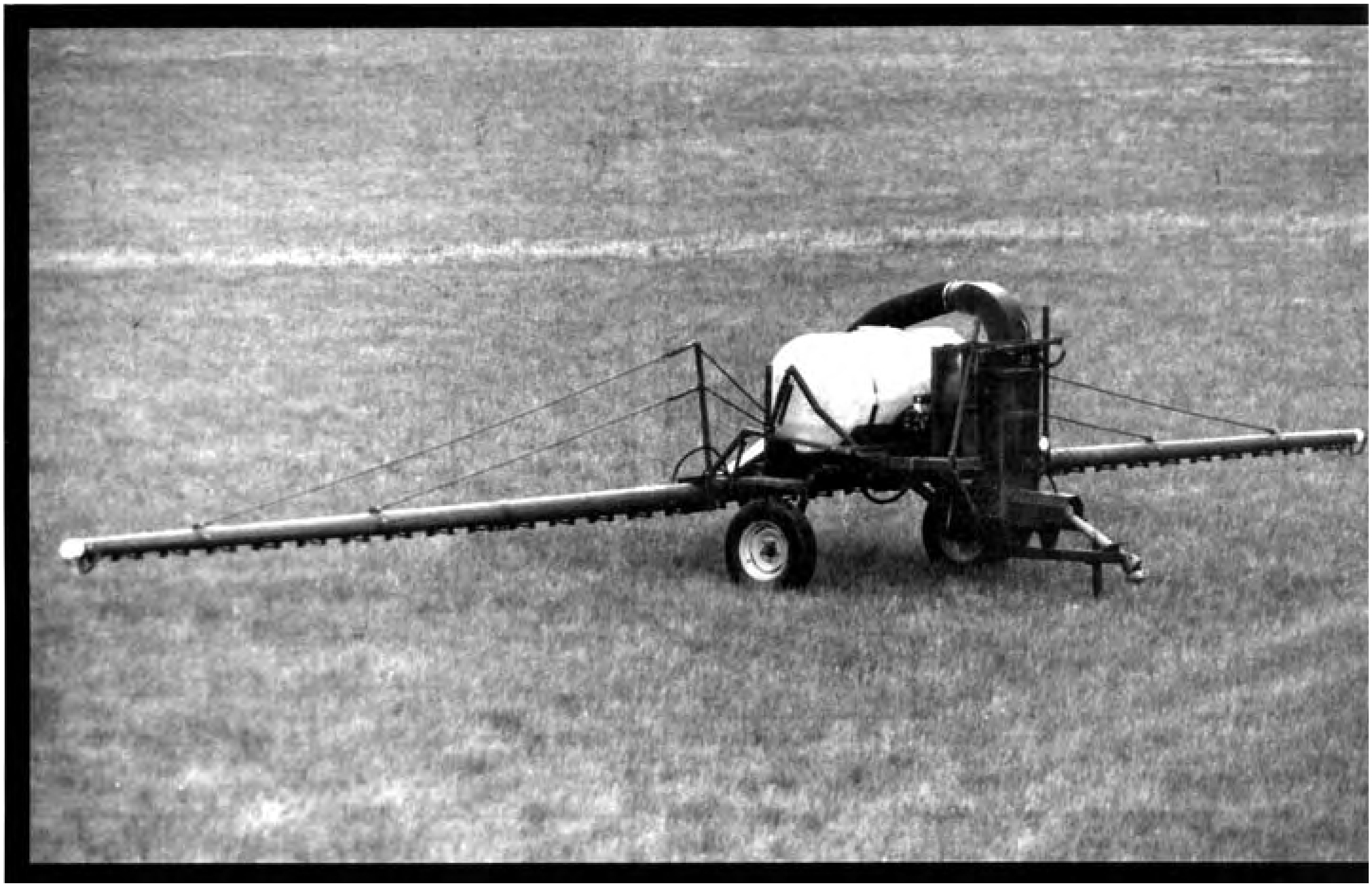
Printed: March 1984
Tested at: Lethbridge
ISSN 0383-3445
Group 8b

EVALUATION REPORT 350



Sprafoil Model PT4583 Field Sprayer

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

SPRAFOIL MODEL PT4583 FIELD SPRAYER

MANUFACTURER

D & W Industries
P.O. Box 834
Sioux Falls, South Dakota 57101
U.S.A.

DISTRIBUTOR

Airfoil Sprayers Limited
#4, 4390 - 76 Avenue S.E.
Calgary, Alberta
T2C 2J2

RETAIL PRICE:

$12,938.00 (March, 1984, f.o.b. Lethbridge, Alberta).

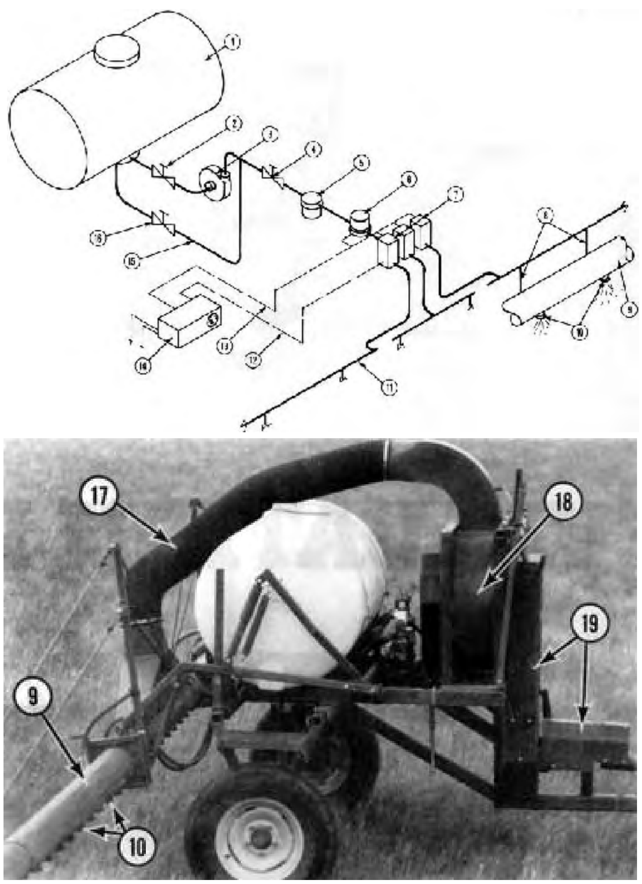


FIGURE 1. System Schematic for Sprafoil Model PT4583 Field Sprayer: (1) Tank, (2) Suction Line Shut-off Valve, (3) Pump, (4) Throttling Valve, (5) Strainer, (6) Motorized Control Valve, (7) Boom Solenoid Valves, (8) Metering Pin Hose, (9) Boom, (10) Nozzle Assemblies, (11) Boom Hoses, (12) Pressure Gauge Tubing, (13) Electrical Connections, (14) Remote Controller, (15) Agitation Hose, (16) Agitator Valve, (17) Connecting Air Hose, (18) Fan, (19) Fan Drive.

SUMMARY AND CONCLUSIONS

Overall Performance: The performance of the Sprafoil model PT4583 field sprayer was good, with weed control similar to that of conventional flat fan nozzles. Performance was reduced by poor liquid atomization at high liquid flow rates, limited range of application rates and inefficient distribution patterns.

Air System: The Sprafoil air system provided uniform distribution of air to all the nozzles across the width of the boom. Air velocity through the nozzles was about 150 mph (242 km/h).

Liquid Atomization: The best liquid break-up (atomization) occurred at very low metering pin delivery rates and deteriorated as the rate increased. Liquid break-up was poor above a system pressure of about 30 psi (207 kPa), which corresponded to an application rate of 11 gal/ac (124 L/ha) at 6 mph (9.7 km/h).

Application Rate: Application rate was changed by either varying the system pressure or ground speed. At any selected ground speed, the range of application rates was limited by a minimum obtainable system pressure of 9 psi (62 kPa) and inadequate liquid atomization at a system pressure above 30 psi (207 kPa). At 6.0 mph (9.7 km/h) the range of application rates varied from 6.4 to 11 gal/ac (72 to 124 L/ha). This was an adequate range of application rate for tractor pulled trailer sprayers but may be restricting for speeds normally used with truck mounted sprayers.

Distribution Patterns: Spray distribution patterns were very poor compared to those of properly operated flat fan nozzles. However, field tests showed no significant stripping in weed control with those chemicals used throughout the test. It appeared that only a small portion of the spray applied was being effective. This would tend to support manufacturer’s claims of spraying at less than recommended rates. However, more research is required before such a recommendation can be supported. Increasing boom height improved the pattern slightly but could result in increased spray drift.

Weed Control: Weed control was similar to that of conventional flat fan nozzles when operated in similar field conditions. Timely application and environmental and growing conditions appeared to have as great an effect on weed control as the type of sprayer used and the chemical application rate.

Under-leaf Coverage: Some under-leaf coverage was clearly observed. The effectiveness of under-leaf coverage is not known. Increased boom height or windy spraying conditions nearly eliminated under-leaf coverage.

Workrate: The Sprafoil field sprayer operated well on smooth fields at speeds up to 8.5 mph (14 km/h). The average workrate varied from 7.5 to 31 ac/h (3 to 12.5 ha/h).

Controls: The Sprafoil was easy to operate. The sprayer was equipped with a Raven model SCS 203 pressure and boom controller which was mounted on the tractor.

Boom: Nozzle angle and height adjustments were easily set by adjusting the boom. Nozzle angle could be adjusted from 7 degrees to the back to 40 degrees forward at the recommended nozzle height of 20 in (508 mm). Nozzle height could be adjusted from 10 to 38 in (255 to 965 mm). The boom suspension reduced and quickly stabilized boom movement. No boom breakaway feature was provided to protect the booms from damage if obstacles were encountered. With some experience, the booms could easily and quickly be placed in either transport or field position.

Spray Tank: The high height of the spray tank filler opening usually required that a portable pump be used to fill the tank. The high step up to the operator’s platform and the long reach to the filler opening made adding chemicals unsafe and inconvenient. The circular shape of the tank and small sump allowed the operator to completely empty the tank. The spray tank was equipped with two jet agitators. Agitation was more than adequate for applying emulsifiable concentrates and wettable powders.

Pump: The Sprafoil was equipped with a Hypro 9202C centrifugal pump. Pump capacity was more than adequate. Pump output when used in the Sprayfoil plumbing system was 25 gal/min (114 L/min).

Plumbing System: Sufficient metering pin pressure was available to provide adequate spray liquid delivery rates to the nozzles. The plumbing system limited the minimum system pressure to 9 psi (62 kPa) or 6.4 gal/ac (72 L/ha) at 6 mph (9.7 km/h). The line strainer located between the pump and the remote control valve was adequate protection against nozzle plugging.

Calibration: No calibration chart was provided but an adequate calibration procedure was given in the operator’s manual. The increase in delivery rate of used brass metering pins was insignificant after 54.5 hours of field use. Variability among individual metering pins was acceptable when new and used when compared to the standards for flat fan nozzles.

Crop Damage: Soil contact pressure beneath the Sprafoil wheels was less than one-half that of an unloaded pickup truck or conventional field sprayer.

Power Requirements: About 18 hp (13.5 kW) was required at the power take-off to operate the Sprafoil fan and pump. A 60 hp (45 kW) tractor was considered adequate for the field conditions encountered during the test.

Safety: Care had to be exercised while transporting the Sprafoil on roads or farm yards due to the 12 ft (3670 mm) height and 17.2 ft (5240 mm) width at the boom ends. Caution had to be exercised while adding chemical to the spray tank due to the high step up to the operator's platform and the long reach from the platform to the tank opening. All moving parts were well shielded.

Operator's Manual: The operator's manual contained little useful operating information. The operator's manual only briefly outlined calibration, maintenance, operation and adjustments. No safety information was included.

Mechanical Problems: Only a few minor mechanical problems were encountered during the test.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to extend the range of application rates to allow spraying at recommended rates with truck mounted sprayers.
2. Modifications to improve the distribution pattern.
3. Modifications to improve liquid atomization at higher liquid delivery rates.
4. Modifications to provide safer and more convenient access to the spray tank.
5. Supplying a slow moving vehicle sign as standard equipment.
6. Improving the operator's manual to include instructions on operation and adjustment, calibration charts, safety information and a component parts list.

Senior Engineer: E.H. Wiens

Project Technologist: P.A. Bergen

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The Sprafoil is designed as a low volume sprayer, using from 1.5 to 4 gallons per acre. Therefore, the truck mounted sprayer has adequate delivery rates.
2. Improved distribution patterns will arise from lower volumes of water than those tested at P.A.M.I. Field tests by other test stations also show no stripping, plus excellent kill. Being a new and different concept, the distribution pattern should not be totally compared to that of flat fan nozzles.
3. Higher fan speed would improve liquid atomization with higher liquid delivery rates, but, the purpose of this sprayer is to use lower volumes of water. Also, higher fan speed would break up the water droplets too fine and create a drift problem. As it is now (according to other specific drift testing) there appears to be less drift than with conventional hydraulic sprayers.
4. A 60 foot model, looking much like a conventional sprayer, is being manufactured now and is therefore much easier and safer to fill. The model PT4583 is designed more for row crop applications.
5. This is being done now.
6. More instructions have been added.

GENERAL DESCRIPTION

The Sprafoil model PT4583 is a trailing, boom-type field sprayer. The sprayer is mounted on a single set of axles with adjustable tread width. The Sprafoil is equipped with a high speed centrifugal fan mounted in front of the sprayer. The fan is driven from a 1000 rpm tractor power take-off. Air from the fan is directed through an 8 in (203 mm) diameter hose to the center of the boom. The hollow, tapered fiberglass boom has 69 nozzle assemblies spaced at 8 in (203 mm) giving a spraying width of 45.9 ft (13.98 m). Spray patterns from individual nozzles are created by the flow of air over the air foil breaking up the liquid metered by the metering pin (FIGURE 2). Boom height and spray angle are adjustable. The booms fold forward for transport. The 167 gal (760 L) plastic tank is mounted behind the fan, across the back of the trailer. The tank is equipped with hydraulic agitation. The centrifugal liquid supply pump is belt driven from the back of the blower. The Sprafoil is supplied with a Raven model SCS 203 remote control which is mounted on the tractor.

FIGURE 1 identifies the sprayer and liquid system components while detailed specifications are given in APPENDIX 1.

SCOPE OF TEST

The Sprafoil model PT4583 was operated for 54.5 hours in the conditions shown in TABLES 1 and 2 while spraying about 939 acres (380 ha). It was evaluated for quality of work, rate of work, pump performance, power requirements, ease of operation and adjustment, operator safety and suitability of the operator's manual. For field testing, the Sprafoil was equipped with an Adja spray marker.

TABLE 1. Operating Conditions.
TABLE 2. Field Conditions.

RESULTS AND DISCUSSION

QUALITY OF WORK

Air System: The Sprafoil air system (FIGURE1) provided uniform distribution of air to all the nozzles across the width of the booms. Variation in air flow rates among all the nozzles was low, with a CV[1] of about 2.6%. A low CV indicates similar air flow rates for all nozzles while a high CV indicates larger variability among individual nozzles. At the recommended fan air pressure of 23 in wg (5730 Pa), total fan output was about 1760 cfm (831 L/s) at standard air conditions[2], providing an air velocity of about 150 mph (242 km/h) through the nozzles.

Liquid Atomization: The Sprafoil nozzles (FIGURE 2) are designed to use air at a high velocity to break up the metered liquid into a spray pattern. The best liquid break-up (atomization) occurred at very low metering pin delivery rates and deteriorated as the rate increased. Liquid break-up was poor above a system gauge pressure of about 30 psi (207 kPa). This corresponds to an application rate of about 11 gal/ac (124 L/ha) at 6 mph (9.7 km/h).

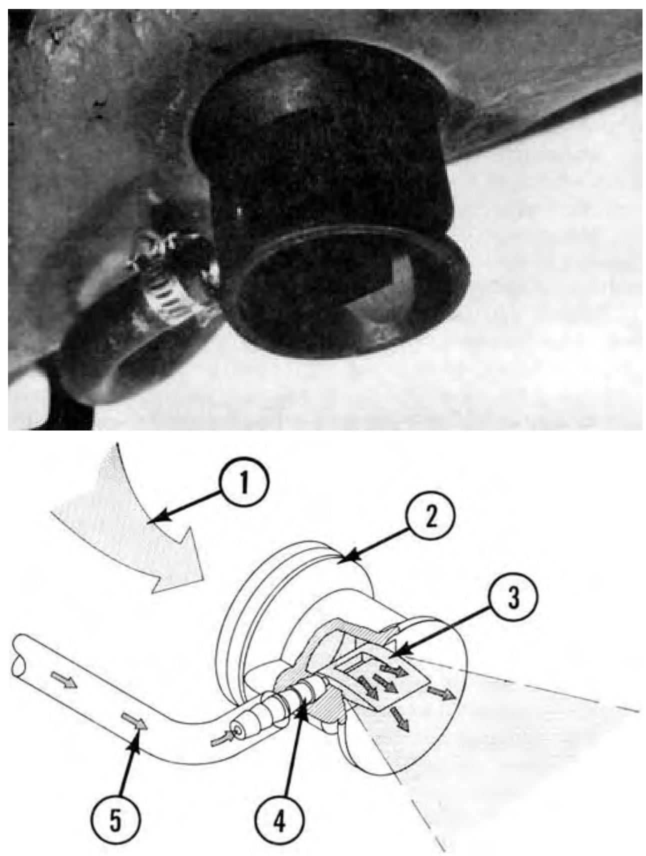


FIGURE 2. Nozzle Assembly: (1) Air, (2) Grommet, (3) Foil, (4) Metering Pin, (5) Spray Liquid.

[1]The coefficient of variation (CV) is the standard deviation of air flow rates for all the nozzles across the boom expressed as a percent of the mean air flow rate.

[2]Standard air is air with a density of 0.75 Ibm/ft³ (1.2 kg/m³) which occurs at 68°F (20°C), 50% relative humidity and a barometric pressure of 29.92 in Hq (760 mm Hg).

Application Rate: Since only one liquid metering pin size was provided, application rate was changed by either varying the system pressure or by varying ground speed. The minimum system pressure obtainable was 9 psi (62 kPa) which, at 6 mph (9.7 km/h), resulted in an application rate of 6.4 gal/ac (72 L/ha). Lower application rates could be obtained by increasing ground speed. However, speeds much in excess of 6 mph (9.7 km/h) are not practical for trailer type sprayers. The maximum application rate, at 6 mph (9.7 km/h) was limited by inadequate spray liquid break up at pressures above about 30 psi (207 kPa). This resulted in an application rate of about 11 gal/ac (124 L/ha). This range of application rates was adequate to apply recommended rates for most commonly used herbicides with a tractor drawn trailer type sprayer. However, truck mounted units usually operate at higher ground speeds than 6 mph (9.7 km/h), which would result in applying less than the 10 gal/ac (112 L/ha) commonly recommended. For example, at a ground speed of 10 mph (16 km/h), the range of obtainable application rates would be from 4 to 6.5 gal/ac (45 to 73 L/ha). FIGURE 3 shows the range of application rates at various ground speeds. For use with truck mounted spraying it is recommended that the manufacturer consider modifications to extend the application rate range to allow spraying at recommended rates.

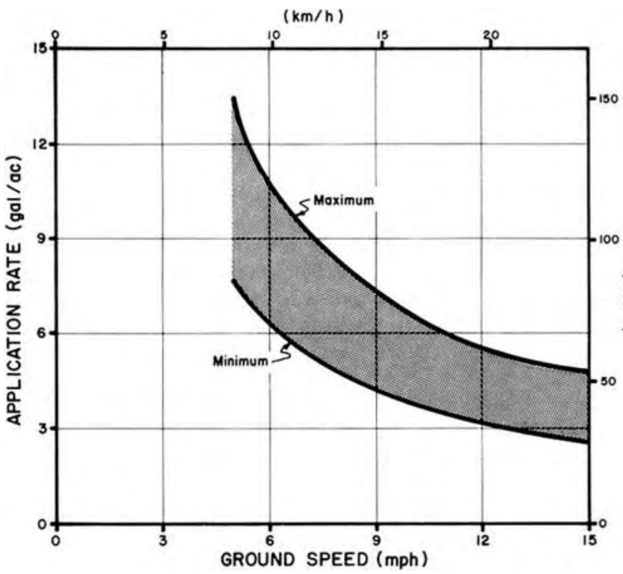


FIGURE 3. Range of Application Rates at Various Ground Speeds.

Distribution Patterns: FIGURE 4 shows the spray distribution pattern along the boom when operated at a system pressure of 9.0 psi (62 kPa) at the recommended nozzle height of 20 in (508 mm). The coefficient of variation (CV)[3] was 71.1%, with application rates along the boom varying from 0.6 to 14.3 gal/ac (7 to 161 L/ha) at 6 mph (9.7 km/h). This greatly exceeded the maximum acceptable CV of 15% normally used for distribution patterns from conventional flat fan nozzles. Very high spray concentrations occurred below each nozzle with little spray volume between nozzles.

Further tests showing the size and distribution of droplets under field conditions showed a concentration of larger droplets under each nozzle, which would contain the bulk of the spray volume and result in spray concentration below each nozzle. Although the distribution pattern in FIGURE 4 is very poor in comparison to properly operated flat fan nozzles, field tests showed no significant stripping in weed control with those chemicals used during the evaluation. This would tend to support the manufacturer's claim of being able to spray at less than recommended rates. However, much more work needs to be done in this area, preferably in conjunction with weed and chemical experts, before such a recommendation can be supported. Observations over the years have indicated that growing and climatic conditions at the time of spraying have as great an effect on weed control as the application rate or device used for chemical application. Extreme caution should be exercised when applying chemical at rates other than those recommended. This type of application could potentially result in reduced weed control or increased crop damage and would be completely at the owner's own risk.

Increasing nozzle height resulted in improved distribution patterns (FIGURE 5). For example, raising the nozzle height from the recommended 20 in (508 mm) to 28 in (710 mm) improved the distribution pattern significantly, resulting in reducing the CV from 71 to 54%. This, however, was still well above the acceptable pattern uniformity (CV ±15%) for conventional flat fan nozzles. Also, increased nozzle height could result in increased spray drift.

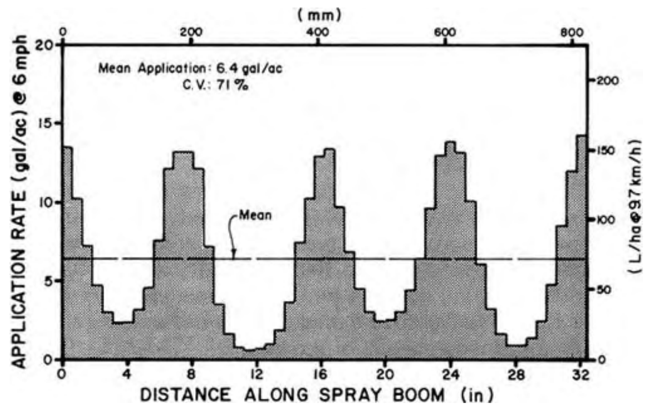


FIGURE 4. Typical Distribution Pattern Along the Boom at 9.0 psi (62 kPa) and a Nozzle Height of 20 in (508 mm).

Weed Control: Although field tests showed that the Sprafoil field sprayer can be an effective herbicide applicator, the poor distribution patterns discussed above indicated that the pattern was very inefficient. Apparently, only a small portion of the total application rate is being effective. It is recommended that the manufacturer consider modifications to improve the distribution pattern.

The sprayer manufacturer indicated the Sprafoil was capable of weed control at both reduced water and chemical rates from those recommended by herbicide manufacturers. As already indicated, this area requires a great deal more study and research in conjunction with weed and chemical experts before a recommendation can be made.

Limited field tests and observations were made at reduced rates with both the Sprafoil and conventional flat fan nozzles with those chemicals listed in TABLE 1. In general, weed control with the Sprafoil was similar to that of properly operated flat fan nozzles. Reduced water rates usually resulted in adequate weed control for both types of nozzles. Limited observations, with those chemicals used during the test, indicated that at recommended chemical rates, similar weed control was obtained at recommended water rates and at half the recommended water rates. Reduced chemical rates, for both types of nozzles, usually resulted in suppressed and stunted weed growth. However, weed control was faster and more complete at recommended chemical rates, especially with broadleaf weed sprays. With Hoegrass, limited observations indicated similar weed control at recommended and half the recommended chemical rates.

In all the above observations, the best weed control was obtained at full recommended water and chemical rates. It should also be recognized that the results are based on field observations and not a scientifically designed experiment. Also, the most revealing observation that has been made over the many years of PAMI sprayer tests, indicates that weed control is as dependent upon timely application and environmental and growing conditions at the time of spraying, as it is upon the rates used and the application device or technique being used. It should again be cautioned, that spraying at other than recommended rates requires further study. Before any changes are made to recommendations, reducing rates would be completely at the operator's own risk.

Under-leaf Coverage: The manufacturer claimed that due to the turbulent spray pattern created by the Sprafoil, some of the

[3]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. For a flat fan nozzle a CV below 10% indicates very uniform coverage while a CV above 15% 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 narrower range.

spray droplets were deposited on the underside of the leaf, resulting in more effective weed control. Tests and observations did indicate that some under-leaf coverage resulted with the Sprafoil, whereas no under-leaf coverage was evident when using conventional flat fan nozzles.

At the recommended boom height of 20 in (508 mm), a significant number of small droplets were observed under-leaf in ideal, no-wind conditions. However, as already discussed, at recommended boom height, the spray distribution pattern and consequently top leaf coverage was extremely variable, with a heavy concentration of spray directly under the nozzles and reduced coverage between nozzles (FIGURE 3). When increasing boom height to improve the distribution pattern, there was virtually no under-leaf coverage at normal weed height, indicating that at higher boom heights, the turbulent spray did not reach the ground. Under-leaf weed coverage would occur higher above the ground and higher than normal weed height. It was observed, that in windy conditions, under-leaf coverage was reduced significantly. Anything below 12 in (305 mm) from the nozzles showed very little under-leaf coverage. Consequently, there must be a trade-off between an improved distribution pattern and under-leaf coverage.

Weed control effectiveness of under-leaf coverage was not specifically evaluated. However, it would seem logical that getting both top and under-leaf coverage would result in improved control, if for no other reason than having chemical being taken up by a larger leaf area.

Spray Drift: There were no tests conducted to evaluate spray drift. Field observations, at recommended nozzle heights, indicated that some of the smaller droplets created by the turbulent spray, formed a mist, which could be susceptible to drift, especially in windy conditions. A similar mist was also observed when using conventional flat fan nozzles. A more detailed drift study is required to quantify and compare spray drift for both application techniques.

Boom Stability: Under normal field conditions the boom remained stable. The boom suspension reduced and quickly stabilized boom movement when operating in rough fields.

Boom Height: FIGURE 5 shows that nozzle height had a significant effect on pattern uniformity. Droplet size and distribution tests indicated the optimum nozzle height appeared to be about 28 in (711 mm). The higher boom height made operation on rolling land easier as the boom ends did not hit the ground as easily. However, with increased boom height, there was increased risk of spray drift.

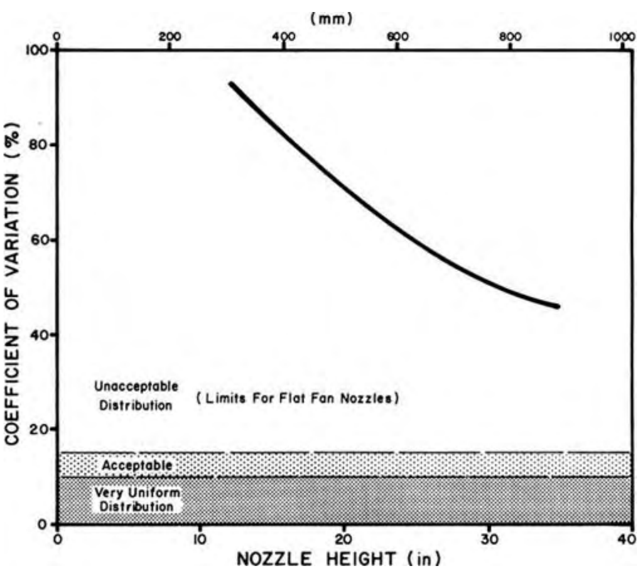


FIGURE 5. Spray Pattern Uniformity at Various Nozzle Heights.

Nozzle Metering Pin Calibration: FIGURE 6 shows the average delivery rate for the brass metering pins over the complete operating pressure range. The manufacturer did not provide any information on metering pin delivery rates, however, an adequate calibration procedure was given in the operator's manual.

The delivery rate of used brass metering pins increased only 1.1% after 54.5 hours of field use. This was considered insignificant. Metering pin wear depends on the type of chemical sprayed and water cleanliness.

Variability among individual metering pin deliveries was acceptable. The CV of metering pin deliveries was 4.1% when new and decreased to 3.4% after 54.5 hours of field use. A low CV indicates similar discharge rates for all metering pins while a high CV indicates larger variability among individual metering pin deliveries.

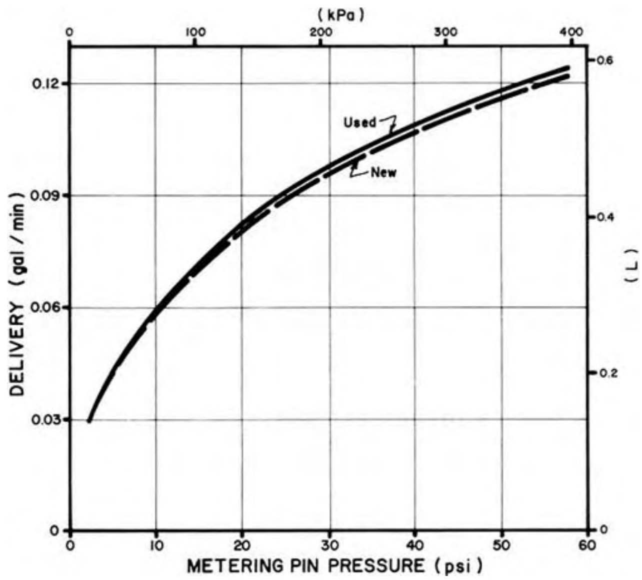


FIGURE 6. Delivery Rates for Brass Metering Pins.

Pressure Loss in Plumbing System: Pressures in the plumbing system were measured at the pump outlet, at the solenoid valves and at the metering pins (FIGURE 1). System operating pressure was measured at the solenoid valves and displayed by the system pressure gauge on the controller. Pressure losses between the system pressure gauge and the metering pins varied from 2 to 14 psi (14 to 97 kPa), depending on the total flow rate. Although the system pressure read on the remote controller differed from metering pin pressure, the error was unimportant if the calibration procedures given in the operator's manual were followed.

Pressure Gauges: The liquid pressure gauge mounted in the remote control read 0 to 1.0 psi (0 to 7 kPa) low in the normal operating range encountered throughout the test. This error was considered unimportant if the calibration procedures given in the operator's manual were followed.

The air pressure gauge, mounted to the left of the fan drive, read about 0.7 in wg (174 Pa) low at the recommended operating pressure of 23 in wg (5730 Pa). This was considered a negligible error.

Tank Strainer: No strainer was provided at the tank filler opening. Foreign particles should be strained from all water entering the sprayer tank. Since no line strainer was located in the pump inlet line or between the pump and the hydraulic agitator, foreign particles could easily plug the agitator orifices.

Line Strainer: The combination 80/20 mesh strainer located between the pump and remote control valve effectively removed foreign material.

Although no protection was provided for the pump, centrifugal pumps are much less susceptible to damage from foreign material than roller pumps.

No strainers were provided at the metering pins.

Soil Compaction and Crop Damage: The Sprafoil trailer wheels travelled over about 1.8% of the total field area sprayed. This was in addition to the crop damage caused by the tractor wheels. The minimum wheel tread width of the sprayer was 89 in (2260 mm) which was greater than the tread width of most suitably sized tractors. However, soil contact pressure beneath the sprayer wheels was less than one-half that of an unloaded pickup truck or conventional field sprayer wheels. The average soil contact pressure under the Sprafoil wheels with a full tank was 14 psi (96 kPa) with a tire track width of 4.9 in (124 mm). For comparative purposes, an unloaded one-half ton truck has a soil contact pressure of about 30 psi (207 kPa).

RATE OF WORK

Field Speed: The Sprafoil field sprayer could be operated at speeds up to 8.5 mph (14 km/h) if the field was smooth enough to allow tractor operation at this speed. Suitable field speeds depended on application rate, field conditions and tractor gear selection. Spraying during a turn is not recommended due to erratic application rates that result across the boom width due to different ground speeds of the boom.

Average Workrate: The average workrate for the Sprafoil field sprayer varied from 7.5 to 31 ac/h (3 to 12.5 ha/h). Considerable variation can be expected due to field size, shape, topography and tank refill time.

PUMP PERFORMANCE

Priming: The Hypro 9202C centrifugal pump supplied with the Sprafoil was not self-priming. Since the pump was mounted below the spray tank, the positive inlet pressure needed for pump priming was automatically provided. The manufacturer cautioned that the pump not be run dry to avoid damaging the pump seals. The tank provided the pump with liquid in all topographic conditions encountered during the test.

Output: The Hypro 9202C centrifugal pump operated at about 3815 rpm when operated at 1000 rpm power take-off speed. FIGURE 7 gives the pump performance curve when disconnected from the Sprafoil plumbing system and operated at 3815 rpm. The maximum pump output was 60 gal/min (273 L/min). FIGURE 7 also shows the pump performance curve for the Hypro 9202C pump when operated in the Sprafoil plumbing system. Even though the maximum pump output was 60 gal/min (273 L/min) when removed from the plumbing system, the maximum pump delivery available to the agitator and booms, due to plumbing restrictions, was only 25 gal/min (114 L/min).

Agitation: 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).

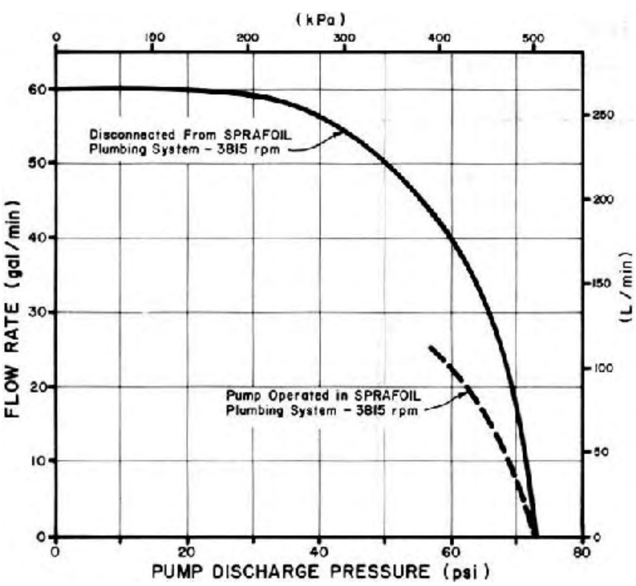


FIGURE 7. Pump Performance Curves.

The Sprafoil was equipped with two jet agitators. Agitation was adequate at all application rates. A typical agitation rate while spraying was about 18 gal/min (82 L/min). At high agitation rates, foaming may occur with some chemicals. The agitation rate could easily be reduced by partially closing the agitator valve. Foaming could also occur when the liquid level in the tank dropped below the jet agitators.

POWER REQUIREMENT

The Sprafoil sprayer air fan and centrifugal pump required a total of about 18 hp (13.5 kW) when operating the fan at recommended air pressure. This power requirement was in addition to the tractor power required to tow the sprayer in the field. A 60 hp (45 kW) tractor was considered large enough for all conditions encountered during the test. The tractor must be equipped with a 1000 rpm power take-off.

EASE OF OPERATION AND ADJUSTMENT

Controls: The Sprafoil sprayer was equipped with a Raven model SCS 203 remote pressure and boom controller mounted on the tractor in a convenient location for the operator. The remote control unit contained boom selection and on/off switches, a pressure adjustment switch and a pressure gauge. The pressure gauge monitored system pressure at the boom solenoid valves. The switches were large and easy to position in rough field conditions.

Application rate was controlled by tractor gear selection and by adjusting the system pressure. Since no optional metering pins were provided, the application rate was limited by the system pressure range and ground speed. It has already been recommended that the manufacturer consider modifications to extend the range of application rates.

The tank shut-off valve and the agitator control valve were located immediately below the tank. The valves were easily accessible due to the high sprayer frame.

The tank liquid level was visible through the plastic tank from the tractor seat in most spraying conditions. The liquid level numbers molded on the left side and back of the tank gave only a rough indication of the amount of liquid in the tank. The numbers were in U.S. gallons.

An air pressure gauge was mounted to the left of the fan drive and was easily visible from the tractor seat.

Maneuverability: The Sprafoil towed and maneuvered well in both field and transport positions.

Hitching: The sprayer could easily be hitched to a tractor equipped with a 1000 rpm power take-off. No hitch height adjustment was provided. The shielding around the rear power take-off universal joint interfered with the hitch jack crank when raising or lowering the hitch. The remote control unit required a 12-volt power source.

Wheel Spacing: The trailer wheels could be easily adjusted. Eight wheel tread spacings from 89 to 121 in (2260 to 3070 mm) were provided. The minimum tread width of 89 in (2260 mm) was greater than the tread width of most suitably sized tractors.

Transport: The Sprafoil sprayer could be folded into transport (FIGURE 8) or placed into field position in about 7 minutes. No tools were required. Rubber tie down straps were provided to secure the booms to the boom supports in transport position. In field position, the transport boom supports had to be folded up in front of the blower to prevent damage when turning.

The Sprafoil required a minimum turning circle diameter of about 41 ft (12.5 m) in transport position which was limited by boom interference with the tractor cab.

Care had to be taken while transporting the sprayer due to the 12.1 ft (3670 mm) height and 17.2 ft (5240 mm) width at the boom ends.

FIGURE 8. Sprafoil in Transport Position.

Spray Tank: The 167 gal (760 L) spray tank was adequate for application rates below 10 gal/ac (110 L/ha). Frequent refilling at higher application rates reduced the average workrate considerably. The filler opening was 72 in (1825 mm) above the ground which made it difficult to fill by gravity from nurse tanks on a farm truck. A portable pump was usually required. The 10.3 in (262 mm) tank opening was adequate for adding chemicals and water. A long reach was required to access the tank opening from the platform on the right side of the tank. The 32 in (813 mm) height of the platform above the ground was inconvenient to step up to from the ground and unsafe while carrying chemicals. It is recommended that modifications be made to provide safer and more convenient access to the spray tank.

The small sump and circular shape of the tank bottom provided the pump with liquid in all topographic conditions encountered and made tank draining convenient. The tank drain was easily accessible due to the high sprayer frame.

Boom Adjustment: Nozzle height and angle adjustments were easily set by adjusting the boom. Both adjustments were easily made by hand.

Nozzle height could be adjusted from 10 to 38 in (255 to 965 mm) with a ratchet operated turnbuckle located behind the fan (FIGURE 9). Nozzle angle could be adjusted from 7 degrees to the back to 40 degrees forward at the recommended nozzle height of 20 in (508 mm) by removing two clip pins (FIGURE 10). The nozzle angle had to be readjusted if nozzle height was changed.

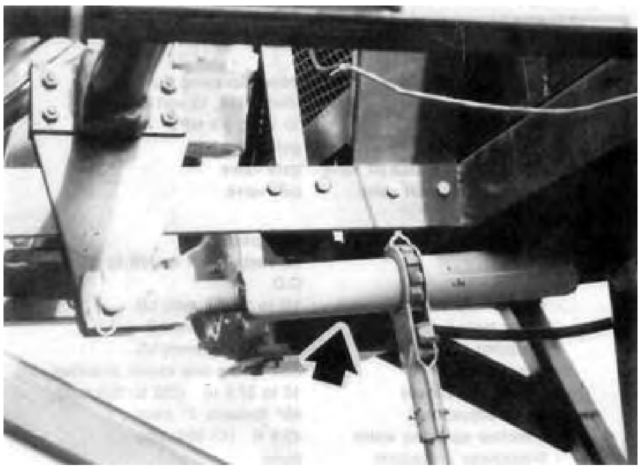


FIGURE 9. Boom Height Adjustment.

FIGURE 10. Nozzle Angle Adjustment.

The booms could be levelled by adjusting the turnbuckles on the boom support rods. However, if the nozzle angle was set forward near its maximum, it was not possible to properly level the booms and the boom support rods provided little support.

No boom breakaway feature was provided to protect the booms from serious damage if the ground or other field objects were hit. Skid runners at the ends of the boom helped prevent boom ends from digging into the ground. Extra care had to be used when operating on hilly and rolling fields or near field objects.

Nozzle Cleaning: The nozzles and the nozzle metering pins could be conveniently removed for cleaning with the use of tools. Occasionally, the nozzles near the boom ends would plug with chaff or insects drawn into the air system by the fan. The nozzle metering pins would occasionally plug and were easily cleaned once removed from the supply hose.

Lubrication: The Sprafoil sprayer had 11 grease fittings. The operator's manual recommended periodic but not over-greasing of all fittings and wheel bearings.

OPERATOR SAFETY

The Sprafoil sprayer was not equipped with a slow moving vehicle sign o; a mounting bracket. It is recommended that a slow moving vehicle sign be supplied as standard equipment.

Care had to be exercised while transporting the sprayer on the road or in a farm yard due to the 12 ft (3670 mm) height and 17.2 ft (5240 mm) width at the boom ends in transport position.

Care also had to be exercised while adding chemical to the spray tank due to the high step up to the operator platform and the long reach from the platform to the spray tank opening. It has already been recommended that the manufacturer consider modifications to provide safer and more convenient access to the spray tank.

Spray solution would drip from the nozzles when the booms were being placed into transport position. It was difficult for the operator to place the booms in transport position without getting dripped on.

All moving parts were well shielded.

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 contained little useful operating information. The operator's manual contained much information on components supplied by other manufacturers such as the power take-off shaft, pump and controller. However, it only briefly outlined sprayer calibration, operation, adjustments and maintenance. It is recommended that the operator's manual be improved to include instructions on operation and adjustment, calibration charts, safety information and a component parts list for the Sprafoil sprayer.

MECHANICAL PROBLEMS

TABLE 3 outlines the mechanical history of the Sprafoil PT4583 field sprayer during 54.5 hours of operation while spraying about 939 ac (380 ha). The intent of the test was evaluation of functional performance. An extended durability evaluation was not conducted.

TABLE 3. Mechanical History

		Equivalent Field Area	
Item	Operating Hours	ac	(ha)
PLUMBING SYSTEM - the suction hose collapsed, requiring replacement at		beginning of test	
FAN DRIVE			
-Several fan drive belts rolled onto their sides, damaging the belts. The belts were replaced at		65	(26)
-The bottom fan drive sheave came loose, resulting in misalignment. The bottom sheave was realigned and tightened at	45	798	(323)
BOOM - A bolt securing a boom support rod broke and was replaced at			
		end of test	

APPENDIX I
SPECIFICATIONS

MAKE:	Sprafoil
MODEL:	PT 4583
SERIAL NUMBER:	F1045
MANUFACTURER:	D & W Industries Sprafoil Division P.O. Box 834 Sioux Falls, South Dakota 57101
OVERALL DIMENSIONS:	
-wheel tread	adjustable eight positions, 89 to 121 in (2260 to 3070 mm)
-transport height	12.1 ft (3670 mm)
-transport length	18.1 ft (5530 mm)
-transport width	17.2 ft (5240 mm)
-field height	7.1 ft (2170 mm)
-field length	10.0 ft (3050 mm)
-field width	46.5 ft (14,180 mm)
-clearance height	11.0 in (280 mm)
-turning radius	
-transport	15.5 ft (4710 mm)
-field	10.9 ft (3310 mm)
TIRES:	2, 700/760-15,6ply, farm service

WEIGHT:

Transport Position	Empty	Loaded
-left	627 lb (285 kg)	1463 lb (665 kg)
-right	638 lb (290 kg)	1485 lb (675 kg)
-hitch	451 lb (205 kg)	429 lb (195 kg)
TOTAL	1716 lb (780 kg)	3377 lb 1535 kg)

Field Position	Empty	Loaded
-left	726 lb (330 kg)	1562 lb (710 kg)
-right	737 lb (335 kg)	1584 lb (720 kg)
-hitch	253 lb (115kg)	231 lb (105 kg)
TOTAL	1716 lb (780 kg)	3377 lb 1535 kg)

SPRAY TANK:	
-material	plastic
-capacity	167 Imperial gal (760 L)
-agitation	hydraulic nozzle jet
-shape	cylindrical with dome ends
saddle	sheet metal support
FILLER OPENING:	
-shape	round
-size	103 in (262 mm) ID
-location	top, center
-height above ground	6 ft (1825 mm)
-type of seal	plastic
STRAINERS:	
-main line	1, 80/20 mesh
PUMP:	
-make	Hypro
-model	9202 C
-type	centrifugal
-operating speed	3815 rpm
-type of drive	belt
PRESSURE GAUGE:	
-make	Raven
-type	bourdon tube
-range	0 to 100 psi
AIR PRESSURE GAUGE:	
-make	Magnehelic
-type	Diaphragm, differential pressure
-range	0 to 30 in wg (0 to 5730 Pa)
FAN:	
-type	centrifugal
-size	24 in (610 mm)
-operating speed	2845 rpm
-type of drive	belt
-connecting hose	8 in (203 mm) ID
DRIVE:	
-type	power take off
-overload protection	friction slip clutch
-speed	1090 rpm
CONTROLS:	
-sprayer control	Raven, Model SCS 203 master on/off switch three, on/off boom selector switches pressure adjust switch 15A buss fuse
-motorized control valve	Raven
-boom solenoid valves	three, Spraying Systems Model 144, 12 volt DC, 30 watt, 3/4 NPT
-suction shut off valve	gate valve
-agitator control/shut off valve	gate valve
-main line shut off valve	ball valve
BOOMS:	
-material	fiberglass
-shape	tapered, 7 to 4 in (178 to 102 mm) OD
-supply hoses	1/2 in (127 mm) ID
-boom hoses	3/8 in (95 mm) ID
-metering pin hoses	69, 1/4 in (6 mm) ID
-suspension	coil spring and shock absorber
-height adjustment	10 to 37.8 in (255 to 960 mm)
-angle adjustment	40° forward, 7° back
-effective spraying width	459 ft (13,980 mm)
-breakaway protection	none
NOZZLES:	
-number	69
-material	grommet - rubber foil - plastic
-metering pins	brass, double barbed with orifice in one end
-spacing	8 in (203 mm)
LUBRICATION POINTS:	
-power take off	
-power take off drive	
-fan	
-boom support linkage	

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

Excellent	Very Good
Good	Fair
Poor	Unsatisfactory

APPENDIX III
CONVERSION TABLE

acres (ac) x 0.40	= hectares (ha)
feet (ft) x 0.305	= metres (m)
horsepower (hp) x 0.75	= kilowatts (kW)
Imperial gallons (gal) x 4.55	= litres (L)
Imperial gallons per acre(gal/ac) x 11.23	= litres/hectare (L/ha)
inches (in) x 25.4	= millimetres (mm)
inches water gauge (in wg) x 249.1	= pascals (Pa)
miles/hour (mph) x 1.61	= kilometres/hour (km/h)
pounds force per square inch(psi) x 6.89	= kilopascals (kPa)
pounds mass (lb) x 0.45	= kilograms (kg)

SUMMARY CHART
SPRAFOIL MODEL PT4583 FIELD SPRAYER

RETAIL PRICE:	$12,938.00 (March, 1984, fob Lethbridge)
AVERAGE WORKRATE:	7.5 to 31 ac/h (3 to 12.5 ha/h)
APPLICATION RATES:	
-range	6. 4 to 11 gal/ac (72 to 122 L/ha) at 6.0 mph (9.7 km/h) 4.0 to 6.5 gal/ac (44 to 73 L/ha) at 10.0 mph (16.1 km/h)
UNDERLEAF COVERAGE:	some
WEED CONTROL:	similar to properly operated flat fan nozzles
AIR SYSTEM:	
-distribution	uniform across the width of the boom
-fan output	1760 cfm (831 L/s) at 23 in of water (5730 Pa) air pressure
-nozzle air velocity	150 mph (242 km/h)
DISTRIBUTION PATTERN:	very high spray concentrations below each nozzle
SPRAY TANK:	
-size	167 Imp. gal (760 L)
-agitation	18 gal/min (82 L/min) more than adequate
-filler opening height	6 ft (1825 mm)
PUMP:	
-maximum output in plumbing system	25 gal/min (114 L/min)
PLUMBING SYSTEM:	
-pressure range -minimum	9 psi (62 kPa)
-maximum	30 psi (207 kPa) limited by inadequate spray liquid atomization
CALIBRATION:	no chart prodded but adequate procedure given
CONTROL:	easy to operate
BOOM:	
-recommended nozzle height	20 in (503 mm)
-range of nozzle heights	10 to 38 in (255 to 965 mm)
-angle adjustment	7 degrees back to 40 degrees forward
-performance	stable during normal operation
CROP DAMAGE:	soil compaction less than one half that of an unloaded pickup truck
TRACTOR SIZE:	60 hp (45 kW) with 1000 rpm power take off
SAFETY:	step up to operator platform too high long reach from platform to tank opening moving parts well shielded
OPERATOR'S MANUAL:	needs improvement
MECHANICAL PROBLEMS:	only minor problems

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