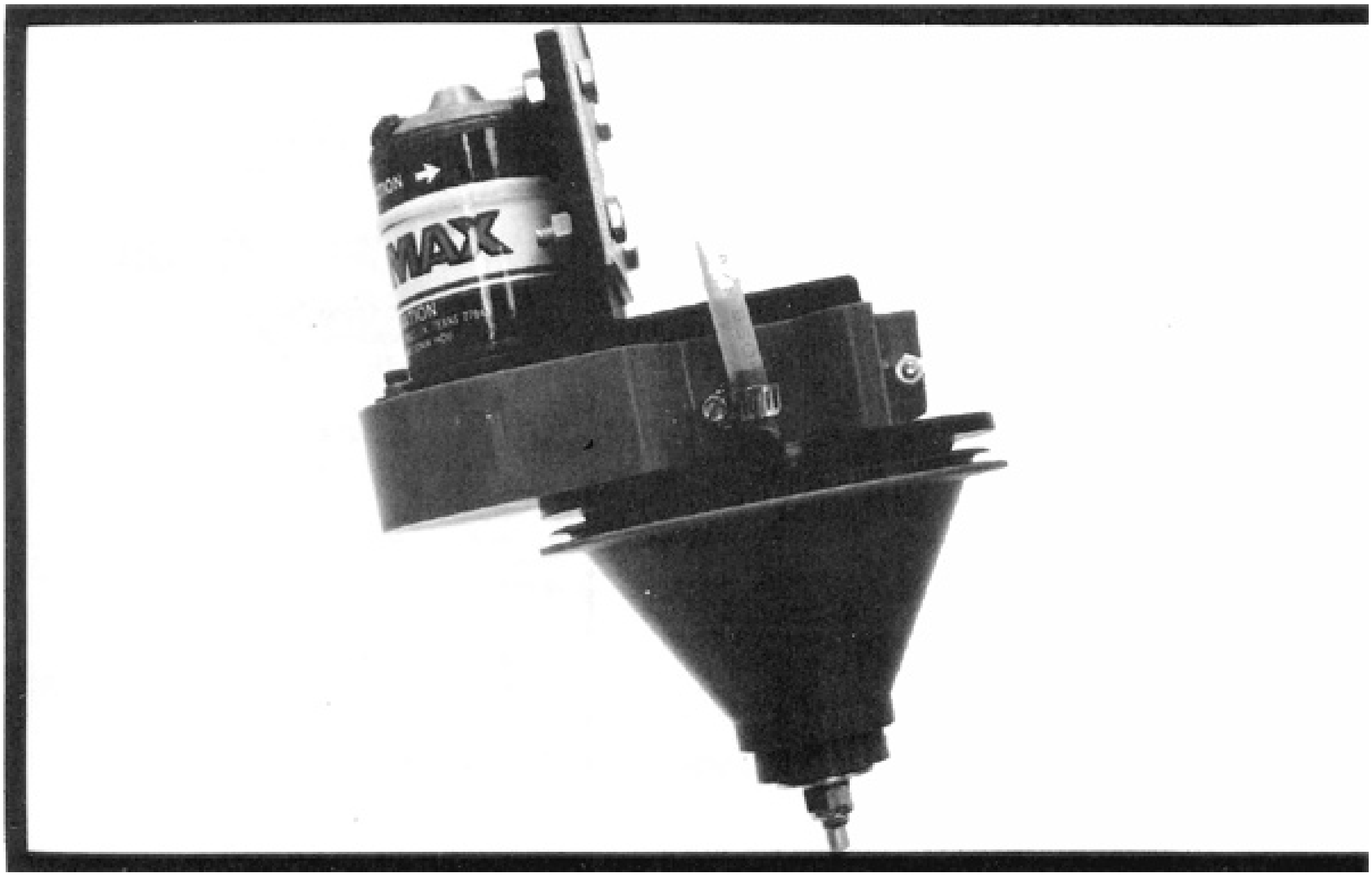
Printed: October 1985
Tested at: Lethbridge
ISSN 0383-3445
Group 8b

Evaluation Report 455



Micromax Controlled Droplet Applicator

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

MICROMAX CONTROLLED DROPLET APPLICATOR

MANUFACTURER:

Micron Corporation
Suite 190
1434 West Belt Drive North
Houston, Texas 77043

DISTRIBUTOR:

Micron Agri Sprayers Canada Inc.
R.R. #3
Walkerton, Ontario
N0G 2V0

Great Northern Manufacturing Company
521 Golspie Street
Winnipeg, Manitoba
R2L 2A5

RETAIL PRICE:

$225.00 (October, 1985, f.o.b. Lethbridge, Alberta.)
One complete unit as shown in FIGURE 2.

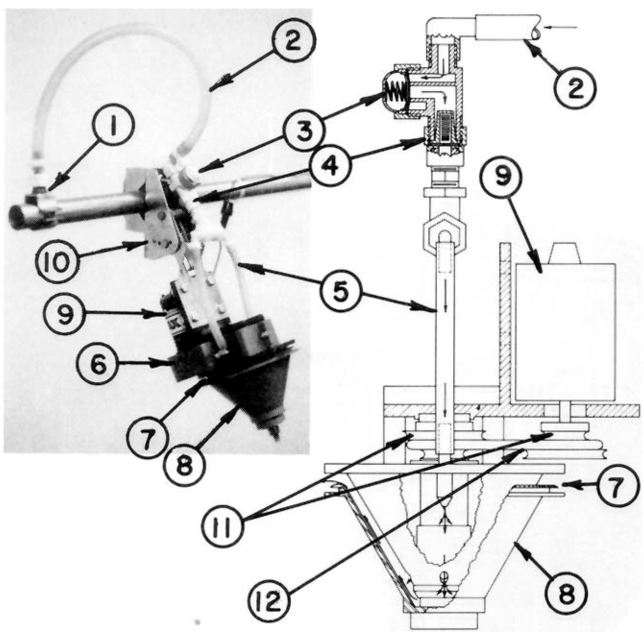


FIGURE 1. Micromax Controlled Droplet Applicator: (1) Existing Sprayer Nozzle Body, (2) Inlet Hose, (3) Diaphragm Check Valve, (4) Orifice Plate Adaptor, (5) Feeder Hoses, (6) Pulley Shield, (7) Spinning Disc Teeth, (8) Cone, (9) 12 Volt DC Motor, (10) Mounting Bracket, (11) Triple Pulley Assembly, (12) Belt.

SUMMARY

Weed Control: Field observations and experiments indicated that the Micromax Controlled Droplet Applicator was acceptable in controlling weeds when used at recommended application and chemical rates. However, in general, faster and more complete control was obtained with the conventional flat fan nozzles normally used on the prairies. At best, the Micromax applicator only equalled the performance of flat fan nozzles. Weed control at reduced rates from those recommended by chemical manufacturers requires further research. However, preliminary results indicated reduced weed control with the Micromax applicators at reduced application and chemical rates., Better weed control was obtained with conventional flat fan nozzles at reduced rates. Unacceptable distribution patterns at the applicator spacing used throughout the test were considered to at least partially account for reduced weed control of the Micromax applicators.

Timely application and environmental and growing conditions have as great an effect on weed control as the type of spraying method and the chemical application rate. Spraying at rates other than those recommended by the chemical manufacturer would be at the operator's own risk.

Application Rate: Application rate was controlled by the orifice plate size, pressure, tractor speed and Micromax applicator spacing. Delivery rate of the orifice plates was close to that specified by the manufacturer. Only negligible wear occurred during the test. The delivery rate from the spinning disc was usually less than that delivered by the orifice plates due to irregular flow through the feeder hoses.

Distribution Patterns: Spray patterns from individual Micromax applicators were non-symmetrical and differed noticeably from each other. Flow rates and spinning disc speed significantly affected individual applicator distribution patterns. Also affecting distribution, but to a lesser extent, were applicator angle and height.

The non-symmetrical and non-uniform individual applicator patterns made it impossible to establish one ideal applicator spacing for all flow rates, spinning disc speeds, applicator angles and applicator heights. Most distribution patterns along the boom were unacceptable, regardless of applicator spacing. Optimum applicator spacing varied considerably depending on the desired spraying parameters and none matched the applicator spacing of 40 and 72 in (1016 and 1829 mm) recommended by the manufacturer.

Spinning Disc Speed: The spinning disc speeds at the three pulley combinations depended on supply voltage and flow rate. At 12 volts, the three speeds were 2250, 4150 and 7150 rpm. These were considerably higher than the 2000, 2500 and 5000 rpm nominal speeds specified by the manufacturer. At a typical tractor operating voltage of 14 volts, the three speeds were 2650, 4900 and 8000 rpm.

Droplet Size: The droplet sizes produced by the Micromax applicators depended on flow rate and spinning disc speed. Droplet size decreased as flow rate decreased and spinning disc speed increased. Droplets were more uniform in size than those produced from conventional flat fan nozzles. More research is required to determine how droplet size affects weed control.

Installation: It took one man about 10 hours to install 16 Micromax applicators on a Spra-Coupe 116-78 sprayer. Installation instructions were clear. Selecting proper spacing, as already discussed, was difficult and confusing. The mounting brackets were easy to position and the plumbing assembly inlet hose was easily connected to an existing boom nozzle body. Fastening the bottom nut on the mounting bracket U-bolt was difficult and inconvenient. Extension arms and brace bars had to be used to properly position some Micromax units away from obstructions. Toggle switches and additional electrical wire had to be purchased to set up a control switch near the operator's station.

Ease of Operation and Adjustment: The Micromax applicators were easy to operate once installed. The applicators simply had to be turned on and the tractor speed and boom pressure adjusted. Application rate was easily obtained from formulas and graphs provided in the operator's manual after selecting the desired spacing, forward speed and orifice plate size. Four different orifice plate sizes were supplied. Changing orifice plates was easy but inconvenient, messy and unsafe. The Micromax applicators could be rotated at three different speeds, to produce different droplet size spectrums, by changing pulley combinations. Changing speeds was somewhat inconvenient

and time consuming. The Micromax mounting bracket provided for convenient applicator positioning at four different forward angles.

Power Requirements: No excessive electrical demands were made on a normal 12 V tractor battery and charging system.

Operator's Manual: The operator's manual was very good, containing much useful information on installation, operation and maintenance.

Mechanical Problems: A few motors failed to operate during the evaluation. Moisture collected inside the motor housing causing the brushes to stick, thus preventing contact with the armature. Some of the pulley shields distorted and interfered with the bottom pulley.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to make attaching the mounting brackets to the sprayer boom easier and more convenient.
2. Modifications to prevent Micromax plumbing assembly leaking.
3. Modifications to make orifice plate changing safer and more convenient.
4. Modifications to prevent moisture from entering the electric motors.
5. Modifications to prevent distorting of the shields around the pulleys.

Manager/Senior Engineer: E. H. Wiens

Project Engineer: B. Storozynsky

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The U-bolt has been superceded by two carriage bolts to improve ease of mounting bracket attachment to spray booms.
2. Improved plumbing with threaded parts have been deleted in favour of less flow restrictive hose barbs.
3. The Spraying Systems threaded check valve has been replaced with Spraying System Quick Jet valve assembly which greatly improves orifice plate changing and filter screen cleaning.
4. Motor sealing has been improved with plastic protective caps over motor tops and lead wires. Improved caulking is being used around the motor lower housing access plug.
5. Mounting brackets now have torsion springs replacing the earlier tension springs which were susceptable to overloading and permanent stretching. The pivot plate has been strengthened to prevent bending, a compromise to prevent atomizer cone shaft bending should it strike the ground.

MANUFACTURER'S ADDITIONAL COMMENTS

Since 1984, the Micromax atomizer has been available in electric motor direct drive versions with selectable electronic constant speed controllers to eliminate belt drives.

GENERAL DESCRIPTION

The Micromax controlled droplet applicator is a spinning disc device that utilizes centrifugal force to produce spray droplets. The Micromax applicator consists of an electric motor, cone shaped cup, pulleys, feeder hoses, orifice plate and mounting bracket (FIGURE 1).

Liquid is supplied to the Micromax through the feeder hose which is attached to an existing nozzle body on the sprayer boom. Liquid flow is regulated by an orifice plate and fed through two feeder hoses to the bottom of the cone. The inside of the cone is grooved to allow the liquid to travel from the bottom to the top of the rotating cone. The grooves end in teeth that extend horizontally on the periphery of the cone. The liquid comes off the rotating cone (spinning disc) annularly, creating a circular pattern.

The Micromax can be mounted on existing sprayer booms at specified spacings. The mounting bracket is adjustable, allowing the Micromax cone to be operated at forward spraying angles of 0, 15, 30 or 45 degrees to the horizontal. In addition, the bracket has a spring loaded breakaway feature to help prevent the unit from becoming damaged if accidentally striking the ground or some foreign object.

The Micromax unit is powered by the tractor electrical system. The cone is driven by a 12 volt dc motor and can be rotated at nominal speeds of either 2000, 3500 or 5000 rpm, by selecting the proper pulley combination.

Detailed specifications are given in APPENDIX I, while FIGURE 1 shows major components and a schematic of the flow through the Micromax system.

SCOPE OF TEST

The Micromax controlled droplet applicators were installed on a Melroe model 116-78 Spra-Coupe sprayer. They were used for 138 hours while spraying herbicides on about 4800 ac (1943 ha). They were evaluated for ease of installation, ease of operation and adjustment, quality of work, electrical power requirements, suitability of the operator's manual and operator safety.

RESULTS AND DISCUSSION

EASE OF INSTALLATION

Parts: Each Micromax spinning disc applicator included four separate parts that had to be assembled before installing on a sprayer. The parts included the Micromax body with 12 volt dc motor, a mounting bracket, electrical wire and connectors, and the plumbing assembly (FIGURE 2). The parts were easily assembled into one unit. The applicator came with four different sized orifice plates.

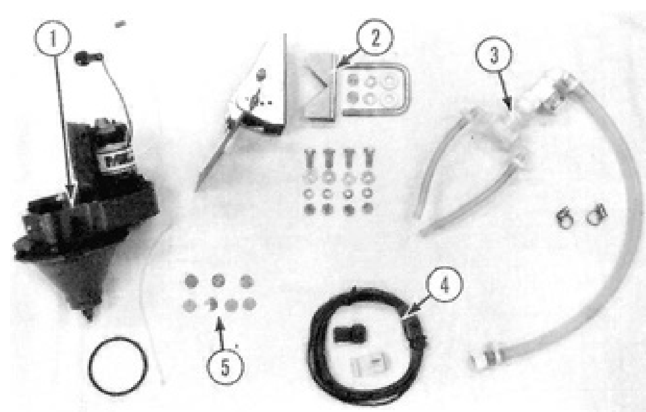


FIGURE 2. Micromax Applicator Parts: (1) Micromax Body and Motor, (2) Mounting Bracket and Hardware. (3) Plumbing Assembly, (4) Electrical Wire and Connectors, (5) Orifice Plates and Plugs.

Installation Time: It took one man about 10 hours to install 16 Micromax assemblies on a Melroe model 116-78 Spra-Coupe (FIGURE 3). Installation instructions were adequate and easy to understand.

Mounting Brackets: The mounting bracket permitted mounting of the Micromax applicators on various types of sprayer booms.

The bracket could be positioned anywhere along the boom, allowing for convenient applicator spacing. Fastening the bolts and washers to the bracket U-bolts was very difficult since inadequate space was provided for tools or the use of hands (FIGURE 4). This made applicator mounting very inconvenient and time consuming. It is recommended that modifications be considered to improve ease of fastening the mounting brackets to the sprayer boom. Care had to be exercised when mounting the brackets on sprayer booms made from thin wall tubing, to avoid crushing the booms.

FIGURE 3. Micromax Applicators Mounted on Melroe Model 116-78 Spra-Coupe.

Due to the wide circular pattern produced by the spinning disc applicator, it was important to mount the applicators away from any type of obstruction such as could be encountered around the sprayer tank and wheels. To prevent the spray pattern from interfering with obstructions, the applicators were mounted on extension arms a minimum of 4 ft (1.2 m) from any obstruction (FIGURE 5). The extension arms usually required additional bracing to prevent the Micromax assembly from bouncing.

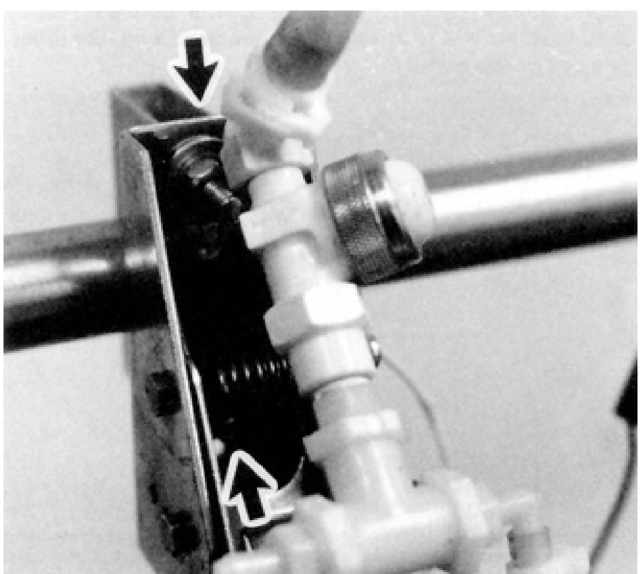


FIGURE 4. Poor Access to U-Bolts Making it Difficult to Fasten Mounting Brackets to Sprayer Boom.

Plumbing: The Micromax applicator came with its own plumbing, designed to attach to existing sprayer booms. The inlet hose was equipped with a standard TeeJet nozzle cap that was quickly and easily attached to standard TeeJet nozzle bodies (FIGURE 6). No additional plumbing was required unless the sprayer boom wasn't equipped with standard TeeJet nozzle bodies.

Leaking was a major problem. Leaking occurred at the Micromax applicator cap, boom nozzle body and between the check valve and orifice plate adaptor. Teflon tape was used to eliminate leaking. Modifications are recommended to prevent leaking.

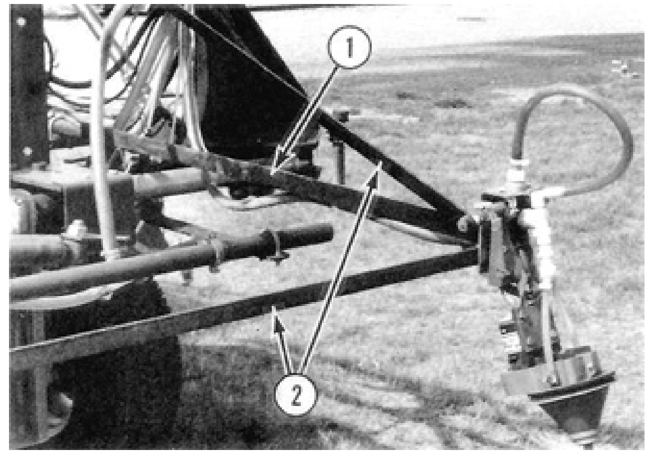


FIGURE 5. Micromax Applicator Mounted on Sprayer: (1) Extension Arms. (2) Bracing.

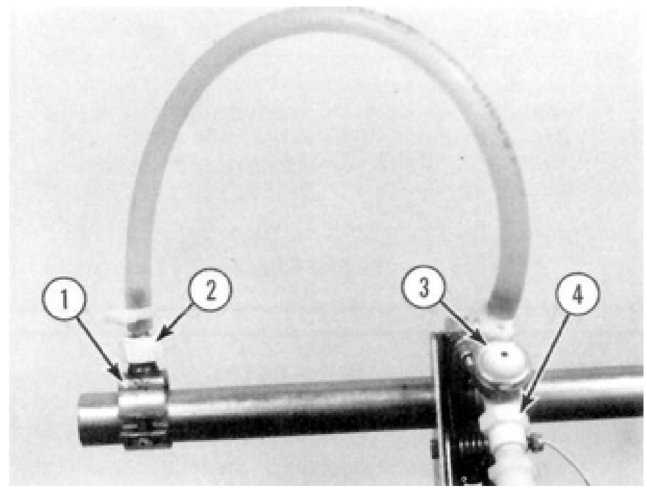


FIGURE 6. Micromax inlet Hose Connected to Existing Sprayer Boom Nozzle Body: (1) Boom Nozzle Body, (2) Micromax Applicator Cap, (3) Diaphragm Check Valve. (4) Orifice Plate Adaptor.

Electrical Wiring: The wire and connectors provided made wiring convenient. Toggle switches and additional wire had to be purchased to set up an on/off applicator control system. Since each unit could draw up to 3 amps and most toggle switches are not rated over 25 amps, the manufacturer recommended that not more than 8 Micromax applicators be connected to one switch. In addition, plastic cable ties were purchased to fasten the wiring to the sprayer boom.

Ground wires could be eliminated if the sprayer boom was grounded. In that case the motor ground wire could simply be attached to the mounting bracket.

EASE OF OPERATION AND ADJUSTMENT

Speed Adjustment: The Micromax Controlled Droplet Applicator could be rotated at three different speeds by repositionIng the belt on the triple pulley assembly (FIGURE 1). Placing the belt at the top, middle and bottom pulleys was supposed to provide nominal cone speeds of 2000, 3500 and 5000 rpm, respectively.

Choosing the proper cone speed depended on the type of spraying, coverage required and spraying conditions. The 2000 rpm speed was intended for use with pre-emergent and pre-plant herbicides, foliar fertilizers and soil insecticides. The low speed allowed higher application rates with larger droplets for spraying in windy conditions. The 3500 rpm speed was intended for use with post-emergent herbicides, defoliants and dessicants. The 5000 rpm speed was intended for use with insecticides and fungicides. The higher speed produced more small droplets which resulted in more droplets per unit area.

Changing speeds was somewhat inconvenient and time consuming. The two feeder hoses had to be disconnected from the Micromax hose and barbs in order to remove the pulley shield (FIGURE 1). The shield had to be slightly twisted in order to remove it.

Repositioning the belt was best done with the aid of a long, thin screw driver. The belt easily slipped onto the new pulley by pulling it towards the pulley with the screw driver and then spinning the cone by hand. Care had to be taken not to stretch the belt. Therefore, it was important to position the belt on the smaller pulley first and then onto the larger pulley. Also, it was important to do one level of pulley at a time.

The motor pulley assembly could be adjusted so the belt was always level. This prevented the belt from stretching and wearing.

Flow Regulation: Flow rate was regulated by orifice plates and pressure. Four different sized orifice plates were provided to regulate flow to the Micromax rotating cone. At an operatIng pressure of 20 psi (138 kPa), the 4916-20, 4916-26, 4916-37 and 4916-55 orifice plates provided flow rates of 0.032, 0.055, 0.103 and 0.235 gal/min (0.15, 0.25, 0.47 and 1.07 L/min), respectively.

The orifice plates fit between tlie diaphragm check valve and the two feeder hoses (FIGURE 1). Changing orifice plates was easy but inconvenient, messy and unsafe. The inlet hose had to be removed from the existing sprayer boom and then the top half of the plumbing assembly could be unscrewed from the orifice plate adaptor. This resulted in the operator being exposed to chemical running and dripping from the inlet hose. In addition, the orifice plate was difficult to remove from its cavity. The orifice plate adaptor assembly had to be inverted and tapped until the plate came out.

As already mentioned, leaking usually occurred after reassembling the inlet hose to the sprayer nozzle body and the diaphragm check valve to the orifice plate adaptor. The connections could not be tightened enough. The connections either cross-threaded or stretched out of shape when tightened. Teflon tape was used on the threaded connections to prevent leaking. This was inconvenient since the threaded connections were small and usually too wet to place the teflon tape properly. Leaking was more of a problem when smaller sized orifice plates were used since they were very thin and required the diaphragm to be overtightened. Modifications are recommended to make orifice plate changing safer and more convenient. It has already been recommended that modifications be considered to eliminate leaking at the various connections.

Application Rate: Application rate was controlled by the orifice plate size, pressure, tractor speed and Micromax applicator spacing. Determining application rate after selecting orifice size, pressure, spacing and speed was done by the formulas, charts and graphs provided in the operator's manual.

Operation: Once installed, the Micromax applicators were easy to operate. The toggle switch had to be turned on to spin the Micromax cone and then the pressure was adjusted using the existing sprayer pressure regulator. It was important to shut off the flow to the applicators before switching off the toggle switch to avoid the cone from filling up. This prevented the belt from slipping and high current draw when the Micromax was initially started.

Spray Angle: The Micromax applicator mounting bracket could be adjusted to spray at four forward angles; 0, 15, 30 and 45 degrees. Four holes in the mounting bracket (FIGURE 2) made it very easy to change spray angle. When pulling back the Micromax body to change spray angle, care had to be exercised to avoid bending the lower portion of the bracket. The bracket was weak at this point and could be easily bent and twisted when pulled, thus altering the angle and direction of spray.

The mounting bracket had a spring loaded breakaway feature. The breakaway feature prevented severe damage to the Micromax applicators when accidentally hitting the ground or when contacting a foreign object.

Choosing a spray angle depended on the type of spraying done and crop canopy penetration required. Better crop penetration occurred from the bottom portion of the spray at the higher forward spray angles. The top portion of the spray, when using higher forward spray angles, was ineffective and susceptible to drift.

Maintenance: For proper performance the Micromax applicators required frequent maintenance. Moisture and dirt collected in the fuse cartridges. Tape was used in an attempt to seal the fuse cartridges. However, heat and moisture from the spray usually resulted in the tape loosening.

Dirt and moisture collected inside the pulley shields which made the pulley area messy. At operating angles greater than zero degrees, dirt collected at the bottom of the pulley shield and interfered with the pulley. The pulley shields had to be removed frequently to clean out the dirt and to check if the belts were on the desired pulley. The belts occasionally skipped onto other pulley combinations.

Field vibration usually caused the Micromax brackets to move slightly, resulting in improper spray patterns. For proper alignment, the Micromax bodies had to be positioned at the zero degree position and then the U-bolts adjusted until the top of the body was at zero degrees both horizontally and laterally. Care had to be exercised to prevent crushing the boom tubing when tightening.

Partially plugged orifice plates were difficult to detect. As a result, when using dugout or lake water the orifice plates had to be checked frequently. This was time consuming and inconvenient.

OUALITY OF WORK

Orifice Plate Delivery: The average delivery of the four orifice plates supplied for use with the Micromax applicators differed only slightly from rates specified by the manufacturer over the normal range of operating pressures (FIGURE 7). Orifice plate wear after use was only slight. For example, the delivery rate of 4916-37 and 4916-55 orifice plates increased by 1.4 and 4.4 percent after 78 and 60 hours of field use, respectively. Orifice plate wear depends on the type of chemical sprayed and water cleanliness.

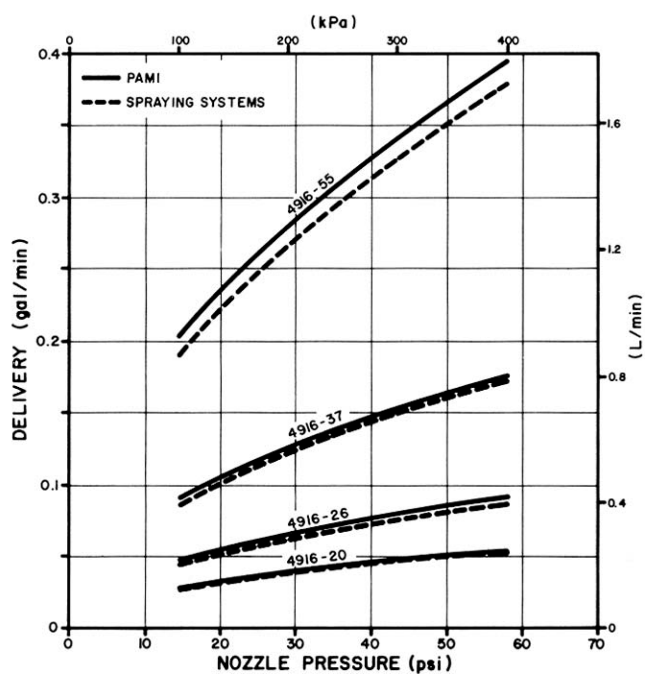


FIGURE 7. Delivery Rates for Stainless Steel Orifice Plates.

The delivery rate from the Micromax spinning disc was usually less than that metered by the orifice plates. The reduction in flow was attributed to the irregular flow from the two feeder hoses. After fluid passed through the regulating orifice plates, fluid to the two feeder hoses was usually irregular and unequal.

Spinning Disc Speed: Micromax spinning disc speeds at the three pulley combinations depended upon supply voltage and fluid delivery rate (i.e. orifice plate size). Spinning disc speed increased as the supply voltage increased (FIGURE 8). At 12 volts, the average speed of nine Micromax applicators, operated at low, medium and high speed pulley combinations with the orifice plates shown, was 2280, 4180 and 7180 rpm, respectively. These speeds were considerably higher than the 2000, 3500 and 5000 rpm nominal speeds indicated by the manufacturer. When installed on sprayers and hooked to a tractor's electrical system, the applicators operated at even higher speeds, since the voltage supplied was usually above 12 volts. For example, at 14 volts, which is a typical operating voltage for most tractors, the three speeds were 2660, 4880 and 8030 rpm.

Flow rate had very little effect on the speed of the spinning disc at the low speed pulley combination (FIGURE 9). However, at the high speed pulley combination, increasing the flow rate (orifice plate size) resulted in a significant decrease in spinning disc speed.

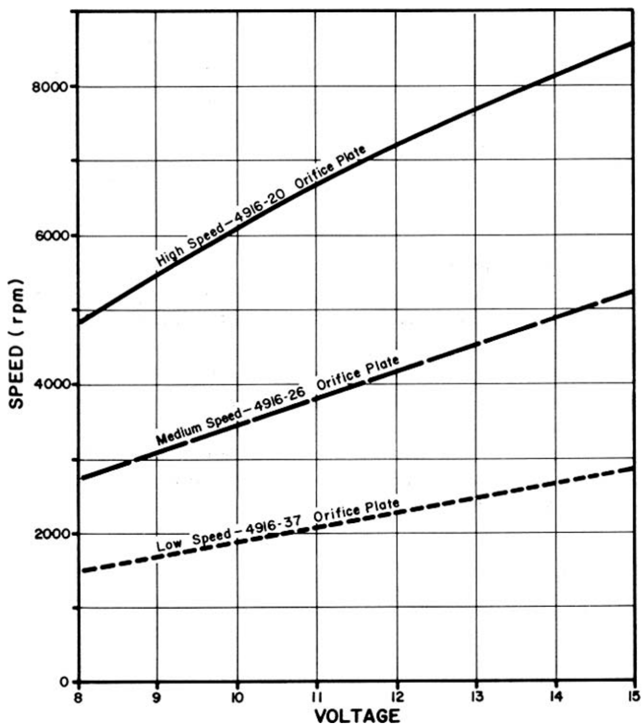


FIGURE 8. Micromax Spinning Disc Speeds at Various Supply Voltages at Low, Medium and High Speed Pulley Combinations.

Distribution Pattern of a Single Micromax Applicator: Micromax applicators delivered spray annularly in a hollow conical fashion, resulting in a saddle-shaped distribution pattern. FIGURE 10 shows typical distribution patterns of three different Micromax applicators. Higher applications occurred at the outside edge of the patterns. Each Micromax applicator tested produced a noticeably different distribution pattern. The patterns were shifted off centre in varying amounts and usually the application rate was higher on one edge of the pattern than on the other. Very few Micromax applicators produced symmetrical patterns. Pattern width and shape were affected differently by variables such as flow rate, spinning disc speed, applicator angle and applicator height.

At low flow rates the overall pattern was narrow with high application rates at the edge of the pattern (FIGURE 11). At higher flow rates, the overall pattern was flatter and wider.

Moderate changes in spinning disc speed above or below the nominal speed had no significant effect on distribution pattern. The distributioh patterns were, however, significantly different at the three nominal speeds (FIGURE 12). At the low speed the pattern was narrow with high application rates at the pattern edges and low application rates in the middle. At higher speeds the pattern became wider, more uniform and more symmetrical.

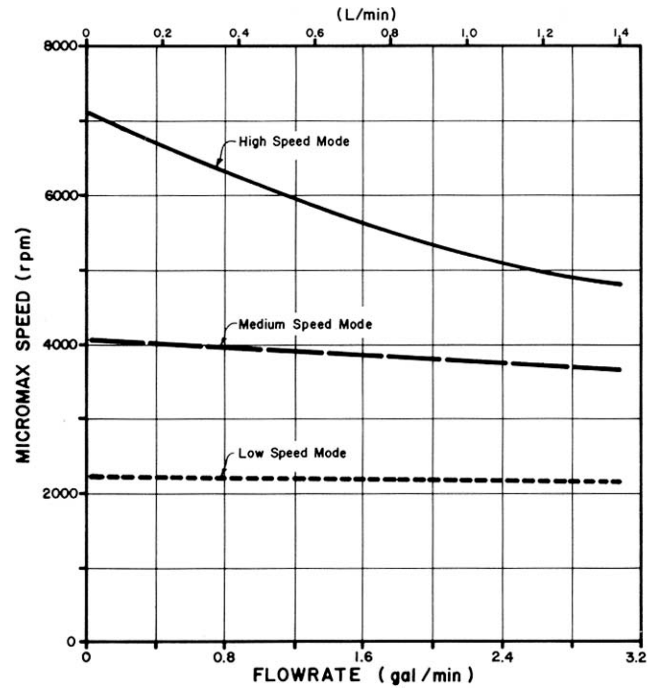
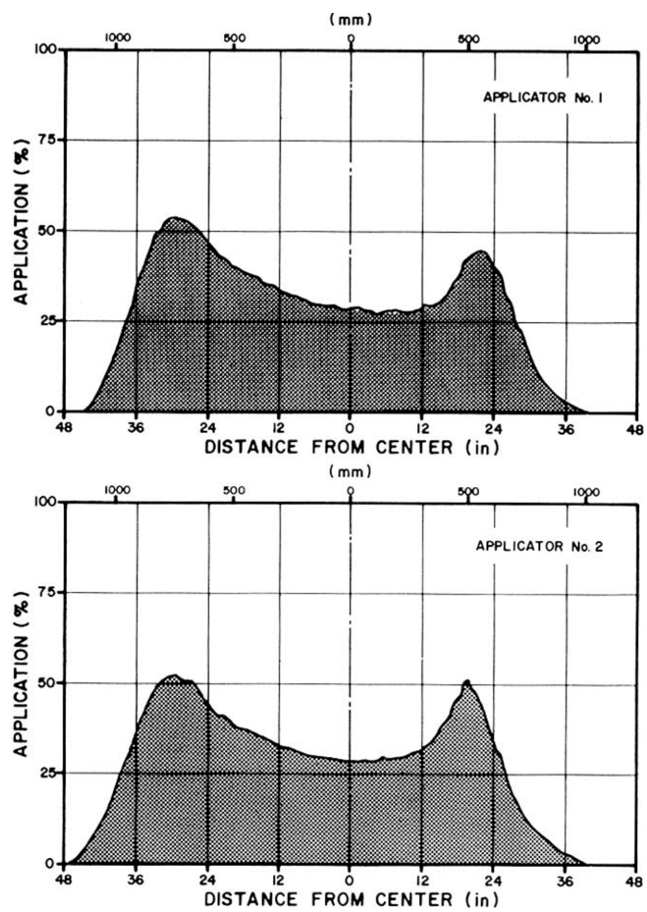


FIGURE 9. Micromax Spinning Disc Speed at Various Flow Rates.

Tilting the nozzle forward resulted in the pattern becoming unsymmetrical (FIGURE 13). At 0 degree forward angle, the pattern was symmetrical. At 30 and 45 degrees the pattern changed significantly, resulting in the pattern shifting to the right or left.

The distribution patterns increased in width as the mounting height increased (FIGURE 14). The patterns were much the same shape between a 15 and 25 in (381 and 635 mm) height. Below 15 in (381 mm) the pattern became very narrow with high application rates at the edge of the pattern.



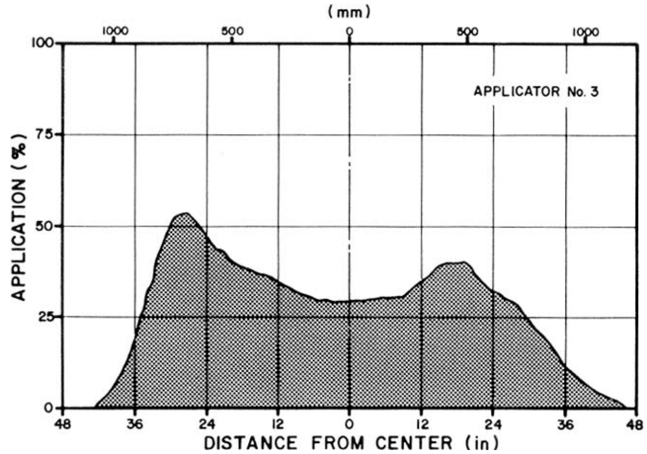
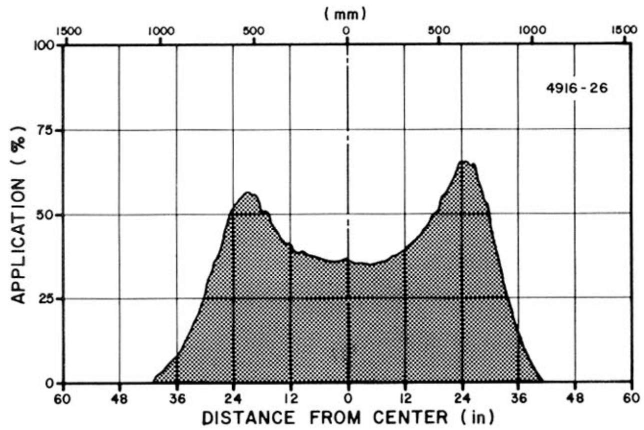


FIGURE 10. Distributiod Patterns of Three Different Micromax Applicators Using 4916-37 Orifice Plates, Operated at Low Speed, at an 18 in (457 mm) Discharge Height, 15 Degree Forward Angle and 22 psi (150 kPa) Pressure.



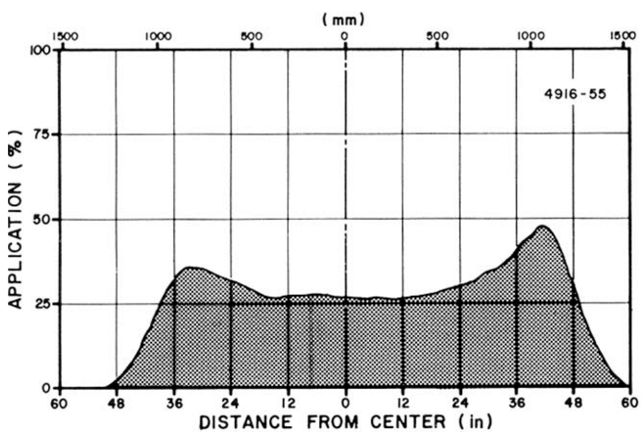
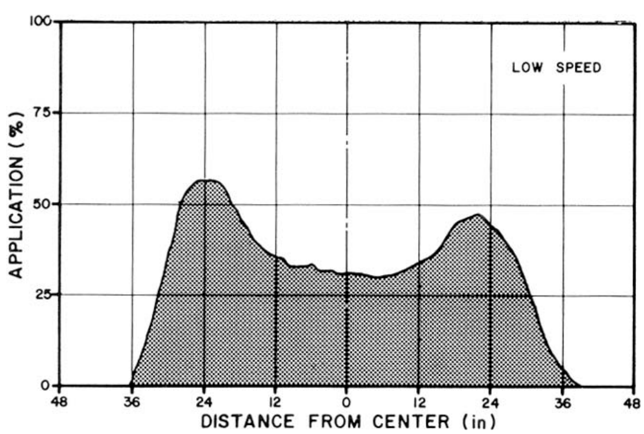
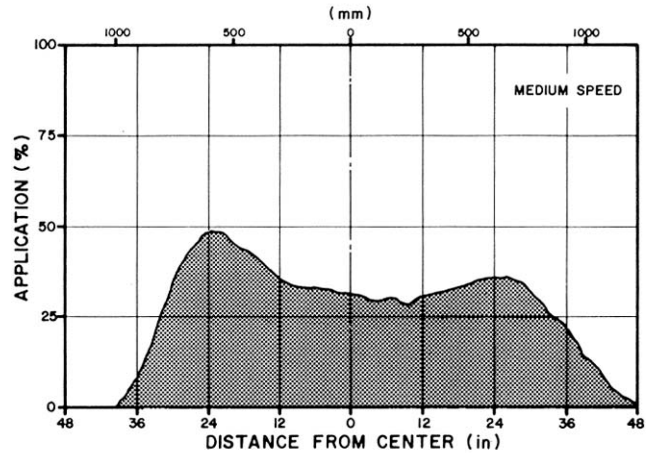


FIGURE 11. Effect of Flow Rates on Distribution Pattern with the Micromax Operated at Low Speed at an 18 in (457 mm) Discharge Height, 15 Degree Forward Angle and 21 psi (145 kPa) Pressure. (Upper: 4916-26, Lower: 4916-55).





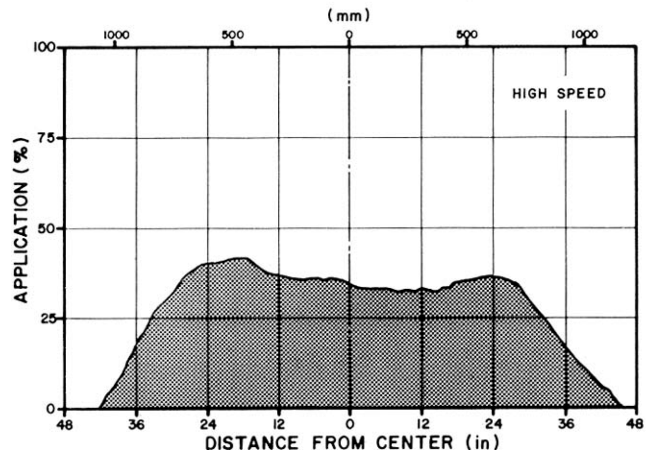
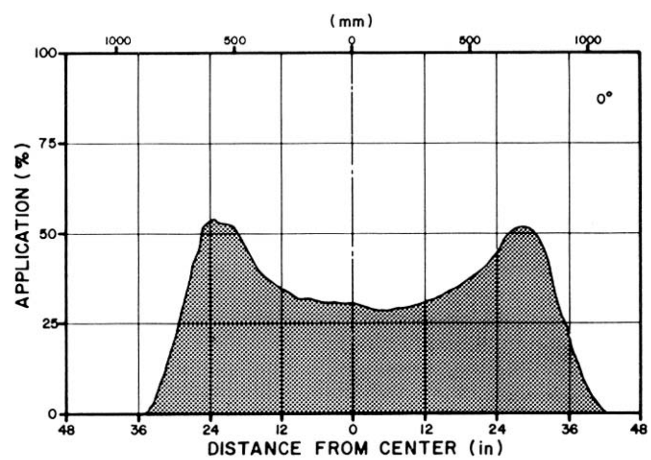
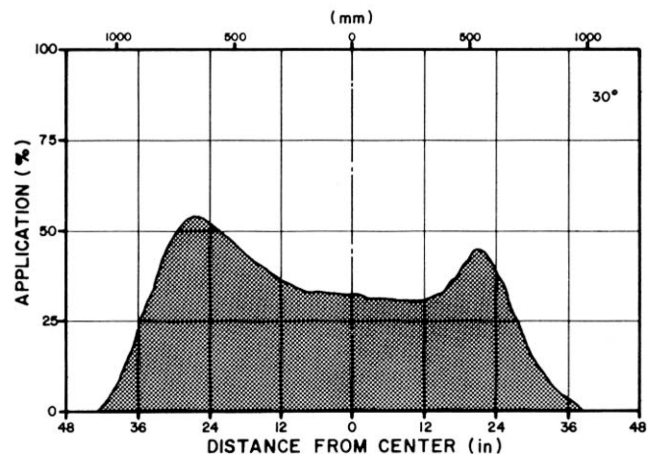


FIGURE 12. Typical Micromax Distribution Patterns at the Three Nominal Speeds Using 4916-37 Orifice Plates, Operated at an 18 in (457 mm) Discharge Height, 15 Degree Forward Angle and 21 psi (145 kPa) Pressure.





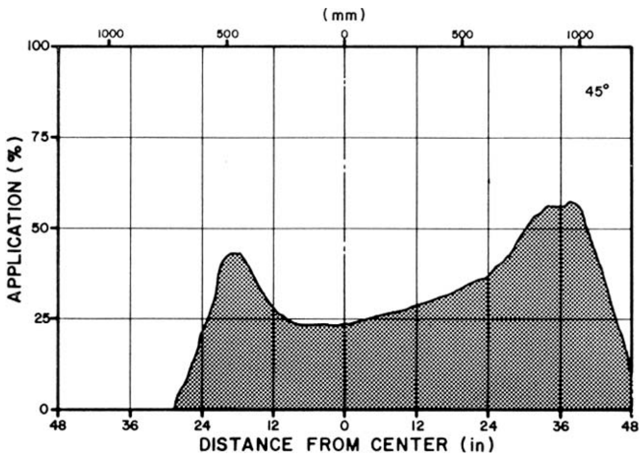


FIGURE 13. Effect of Tilting Applicator on Distribution Pattern, Operated at Low Speed at an 18 in (457 mm) Discharge Height and 21 psi (145 kPa) Pressure.

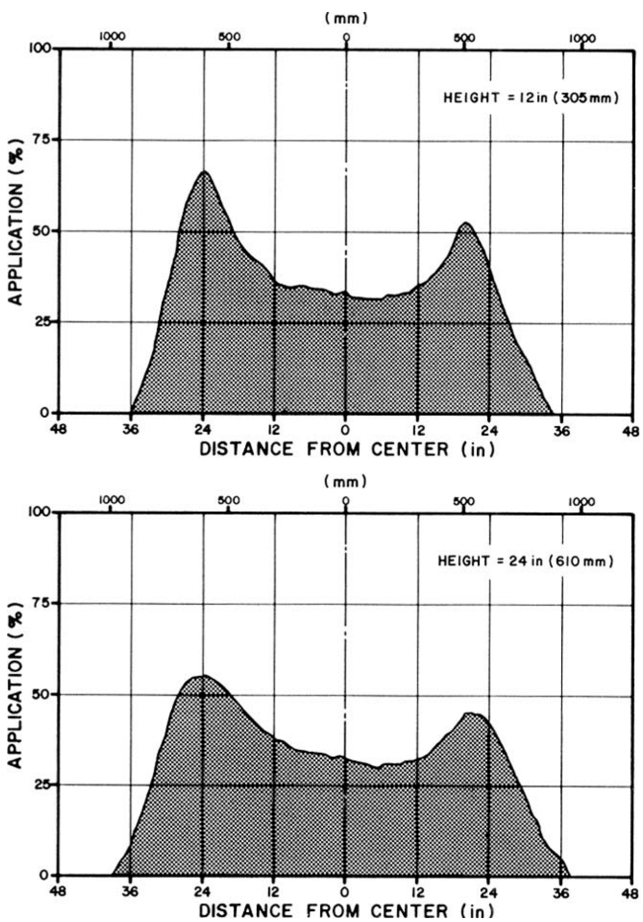


FIGURE 14. Effect of Applicator Height on Distribution Pattern, Operated at Low Speed at a 15 Degree Forward Angle and 21 psi (145 kPa) Pressure.

Distribution Pattern Uniformity: To obtain a more uniform spray distribution pattern than that obtained from individual applicators, the applicators were spaced so individual patterns overlapped. Due to the non-symmetrical and non-uniform patterns produced by individual applicators, one ideal spacing for all parameters encountered, such as flow rate (i.e. orifice plate size), disc speed, angle, and height, was not possible.

FIGURE 15 shows distribution pattern uniformity at various applicator spacings, spinning disc speeds and orifice plate sizes when operated at an angle of 15 degrees, an applicator height of 18 in (457 mm) and a pressure of 22 psi (150 kPa). The coefficient of variation (CV) was used to express spray distribution pattern uniformity. As noted, there was considerable variation in distribution pattern uniformity. In most conditions, the CV's greatly exceeded the maximum acceptable CV of 15 percent normally used as a standard for conventional flat fan nozzles. At the manufacturer's recommended spacings of 40 and 72 in (1016 and 1829 mm), distribution pattern uniformity was unacceptable for all conditions with CV's ranging from 19 to 40 percent.

Optimum applicator spacing varied considerably with applicator disk speed and orifice plate size. At the low speed and 4916-55 orifice plates the optimum spacing occurred at 30 and 85 in (762 and 2159 mm). At the low speed and 4916-37 orifice plates the optimum spacing occurred at 30 and 70 in (762 and 1778 mm). At the medium speed and 4916-37 orifice plates the optimum spacing occurred at 30 and 70 in (762 and 1778 mm). At the medium speed and 4916-26 orifice plates optimum applicator spacing occurred at 60 in (1524 mm). At the high speed and 4916-20 orifice plates the optimum spacing occurred at 55 in (1397 mm).

FIGURE 16 shows a typical distribution pattern at the optimum applicator spacing of 30 in (762 mm) at the medium speed. High concentrations of spray occurred between each nozzle. This was typical of all distribution patterns at the smaller applicator spacings. FIGURE 17 shows a typical distribution pattern at the other optimum spacing of 70 in (1778 mm) at the medium speed. High and/or low spray concentrations occurred where individual applicator patterns overlapped.

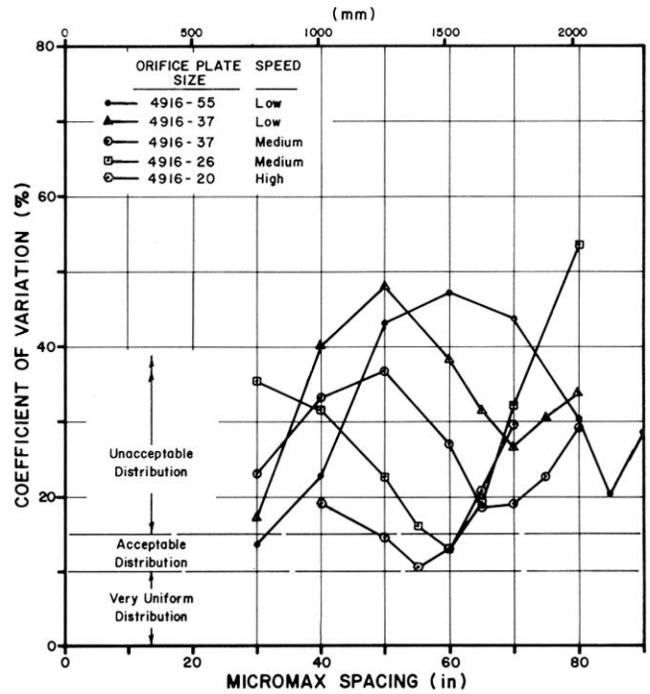


FIGURE 15. Distribution Pattern Uniformity over a Range of Applicator Spacings at Different Speeds and with Different Orifice Plates.

As noted from FIGURE 15, the most uniform distribution patterns for a given spinning disc speed and flow rate usually occurred at either a narrow or wide applicator spacing. Operating the Micromax applicators at spacings less than 40 in (1016 mm) is not recommended since spray patterns from adjacent applicators interfered with each other. Also, narrow spacings increased the number of Micromax applicators required and increased the application rate and water requirements. The wider spacing required fewer applicators and consequently was less expensive. Also, the application rate was reduced and less water was required. For example, comparing Micromax applica-

[1]The coefficient of variation (CV) is the standard deviation of application rates for successive 0.63 in (16 mm) sections along the boom expressed as a percent of the mean application rate. The lower the CV, the more uniform is the spray coverage. 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 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.

tor spacings of 30 and 85 in (762 and 2159 mm) using 4916-55 orifice plates, the application rate was 7.9 and 3.1 gal/ac (98 and 35 L/ha), respectively.

The Micromax applicator spacing was usually permanent once installed. The Micromax mounting brackets and plumbIng could be adjusted to a different spacing to produce better distribution patterns when different spinning disc speeds and flow rates (orifice plates) were selected. However, this was time consuming and required the motor wire lengths to be changed and reconnected. The mechanical wire splice that was used to connect the motor and main positive wires was difficult to remove.

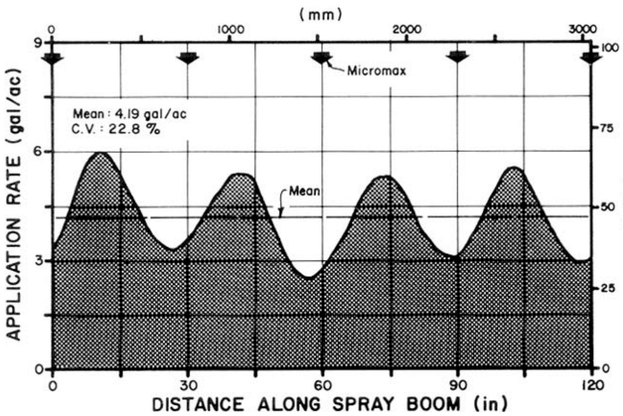


FIGURE 16. Typical Distribution Pattern at 30 in (762 mm) Applicator Spacing, Medium Applicator Speed, 15 Degree Angle and 18 in (457 mm) Applicator Height, using 4916-37 Orifice Plates.

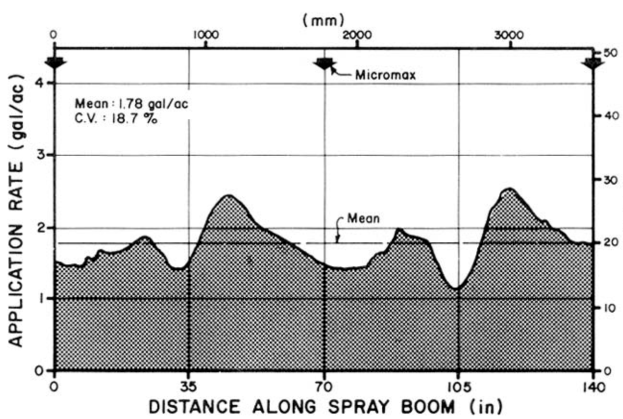


FIGURE 17. Typical Distribution Pattern at 70 in (1778 mm) Applicator Spacing, Medium Applicator Speed, 15 Degree Angle and 18 in (457 mm) Applicator Height, using 4916-37 Orifice Plates.

Weed Control: Field scale observations of weed control, using the Micromax applicators were made in 1982 and 1983. In 1984 and 1985, replicated experiments, using four different application techniques, were conducted.[2] The Micromax applicators were one of the application techniques included in the experiment. In both the field scale observations and the experiment, recommended as well as reduced water and chemical rates were used.

Although weed control over the years varied, in general, field observations and experiments indicated that the Micromax applicator provided acceptable weed control when used at the chemical manufacturer's recommended rates. However, in general, faster and more complete control was obtained with conventional flat fan nozzles normally used on the prairies. For example, in 1984 Buctril M was used at the recommended rate to control weeds in a field predominantly infested with stinkweeds. Three weeks after the test plots were sprayed, it was difficult to find any green stinkweeds in the plots sprayed with flat fan nozzles. On the other hand, it was easy to locate stunted and only partially wilted stinkweeds in the Micromax plots. At best, the Micromax applicator only equalled the performance of flat fan nozzles at recommended spraying rates.

Poor distribution patterns (FIGURE 18) were considered to at least partially account for reduced weed control of the Micromax applicators. All field work was done at the manufacturer's recommended applicator spacing of 40 in (1016 mm), using 4916-55, 4916-37 and 4916-20 orifice plates to apply 7.4, 3.3 and 1.0 gal/ac (82, 37 and 11 L/ha), respectively, at 5.0 mph (8 km/h). As shown in FIGURE 15, all distribution patterns at this applicator spacing were unacceptable. Optimum applicator spacing for the desired application rate would result in improved distribution patterns and improved weed control. However, as noted in FIGURE 15, optimum spacing is highly variable for the various spinning disc speeds and application rates.

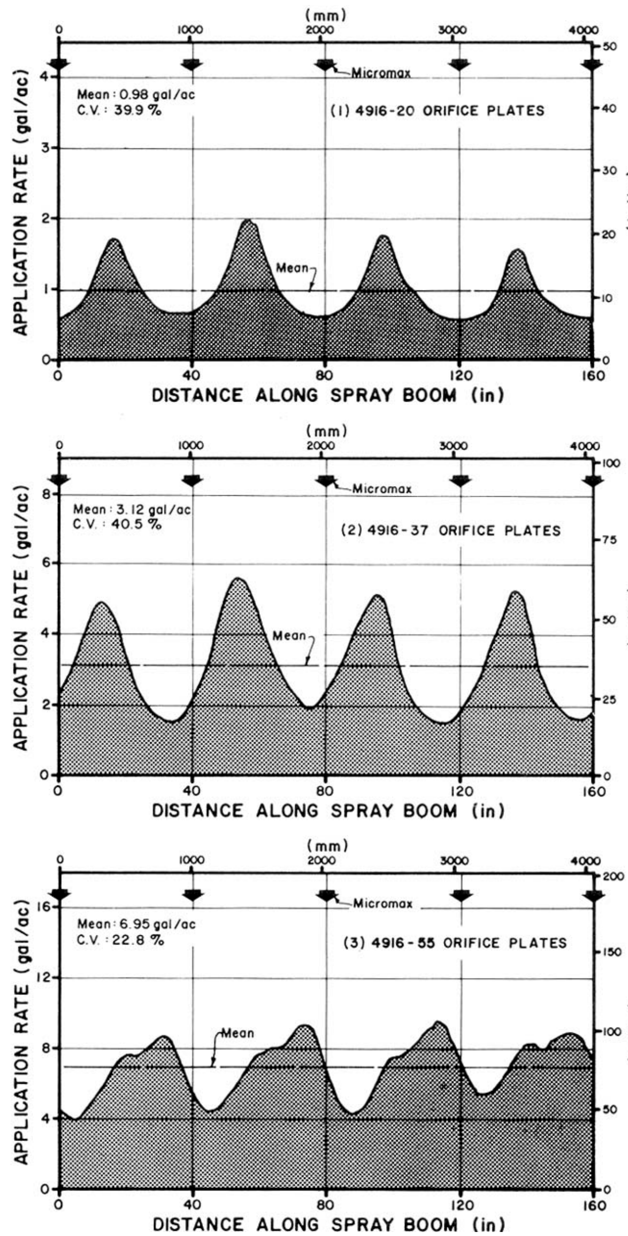


FIGURE 18. Distribution Patterns with Micromax Applicators at 40 in (1016 mm) Spacing, Operated at Low Speed, 18 in (457 mm) Discharge Height and 15 Degree Forward Angle Using (1) 4916-20, (2) 4916-37 and (3) 4916-55 Orifice Plates.

Weed control at reduced rates from those recommended by the chemical manufacturers requires further research. However, preliminary results indicated reduced weed control with the Micromax applicators at reduced application and chemical

[2] "Annual Broadleaf Weed Control in Wheat with the Controlled Droplet Applicator," Maurice, D.C., Yarish, W., Wiens, E.H. Unpublished report to the Expert Committee on Weeds, Western Canada Section, Dec. 3 to 6, 1984, Winnipeg, Man.

rates. Even though the majority of weeds were affected (stunted) to various degrees, it was always possible to find healthy, green weeds in fields sprayed at reduced rates. In all observations, the best weed control was obtained at full recommended chemical rates, regardless of the application rate. The poorest weed control with the Micromax applicators occurred when using half the recommended chemical rate at the low application rate of 1.0 gal/ac (11 L/ha). Stripping was evident, especially at the low application rate of 1.0 gal/ac (11 L/ha). Better weed control was obtained with conventional flat fan nozzles at reduced rates, however control was seldom complete.

The effect on weed control of other variables such as droplet size was not conclusively evaluated. This whole area requires considerably more study and research in conjunction with weed and chemical scientists to establish how droplet size affects weed control. All field work with the Micromax applicators was performed in the low speed mode, which resulted in a spinning disc speed, at a typical field operating tractor voltage, of approximately 2500 rpm. The next available spinning disc speed, in the medium speed mode at a typical tractor voltage, was approximately 4500 rpm. Droplets produced at this speed formed a fine mist, which was considered impractical for conditions encountered in the prairies (see section on Droplet Size).

The most revealing observation that has been made over the many years of PAMI sprayer testing 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 be cautioned that until such time as more definio rive answers are available on spraying at reduced rates, spraying at rates other than those recommended by the chemical manufacturer will be at the operator's own risk.

Droplet Size: The droplet sizes produced by the Micromax depended on fluid delivery rate (orifice plate size) and spinning disc speed. FIGURES 19 to 21 show the coverage and droplet size spectrum of the Micromax applicators operating at various disc speeds and with different orifice plates. Observations indicated that the average droplet size increased with increased flow rate (orifice plate size) and decreased with increased spinning disc speed. The number of drops per unit area also increased at the higher spinning disc speeds.

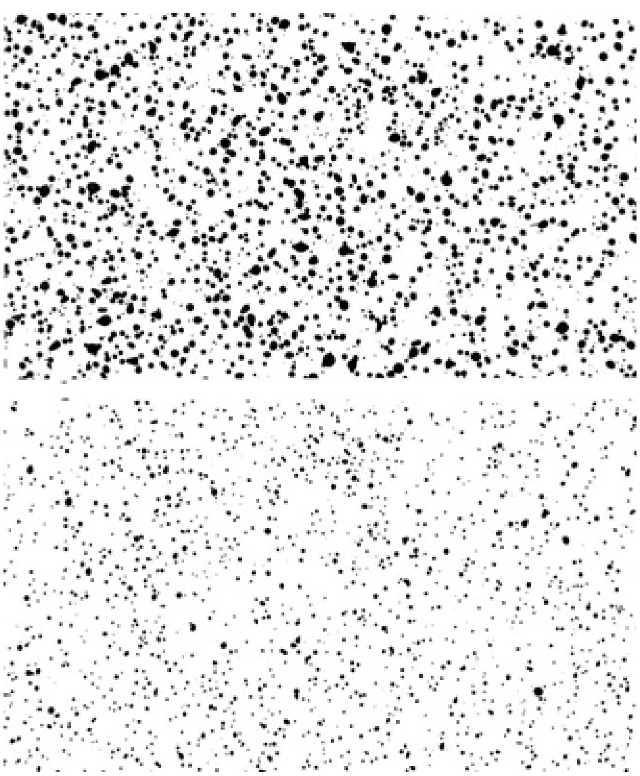


FIGURE 19. Droplet Sizes Produced by the Micromax when Spraying at the Low Speed (2465 rpm) (Upper: 4916-55 Orifice Plate, Lower: 4916-37 Orifice Plate).

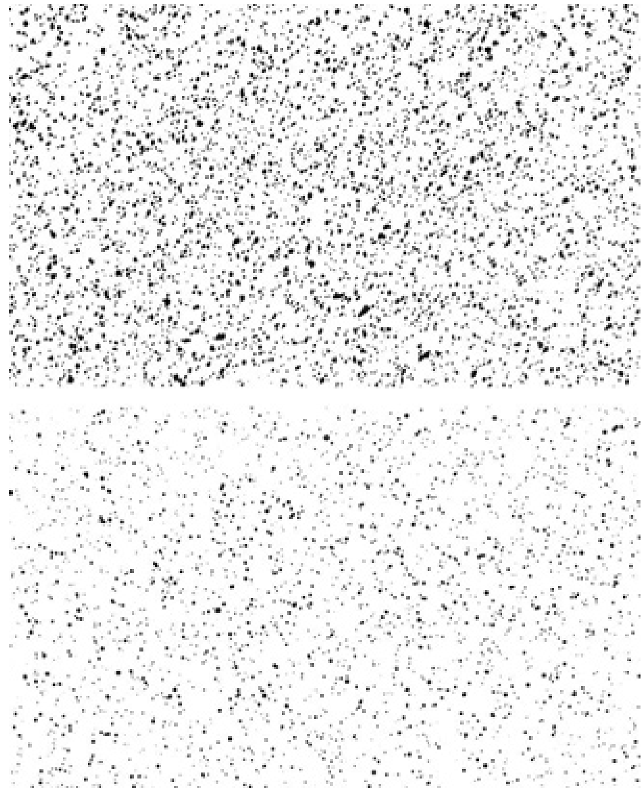


FIGURE 20. Droplet Sizes Produced by the Micromax when Spraying at the Medium Speed (4500 rpm) (Upper: 4916-37 Orifice Plate, Lower: 4916-26 Orifice Plate).

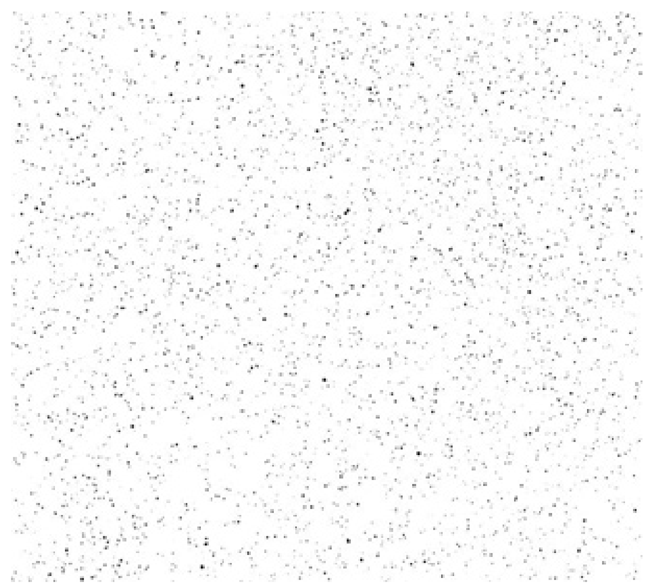


FIGURE 21. Droplet Sizes Produced by the Micromax when Spraying at the High Speed (7600 rpm) with the 4916-20 Orifice Plate.

For comparison, FIGURE 22 shows the coverage and droplet size spectrum of three different sizes of conventional flat fan nozzles operated at 36 psi (250 kPa). The conventional flat fan nozzles produced a wide range of droplet sizes, whereas the Micromax applicators produced droplets more uniform in size.

Due to the uniform droplet spectrum produced by the Micromax applicators, it is believed the chemical applied was more efficiently used. That is, less chemical was lost through evaporation, run-off and drift. This may explain the acceptable weed control with Micromax applicators, at recommended rates, even though distribution patterns were unacceptable. As has already been indicated, more research is required to determine how droplet size affects weed control.

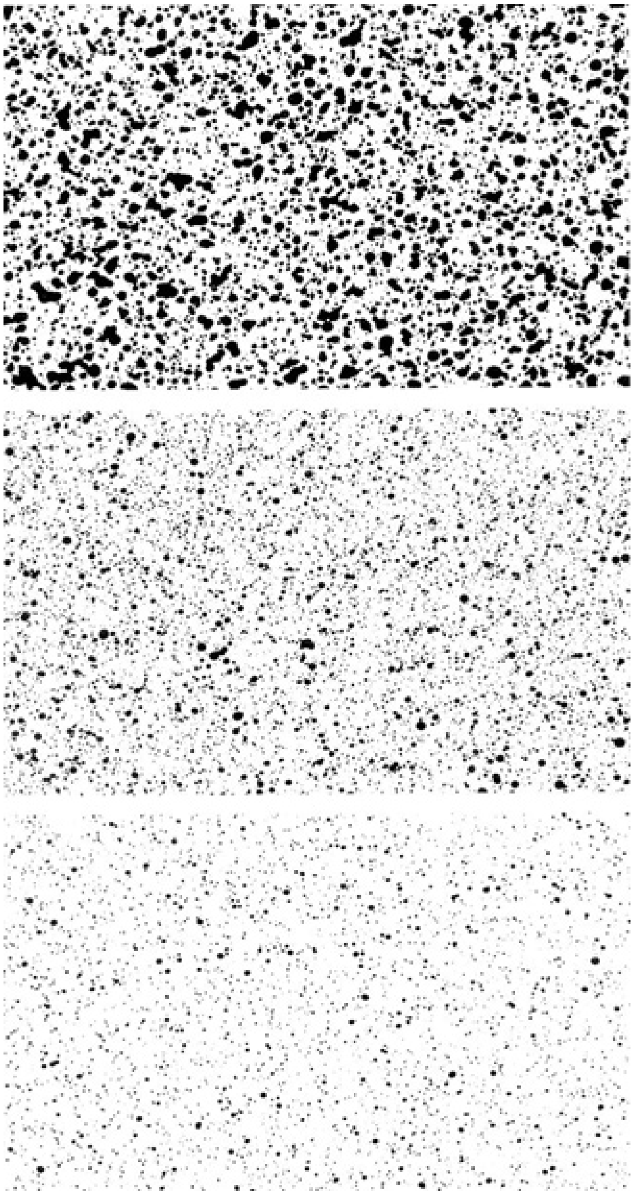


FIGURE 22. Droplet Sizes Produced by Conventional Flat Fan Nozzles (Upper: Spraying Systems 8002, Middle: Spraying Systems 8001, Lower: Delevan LF.67).

Spray Drift: There were no measurements made to evaluate spray drift. Field observations indicated that the droplets created by the Micromax applicator were readily susceptible to drift in windy conditions, especially when operated at an angle. However, in a crosswind the drift moved along the boom in a uniform pattern, thus making it possible to operate near sensitive surrounding crops without damaging them. When angled forward, the spray emitted upwards was very susceptible to wind which caused a more turbulent drift. The spray from conventional flat fan nozzles drifted in a more erratic and turbulent fasbion. A more detailed drift study is required to quantify and compare spray drift for various application techniques.

Pressure Gauge: No pressure measuring equipment was provided with the Micromax applicators. It was important to know the actual pressure at the orifice plate for accurate application rates. Ideally, a pressure line should be installed between the orifice plate and the sprayer boom. This pressure line should be connected to a pressure gauge near the operator's station. The existing sprayer pressure measuring point could be used, however, due to plumbing restrictions, that pressure didn't always indicate the actual pressure at the orifice plate.

Line Strainer: The 50 mesh slotted strainer located between the diaphragm check valve and orifice plate effectively removed foreign material.

ELECTRICAL POWER REQUIREMENTS

No excessive demands were made on the tractor battery or electrical charging system. The amount of current drawn by a Micromax applicator depended on flow rate, spinning disc speed and supply voltage. TABLE 1 shows the current drawn by one Micromax applicator when attached to a 12 volt electrical system.

TABLE 1. Micromax Current Draw at 12 Volts.

SPINNING DISC SPEED	ORIFICE PLATE			
	4916-20	4916-26	4916-37	4916-55
Low	0.8 A	0.9 A	1.0 A	1.1 A
Medium	1.1 A	1.3 A	1.5 A	2.0 A
High	2.3 A	2.9 A	3.4 A	4.5 A

OPERATOR'S MANUAL

The operator's manual was clearly written and contained much useful information on mounting instructions, Micromax spraying principle, operation, adjustments, calibration and maintenance. An illustrated parts list was also included.

OPERATOR SAFETY

When changing orifice plates, it was difficult to remove the plumbing assembly from the orifice plate cavity without being exposed to chemical from the inlet hose. It has already been recommended that orifice plate changing be made safer and more convenient. The spinning cone was harmless and the pulley system was 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.

MECHANICAL PROBLEMS

The Micromax applicators were operated in the field for 138 hours. The intent of the test was evaluation of functional performance and an extended durability evaluation was not conducted. Some mechanical problems were encountered during the test.

The fuse cartridges were exposed and gathered dust and moisture. Occasionally the cartridges broke. Taping the cartridges with electrical tape eliminated the dust, moisture and breakage.

Each year several motors failed to run after being stored over winter. Moisture collected inside the motor housing, corroding the bolts and housing. Corrosion also caused the brushes on the electric motors to stick, preventing them from contacting the armature. Modifications are recommended to prevent moisture entering the electric motors.

The shields around the pulley assemblies distorted and interfered with the bottom pulley. Modifications are required to prevent the pulley shields from distorting.

Placing the Micromax applicators in the 45° position resulted in some springs being stretched. The springs then no longer had enough tension to hold the applicators in the 0 or 15° position.

APPENDIX I

SPECIFICATIONS

MAKE:	Micromax Controlled Droplet Applicator
COMPONENTS:	adjustable mounting bracket, plumbing assembly, motor-cone assembly and electrical wire-connectors
MOUNTING BRACKET:	
- material	16 gauge steel
- mounting	5/16 (8 mm) in U-bolt with clamp
- height	8 in (203 mm)
- width	3 in (76 mm)
- weight (including hardware)	1.48 lb (668 g)
- position	0, 15, 30 and 45 degrees. Spring loaded breakaway
PLUMBING:	
- weight	0.28 lb (126 g)
- components	
- inlet hose	3/8 in (9.5 mm) I.D. - with nozzle cap 11/16 in (17.5 mm) FNPT
- diaphragm check valve	1/4 in (6.4 mm) MNPT inlet - 11/16 in (17.5 mm) MNPT outlet
- strainer	50 mesh slotted
- orifice plate adaptor	11/16 in (17.5 mm) FNPT inlet - 1/4 in (6.4 mm) FNPT outlet
- coupler	1/4 in (6.4 mm) MNPT
- tee	1/4 in (6.4 mm) FNPT
- feeder hoses	2-1/4 in (6.4 mm) I.D. - 6 in (152 mm) long
- elbows	2-1/4 in (6.4 mm) MNPT inlet - barbed outlet
NOZZLE BODY:	
motor	12 volt DC
cone speeds	2000, 3500 & 5000 rpm (nominal)
fuse	4 amp slow blow
height	8.7 in (222 mm)
weight	2.62 lb (1180 g)
width	6.7 in (170 mm)
ELECTRICAL:	
- cable	115 in (2.92 m) long
ACCESSORIES:	
- hose clamps	2-5/8 in (16 mm)
- belt	1 - 0.14 in (3.5 mm) thick
- tie strap	1 - 8 in (203 mm) long
- nozzle plugs	3 - brass
- orifice plates	4 - 4916-20, 4916-26, 4916-37, 4916-55
TOTAL WEIGHT:	4.7 lb (2112 g)

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

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