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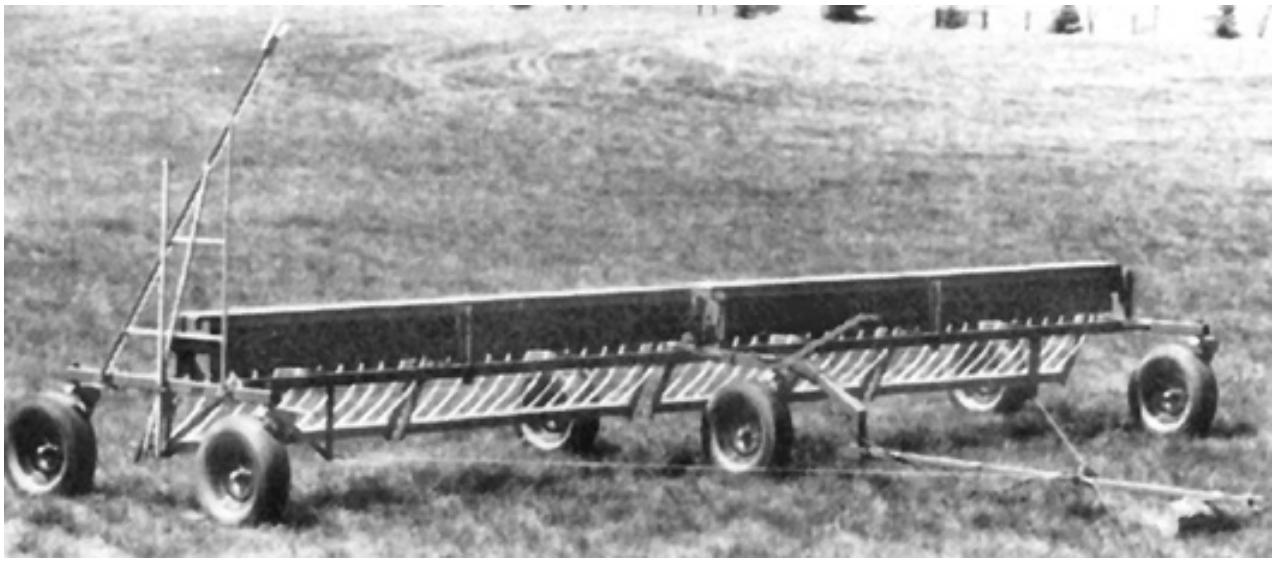
Evaluation Report 96



Beline Linear III Granular Applicator

A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

BELINE LINEAR III GRANULAR APPLICATOR

MANUFACTURER:

Applicator - Beline Manufacturing Company Limited
Box 1401
Kindersley, Saskatchewan

Trailer - Kepp industries Limited
Luseland, Saskatchewan

DISTRIBUTOR:

Beline Manufacturing Company Limited, Kindersley

RETAIL PRICE:

Applicator - $2377.00 (May, 1978, f.o.b. Kindersley, Saskatchewan)

Trailer - $1700.00 (May, 1978, f.o.b. Kindersley, Saskatchewan). No longer being manufactured.

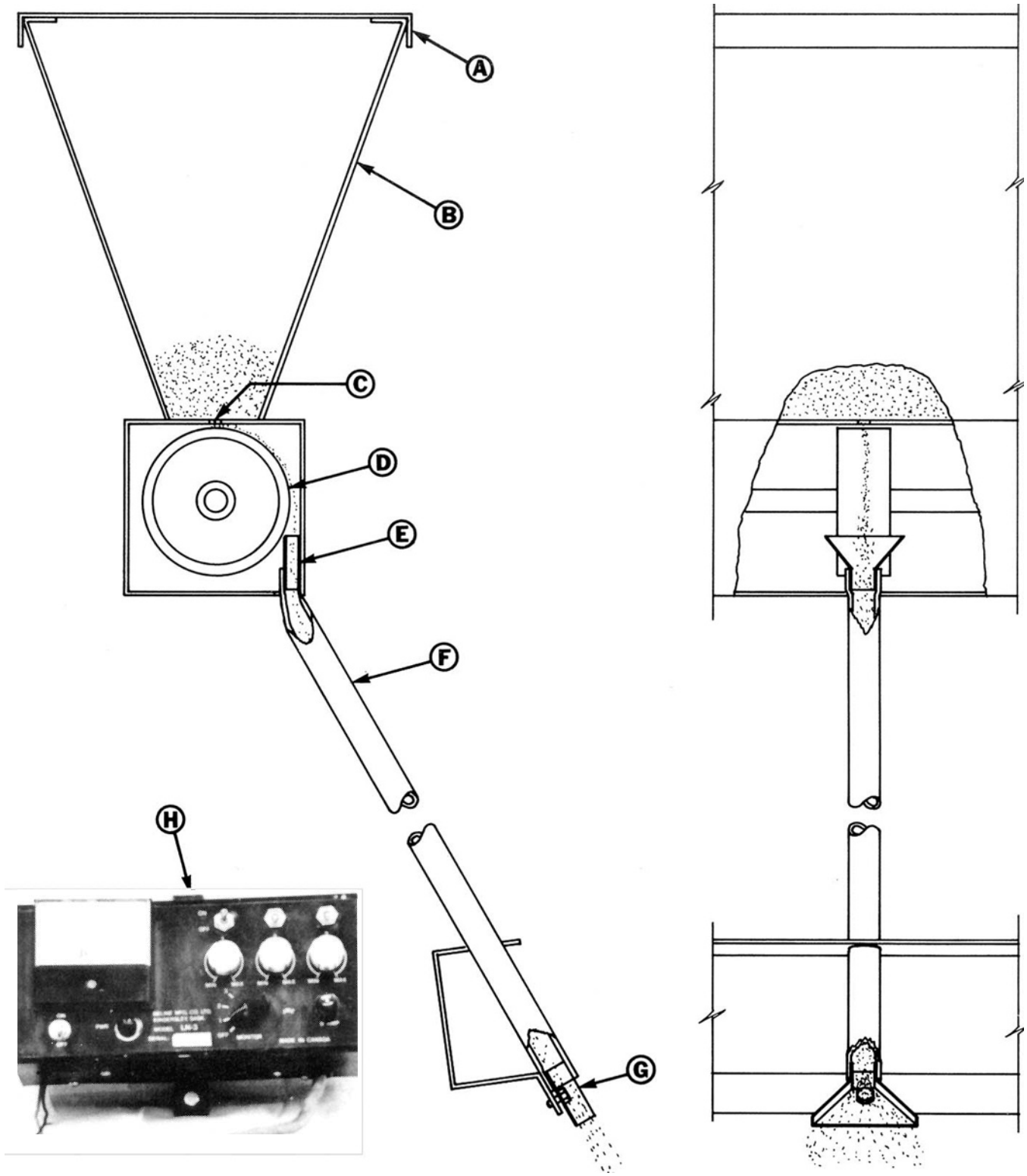


FIGURE 1. Schematic View of Beline Linear III Granular Applicator: (A) Hopper Lid, (B) Hopper, (C) Hole, (D) Metering Wheel, (E) Collector, (F) Delivery Hose, (G) Spreader, (H) Control Panel.

SUMMARY AND CONCLUSIONS

Overall functional performance of the Beline Linear III granular applicator was *fair.* Metering uniformity of individual hoppers was *very* good but distribution of granules on the soil surface was *poor.* Functional performance was reduced by occasional meter plugging, calibration variation among hoppers, and trailer castor wheel shimmy. Durability of the Beline hoppers, during functional testing, was *very good.* Trailer durability was *fair.*

The Linear III had sufficient range of adjustment to suit recommended application rates for Avadex BW but slowing to about 6 km/h (3.7 mph) and interchanging meter drive sprockets was necessary to apply maximum rates of Treflan. The manufacturer's calibration chart was in error, indicating higher application rates than delivered by the hoppers. Calibration among hoppers varied with a typical variation of about 2 kg/ha (2 lb/ac) between the highest and lowest hopper when applying 12 kg/ha (11 lb/ac) at 9 km/h (5.6 mph). Application rates were affected by field roughness, and were about 1.5 kg/ha (1.5 lb/ac) higher on rough fields than on smooth fields. Application rates were not affected by level of granules in the hopper and only slightly affected by field slope. Ground speed directly affected application rate.

The delivery of granules from the meters was very uniform across the width of each hopper, resulting in a coefficient of variation of only 4%. However, most granules fell on the ground in bands below each spreader, resulting in a distribution pattern with a coefficient of variation of 95%. Distribution of granules in the direction of travel was uniform if meters did not partially plug. However, thorough soil incorporation was necessary to get uniform distribution in the soil, due to the banding.

The Linear III performed well on rough and hilly fields, but field speeds above 9 km/h (5.6 mph) caused castor wheel shimmy. Maximum field capacity was about 8 ha/h (19 ac/h). The hopper held about 182 kg (400 lb) of Avadex BW which was sufficient to cover about 12 ha (30 ac), at common application rates, without refilling. Hopper lids were weathertight. Hoppers were of suitable height for easy filling from the ground. Hoppers did not completely empty in the field but were easy to clean out by hand.

The control meter was easy to adjust, but uniform application rates were not possible since calibration of each hopper was different. Application rate was affected by ground speed, so accurate tractor speed was required when setting application rates.

The applicator was convenient to operate and was fairly easy to fold into transport or field position, taking one man about 5 minutes. The end wheels left tracks in the field to aid lining up successive field passes. Granules falling from the spreaders were not visible from the tractor, making it difficult to ensure applicator operation. Drives for the two applicator halves could be separately engaged or disengaged from the tractor.

Hitching was convenient. Towing at speeds above 16 km/h (10 mph) in transport, caused castor wheel shimmy. Backing in transport or field position was impossible,

Some mechanical, problems occurred during the test. Several welds on the trailer frame failed. Set screws on the meter drive loosened, causing application misses in the field.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to improve calibration uniformity among hoppers.
2. Investigating modifications to the spreaders to improve distri-§ution of granules on the ground.
3. Investigating the possibility of making application rate independent of forward speed to improve ease of calibration.
4. Modifications to prevent castor wheel, shimmy and to improve trailer operation in transport.
5. Modifications to prevent meter drive set screws loosening.
6. Providing some means of indicating if granules are being applied on the field.
7. Modifications to prevent failure of welds on the trailer.
8. Supplying a slow moving vehicle sign.
9. Preparing the operator's manual in both English and SI units.
10. Including complete assembly instructions in the operator's manual.

Chief Engineer - E. O. Nyborg
Senior Engineer - E. H. Wiens
Project Engineer - K. W. Drever

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The tolerance limits on the clearance between the metering wheels and hopper bottom have been reduced to improve metering uniformity. A simpler procedure for changing this clearance will be included in the new operator's manual.
2. The width of spread can be increased by placing additional washers under the existing spreaders.
3. We do not feel that it is always desirable to have the application rate independent of forward speed.
4. The trailer is no longer being manufactured.
5. Changes have been made to overcome this problem.
6. This recommendation is being taken under consideration.
7. The trailer is no longer being manufactured.
8. This recommendation is being taken under consideration.

9 & 10. A new operator's manual is being prepared using both SI and English units and will contain complete assembly instructions.

Additional Comments: The 1978 model of the applicator has larger metering orifices and greater metering wheel to hopper clearances. This enables higher rates of Treflan to be applied without having to change sprockets and reduces metering orifice plugging due to foreign material in the hopper.

Results obtained from extensive field and laboratory testing by our company, in many cases are different from those reported by PAMI.

GENERAL DESCRIPTION

The Beline Linear III granular applicator is a trailer mounted, dribble type spreader. It consists of four hoppers, with total capacity of 0.28 m^3 (10 ft^3), supported on a six wheel trailer. Granules flow through 48 holes in the hopper bottom, spaced at 178 mm (7 in), resulting in an 8.5 m (28 ft) spreading width. Nylon metering wheels below the holes are driven by two, 12 volt electric motors, one for each side of the applicator. Granules fall from the metering wheels into collectors which direct the granules into delivery hoses. Spreaders at the bottom of the hoses broadcast the granules on the ground.

Application rate is controlled by changing meter wheel speed or ground speed. Metering wheel speed is adjusted from a control panel (FIGURE 1) mounted on the tractor.

The hitch pole is folded up and the applicator towed from one end for transporting.

FIGURE 1 shows a schematic view of the hopper while detailed specifications are given in APPENDIX I.

The hoppers supplied were trailer mounted. Optional brackets and accessories are available for mounting the hoppers directly on cultivators, discers or other tillage machines.

SCOPE OF TEST

The Beline Linear III granular applicator was operated for 50 hours while spreading granular Avadex BW on about 354 ha (874 ac). Field speeds ranged from 8 to 9 km/h (5 to 5.6 mph). The applicator was evaluated for quality of work, ease of operation, operator safety and suitability of the operator's manual. Metering and distribution system accuracy was evaluated in the laboratory with Avadex BW. Standard procedures[1] were used to determine the effect of field and machine variables on metering and distribution.

Metering performance was also evaluated in the laboratory with the metering system modified to apply Treflan.

RESULTS AND DISCUSSION

QUALITY OF WORK

Calibration Chart Accuracy: FIGURE 2 compares the manufacturer's calibration for Avadex BW with calibration results obtained for each hopper in a simulated smooth field at 9 km/h (5.6 mph). Calibration of all four hoppers varied and was less than the manufacturer's calibration. For example, at a control meter reading of 70, application from hoppers varied from 10.5 to 12.7 kg/ha (9.3 to 11.3 lb/ac) compared to the manufacturer's application rate of 14.0 kg/ha (12.5 lb/ac). Hoppers could not be individually set for uniform application since each electric motor drove the metering wheels on two hoppers.

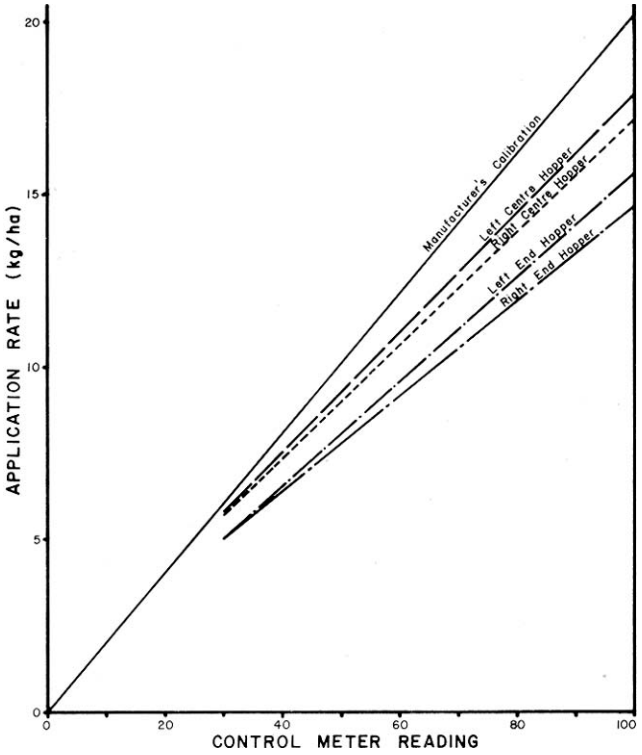


FIGURE 2. Calibration Curves for Avadex BW in a Simulated Smooth Field at 9 km/h (5.6 mph).

FIGURE 3 compares the application rates from the left centre hopper when operated in simulated rough and smooth fields. Field roughness increased the application rate, at a control meter reading of 70, by 1.0 kg/ha (0.9 lb/ac).

The application rate was not affected by the level of Avadex BW in the hopper. Application rate was affected only slightly by fore and aft and sideways field slope. A 0.3 kg/ha (0.3 lb/ac) change in application was typical when applying 10.6 kg/ha (9.4 lb/ac) at 9 km/h (5.6 mph).

Forward speed affected application rates, since delivery from the meters was constant for a given control meter reading. Higher application occurred at low speeds and lower application at high speeds. Constant ground speed was necessary for uniform application of granules.

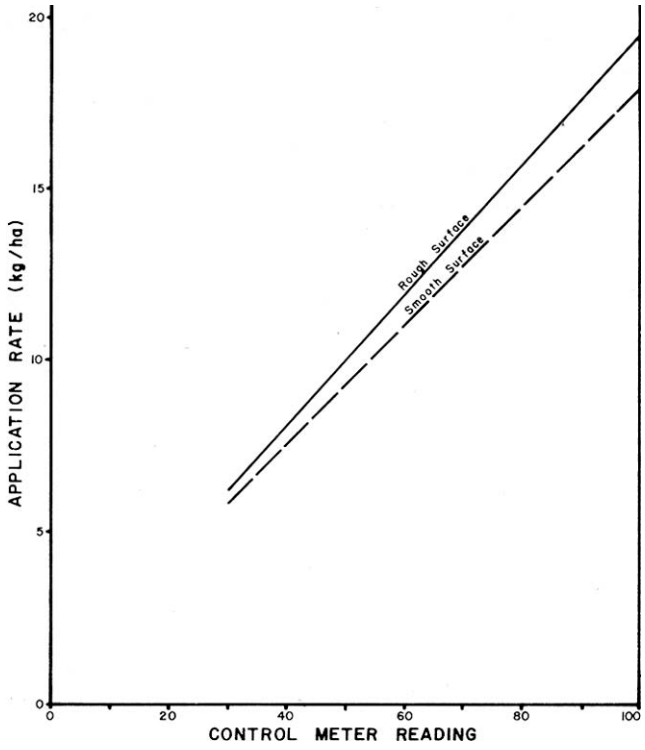


FIGURE 3. Avadex BW Calibration Curves for the Left Centre Hopper Operated in Simulated Rough and Smooth Fields at 9 km/h (5.6 mph)

Metering Accuracy: FIGURE 4 shows delivery rates from twelve adjacent meters at a control meter reading of 90 while applying Avadex BW on a simulated smooth field at 9 km/h (5.6 mph). Application rates from the individual meters varied from 13.6 to 15.6 kg/ha (12.1 to 13.9 lb/ac) resulting in a coefficient of variation[2] of only 4% when granules were flowing through all the

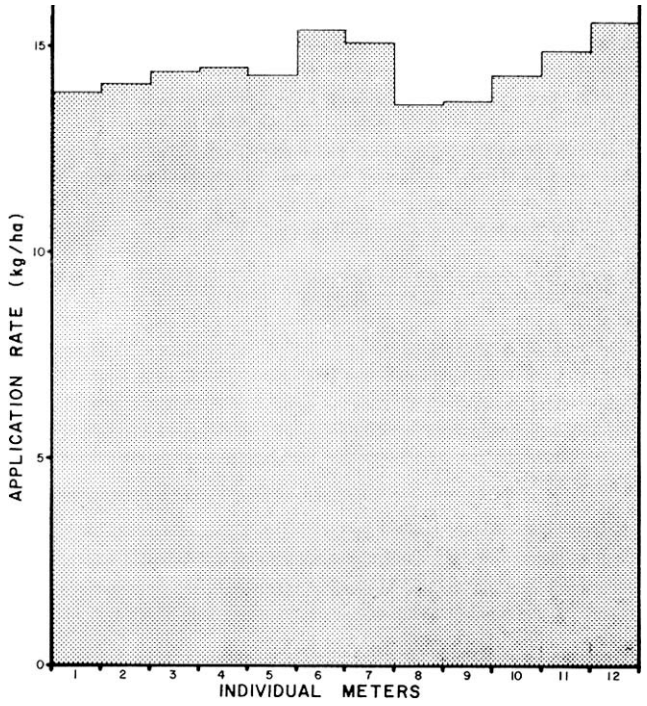


FIGURE 4. Typical Variation in Delivery Rates from Adjacent Meters in One Hopper with no Plugging

[1] *PAMI T772-R78. Detailed Test Procedure for Granular Applicators.*

[2] *The coefficient of variation (CV) is the standard deviation of the application rates, expressed as a percent of the mean application rate. A low CV represents uniform application whereas a high CV indicates non-uniform application. One granular herbicide manufacturer has suggested that the CV should be no greater than 10%.*

meters properly. However, material such as string, pieces of paper, large granules or other material occasionally caused partial plugging. FIGURE 5 shows typical delivery rates when meters were partially plugged at a control meter reading of 90 at 9 km/h (5.6 mph). Application rates varied from 7.0 to 15.0 kg/ha (6.2 to 13.4 lb/ac) resulting in a coefficient of variation of 20% when meters 4 and 11 were partly plugged by large granules. Partial meter plugging occurred less frequently on rough fields than on smooth fields.

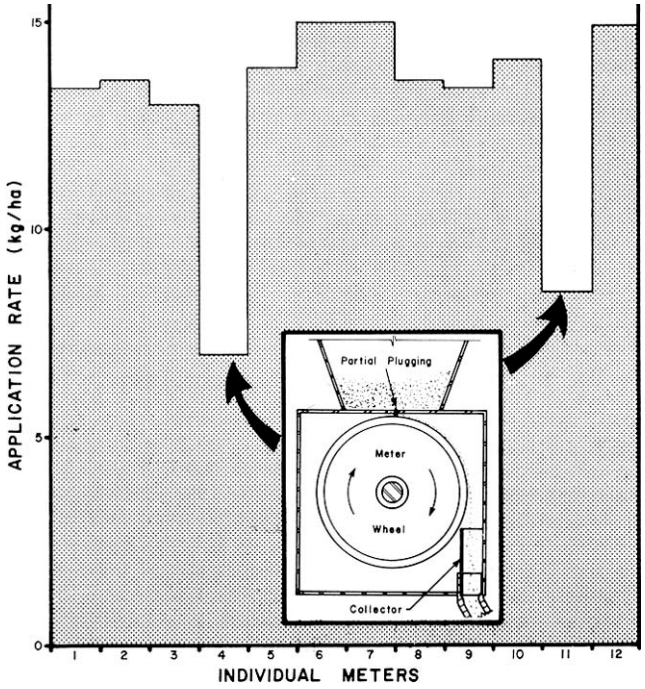


FIGURE 5. Typical Variation in Delivery Rates from Adjacent Meters in One Hopper with Partial Meter Plugging.

Spreading Accuracy: Although metering from the hoppers was very uniform, distribution on the ground was not uniform. Granules metered from the hoppers fell onto spreaders beneath each meter (FIGURE 1). FIGURE 6 shows a typical distribution of Avadex BW granules on the ground under a 1.14 m (45 in) wide section of the applicator. Granules were deposited in adjacent 100 mm (4 in) wide bands below each spreader with very little coverage on a 75 mm (3 in) wide strip between each band, resulting in a coefficient of variation of about 95%. Similar distribution occurred at all application rates. Although the distribution pattern varied with wind and field roughness, the high concentration below each spreader indicated that thorough soil incorporation was necessary to get uniform distribution in the soil. Spreader modification could possibly improve distribution on the soil sudace.

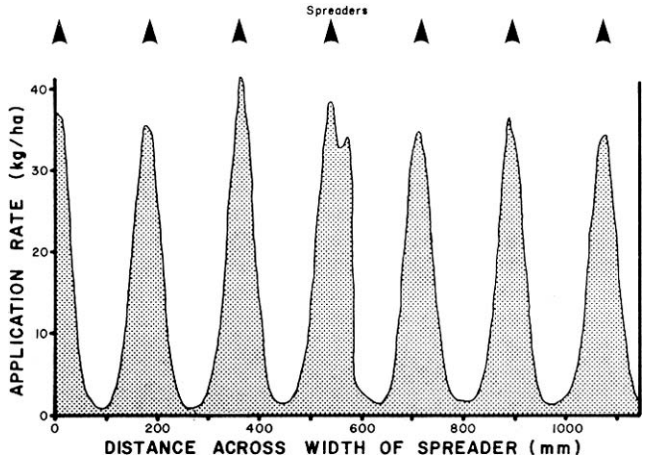


FIGURE 6. Typical Distribution of Avadex BW Granules on the Ground under a 1.14 m (45 in) Wide Section of the Applicator when Applying 14 kg/ha (13 lb/ac) at 9 km/h (5.6 mph).

Distribution of granules in the direction of travel was uniform with no detectable surging when the meters were not partially plugged.

Calibration with Granular Treflan: The Linear III could only apply Treflan at the recommended rates by slowing down and interchanging the meter wheel and motor sprockets as recommended for higher application rates. FIGURE 7 shows application rates of Avadex BW and Treflan from the left two hoppers in a simulated smooth field at 9 km/h (5.6 mph) with sprockets interchanged. Maximum Avadex BW application rate was about 21 kg/ha (19 lb/ac) and maximum Treflan application was about 16 kg/ha (16 lb/ac). Maximum rates would be about 1.5 kg/ha (1.5 lb/ac) higher on rough fields (FIGURE 3). Slowing down to about 6 km/h (3.7 mph) was necessary to apply Treflan at 28 kg/ha (25 lb/ac).

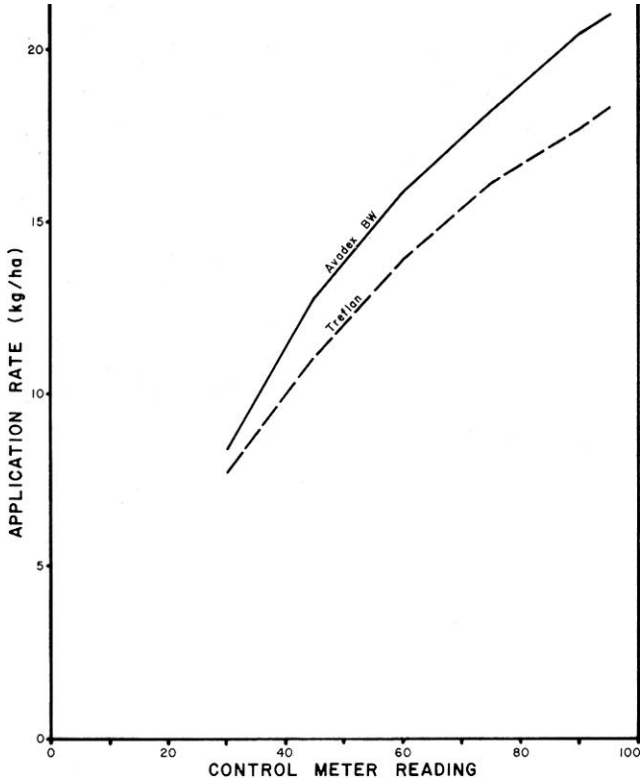


FIGURE 7. Typical Calibration Curves for Avadex BW and Trefian with Meter Drive Sprockets Interchanged in a Simulated Smooth Field at 9 km/h (5.6 mph).

EASE OF OPERATION

Hitching: The Linear III was conveniently hitched to a tractor without a jack. The meter wheel motor control panel (FIGURE 1) was mounted on the tractor. Electrical connectors provided for connecting the control panel to the motors were convenient. Terminals provided for connecting the control to the tractor battery (FIGURE 8) usually required additional clamps.

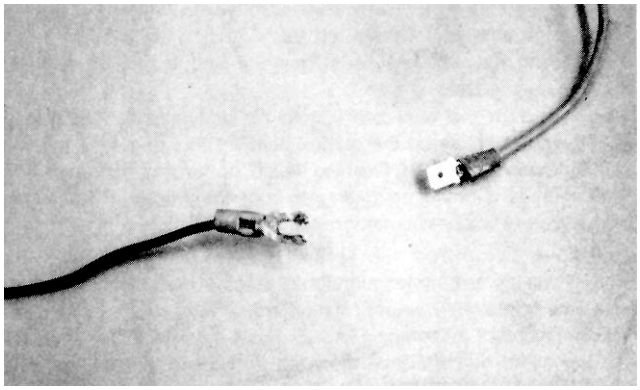


FIGURE 8. Terminals Provided for Connecting Control Panel to the Tractor Battery.

Hoppers: The hoppers were conveniently positioned for filling with bagged granules while standing on the ground.

The hoppers held about 182 kg (400 lb) of Avadex BW which was sufficient to cover about 12 ha (30 ac), when.applying 13.5 kg/ha (12.0 lb/ac), before refilling.

Since about 18 kg (40 lb) of Avadex BW would not run out of the hoppers in the field (FIGURE 9), hoppers had to be cleaned out by hand when finishing spreading. Hoppers were easy to clean out and all parts were accessible for a thorough cleaning at the end of the season. The hopper lids were weathertight. No leakage of rain into the hoppers occurred during the test.

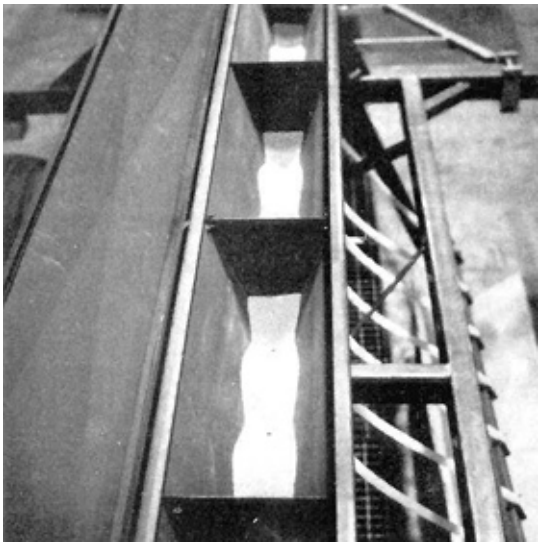


FIGURE 9. Avadex BW that would not Flow from the Hopper in the Field.

Setting the Application Rate: The application rate was adjusted either by changing the control meter setting (FIGURE 1) or by changing the ground speed. This was a complicated procedure since tractor forward speed had to be determined and control meter setting selected to match the desired application rate at that tractor forward speed. The control meter was easy to set but uniform application was not possible due to the calibration variability of hoppers (FIGURE 2). It is recommended that the manufacturer consider modifications so that calibration of all hoppers is the same. It is also recommended that the manufacturer investigate modifications to make application rate independent of forward speed to improve ease of calibration.

Field Operation: The trailer was hinged at the centre and performed well on hilly fields. The wheels at the applicator end were rigid and were not mounted on a walking beam. When crossing gullies, all of the applicator weight was carried on the front or rear wheels.

Performance was satisfactory at speeds up to 9 km/h (5.6 mph) resulting in a maximum field capacity of about 8 ha/h (19 ac/h). Higher field speeds caused severe castor wheel shimmy. Modifications to reduce castor wheel shimmy are required.

The applicator end wheels left tracks that were easy to follow when making successive passes down the field, especially on fields with little trash cover.

Each half of the applicator could be conveniently stopped or started with switches on the control panel. This was useful to avoid double application when finishing fields or turning on headlands. Application rate could be changed from the tractor by changing forward speed or control meter reading.

Granules falling from the spreaders were not visible from the tractor. The control meter monitored electric motor operation, but occasionally metering wheel rotation was interrupted due to meter drive set screws loosening (TABLE 1). A metering shaft indicator was fabricated by PAMI and mounted at the end of each metering wheel shaft (FIGURE 10). Metering wheel rotation could then be observed from the tractor as a check on distributor operation. It is recommended the manufacturer provide some means of indicating granules are being delivered.

FIGURE 10. Metering Shaft Indicator Fabricated by PAMI.

Transporting: The Linear III was placed into transport or field position by one man in about five minutes. The tractor had to be unhitched since the field and transport hitch were in different locations. The centre wheel lock pins (FIGURE 11) were difficult to remove and insert since they fit too tightly and were too short.

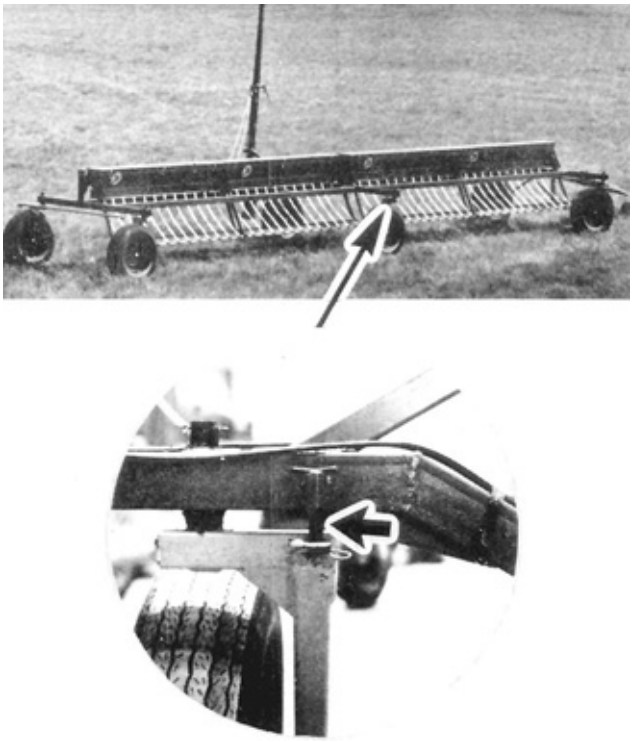


FIGURE 11. Centre Wheel Lock Pin.

Towing the trailer in transport was inconvenient. The rear castor wheels shimmied at speeds above 16 km/h (10 mph). The right front castor wheel interfered with the spreader bar (FIGURE 12) when turning too short to the right. Backing in either field o transport position was impossible since the castor wheels rotated and interfered with the frame. Modifications to improve trailer operation in transport are required.

Lubrication: The trailer had 6 grease fittings requiring daily lubrication. All fittings were accessible.

OPERATOR SAFETY

The Linear III was safe to operate if normal safety procedures were followed.

A slow moving vehicle sign was not provided. It is recommended that a sign be supplied to comply with provincial safety regulations.

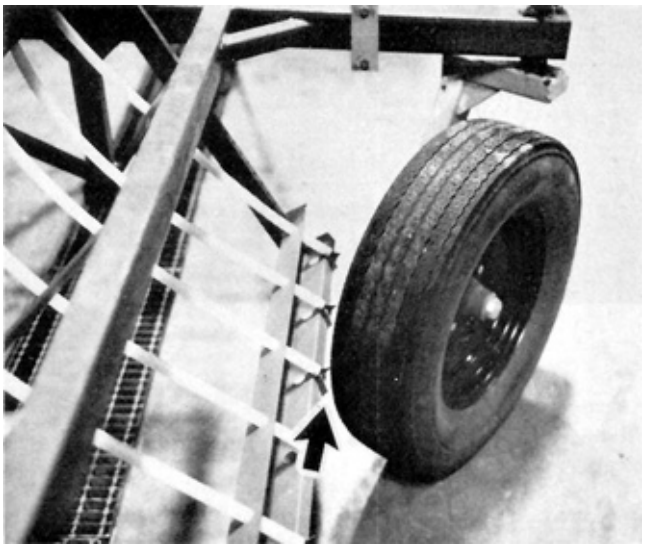


FIGURE 12. Interference Between Front Castor Wheel and Spreader Bar when Turning to the Right in Transport.

OPERATOR'S MANUAL

The operator's manual included operating, servicing and calibration instructions, a parts list, and useful instructions for mounting the hoppers on implements. However, instructions for mounting the hoppers on the trailer were insufficient. Complete assembly instructions should be included in the operator's manual.

A calibration chart for Avadex BW was supplied but since calibration of each hopper was different, the chart was not accurate for all hoppers.

Operating instructions and calibration charts were prepared in English units. It is recommended that they also be prepared in SI (metric) units to facilitate applicator operation after conversion to the SI system.

MECHANICAL PROBLEMS

TABLE 1 outlines the mechanical history of the Beline Linear III granular applicator, during 50 hours of operation while spreading Avadex BW on about 354 ha (874 ac). The intent of the test was evaluation of functional performance. The following mechanical problems represent only those which occurred during the functional testing. An extended durability evaluation was not conducted.

TABLE 1. Mechanical History

Item	Operating Hours	Equivalent Field Area ha	(ac)
Trailer			
- Modifications had to be made before the hoppers could be properly mounted at		Beginning of Test	
- The hitch cable bracket brace failed at the bottom weld and was rewelded at	1	7	(17)
- The right outer and left centre hopper mounting brackets cracked. These were reinforced and welded at	16	113	(280)
- The right hitch cable bracket weld failed and was repaired at	18	127	(315)
- The left hitch cable bracket weld was cracked and rewelded at	28	184	(454)
- The left front cable clevis bolt loosened and the clevis assembly was lost. It was replaced at	24	170	(420)
Meter Drive			
- The sprocket on the left motor was lost and replaced at	15	106	(262)
- The right motor sprocket set screw loosened and was tightened at	15	106	(262)
- The set screw on the shaft coupler connecting the left hopper meter shafts loosened and was tightened at	25	177	(437)
- The set screw on the right sprocket adaptor loosened and was tightened at		End of Test	

DISCUSSION OF MECHANICAL PROBLEMS

TRAILER

Modifications: Modifications were required to properly mount the hoppers on the trailer frame. The left inner hose holder arm interfered with the trailer frame. Part of the hose holder arm was cut out to eliminate this interference.

The shaft extension used to couple the inner hopper meter wheel shafts to the outer hopper meter wheel shafts were too short. Longer extensions were fabricated by PAMI to couple the inner and outer meter wheel shafts.

Welds: Many weld failures occurred on the trailer. Modifications to prevent premature weld failures are required.

METER DRIVE

Set Screws: Four set screws on the meter drive loosened during the test. One motor sprocket was lost and collars slipped on the meter shaft causing misses in the field. Modifications are required to prevent this problem from occurring.

APPENDIX I

SPECIFICATIONS

MAKE: Beline Granular Applicator

MODEL: Linear III

SERIAL NUMBER: (control) - 1268-7

OVERALL DIMENSIONS:	Field Position	Transport Position
- height	2990 mm (9.8 ft)	3460 mm (11.4 ft)
- length	6250 mm (20.5 ft)	11995 mm (39.4 ft)
- width	9300 mm (30.5 ft)	2700 mm (8.9 ft)

METERING SYSTEM:

- type	metering wheel
- drive	chain from 12 V DC electric motors
- adjustment	metering wheel speed
- transfer to ground	free fall from spreaders
- number of metering wheels	48
- metering wheel spacing	178 mm (7 in)
- discharge height (spreaders)	360 mm (14 in)
- effective spreading width	8544 mm (28.0 ft)

WEIGHTS: (field position with empty hoppers)

- trailer wheels	704 kg (1550 lb)
- hitch	23 kg (50 lb)
Total	727 kg (1600 lb)

WHEELS:

- number	6
- rim size	380 mm (15 in)

HOPPER CAPACITY: 0.28 m^3 (10 ft^3)

NUMBER OF LUBRICATION POINTS: 6

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

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

APPENDIX III

METRIC UNITS

In keeping with the Canadian metric conversion program, this report has been prepared in SI units. For comparative purposes, the following conversions may be used:

1 kilometre per hour (km/h)	= 0.62 mile per hour (mph)
1 hectare (ha)	= 2.47 acres (ac)
1 kilogram (kg)	= 2.20 pounds (lb)
1 kilogram per hectare (kg/ha)	= 0.89 pound per acre (lb/ac)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 metre (m) = 1000 millimetres (mm)	= 39.37 inches (in)

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