Farm Dairy Effluent Irrigation Evaluations

Spitfire Effluent Irrigator

Machine Details

- Spitfire Irrigators Ltd,
  266 Normandale Rd,
  Lower Hutt City,
  WELLINGTON, NEW ZEALAND, 5010
  www.spitfire.net.nz

- Medium traveller with rubber orifice on oscillating boom
  - new Spitfire irrigator
  - Wetting width approx 30m
  - Overlap optimised ~ 26 m

The Spitfire Irrigator was delivered to the Centre for Land and Water in Hastings for assessment.

- All testing was done with clean water from an artesian bore
- Pressure was provided by a base pump plus a portable booster at field off-takes. Pressure was measured at entry to the irrigator with a standard pressure gauge mounted on a short length of pipe fitted with camlock fittings
- Flow was measured with a new mechanical flow meter fitted in galvanised pipe with 10 diameters up stream and 5 downstream

Figure 1. Effluent irrigator crossing the catch can transect

Figure 2. Spitfire with oscillating nozzle

Spitfire effluent irrigation evaluation

Oscillating Traveller

- This irrigator was able to apply effluent at low rates which indicates it could match infiltration and water holding capacities of many soils.
- The machine had a relatively stable forward speed along the length of run. Speed is controlled electronically so excess speed can be managed. However minimum speed is determined by available water power, so under heavy loads can vary. In testing at 275kPa on flat ground using 200m of 62mm OD polyethylene delivery pipe, speed variation was minor.
- The wetting pattern was typically triangular, with good uniformity after allowing for appropriate over-lap.
- The nozzle arrangement does cause the spray jet to rise relatively high. At the settings used for testing the pattern was affected by even relatively light winds. However, as shown in Figure 3, the application pattern still gave reasonably good uniformity after allowing for overlap. Testing was discontinued if mean wind speed rose above three metres per second.

A summary of system performance is given in Tables 1 and 2.

Table 1: Summary of Effluent Irrigation Performance at Single Transect

PERFORMANCE SUMMARY			**Run 1, Transect 1**			
			Run Spacing			
	no overlap	30m	28m	26m	24m	20m
Wetting Diameter (m)	52	52	52	52	52	52
Wetting Area (m2)	1062	1062	1062	1062	1062	1062
Inside wet ring radius (m)	5	5	5	5	5	5
Outside wet ring radius (m)	26	26	26	26	26	26
Wetting Ring Area (m2)	1023	1023	1023	1023	1023	1023
Speed (m/min)	0.82	0.82	0.82	0.82	0.82	0.82
Mean Depth (mm)	6.2	12.5	13.4	14.4	15.6	18.7
High Quartile Applied Depth (mm)	10.2	14.5	15.7	16.8	17.2	23.8
Low Quartile Applied Depth (mm)	1.1	10.1	10.6	12.2	13.7	15.3
DU High Quartile	1.63	1.17	1.18	1.17	1.10	1.27
DU Low Quartile	0.18	0.81	0.79	0.85	0.88	0.82
	0.55	0.15	0.15	0.12	0.09	0.18
Mean Application Rate*(mm/h)	8.8	8.8	8.8	8.8	8.8	8.8
Effective Application Rate*(mm/h)	9.1	9.1	9.1	9.1	9.1	9.1

* Note: The Application Rate is determined from non-overlapped data. The Mean Application Rate assumes the entire wetting pattern receives effluent at the same intensity. The Effective Application Rate is calculated using only the “wetted ring” that receives effluent. (In this case, only a half circle is covered at any time.)

Table 2: Uniformity of Effluent Irrigation Performance on two runs each with three transects

				Run Spacing		
	no overlap	30m	28m	26m	24m	20m
Run 1						
No. of Data Points	146.00	90.00	84.00	78.00	72.00	60.00
Mean Applied Depth (mm)	13.57	22.01	23.58	25.39	27.51	33.01
CoV	0.54	0.14	0.13	0.14	0.15	0.15
Run 2						
No. of Data Points	156.00	90.00	84.00	78.00	72.00	60.00
Mean Applied Depth (mm)	6.59	12.06	12.92	13.91	15.07	18.09
CoV	0.43	0.17	0.16	0.15	0.13	0.18

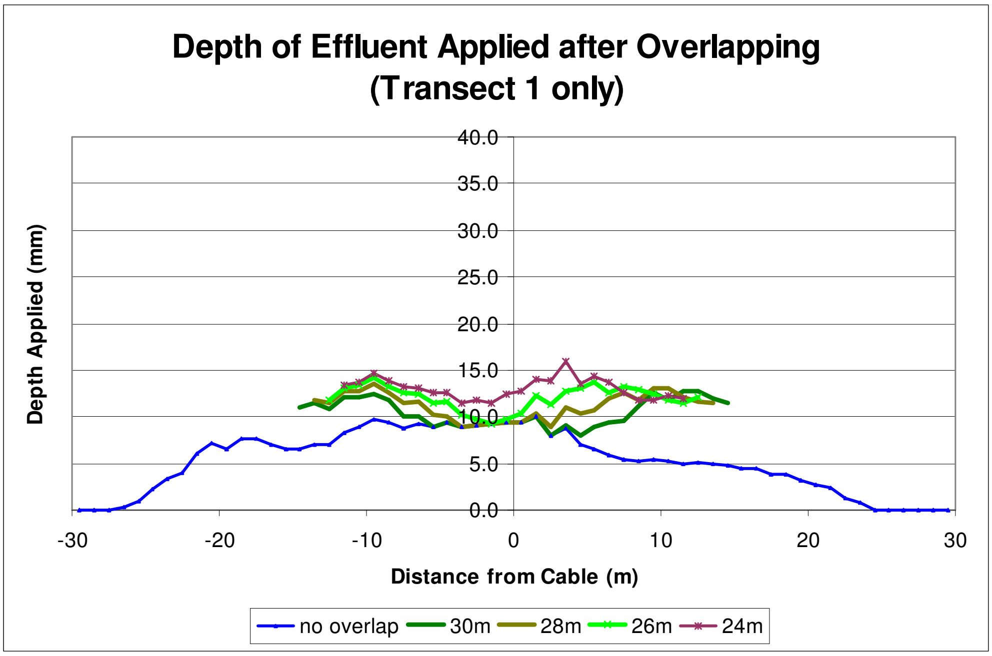

Figure 3. Effluent application pattern measured at 275kPa pressure and full machine speed with no overlap (blue line) and calculated overlapped pattern based on 30, 28, 26 and 24m run spacings

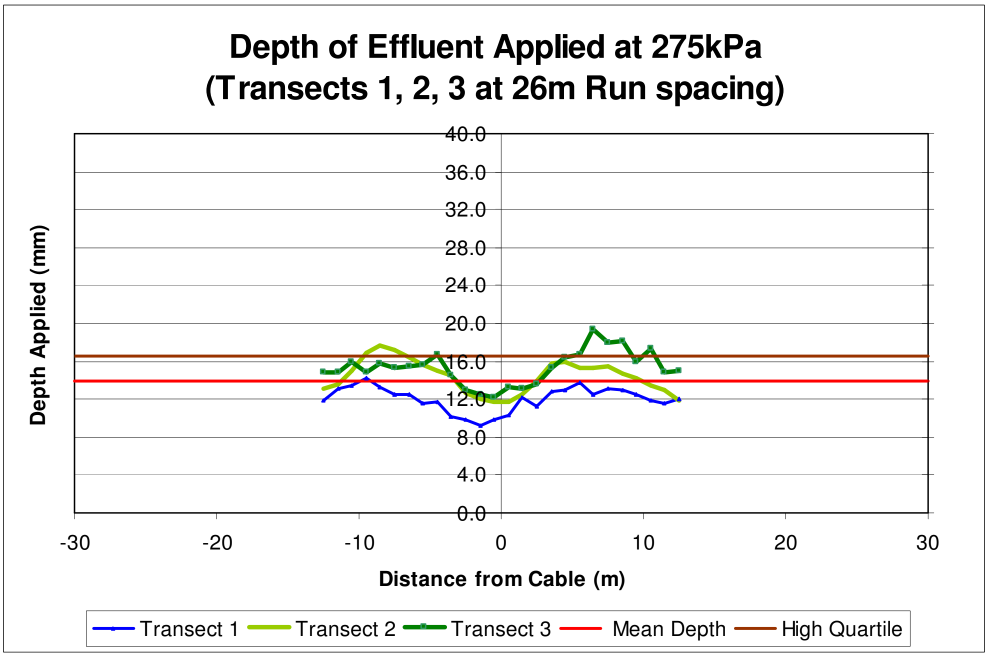

Figure 4. Effluent application pattern of three transect along a single run, measured at 275kPa pressure and full machine speed with calculated overlapped pattern based on 26m run spacing

In the graph (Figure 4), the applied depths after allowing for 26 m run spacing are shown as the solid green and blue lines. The High Quartile and Mean Applied depths are shown as the orange and brown dashed lines.

One eighth of the effluent application area receives more than the High Quartile Depth, 7/8th of the area less than the High Quartile. It is important to consider the summed values from all transects across the entire effluent application area to determine a “Field Uniformity” value.

Machine Performance Variables

1 Electronic Speed Control

- The electronics controlling machine speed run of a lead acid battery. The battery is reputed to last several months between charges.
- During testing at 300kPa we noted a minor problem of speed control with the electronics seeking to reset each oscillation. The boom ceased moving for a period while this occurred. Once pressure was lowered to 275kPa, this action stopped and the machine ran smoothly

2 Pressure

- The pressure at which the machine should be operating is given as 300 – 350kPa.
- Lower pressures may have insufficient ‘pulling power’ and machine speed may drop as hose weight increases. Higher pressure is noted to create smaller droplets with potential to drift.
- The testing reported here was carried out at 275kPa for the main run, with an additional run at 300kPa. As noted, the governing electronics mis-functioned at this pressure, but not at 275kPa.

3 Overlap effects

- Once overlap was factored in the irrigation uniformity achieved was very high. Because the pattern is in effect an extended isosceles triangle, the uniformity was even over a relatively wide range of overlaps. This is positive in managing minor wind effects and minor deveiations from travel path in adjacent runs.
- The design of this machine avoids the typical ‘donut ring’ pattern of rotating boom irrigators. The spread pattern is a wide fan of somewhat less than 180 degrees behind the machine.
- There are still peaks at the sides of the application pattern are typical of travelling irrigators.
- This machine has high uniformity with the overlapped application coefficient of variation for this single transect better than the Fertiliser Spreader benchmark of 0.15.
- The whole run “Field Uniformity” is also very good, exceeding the Fertiliser Spreader value for many of the overlap combinations modelled.

4 Alternate travel path positions

- There is probably little benefit in running successive passes offset by half the lane spacing, as is usually the case with travelling irrigators.