Farm Dairy Effluent Irrigation Evaluations

Numedic Effluent Irrigator

Machine Details

- Numedic Irrigators ADCAM 750
- Medium traveller with rotating boom
    - new ADCAM 750 irrigator
    - Wetting width approx 33m
    - Overlap optimised ~ 28 - 30 m, no spacings gave high uniformity

The ADCAM 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 for higher pressure tests. 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 showing breakup of spray

ADCAM 750 effluent irrigation evaluation

Rotating 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 wetting pattern was typical of travelling rotating boom irrigators, with noted peaks at the edges of the travel run. However, the machine demonstrated good uniformity after allowing for appropriate over-lap when sufficient pressure was available.
- The machine had a relatively stable forward speed along the length of run. However maximum speed is determined by available water power, so under heavy loads speed can vary. In testing at 180-237kPa on flat ground using up to 200m of 62mm OD polyethylene delivery pipe, speed variation was small.

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 2**		
			Run Spacing		
	no overlap	30m	28m	26m	24m
Wetting Diameter (m)	33	33	33	33	33
Wetting Area (m2)	855	855	855	855	855
Inside wet ring radius (m)	11.0	11.0	11.0	11.0	11.0
Outside wet ring radius (m)	16.5	16.5	16.5	16.5	16.5
Wetting Ring Area (m2)	238	238	238	238	238
Speed (m/min)	0.87	0.87	0.87	0.87	0.87
Mean Depth (mm)	7.0	9.4	10.1	10.8	11.7
High Quartile Applied Depth (mm)	13.5	14.0	14.2	15.0	19.3
Low Quartile Applied Depth (mm)	0.0	5.2	6.8	7.1	7.0
DU High Quartile	1.92	1.49	1.41	1.38	1.64
DU Low Quartile	0.00	0.56	0.68	0.65	0.60
CoV	0.74	0.40	0.30	0.30	0.44
Mean Application Rate*(mm/h)	16.6	16.6	16.6	16.6	16.6
Effective Application Rate*(mm/h)	59.7	59.7	59.7	59.7	59.7

* 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.

The overall Field Uniformity at 180kPa is lower than desired, as was the uniformity for individual transect tests at lower pressure. Up to 180kPa coefficient of variation was in a range of 0.35 to about 0.65. At 237kPa the uniformity was much higher, apparently due to improved break-up of the jet, and smaller droplets spreading out more.

For one test, the standard nozzles were replaced by Techipharm spreader nozzles. These had little effect on improving uniformity. The smaller nozzle diameter increased machine pressure, which the other data indicates should improve uniformity.

Table 2: Uniformity of Effluent Irrigation Performance of Run with three transects

			Run Spacing		
	40m (no overlap)	30m	28m	26m	24m
Three Transect Run					
No. of Data Points	120.00	90.00	84.00	78.00	72.00
Mean Applied Depth (mm)	8.28	10.94	11.83	12.62	13.80
CoV	0.65	0.30	0.29	0.33	0.43
Individual Transects					
T1 Mean Depth	8.6	11.5	12.3	13.3	14.4
T2 Mean Depth	7.0	9.4	10.1	10.8	11.7
T3 Mean Depth	9.2	11.9	13.1	13.8	15.3

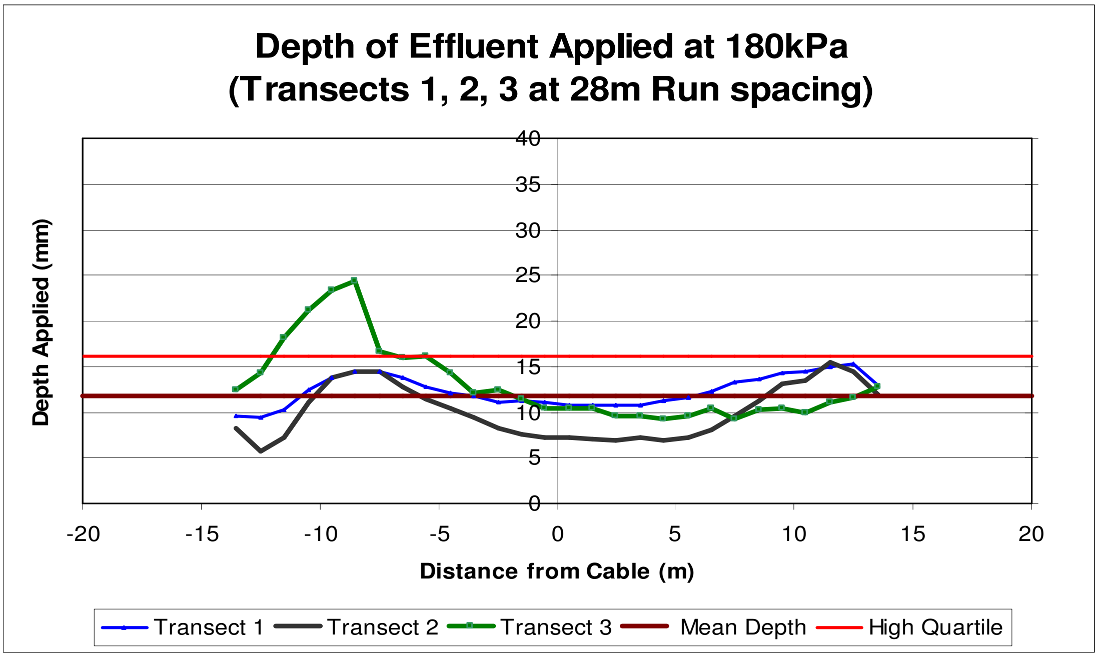

Figure 2. Effluent application pattern of three transect along a single run, measured at 180kPa pressure and full machine speed with calculated overlapped pattern based on 28m run spacing

In the graph (Figure 2), the applied depths after allowing for 28m run spacing are shown as the solid green, blue and dark grey lines. The High Quartile and Mean Applied depths are shown as the orange and brown 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.

The peak on the left of transect 3 is explained by increased cross wind during that transect test. However the wind was not particularly high – 2.5m/s mean with peak gusts under 5m/s.

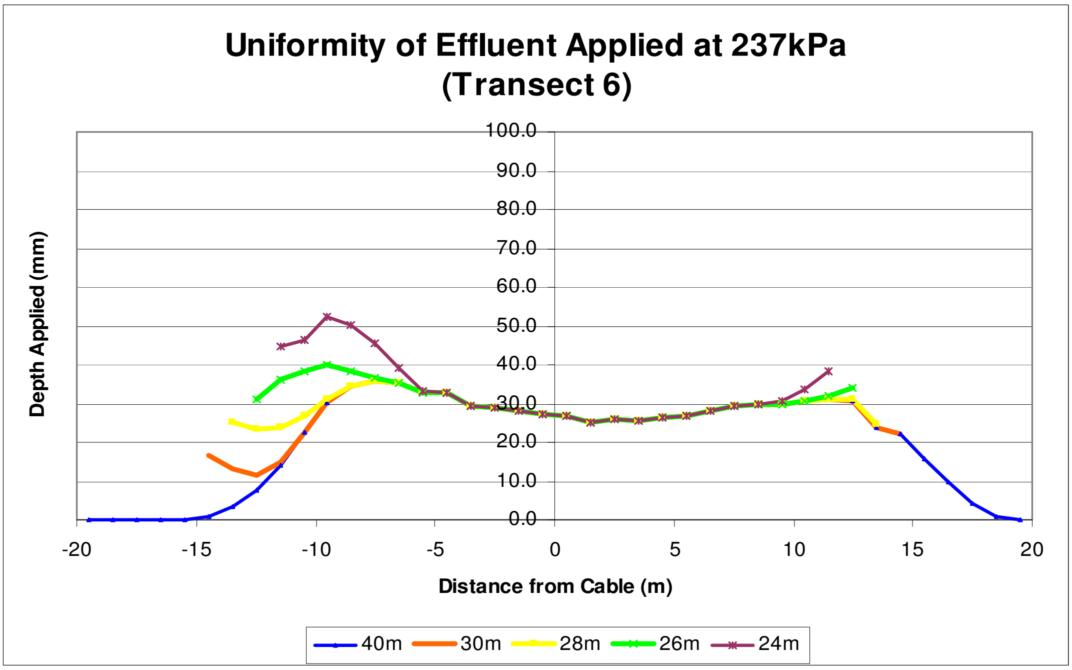

Figure 3. Effluent application pattern measured at 237kPa pressure with machine speed standardised: calculated overlapped pattern based on 40, 30, 28, 26 and 24m run spacings

Figure 3 shows the un-overlapped (=40m) transect depths measured, and overlapped values based on adjacent run spacings of 30, 28, 26 and 24m.

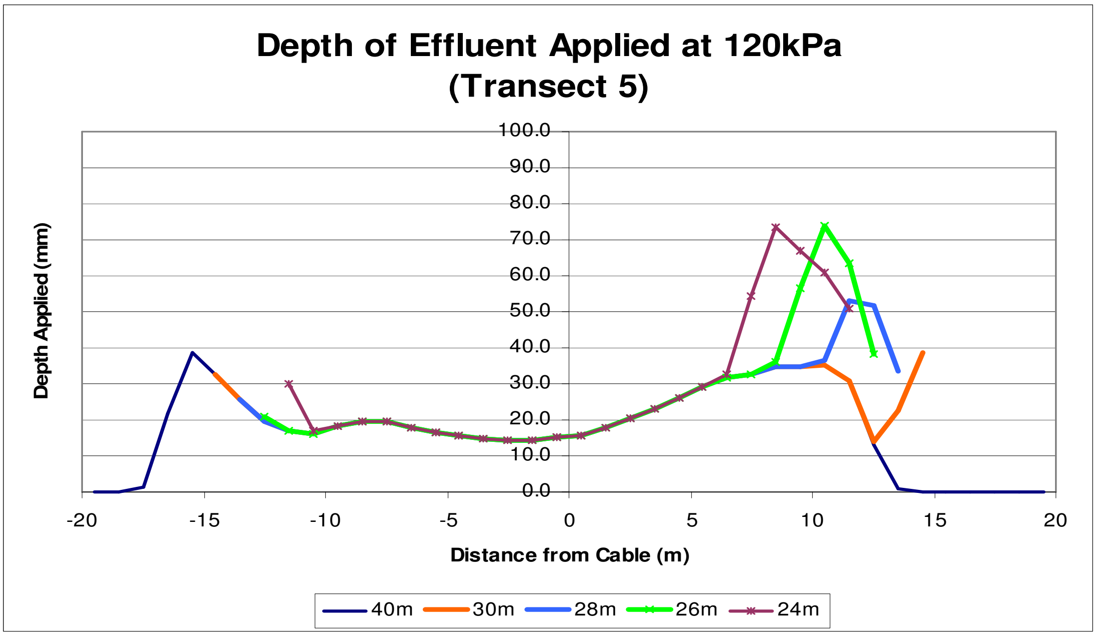

Figure 4. Effluent application pattern measured at 120kPa pressure with machine speed standardised: calculated overlapped pattern based on 40, 30, 28, 26 and 24m run spacings

Figure 4 data are for the same machine settings, but a machine inlet pressure reduced to 120kPa. The peaks at the edge of the run are more marked, and the overlapped values notably higher, indicating applied depths range from 14mm to 70+mm after overlapping is taken into account.

Machine Performance Variables

1 Cam Speed Control

- This machine is winched by a ratcheted drum, powered by the turning of the rotating boom. The machine speed can be varied by including or excluding cam lugs. Removing a cam lug stops the ratchet mechanism functioning on that part of a rotation.
- There is no method of governing the speed, so as terrain, hose weight or pressure vary, so does machine speed.

2 Pressure

- The pressure at which the machine should be operating is given as 150-250kPa.
- The testing reported here was carried out at 180kPa for the main run, with additional transect tests at 120 and 237kPa.
- Lower pressures may have insufficient 'pulling power' and machine speed may drop as hose weight increases. Low pressures significantly reduce application uniformity.
- Higher pressure is noted to create smaller droplets with potential to drift. At the highest pressure used for testing (276kPa) little noticeable drift was observed but application uniformity was improved.

3 Overlap effects

- Even when overlap was factored in the irrigation uniformity achieved was poor at low pressures. At the higher pressure of 210kPa, uniformity was much higher.
- This machine exhibits the typical 'donut ring' pattern of rotating boom irrigators. The pattern has peaks at the edges of the run, which are more marked as pressure is reduced.
- With higher operating pressures this machine can have high uniformity with the overlapped application coefficient of variation for a single transect attaining levels around the Fertiliser Spreader benchmark of 0.15.

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.