USING 'LOW RATE' IRRIGATION TO APPLY FARM DAIRY EFFLUENT TO LAND IN OTAGO

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INTRODUCTION

Managing land application of farm dairy effluent has often proven difficult in New Zealand, particularly on wet soils where there is a greater risk of subsequent drainage and overland flow contamination of water bodies by nutrients and pathogenic micro-organisms. Traditional irrigator hardware in the form of a twin boom rotating travelling irrigator has proven less than satisfactory to safely apply effluent to soils with poor structure, mole and pipe drainage systems and small moisture deficits. This is due to the high application rate, limited depth options and uneven effluent distribution associated with travelling irrigators.

OTAGO RESEARCH

Since the advent of the 'Dairy Green' project, 'low rate' K-Line irrigation pods have been successfully used to apply effluent in Southland and Otago. AgResearch has investigated the environmental performance of K-Line systems when used to apply effluent to land in West (Kelso) and South Otago (Clydevale). Trials were established to determine contaminant losses in mole and pipe drainage (Kelso) and overland flow (Clydevale) from a low rate system and to compare these losses from a travelling irrigator. Both trials were on the poorly drained and weakly structured Waikoikoi silt loam (Pallic soil). Research was carried out during the difficult to manage spring and late autumn periods when soils were often at or close to Field Capacity.

Due to the low application rate (4 mm/hr) of K-Line pods, plus their greater control of application depth and relatively uniform application profile, considerable decreases in both the volumes of mole and pipe drainage (and overland flow), and the relative concentration of effluent contaminants in the flows was measured when low rate applicators were used to apply effluent. For example applications of >12 mm effluent to the Clydevale site under wet soil conditions resulted in the loss of 78% of applied effluent when a rotating travelling irrigator was used. This compares to a loss of only 44% of applied effluent when a K-Line system was used. Further research outlined the ability of low rate irrigation systems to almost completely avoid mole and pipe drainage and overland flow losses of contaminants under relatively moist soil moisture conditions by adopting an intermittent (20 min on/40 min off) pumping regime whilst restricting total application depths to less than 8 mm.

COST OF ESTABLISHMENT

Low rate K-line irrigation can in most cases be plugged into existing effluent irrigation infrastructure and would require approx. $3000 to purchase the 24 pods and appropriate pipe required. The use of K-Line systems normally requires sediment separation and pond storage. The total cost of purchasing K-Line equipment and adding two months storage which includes a weeping wall to separate effluent solids, works out at between $40 and $50 per cow.

APPLICABILITY OF 'LOW RATE' IRRIGATOR USE

When combined with at least two months effluent storage, low rate applicators such as K-Line should be considered for applying effluent to mole and pipe-drained land and sloping land with weakly structured soils. Mole and pipe drained land provides potential rapid pathways for effluent transport to fresh water bodies, whilst poorly structured soils on sloping land have low infiltration rates, therefore resulting in an increased likelihood of overland flow generation following land application of effluent. The low application rate from a K-Line irrigation system helps minimise the risk of contaminant losses via these transport pathways.

KEY DESIGN CRITERIA

Pod spacing

K-Line pod distribution patterns will overlap if placed too closely together. Whilst such overlap is essential for an efficient water irrigation scheme, it carries enhanced environmental risks when irrigating effluent, as the increase in application rate and depth at the point of overlap subsequently increases the likelihood of bypass flow into mole and pipe drainage systems and the incidence of overland flow. Considering the maximum K-line irrigators throw of 10 m, it is recommended that pod spacings of 20 m should be adopted as the industry standard for applying effluent through a K-line system.

K-Line pods applying farm dairy effluent at the sloping trial site near Clydevale

Intermittent pumping

Intermittent pumping requires the use of a timer to turn the irrigator pump on and off, thus increasing the time that it takes to irrigate a given volume of effluent. This strategy provides greater control of application rate. It is recommended that on poorly structured soils, slowly permeable soils, or soils with mole and pipe drainage, that an intermittent pumping schedule of 20 minutes on and 40 minutes off be adopted. Such a schedule would require five hours and 20 minutes to deliver approximately 8 mm of effluent.

Storage

The provision of effluent storage allows for the implementation of a deferred irrigation system for scheduling effluent applications. Effluent is stored at times when soils are close to or at Field Capacity and thus when drainage and overland flow is likely to occur. Furthermore, storage allows some settling and breakdown of effluent solids, thus minimizing potential blockages of K-line irrigation nozzles. A soil moisture decision support tool is available for the South Otago region on the Otago Regional Council website http://land.orc.govt.nz/landinfo/ and provides practical advice on when to apply effluent depending on soil moisture levels and the use of either a travelling irrigator or low rate irrigation.

K-Line pods applying effluent to the mole and tile drained trial site near Kelso

Application criteria where no pond storage is available

When no storage of effluent is possible, but provision can be made for a solids separator to remove solids from raw effluent, then daily irrigation of effluent through a low rate system would be possible. Under such circumstances the depth of effluent applied should be less than the available soil water deficit to prevent drainage and overland flow. However, if there is little or no deficit, application depths should not exceed 5 mm.

Pump requirements

The 250 kPa pumping pressure required to operate a 24 pod K-line application system is similar to that of a standard travelling irrigator. However, the pump size required is only 7.5 kW compared to the standard 15 kW pump used to operate a travelling irrigator.

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