Drip Line irrigation as an alternative to Sprinkler Irrigation in White Clover

A technique to improve water use efficiency by reducing irrigation water losses and mitigate operation problems under centre pivots irrigating white clover.

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Aim

The aims of this trial were threefold. Firstly to reduce the delivery losses that are associated with the use of standard sprinkler packages in windy and high temperature conditions. The drip lines will deliver water at the surface, with a consequent reduction in drift and evaporation and improvements in water use efficiency.

Secondly the trial will examine the impacts on crop yield below the commonly accepted rate required under pivot in the Frances area. And thirdly to assess if the use of dripline will help to improve the problem of ponding of water in the pivot wheel tracks.

Take Home Messages
It is possible to significantly improve the water use efficiency by switching from sprinkler to dripline irrigation in white clover
Reducing the cleanout seed can also be achieved through the use of dripline irrigation
Provided similar results can be obtained in future years the use of dripline irrigation has the potential to become widespread and replace sprinkler irrigation as the district practice

Method

Research location

The research was conducted 7 km west of Frances on the property of Wayne and Sally Hawkins. The research compared the production under a 50 ha pivot, grown to Super Huia white clover. The trial was conducted in the 2nd and 3rd year of the stands life. Currently all of the white clover seed produced in the region is from sprinkler pivot irrigation.

Irrigation application management

A Zimmatic pivot fitted with I-Wob irrigation emitters was used as the Control treatment. The trailing drip line is a series of trailing poly tubes with numerous small outlets for the water to seep through. These trailing lines are spaced 25 cm apart and are 8m in length.

A total of 210mm [2.1 megs/ ha] was applied to the white clover from mid October through to the 19th of December. A total of 13 mm of rainfall fell between mid October and the end of November and then a total of 89 mm fell in December with the most significant of this on the 13th [64mm].

At the sites, the timing of irrigation events was determined by assessment of soil moisture monitoring device called the Gopher. Appropriate refill and field capacity points were established for the site and irrigation events were timed to be when the soil moisture content approached the refill point. The irrigation scheduling was determined by watering the control area along district practice.

Two different treatments of trailing drip were applied to the middle spans of the pivot, each being about 15m in width. The inside of the trailing drip had the same amount of water applied as the control treatment. The other trailing drip line had 30% less water applied than the control.

Data collection and assessment

The yields of the crop were assessed by two methods. At harvest in January the department harvester took three harvested strips from each of the treatments. The second assessment was carried out by conventional harvester equipment. A full cut of the header front for an entire lap of the pivot was taken for all three treatments. This seed was then sent for weighing pre-cleaning and then weighted again post cleaning.

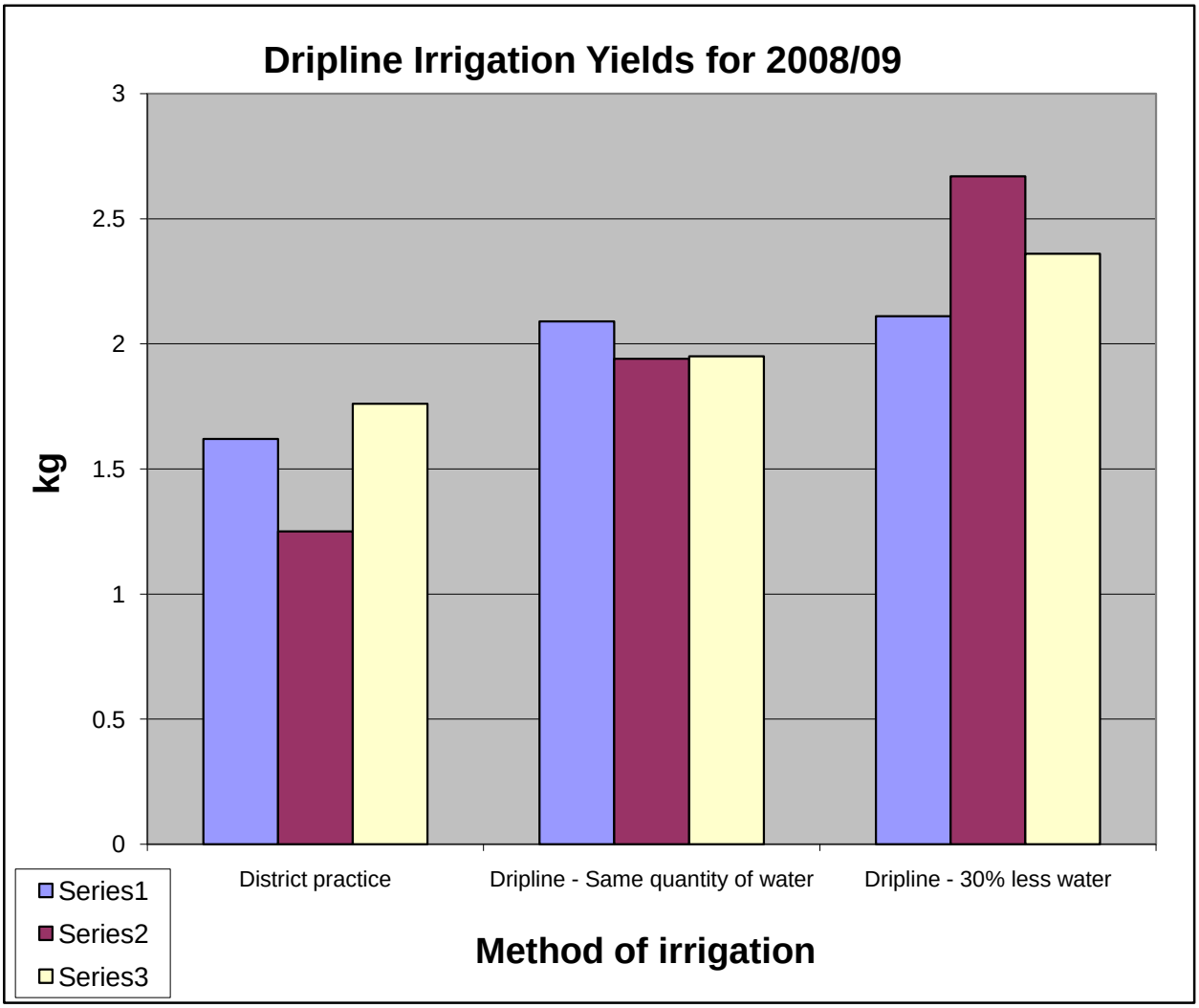
Results

Season 2007/2008

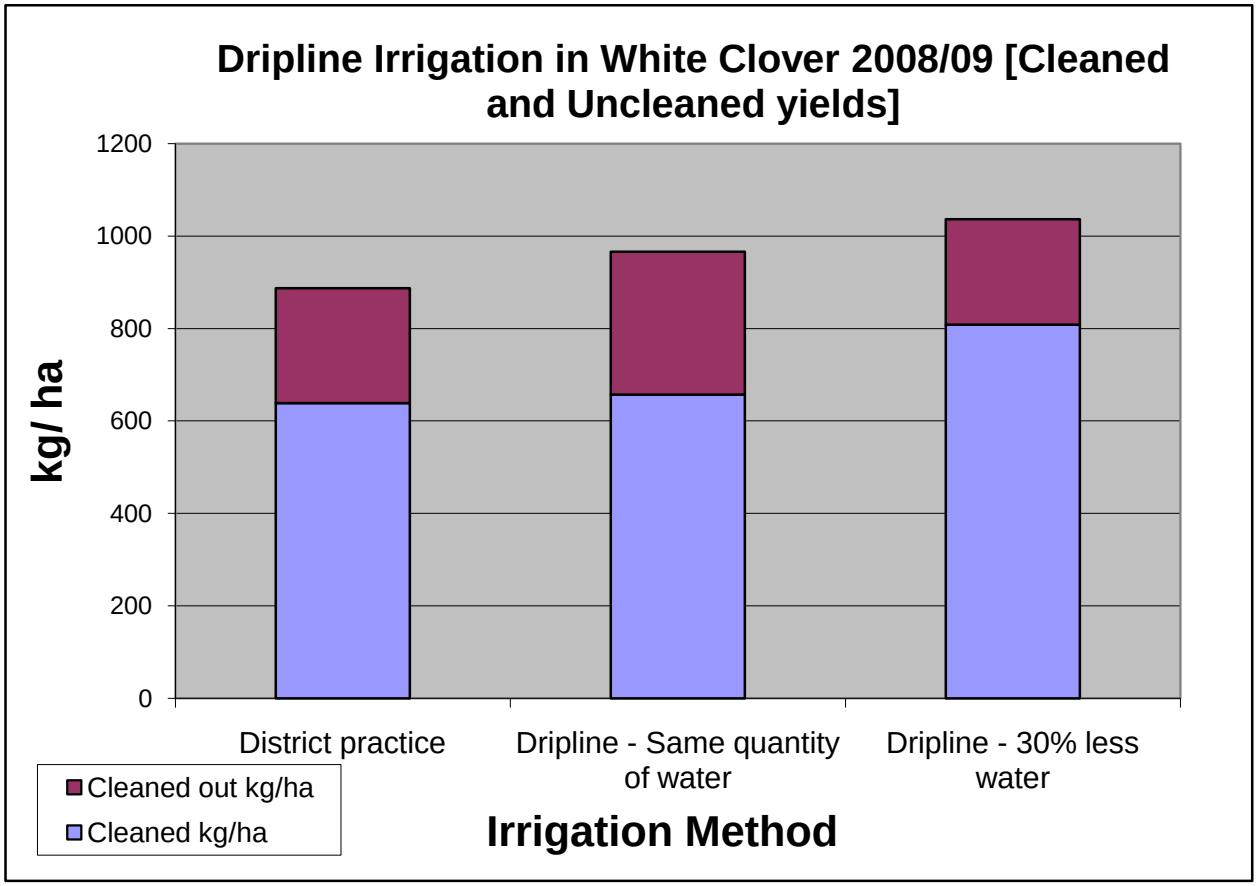
As the dripline irrigation was applied mid way through the irrigation season [December] the results were not assessed for this season.

Season 2008/2009

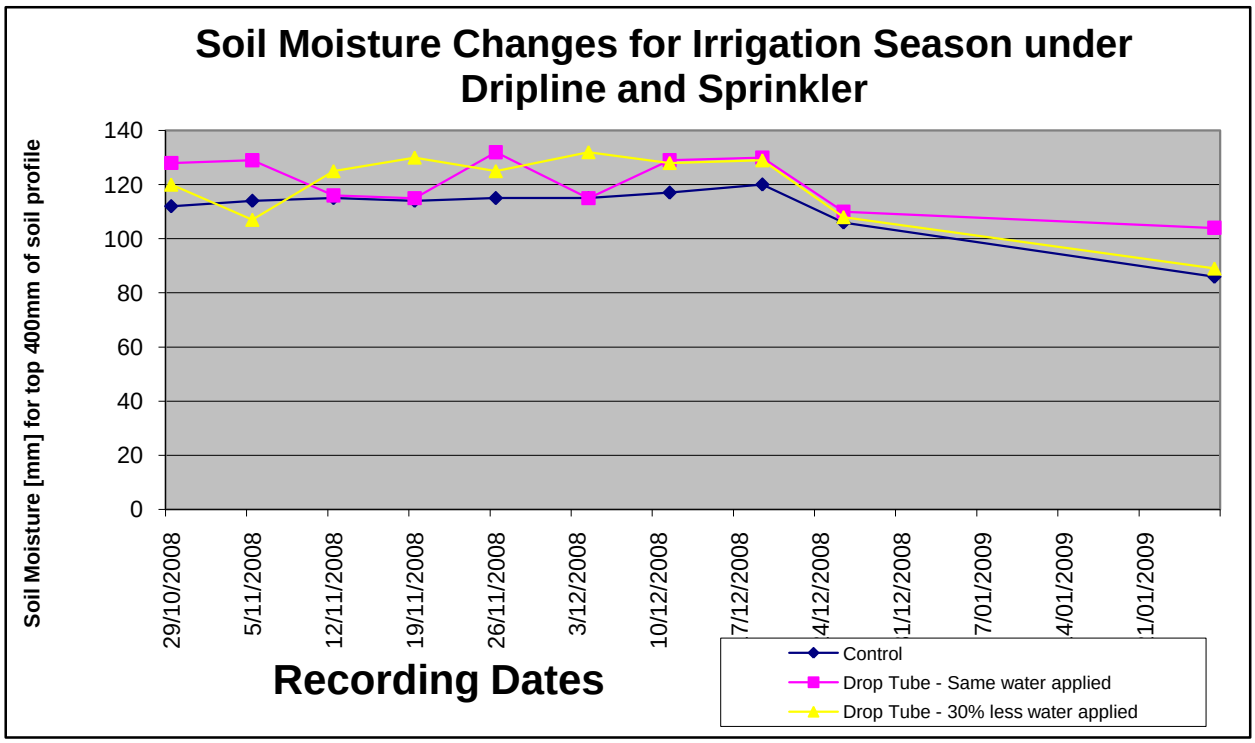
Graph 1: Yield of white clover under dripline irrigation for 2008/09 - assessed by plot harvester



Graph 2: Yield of white clover under dripline irrigation for 2008/09 - assessed by contract harvester



Graph 3: Soil moisture changes over the irrigation season



Interpretation

Yield and Seed Quality Results

The yields were only compared in the 2008/09 harvest season as the previous year of 2007/08 had only part of the irrigation season where the dripline was installed. Both the conventional harvest and the plot harvester had various advantages when comparing the yield treatments. Firstly with the plot harvester the strips were replicated 3 times to improve the accuracy of the results but were did observe that the harvester was not able to pick up the lower heads and hence may have underestimated the yield of the conventional treatment. The conventional harvester was able to reach the lower heads, simulating the district practice. The treatment strips were also larger, being one entire lap of the pivot circle.

In the plot harvested scenario both of the dripline treatments had statistically significant improvements in uncleaned yield. The dripline that applied the equivalent amounts of water as the control yielded 29% higher than the control and the treatment that had 30% less water applied yielded 54% above the control treatment.

In the conventional harvested trial the results were along similar trend, albeit not to the same extent. The uncleaned analysis showed that the dripline with the same applied water yielded 9% higher than the control and the dripline with 30% reduced water yielded 17% higher than the control. These uncleaned results were still significantly higher.

In regards to the cleanout results the control treatment had a cleanout of 28% which is around the normal range. In the dripline treatment [same water applied] the cleanout was higher at 32% and indicates that this treatment had more water applied to it than was ideal. This is confirmed by the visual observations. In the second dripline treatment [30% less water applied] the cleanout was 22% with the improvement being a function of the reduced application of water to the seed heads of the white clover. The cleanout would have also been improved by having the heads stand more upright compared to the standard district practice.

When the cleaned yield in taken into account, the dripline with reduced water applied extended it's yield advantage over the control [639 kg/ha] by 26% to a yield of 808 kg/ha. With the dripline that applied the equivalent in water, the yield advantage compared to the control was reduced to only 3% [657 kg/ha].

Other Observations

It was difficult to see what effect the driplines had on reducing the wheel tracking effect as the dripline were not installed directly adjacent to the wheel tracks. In regards to ponding and its effect on infiltration it can be concluded that these driplines will improve the wetted "footprint" which will assist in minimizing the ponding and therefore runoff effect.

It was visually observed that the sprinklers tend to push the seed heads lower into the canopy compared to the driplines which have no overhead force to push heads down. It was also noted that at the time the pivot had completed it's last irrigation there were a greater number of shot heads in the conventional treatment. This may also be the case for the dripline that had the same water applied as the cleanout results suggest.

As evidenced by the yield results it appears that the driplines have reduced the delivery losses associated with sprinkler irrigation. A much improved water use efficiency [esp. in 30% reduced dripline] indicates this. The gross return per ML [based on a seed price of $4 per kg] in the control was $1217, whereas the return per ML for the reduced dripline was $2198, or an 80% improvement. The dripline that applied the equivalent water was a return of $1251/ ML.

Application

The results indicate that dripline irrigation is a suitable alternative for irrigating white clover for seed compared with current district practice. Seed producers irrigating white clover can confidently investigate the establishment of dripline under centre pivot systems as an alternative or replacement to the standard sprinkler method. However, establishment of dripline systems under centre pivots appear to be more costly than the current sprinkler irrigation and it is unknown as to the life span of the dripline system.

With the current changes to water allocation in the form of metered/volumetric allocations as well as allocation reductions, the improved efficiency findings of the research are of great value.

Looking forward to a future with reduced water availability and increasing water prices the need to improve the water use efficiency of white clover seed crops and increase return per ML is important. With use of dripline systems, white clover seed producers may be able to maintain their level of seed production and improve their returns per ML. This will underpin the growers viability and productive capacity.

Advantages of the dripline system include being able to irrigate in windy and hot weather with no efficiency reduction, this being an important advantage when the flow rates of some bores are being reduced. This system also reduces the impact of salty water on pivots, therefore increasing the potential lifespan of a major capital investment.

The most exciting result out of this trial is the dramatic yield improvements that we gained from using the dripline system. When we can improve the yield and reduce the cleanout % by using less water it becomes clear that any additional costs associated with this dripline system can be easily justified. It appears that this dripline system has the potential to improve both the economic and environmental sustainability of his system. By potentially using less water it enables the grower to expand his production area or maintain his area under reduced water allocations. Combine this with the ability to grow significantly more seed per ML, it shows that this system has great potential in this area.

Acknowledgments

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