Application of RDI Precision Irrigation

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Abstract: *Precision irrigation via various forms of drip and mechanized irrigation addresses many of the challenges facing the pressures on water resources for agriculture. Each has some limitations such as water quality, ability to effectively irrigate irregular shaped fields, energy requirements and management expertise. This paper will provide an update of performance in commercial fields of thenon-coated, porous tube precision irrigation package developed by DuPont, Inc and Valmont Industries, Inc. referred to as RDI. The focus will be on the science behind the product and its application to particular field situations where other types of precision irrigation may be challenged to provide economical solutions. The paper will provide information on differences of a RDI design and other types of precision irrigation.*

Keywords: Precision irrigation, plant roots, sub surface irrigation, center pivot

Introduction:
Shrinking availability of resources in many parts of the world have driven advances in precision irrigation. This has led to changes in irrigation methods. Center pivots have changed from having sprinklers operating at 50psi or more on top of the pipeline to mounted on drops in the crop canopy operating at 10psi. Drip irrigation methods have adapted and one direction it has taken is subsurface irrigation. More and more the focus is on applying the water as efficiently as possible and controlling the water in the root zone. This matches up with interest in the root environment (Arkin, 1981). Precise application of water for plant production has become common. While mechanized and subsurface drip irrigation are overall doing a good job, opportunities still exist to improve the delivery of water for irrigation. As discussed during the 2013 Irrigation Association Technical Meetings (LaRue, 2013) center pivots are an economical delivery system, but may not meet farmer needs to irrigate small irregularly and oddly shaped fields. Subsurface drip irrigation can be very efficient, but has some limitations due to maintenance requirements and water quality challenges. Both types of irrigation require good management practices to work well. The RDI product was introduced to better meet the challenges of precision irrigation.

Objective:
The goal of this study is to provide an update to the science and application of using a porous, non-coated tube for precision irrigation.

Discussion:
The RDI tube is made from a DuPont porous material and converted into a tube by Valmont. The tube is designed to release water through its pores when the surface tension is broken. This can be accomplished in two ways

- When surfactants come in contact with the surface of the tube
    - These can be either natural or artificial

    - Naturally occurring surfactants are released by the plant roots
- When the water pressure in the tube exceeds the hydro head of the specific tube material. As the pressure changes the flux through the tube walls changes linearly.

The tube does not have defined emitters spaced along its length but rather due to is porosity releases water at all along the tube. Work is being done and data collected to see how this product 'fits' with conventional subsurface drip irrigation (NRCS, 2004)

In the spring of 2014 the limited commercial sale of the RDI product began. Other field tests were continued and maintained. The design basic design parameters are:

- The preferred operating mode is having water available twenty four hours per day, seven days per week.
    - Typical operating pressure in the tube is 2.0 psi
    - With a spacing of 30 inches between lines the daily application could be 0.30 in/day or more depending on the release of exudates
- Often however water is not available twenty four hours per day due to an electric pump being on load management or when the subsurface irrigated field is connected to a well also supplying a center pivot. In either of these cases the pressure in the tube is maintained at a higher level to ensure the adequate delivery of water to the crop. At these higher pressures the impact of surfactants (exudates from the roots) is minimized.

The following are specific examples of some field situations from the 2014 growing season.

Example #1

- Area – southwest corner of center pivot, 7.5 acres
- Soils – silt loam
- Slope – uniformly about 1.5%
- Crops – corn / soybean rotation
- Situation
    - Amount of water used and labor for furrow irrigation
    - Poor yields due to uneven distribution
    - Want simple solution
- Challenge to sub surface design
    - Operating the sub surface irrigated field with the center pivot
- Solution
    - Regulating the operating pressure at the well to the general required pressure range
    - Installation of three zones to meet uniformity requirements for the field by providing slightly different pressures

Example #2

- Area – east and west sides of a field where corner machine could not cover
    - East side – 34 acres, west side – 14 acres
- Soils – silt loam

- Slope – varies by corner
    - Northeast – uniform 0.20%
    - Southeast – rolling with up to 4% slops
    - Northwest – uniform 0.20%
    - Southwest – uniform 2.5 to 3.0%
- Crops – corn / soybean rotation
- Situation
    - West side – rarely sufficient water or time for furrow irrigation
    - East side – energy use and poor yields due to uneven water distribution using furrow irrigation
    - Due to slopes in field had to plant rows in different directions
        - Wanted to plant and manage the field in one direction
- Challenge to the sub surface irrigation design
    - Topography in parts of the field
    - High iron levels in the east well
- Solution
    - East side
        - Replace 50hp flood pump with 7.5hp pump dedicated to the RDI field
        - Break the field into three zones each operating at a slightly different pressure
        - Use of RDI 73B40 to minimize the impact of the iron levels
    - West side install a small well with 2.0hp pump dedicated to RDI
        - Break the field into two zones each operating at a slightly different pressure

Example #3

- Area – southeast corner of a center pivot – 4.5 acres
- Soils – loamy sand and fine sand
- Slope – uniform 0.20%
- Crops – corn / peanut rotation
- Situation
    - Had not been farmed in twenty years
    - Only corner farmable and not economical for a corner pivot
    - Want to generate some income
- Challenge to subsurface irrigation
    - Old building site
    - Sandy soils
- Solution
    - Installed a 2.0hp pump in the old well dedicated to RDI field
    - Installed RDI 73B40
    - Installed fertigation package to apply 28-0-0-5

Example #4

- Area – long narrow shaped field with building site – 22 acres
- Soils – split between sandy loam and silt loam

- Slope – rolling field with changes along the field of one to five feet
- Crops – corn / soybean rotation
- Situation
  - Nutrient management and cost of pre applying all of the nitrogen
  - Most years to maximize profitability need only three to six inches per acre of irrigation
  - Not economically feasible to water with center pivots or linears
- Challenge to subsurface irrigation
  - Soil changes
  - Topography
- Solution
  - Installed RDI 73B40 in three different zones for the sub surface irrigation
  - Applied 28-0-0 through the 73B40

Results:
For the payback assumed a price of $4.50 per bushel price for corn and expected yields except for Example #3 where harvest has been completed. Savings were based on actual energy costs when available and an estimate of labor.

Example #1
- Outcome
  - Labor required – none, never checked during the growing season
  - Water - significant savings over previous flooding – at least 40%
  - Energy savings – operated with the center pivot
  - Yield – four to five times yields of previous years
- Payback with savings and yield increase – four to six years

Example #2
- Outcome
  - Labor required – very little, rarely checked other than to shut off after significant rain event
  - Water - significant water savings over previous flooding – about 45 to 55%
  - Energy savings – on the east side about $1,500 for the season
  - Yield – significantly more crop harvested than had been previously
    - West side – during previous five years almost no crop had been harvested
- Payback – with savings and yield increase four to five years

Example #3
- Outcome
  - Labor required – none other than to fill fertilizer tank
  - Water savings – none as had not been irrigated
  - Energy savings – none as had not been irrigated
  - Fertigation was critical due to early season excessive rainfall
- Payback – four years

Example #4

- Outcome
    - Labor required – none other than to fill fertilizer tank
    - Water savings – none as had not been irrigated
    - Energy savings – none as had not been irrigated
    - Fertigation was critical to maintain the crop
- Payback – five to six years

Conclusion:

The application of a porous, non-coated tube for subsurface irrigation has had a few challenges that are being overcome and its significant benefits continue to drive interest in the product. In installations being specifically monitored the customer expectations are being met and in some cases significantly exceeded. The non-coated porous tube has been easy to use in irregular fields. Water quality issues have not been significant other than high iron in one well which has not impacted the flows of the porous tube. Management and maintenance requirements have been minimal and in some cases there has been none other than to turn the system off and back on after significant rain events.

Work continues to explore performance of the non-coated, porous tubes with more crops and soils. In addition work is continuing to see if and how the porous tube can be described and characterized like conventional drip with emitters or if a different way of characterizing is needed.

References:

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