Research on Drip Irrigation for Sugar Cane

By

Peter Spyke
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Components of Florida Crystals Irrigation System

- 4 zones irrigation, operating two at a time
- 2,000 gpm pumping station
- Solar powered 12V Battery with Power Inverter for Controller
- NMC Light Controller
- Diesel power with automation
- Self-priming pump in wet well off of ditch
- A and B Tank Fertigation
- Buried drip tape .20 - .25 gph, 18” emitter spacing

Subsurface Drip Irrigation (SDI) has been used to irrigate sugar cane in many places around the world. The following is a summary of the information about some of these circumstances.

-- Basic Information

WHAT IS SUBSURFACE DRIP IRRIGATION?

Subsurface irrigation allows the precise application of water, nutrients and other agro-chemicals directly to the root zone of plants. This allows the farmer to optimize the growing environment and leads to higher quality and quantity crop yields. The depth and placement of subsurface driplines is determined by the soil composition and the crop needs. An efficient installation has water moving by capillary action at a depth of 4 to 30 inches beneath the surface, forming a continuous wetted area along the plant rows. Frequent irrigation cycles (several times daily) maximize capillary action and minimize water surfacing.

Comparison table

Given the same amount of water, subsurface drip irrigation covers a 46% larger wetted volume of soil than a surface drip system. This decreases the saturation point of the soil, which not only leaves room for more air, but also improves the capillary movement of water and decreases the water lost to deep percolation.

Emitters can be spaced farther apart than with surface lines to achieve the same wetting pattern.
Basic Sugar Cane drip irrigation system Information, excerpts from Netafim

Drip version – Surface or subsurface drip irrigation (SDI) combined with fertigation. Fertigation is the application of plant nutrients through an irrigation system, also known as Nutrigation™

Drip product – DripNet PC, Super typhoon, DLN 17009.
Dripline spacing – 1.8 m with one lateral per two crop rows.
Emitter spacing – 0.30 m to 0.50 m depending on soil texture.
Emitter flow rate – 1.0 LPH, 1.6 LPH and 2.0 LPH depending on soil texture.
Dripline installation depth in SDI – 0.15 m to 0.3 m

Crop water requirement & irrigation scheduling

Estimate crop water requirements as a product of daily reference crop evapotranspiration by Penman-Monteith method and crop coefficient for a given day according to the plant developmental stages.

Begin with 0.4 Kc of daily ETo in the initial period, raise it to 0.7 to 1.05 at tillering and canopy establishment phase, 1.2 at grand growth period and decrease it 1.15 to 0.95 to 0.7 at ripening and maturity period of sugarcane.

Peak crop water requirement: 6 – 7 mm/day in India & South Africa and 4 – 5 mm/day in Brazil.

Seasonal crop water requirement: 1100 to 1500mm under drip irrigation for range of environments.

Scheduling irrigations when tensiometers installed at 20cm soil depth register 15 – 25 centibars of soil moisture tension at tillering and grand growth period - 60 centibars at ripening period maximizes cane and sucrose yield.

Fertigation

Apply mineral fertilizers based on the targeted cane yield, leaf nutrient analysis, results of fertilizer experiment, leaf deficiency symptoms, nutrient uptake, soil nutrient analysis, and nutrient recycling.

Nutrient uptake per ton of cane yield:
0.7 – 1.2 kg N
0.4 – 0.8 kg P2O5
1.8 – 2.5 kg K2O
Optimum leaf nutrient levels are:

1.9 – 2.2% N
0.2 – 0.24% P
1.1 – 1.3% K
0.2 – 0.3% Mg
0.8 – 1.0% Ca
0.25 – 0.30% S
9 – 30 ppm B
8 – 10 ppm Cu
100 – 250 ppm Mn
200 – 500 ppm Fe
25 – 50 ppm Zn

Recommended nutrient dose per hectare (under range of environments):

250 – 300kg N + 80 to 100kg P2O5+ 125 to 250kg K2O

For fertigation use only water soluble fertilizers such as:

urea (46% N)
potassium nitrate (13% N & 46% K2O)
monoammonium phosphate (12% N & 61% P2O5)
ammonium nitrate (34% N)

-- Information on Drip Irrigation of Sugar Cane in Phillipines

Crop spacing: Row to row – 1.5 m and plant to plant – 0.15 m
Seed rate: 50000 number of three-bud setts/ha
Plant population at harvest: 130,000 millable canes/ha
Soil physical properties: Clayey soil texture
Soil pH: 6.6
Soil salinity (ECe): 0.45 dS/m
Water source: Canal water
Power source: Diesel pump

Subsurface drip irrigation (SDI) system

Head control unit, main and sub-main pipes besides DripNet PC integral dripline
16 mm diameter, with a lateral spacing of 1.5 m, emitter spacing of 0.5 m and
emitter flow rate 1.0 Liters/hour.

Each crop row was irrigated with one dripline installed at 0.3 m below the soil.

Year of drip system installation: 2007
Agronomic and technical support

Crop water requirement and irrigation scheduling: Depth and frequency of water application; water quality consideration, measurement of applied water.

Fertigation scheduling: Soil and water analysis, estimation of nutrient dose, selection of fertilizers and compatibility, application skill via drip system and foliar diagnosis for nutrient deficiencies.

System operation and maintenance: Pressure reading and maintenance, valves operation, measurement of applied water. Cleaning of filters, fertilizer tank, acid treatment, chlorination, etc.

Training and capacity building: Soil water plant relationships, drip irrigation and fertigation principles, benefits, limitations and utility; water quality and herbicide usage.

Results

Improved cane yield: Conventional overhead sprinkler irrigation - 70.0 tons/ha and with subsurface drip yield increased by 90% (133.5 tons/ha).

Improved cane quality: Increase in sucrose content by 5.2% in comparison to overhead sprinkler irrigation.

-- Drip Irrigation in Sugar Cane in Hawaii

Drip irrigation has been around for over 25 years. In Hawaii, over 100,000 acres of sugar cane and pineapple are subsurface drip irrigated. A high percentage of the drip irrigation development work in Hawaii was done in sugar cane with the assistance from the Hawaiian Sugar Planters' Association (HSPA) and the University of Hawaii. Drip irrigation of sugar cane in Hawaii was first initiated in March 1970 on an 8,000 square foot plot at the HSPA's Kunia Experiment Station. The first plantation installation was by Olokele Sugar Company, on the Island of Kauai, in December 1970.

Zimbabwe (2004)

In the standard layout, cane rows were spaced 1.5 m apart and a drip line (tape) was placed at 0.23 m below ground level under each cane row. In the tramline layout, the drip tape was placed 0.10 m deep and between two cane rows that were 0.42 m apart. The drip tapes were laid out at 1.8 m apart.
Planting

Planting was done by hand on 26 June 1997. Cane was planted in double rows using three-eyed setts that had been dipped in a fungicide for five minutes, to control smut. In the standard layout, sugarcane was planted about 0.10 m above the tape. In the tramline layout, two cane lines shared a drip tape that was placed 0.10 m deep.

Irrigation scheduling

A T-Tape Typhoon 25 drip tape was used. The emitters were spaced 0.4 m apart, and delivered 1.6 L of water per emitter per hour. The drip system had two sand filters and one separate disc filter tank. Prior to covering the cane setts, 10 mm water was applied to ensure that moisture reached the setts, and to check that the emitters were not blocked.

Fertigation

The amounts of potash and phosphate fertilisers applied were based on soil sample analysis prior to planting. Fertigation was done using a Dosatron. Muriate of potash at 60 kg K2O/ha and ammonium nitrate (AN) at 120 kg N/ha were applied to the plant cane. The N fertiliser was increased to 180 kg N/ha in the ratoon crops, applied as AN at 30 kg N/ha at each fertigation event.

India

Among drip irrigation systems in the plant crop, sub surface drip (Biwall) at 40/140 cm spacing recorded a significantly higher number of millable canes, cane length and single cane weight compared to either conventional furrow irrigation or furrow irrigation based on IW/CPE (Irrigation Water Cumulative Pan Evaporation) ratio. In ratoon crop, Biwall irrigation at 60/120 cm gave significantly higher cane length and single cane weight compared to any other methods of irrigation.

Roots

If your system is already in the ground you could try injecting Agan Triflurex through the dripline. This is the only grade of trifluralin labelled for this application. However, if you follow the instructions correctly, as you are required to do, I doubt if you will get enough trifluralin into the system to protect any distance from the dripper outlet.
Direct Advice from Sugar Cane Drip Irrigation Engineers from Trickle-L
Irrigation Email Listserv

If additional contact is desired with any of these resource people, we can make
arrangements to do so.

Pete,

You might try to contact Randall Moore, with Hawaiian Commercial & Sugar Co.on the island of
Maui, HI or David A Young with Wai Engineering on teh island of Oahu or give me a call to
discuss. I did design and installation in Hawaii for a number of years. Many of our fields were quite
sandy on the Island of Maui.

Randall can be reached at:
rmoores@hcsugar.com
Dave can be reached at:
waidave@hawaii.rr.com

Mark Hewitt

Mark Hewitt
509-628-3295-office
509-430-7355-cellular
Mhewitt@RainBird.com or
Mhewitt777@aol.com

Pete,

We use drip irrigation to irrigate sugar cane, but it is not considered
a subsurface drip system. We use primarily 10 mil Netafim Typhoon
tubing with a flow rate of 0.31 gpm per 100 feet at 10 PSI (15 gpm per
acre). The drip tubing is replaced every two years after we harvest the
fields.

Tube spacing: 9 feet
Row spacing: One drip tube for two rows of cane that are 3 feet apart
with a 6 foot dry space between the two rows of cane.
Emitter spacing: 36 or 24 inches.
Tubing depth: 3 to 4 inches.

See attached article for additional information.
Web site: http://www.hcsugar.com/

Let me know if you need more information.

Randall Moore
HAWAIIAN COMMERCIAL & SUGAR COMPANY
G'day Pete,

Our soils have high intake rates so there are very few long term systems. However, for normal 2 year sugar cane, the typhoon drip tubing (10 mil x 0.6 gph x 36" spacing) with about 4" to 6" of cover. The systems are chlorinated at 10 ppm at the distal end about once per week using chlorine tablets. The ends are not normally flushed unless there has been a pipeline break or problems are noted. We are currently installing a dripnet PC system using 5/8" and 3/4". The customer will be using GPS on the equipment so that they can reuse the SDI for many years on their seed cane fields.

In general, we have slope everywhere so the control risers with a 12 psi regulator are spaced about 100 feet apart with the lateral length at about 500 feet. I suspect that with your terrain you will be able to use longer sub mains. I will send some photos of typical riser units, some with auto valves and some with manual.

The standard filtration is now the AGF filter at about 200 gpm per tank to allow for backflush without affecting field pressure. Some photos are also attached.

If you don't mind, you could call me tomorrow on my cell phone anytime after noon your time.

Aloha,
Dave Young
Wai Engineering, Inc.
95-522 Kipapa Drive
Mililani, HI 96789
cell 808 286-4233

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From: "Leonard Ndlovu" <LNdlovu@rssc.co.sz>

Dear Pete,
RSSC is planting on a tramline spacing, i.e., the dripperline is buried in the center about 100 mm deeper than sugarcane sets which are then placed about 200 mm on either side of the tape. The short distance enables lateral movement of water to the set which is can also be partially achieved by pulsing the irrigation. The approach of placing the dripper line under the set or cane line may have its advantage but our experience this end, depending on the wall thickness, roots can pinch the tape to a point where passage of flow is zero.

Regards
Leonard
From: Aloni Nir <NAloni@JohnDeereWater.com>
To: "pdspyke@arapahocitrus.com" <pdspyke@arapahocitrus.com>
Subject: Re: Trickle-L: (no subject)

Pete
The flow rate we used was 1.75 l/H and the depth was about 5-10cm below the seed cane. The flow rate was a compromise because the low quality of water.
Regards
Nir
Nir Aloni

Chief Agronomist

John Deere Water

+972542408012

From: "David Young" <waidave@hawaii.rr.com>
To: "Pete Spyke" <pdspyke@arapahocitrus.com>
Subject: Emailing: KEKAHA 4, DIESEL BOOSTER, APOLLO 4 TRAILER MOUNT W PUMP, MON PUMP 1, STAFF GAUGE 01032010, CHOPPER JOB

Here are some project photos. We need to use sand media filters for ditch or reservoir water.
One alternative to sand media filters – Netafim Apollo filter system in picture below

Miscellaneous system pictures
Hi Pete,

There are as many ways to build a riser as there are customers. Because of our terrain, in most cases we need some type of pressure regulator and recently we have started to automate those with a battery powered brain. The flow rate per acre varies from as low as 15 gpm to 60 gpm per acre so that also determines the pressure reducing valve and the riser configuration.

In most cases, the farmer uses 2" oval hose on the surface rated at 21 psi as the submain connected to the riser and drip manifolds. The polyethylene hose is a commodity item available from JDW, TORO, or Netafim. There are a couple of photos showing that connection with a barbed type coupling that is inserted in the oval hose then connected with a twist lock fitting to the drip tape. Those fittings are available from several sources but we prefer the Irritec fitting. See photo PHB Koloa.

Aloha,

Dave Young
Wai Engineering, Inc.
95-522 Kipapa Drive
Mililani, HI 96789
cell 808 286-4233
Subject: RE: SDI in Sugar Cane
From: "Moore, Randall at HCS" <rmoore@hcsugar.com>
To: Peter Spyke <pdsyke@arapahocitrus.com>

Pete,

Re: water losses -- “the water and fertilizer on one side of the drip line with single row of plants.”

There maybe some water loss while germinating the seed and when the cane plants are small, but the plants should send out roots and use the water after a few months of growth.

Randall
FIELD 7192 SYSTEM
Submain and Flush Line
Rev. 02/20/2011
NTS, DAY

Submain detail

3/4" slip coupling
3/4" IPS PVC flex hose
5/8" or 7/8" spig coupling to Dripnet PC

3" Class 125 PVC Submain

Slip tee
3" x 3" x 3/4"
9 feet on center

Flush line detail

3/4" slip coupling
3/4" IPS PVC flex hose
5/8" or 7/8" spig coupling to Dripnet PC

2" Class 125 PVC Flush Line

Slip tee
2" x 2" x 3/4"
Length varies Field fit

Install 2" x 90 degree elbow with above ground 2" PVC ball valve at both ends of flush lines for each block (7 blocks)
FIELD 7192 SYSTEM
LONG LINE SEED
Rev. 08/16/2010, 02/19, 20/2011
NTS, DAY

NOTES:
1. Submain to be 3".
2. Drip tape will be Dripnet PC by size shown.
3. Flush manifolds will be 2" with a ball valve on each end.
4. Pipes will be buried with 3 feet of cover.
5. All valves to be above ground.
6. There will be a 40' road with Submain means all on one side of the road.
7. Install 3" x 45 degree elbow with threaded cap at the end of each Submain.

These areas can be either 630 or 875 Dripnet PC.