686 IRRIGATION WATER MANAGEMENT

Section 686.211 Example of Furrow Intake Evaluation

D. Miller Farm Furrow Intake Calculations

Determination of the furrow intake family is accomplished by measuring the intake at different times after the irrigation has started.

Collected Data

Soil: Hastings silt loam (from county soil map)

Length of furrow evaluated L=900 ft

Width of furrow W = 2.5 ft

Slope of furrow S = 0.003 ft/ft

Determine average inflow (Q_i) during the total evaluation

$$Q_i = \frac{Sum\ of\ Volume}{Total\ \ \min.} = \frac{6775.90\,gal.}{480\,\min.} = \frac{14.12\,gpm}{}$$

Determine Width over which intakes occurs formula from page 686-21.

$$P = 0.2686\left(14.12\ x\ \frac{.04}{.003^{0.5}}\right)^{0.4247} + 0.7462 = 1.47\ ft.$$

Determine volume of storage in furrow from formula page 686-21.

$$V_s = 900\left[(0.09731)\left(14.12\ x\ \frac{.04}{.003^{0.5}}\right)^{0.7527} - 0.00574\right] = 502\ gals$$

The plotting points for the different time intervals are determined as follows:

Average time the water has to be absorbed into the soil in the total furrow evaluated = opportunity time = T_{op}

T_{op} = [inflow time (hrs) – outflow time (hrs)] 60 min/hr

The accumulated intake (in) for the width P

$$F_f = \frac{1.6041\left[Inflow\,vol.(gal) - Outlflow\,vol.(gal) - Surface\,Storage(gal)\right]}{length\ x\ P}$$

*Plotting points @ 1640 hrs.

$$T_{op} = \frac{[(16.67 - 8.5) + (16.67 - 11.0)]\ x\ 60 = 415\,\min.}{2}$$

$$F_f = \frac{1.6041}{900\ x\ 1.47}(6776 - 2956 - 502) = 4.02\ in.$$

Plotting points @ 1600 hrs.

$$T_{op} = \frac{[(16.0 - 8.5) + (16.0 - 11.0)]}{2} 60 = 375 \min.$$

$$F_f = \frac{1.6041}{900\ x\ 1.47} (6388 - 2596 - 502) = 3.98\ in.$$

Plotting Points @ 1300 hrs.

$$T_{op} = \frac{[(13.0 - 8.5) + (13.0 - 11.0)]}{2} 60 = 195 \min.$$

$$F_f = \frac{1.6041}{900\ x\ 1.47} (3830 - 946 - 502) = 2.88\ in.$$

* Plotting point @ 11:30 (11.5)

$$T_{op} = \frac{[(11.5 - 8.5) + (11.5 - 11.0)]}{2} 60 = 105 \min.$$

$$F_f = \frac{1.6041}{900\ x\ 1.47} (2545 - 169 - 502) = 2.27\ in.$$

* There should be flow at both the inflow and outflow measuring devices if the plotting points are to be used for determining the intake family.

The plot shows that the furrow intake family is 0.5 which agrees with the design assumption in Soils Section 681. It can be assumed that adjustments can be made to the system using either the IRMA tables or a calculator program in Section 689.

F_f total (Figure 686-12) = $\frac{1.6041}{900\ x\ 1.47}(6776 - 3035) = 4.53 in.$

F_f total (Figure 686-12) = $\frac{F_f\ x\ P}{W} = \frac{4.53\ x\ 1.47}{2.5} = 2.66 in.$

Runoff R_o = $\frac{1.6041}{900\ x\ 2.5}(3035\ gal) = 2.16 in.$

The above items tell us that 2.66 in. has gone in the ground but we don't know what part of this is F_n (net application) and what part is D_P (Deep Perc). Even though the D_P isn't known, the rate of advance of the furrow stream is an indication of the magnitude of deep perc that is occurring.

The items also tell us that

$\frac{+2.16 in.}{2.66 in. + 2.16 in.} = 45\%$ of the applied water run off

The preceding example showed the following items about this irrigated field.

1. What the intake rate of the soil is with different application times. See Figure 686-15.
2. How much water runs off of the field. This becomes most meaningful if the evaluation was done for the total set time. A direct comparison can then be made with the IRMA Tables.
3. What intake family the soil fits. This is important because it helps determine if the soil series is properly placed in Section 681.
4. What the gross amount of water is that is delivered to the crop area.

Some of the things this example won't show you about this irrigated field are:

1. What the original moisture condition of the soil profile was.
2. If it was time to irrigate.
3. What if any deep percolation occurred.
4. The uniformity of the irrigation throughout the run.
5. What the efficiency of the irrigation was.

To determine the above, it is necessary to probe the soil profile and test the moisture content before and after the irrigation. The procedure in the example can't be used as a scheduling tool.