BORDER STRIP IRRIGATION SYSTEMS

INTRODUCTION

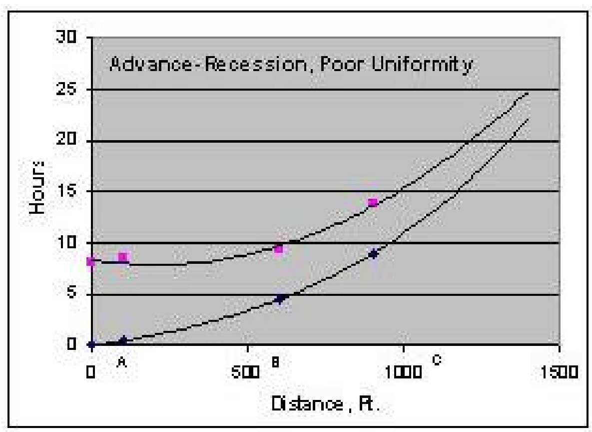
Border strips are run entirely differently than furrows. When water is turned off in a furrow it is essentially gone from the furrow immediately. In a border strip, because of the configuration and the crop friction, water takes a long time to run off. Thus, water is turned off in a border strip before it reaches the end of a strip. Border strips can be the most complex to manage as they are usually efficient only for a very narrow range of applications. If you know you will be applying small, frequent irrigations, make the strips shorter and narrower. See the following link for information of selecting an irrigation method (ftp://ftp-nhq.sc.egov.usda.gov/NHQ/pub/outgoing/jbernard/CED-Directives/neh-2of2/neh15/neh-15-03.pdf) from the NRCS National Engineering Handbook.

Border strips share some of the same operating characteristics as furrows. That is, the amount of water infiltrating depends on the intake rate of the soil and the opportunity time at any point in the strip.

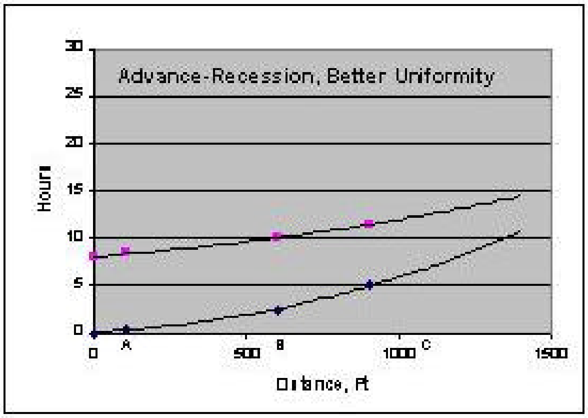
There are several important differences . . .

- When flow into a border strip is turned off, it takes time for water to run off. In other words there is a measurable recession time. (Remember that when water is turned off in a furrow, it disappears from the furrow relatively quickly.)
- Also, because more surface area is wetted with border strips it doesn't take as long to soak in the same amount of water. You do not have to wait for water to sub across a bed or into a dry furrow. Thus, sets are usually shorter with border strips than with furrows.
- Finally, with a wide strip and the broadcast seeding that usually accompanies their use, there is not a problem with cross-row uniformity as with furrows.

Example 1, Poor Uniformity



Example 2, Better Uniformity



ADVANCE-RECESSION CURVES

The important operational characteristic of border strips is that they usually have measurable recession time. That is, when you turn water off in a border, it takes a significant, measurable amount of time for water to run off the strip.

A major reason for this is the obstruction of the crop in the strip. Water is held back by the crop, both when it is advancing down the strip and when it is running off. Another reason is that the water in a strip is not confined as it is in a furrow and thus, doesn't build up as much head (depth of flow). Because of this measurable recession we do not have to get the advance ratios as in furrows. Although set times in border strips are generally shorter than in furrows (because we are wetting more soil and thus, soaking water into the field faster), we normally turn the water off in a border strip before it reaches the end.

The impact of recession time is shown in Example 1. It depicts the advance and recession of water in a border strip during an irrigation. The bottom, solid line is the advance of water. This particular irrigation got water to the 600 foot mark in about four hours (at 'B', note the intersection of 600 feet on the horizontal line with 4 hours on the vertical). The upper, dashed line is the recession as water is turned off. Note that water was turned off eight hours after it was turned on, when it was about 1000' down the 1100' strip. This recession curve shows that water disappeared from the 600 foot mark about 9 1/2 hours after the irrigation was started.

Remember that recession is the rate at which water disappears from the soil surface. In the figure above, the distance 'A' between the advance curve and the recession curve is how long water was on the soil surface, infiltrating. It is the OPPORTUNITY TIME.

In Example 1 there was about 8 hours of opportunity time at the 100 foot mark (distance A). Water advanced to the 100 foot mark in about 1/2 hour. It finally receded from the 100 foot mark at about 8 1/2 hours into the irrigation. Thus, water was on the surface at the 100 foot mark for about 8 hours (8 1/2 recession - 1/2 advance). In contrast there was only five hours at the 900 foot mark (distance B). And only 3 hours at the end of the strip (distance C).

We've said before that good distribution uniformity with surface systems means getting the opportunity times close together. In border strips we are saying we want the rate of recession to equal the rate of advance as much as possible. The previous figure is not very good DU. Example 2 depicts a much better irrigation.

Note that there is 7 1/2 hours of opportunity time at the 100 foot mark, 6 1/2 at 900 feet, and 5 1/2 at the end of the strip. Also, note that the advance curve and recession curve are close to parallel over much of the strip.

The improvement is due to speeding the water advance. You can tell this by the difference in the Advance Curves. The curve in Example 2 is flatter than that in Example 1 . Water moved faster over the strip. Where water took

4 hours to reach 600 feet in the previous irrigation, it only took about 2 1/2 hours in the irrigation in Example 2 (at 'B').

How close you should try to make the opportunity times in a border strip depends on the type of soil. As with furrows, the coarser the soil, the closer the opportunity times need to be.

TAILWATER WITH BORDER STRIPS

There should not be much tailwater generated with border strip systems. Note the shaded portion of the two previous figures. This area represents tailwater (see how the Advance Curve "goes beyond" the end of the strip, point "C", indicating the start of runoff). If the area between the Advance Curve and Recession Curve past the end of the strip is large, then the amount of tailwater generated is large.

IMPROVING BORDER STRIP DU

Modifying border strip irrigation for distribution uniformity can be done in a number of ways, all related to evening the opportunity time down the strip . . .

- Increase/decrease the flow into the strip.
- Turn off the water sooner/later in the strip.
- Make the strip wider/narrower depending on side fall.
- Make the strip longer/shorter.

There is no benchmark recommendation for border strips as there is with furrows--no advance ratio that will change with soils. The most valuable tool used in border strip irrigations may be the soil probe . Use it after an irrigation to judge how far water infiltrated at the top, middle, and bottom of the strips.

One important fact is that for any given slope, strip width, soil, and crop, the recession curve will stay relatively constant, no matter what the inflow or the time of set. Thus, evening up the opportunity time may be a matter of increasing/decreasing the inflow.

Border strips can be the most complex to manage as they are usually only efficient in a narrow range of applied depths. If you know you are going to be consistently applying small depths, use shorter, narrower strips. And vice-versa for larger applications.

EFFICIENCY WITH BORDER STRIPS

You should do the same sort of preplanning that was described for furrows. The same equations can be used.

(1) GROSS APPLIED =
GPM x HOURS x 96.3 / AREA

where:
GROSS APPLIED is the inches of water applied to the AREA.

GPM is the flow in gallons per minute per strip.

HOURS is the total set time in hours.

AREA would be the width of the strip times the length of the strip.

The GROSS APPLIED is the amount of water that was turned on to the strip. If tailwater is allowed, subtract the percentage of GROSS APPLIED you think you can recover in surface runoff. That is, determine how much water that you apply will runoff the field and be used. Then, subtract this from the depth applied.

Use the following equation . . .
(2) NET APPLIED =
(1 - SAVED RO/100) x GROSS APPLIED

where:
NET APPLIED is the net average depth of water infiltrated in the furrow in inches

SAVED RO is the percentage(0-100) of GROSS APPLIED that you think will be saved as surface runoff

GROSS APPLIED is the gross applied as previously calculated.

Also, when determining NET APPLIED, the saved runoff percentage, SAVED RO, should be smaller than with a furrow system. And again, you will have to react to the results of the first set. Use a soil probe to judge the total amount of water infiltrating as well as the amount infiltrating at the top, middle and bottom of the strip.

BORDER STRIP EVALUATIONS AND RECOMMENDATIONS

The major part of evaluating a border strip irrigation is to plot the advance and recession curves. The evaluator will mark off 100 foot increments of the strip and time the advance of water. Then, after water is turned off, the rate at which water disappears from the surface down the strip will be plotted. These plots can indicate whether inflow should be increased or decreased and also show where there are high or low spots in the field. A soil probe is used to see if enough water infiltrated.

Border strips are usually only efficient in a very narrow range of application depths. When the crop needs fall in that range, the utilization of this irrigation system can be very good. Operational flexibility is necessary to improve the performance of this type of system . The ability to efficiently deal with tailwater is key to improving flexibility. Increasing set times to increase application amounts will likely entail larger tailwater streams. Increasing onflow streams to improve advance times and distribution uniformity will also likely entail the management of larger tailwater amounts.

Further reading, FAO Irrigation Methods, IWTM 5 (http://www.fao.org/docrep/S8684E/s8684e00.htm).