Dr. Norris L. Powell

Subsurface Drip System Fine Tunes Nutrient Management For High Yields

Virginia researcher also shows the importance of monitoring soil makeup and moisture in attaining high yields.

Summary: *High economic yields were obtained at the Virginia Tech Tidewater Agricultural Center in Suffolk, Virginia, using drip/trickle tubing buried with 3-foot tube spacing below the soil surface of each row. The addition of boron also proved to be a critical element in Virginia sandy loam soils that are boron deficient. With better nutrient management (P K, Ca, B, Mg), projections show yields of 225-280 bu/A corn, 60-80 bu/A soybeans, 1,200-1,700 lbs/A cotton, and 5,000-7,000 lbs/A peanuts can be commercially obtained on a sustained basis with subsurface drip irrigation (SDI).*

Briefly, some background onhow we began our journey toward high economic yields. Over the last decade, dryland corn production on the coarse-textured soils of the coastal plains of Virginia,has averaged from 50 to 177 bu/A, depending on rainfall (Figure 1).

Earlier irrigation research on corn and peanuts (1980 to 1983), using a hard hose tow traveling gun, showed that both crops were responsive to water during very dry years. During that period, corn averaged 102 bu/A dryland (ranging from 32 to 146 bu/A) compared to 178 bu/A irrigated (ranging from 167 to 199 bu/A). Peanut pod yield averaged 2,000 lbs/A dryland compared to 4,000 lbs/A irrigated (1980). However, irrigated peanut production fell below non-irrigated peanuts during the next three years when growing season rainfall. Briefly, some background on how we began our journey toward high economic yields. Over the last decade, dryland corn production on the coarse-textured soils of the coastal plains of Virginia, has was 67 to 95 percent of normal. The drop was attributed to increased disease pressure within the plant canopy because of added water. Sclerotinia blight was not controllable with chemicals. Thus, this foliar disease was able to thrive in the moist soil and plant canopy, causing considerable loss.

From this it became apparent that water management was a limiting factor for high-yield crop production. When irrigating, we further concluded water needed to be applied *below* the soil surface in the crop root zone where its use is most efficient.

Soil is another factor we had to consider in the equation. Our native soils (uncultivated, unfertilized, and unlimed) are low in fertility, organic matter, and pH. Our Emporia fine sandy loam is a good example. This soil, with low CEC because of its coarse texture and kaolinic 1:1 clays, is low in organic matter, pH, P, K, Ca, and Mg in the top three horizons where most of the crop root zone thrives. Readings of 2.6 percent organic matter levels found in the plow layer of this soil have been considered high, the most likely explanation for this anomaly being that Emporia fine sandy loam represents a forested soil. Most cultivated soils would have 0.5 to 1.5 percent organic matter in the plow layers.

Once water becomes a *non*-limiting factor for crop production on these coarse-textured soils noted above, fertility will then be limiting.

Boron low

Through tests on an Emporia/Uchee soil (Table 1), we later discovered yet another critical element found to be low in these soils—boron. Studies show that 0.5 to 1.0 ppm is needed for adequate crop production.

From an irrigated study of corn in 1983 and 1984, we found in 1983 that green leaf area index (GLAI) closely resembled predictions. However in

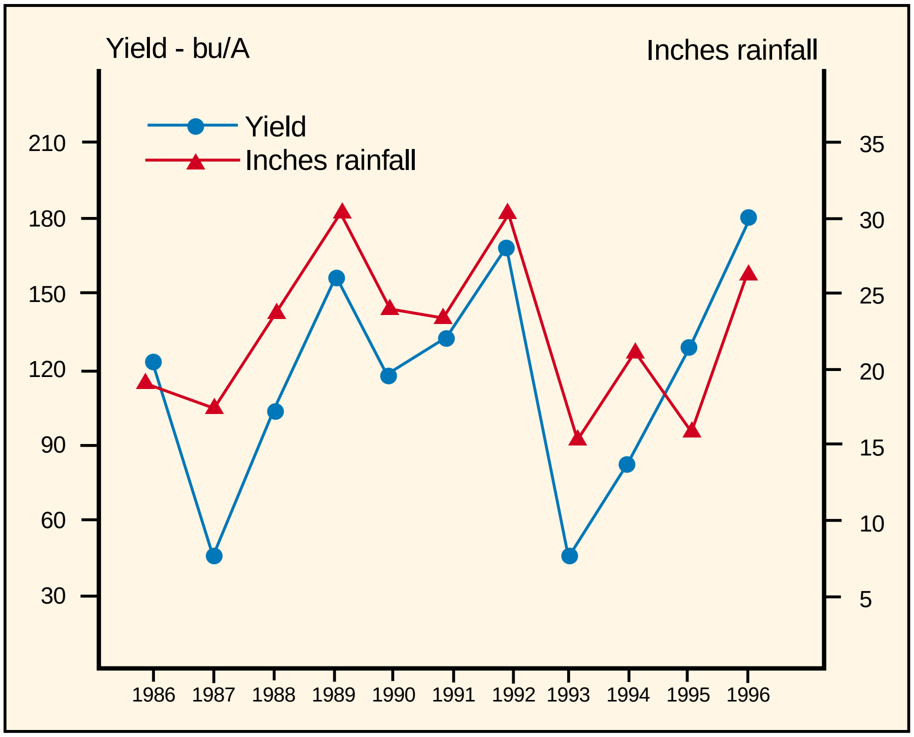

Figure 1. Correlation between yield and rainfall in non-irrigated corn trials from 1986 to 1996. Powell, Virginia Tech.

1984, GLAI appeared to remain constant during the second stage instead of slowly declining as predicted. The only difference between the two crop years was the addition of boron to the irrigated crop in 1984.

This simply confirmed the need for additions of boron if high corn yields were to be achieved.

Subsurface fertigation

To improve crop production and manage root zone moisture and fertility, a subsurface microirrigation research project was initiated in 1986 at the Virginia Tech Tidewater Agricultural Research and Extension Center in Suffolk, Virginia.

As shown in Figure 2, drip/trickle tubing was buried 14 to 16 inches below the soil surface below each row (3-foot spacing), below alternate row middles (6-foot spacing), and below each third row (9-foot spacing). Tube spacing was important because it was a large part of the equipment cost per acre. Wider spacing translated into lower installation cost per acre.

This type of system has the advantages of low energy cost (10 psi in the field) and 100 percent water efficiency (no water lost to evaporation, runoff, or deep drainage).

A properly designed, installed, and managed system of this type will last in excess of 10 years.

Table 1. Soil test levels taken in an Emporia/Uchee soil, Powell, Virginia Tech.

Depth	pH	P	K	Ca	Mg	B
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0-6	6.43	44 H+	47 M-	475 M-	44 M-	0.09
6-12	6.40	30 H	25 L	310 L+	35 L+	0.05
12-18	6.24	3 L	35 L+	127 L	23 L	0.00
18-24	5.63	1 L-	49 M-	173 L	47 M-	0.01

H = High; M = Medium; L = Low

Ballpark on installation costs is somewhere between $750 and $800 per acre for the 3-foot spacing, provided enough acres are used to justify a pumping station (pump, filter, etc.).

Mix critical

Average irrigated corn yields for the period 1986 to 1989 (Figure 3) were disappointing, even though they were equal to or greater than non-irrigated yields.

Plots were fertilized in the spring with 500 lbs/A 5-lO-30. $ZnSO_4$ was broadcast at the rate of 50 lbs per ton of fertilizer or 12.5 lbs/A over the surface as a dry fertilizer. An additional 200 lbs/A of fluid N as 25-0-0-3S was applied to the crop through the irrigation water in approximately four equal applications at 7- to 10-day intervals, starting five to six weeks after planting with the last application prior to or at silking and tasseling.

Where non-irrigated plots equaled average yields of irrigated plots (155 bu/A), we attributed it to an unusually wet season.

Some yields of 210 to 220 bu/A were recorded from rows directly above the tubing in the 9-foot tube spacing. From this we concluded that higher overall yields would be achievable with 3-foot and 6-foot tube spacing, providing the mix of water and plant nutrients was proper.

Added kick

Even higher average irrigated yields were achieved in 1990 to 1993 by again adding boron to the N provided through irrigation water (Figure 3). Boron as *Solubor* was dissolved in N solution. On some plots, boron was added at the rate of a quarter to half pound per acre on each of the four 7- to 10-day intervals. Yields, especially at the 3- and 6-foot tube spacing, made a significant jump. Yields hit 205 to 260 bu/A in the rows directly above the 9-foot tube spacing.

Further fine-tuning

In 1994 and 1995, average yield increases were achieved by changing to calcium hypochlorite as a water disinfectant instead of using sodium hypochlorite (Figure 3), which added Ca to the soil instead of Na. Plant population was also increased from 26,000-28,000 plants/A to 38,000-42,000 plants/A by using a triple row planting configuration instead of single rows. In the rows directly above the 9-foot tube spacing, yields ranging from 250 to 280 bu/A were recorded.

Prospects good

Our experiments over the last decade have shown that high economic yields can be obtained with a subsurface micro- irrigation system using 3-foot tube spacing. With better nutrient management (P, K, Ca, B, Mg), it is projected that even higher average yields can be commercially obtained on a sustained basis with subsurface drip irrigation (SDI) systems. Projected average yields could run as high as 225 to 280 bu/A for corn, 60 to 80 bu/A for soybeans, 1,200 to 1,700 lbs/A for cotton lint, and 5,000 to 7,000 lbs/A for peanut pods!

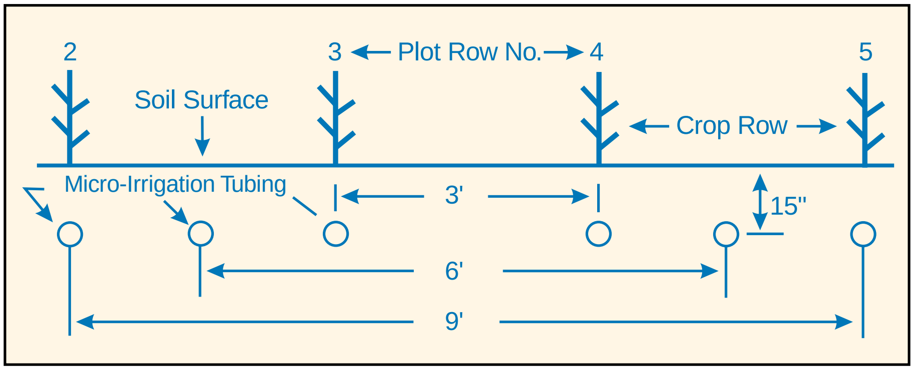

Figure 2. Subsurfce microirrigation system, Powell, Virginia Tech, 1986-96

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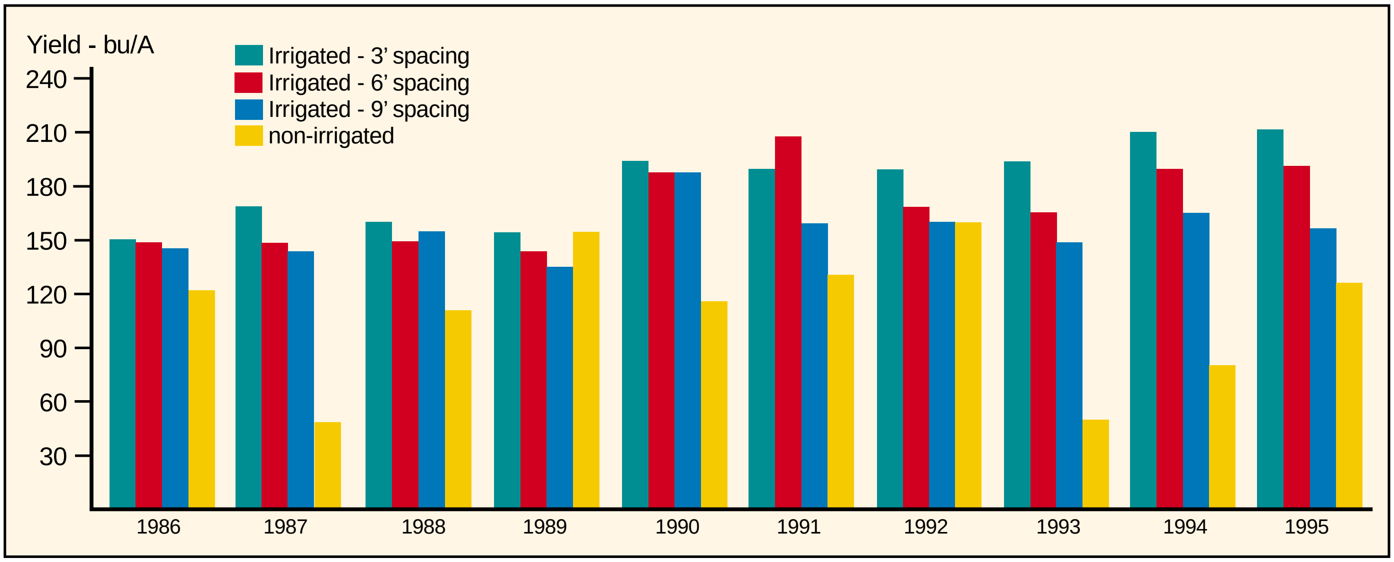

Figure 3. Average corn yields, irrigated and non-irrigated, Powell, Virginia Tech, 1986-95.