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More Work Needed on Alternate Furrow N Fertilization

Improved N-use efficiency not evident in initial corn/cotton irrigation studies.

Summary: *A potential way to improve crop nitrogen (N) use efficiency may be to place furrow irrigation water and nitrogen fertilizer in opposite furrows and therefore not expose fertilizer N to loss pathways associated with irrigation. Research of this "alternate furrow" system in corn and cotton showed that N fertilizer can be placed in alternate fur-rows' (60- inch spacing) without sacrificing crop yield. However, improved N-use efficiency was not noticed.*

Research was conducted in southeastern Missouri during 1991 and 1992 to evaluate the efficacy of alternate furrow irrigation and applied N fertilizer management systems in corn. A similar study was initiated for cotton in 1992. Surface furrow irrigation is the water delivery system for much of the irrigated corn and cotton produced in the mid-southern United States. Both crops require adequate amounts of N. Corn grown in the mid-South annually receives 120 to 220 lbs/A of N; cot-ton annually receives 60 to *150* lbs/A.

Furrow irrigation systems often have poor water use efficiencies, usually because of nonuniform water distribution and percolation. Often, the upper sections of sandy and the lower sections of clayey-textured furrow irrigated fields receive too much water, Improving N-use efficiencies will lead to higher crop yields, better crop quality and reduce the risk of fertilizer N entering undesired or environmentally sensitive niches.

Interactions may occur between furrow irrigation water management and fertilizer N effectiveness. The overwatering associated with furrow irrigation may have an antagonistic effect on maintaining a high N-use efficiency. Temperatures during the growing season are warm enough to nitrify most N from ammoniacal based fertilizers within a few weeks of application. Nitrate-N can then be subject to leaching and/or denitrification when excessive amounts of water are added to the soil/plant environment.

Water has been conserved with variable yield responses in irrigation systems where only alternate furrows receive water. Lateral water movement and rainfall supply some water to nonirrigated furrows. Soil texture plays an important role in a field's ability to use alternate furrow irrigation effectively. Soils containing high sand content may not permit enough lateral wicking action to supply adequate moisture to nonirrigated rows. Plant roots have shown the ability to obtain the majority of water required from a single irrigated furrow.

In Illinois and Idaho research, corn roots have demonstrated a "single sided" ability to obtain crop nutrients without sacrificing grain yield. Alternate **furrow** placement of N on cotton has not been studied. Sidedressed N in alternate furrows (60 to 80 inches apart, depending on row

Table 1. Influence of N quantity on corn grain and cotton lint yield at alternate furrow expweimental sit, 1991-9192.

Crop/Year	N rate (lbs/A)	Yield/A
Corn 1991	0	94 bu
	60	119 bu
	120	126 bu
	180	137 bu
Corn 1992	0	94 bu
	60	135 bu
	120	153 bu
	180	157 bu
Cotton 1992	0	901 lbs
	40	1,259 lbs
	80	1,295 lbs
	120	1,317 lbs

Table 2. Alternate furrow N fertilization irrigation treatments.

Water Placement	N Placement	N Quantity – lbs/A	
		Corn	Cotton
Every Furrow	Every Furrow	0	0
Alternate Furrow	Alternate Furrow	60	40
(non-fertilized)	(non-irrigated)	120	80
		180	120

spacing) may reduce soil disturbance, tractor pulling power and root pruning. A combination alternate fur-row irrigation/fertilization corn or cotton production system may be possible in some environments. In this system, it is hypothesized that plant roots would acquire adequate water from one side and meet N fertilization needs from the other. A synergistic effect might occur with benefits of better N fertilizer use efficiencies, since irrigation water and N would seldom interact.

Turning now our attention to Missouri, we'll zero in on what happened during 199 1/1992 at our research sites located at the University of Missouri Delta Research Center near Portageville, Missouri, taking one crop at a time.

Corn

No treatment interactions affected corn grain yield during the study, indicating that yield responses at this site were not a function of a combination of experimental treatments, but rather each treatment affected corn yield independently.

In 199 1, water placement in alternate furrows caused a 22 bu/A reduction, compared to putting water in every furrow (Figure 1). In 1992 a statistically insignificant trend showed higher yields in plots where each furrow received irrigation. This yield reduction caused by water placement could not be attributed to maturity (grain moisture), plant growth or plant N (higher in alternate furrow irrigation water placement/N fertilizer treatments in 1991).

Apparently, alternate furrow irrigated corn experienced an undetected water stress at some point during the growing season. This can be partially explained by the lower decrease in corn yield associated with alternate fur-row irrigation in 1992, which had frequent rainfall and relatively lower temperatures when compared to 1991. This moisture stress must be eliminated before the alternate furrow system can be developed.

Every furrow and alternate furrow treatments received equal amounts of water per irrigation. Runoff was higher in alternate furrows. A more appropriate approach would have been to apply more frequent irrigations, but less water per irrigation to the alternate furrow corn.

Corn ear leaf N concentrations were slightly higher in alternate furrow irrigation in 1991 but were similar across irrigation treatments in 1992. Thus, potentially improved N-use efficiency caused by irrigating only nonfertilized furrows was not positively determined during the first two years of

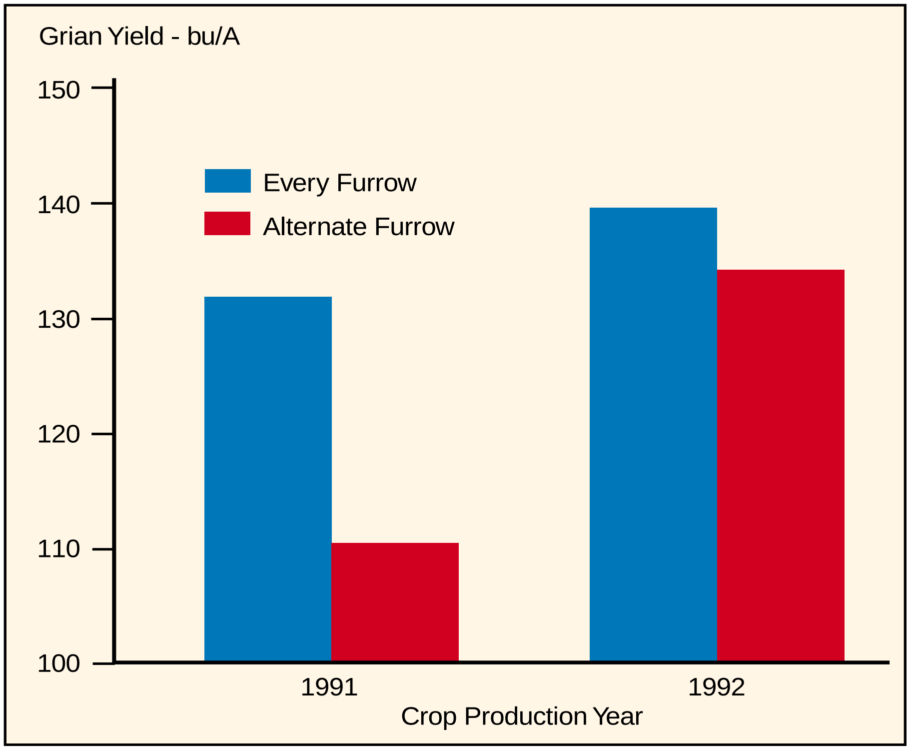

Figure 1. Influence of irrigation water placement on corn grain yields, 1991-1992.

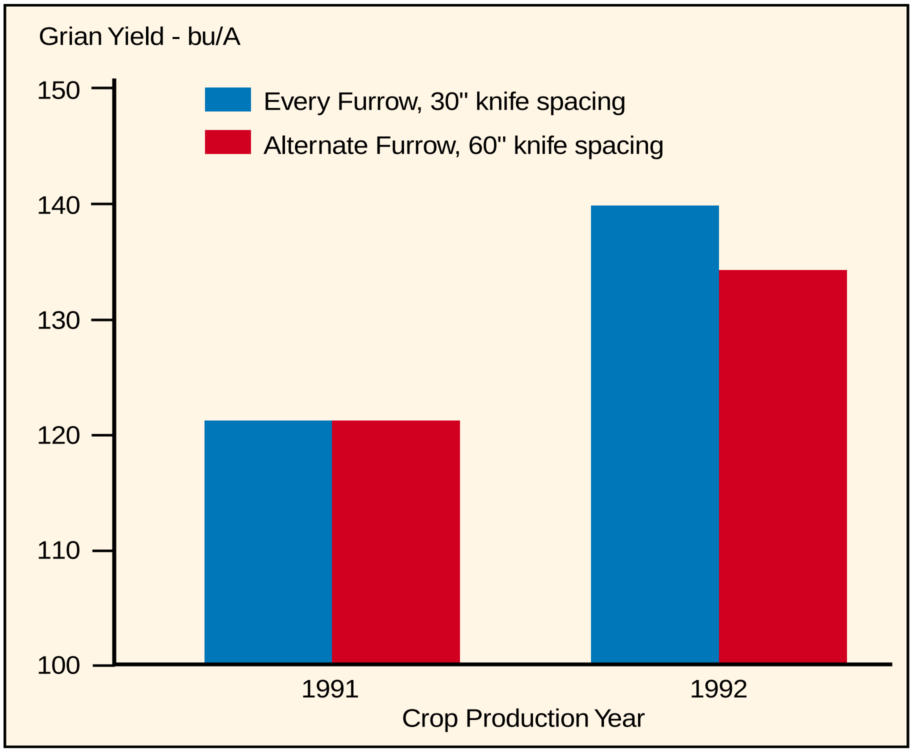

Figure 2. Influence of nitrogen fertilizer placement on corn grain yields, 1991-1992.

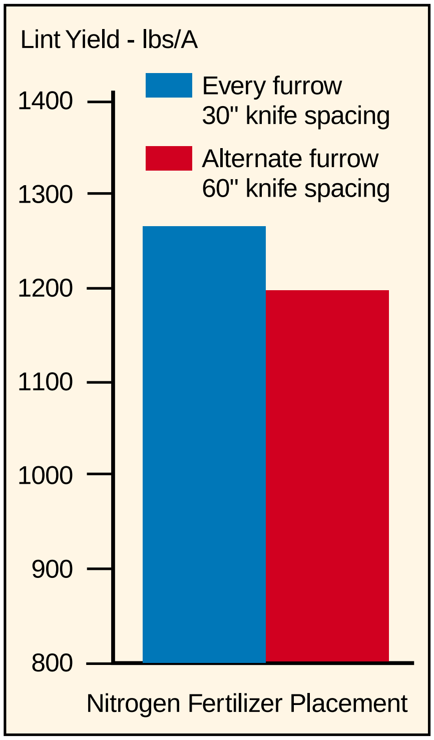

Figure 3. Influence of nitrogen fertilizer placement on cotton lint yields, 1992.

the Missouri project. Improved irrigation scheduling or timely rainfall may eliminate negative yield response to alternate furrow irrigation and accentuate the benefits of potentially improved N-use efficiencies.

Fertilizer placement did not affect yield in 1991 or 1992 (Figure 2), indicating that corn can be produced with alternate furrow fertilization management regardless of irrigation effective-ness. The site responded to N fertilization, with grain yield increasing with each additional 60-lb/A N application (Table 1). Plant N and corn growth responded similarly to N applications.

Cotton

Rainfall at the Delta Research Center in 1992 was uniform and adequate, resulting in no cotton irrigation requirement. Nitrogen placement information showed no statistical yield reduction associated with placing N 60 inches apart in alternate furrows (Figure 3). However, unlike corn, there was a trend toward reduced yields in alternate fur-row (60-inch spacing) N placement compared to every furrow (30-inch spacing) N placement. There was also no difference in the cotton crop's ability to take up N when it was placed 60 inches apart, but like yield, cotton N content tended to be lower when compared to 30-inch knife spaced N. The difference between corn and cotton response to alternate furrow water and N fertilizer placement may be a function of different rooting systems between crops. Cotton has a taproot that may not be able to extract water and nutrients spaced far apart, compared to corn that has a more fibrous root system that may be better suited for wide-spaced nutrients and water. The site responded to N fertilizer with a lint yield increase occurring at each additional 40 lbs/A N increase (Table 1).

Methodology

Corn was planted both years in Tiptonville silt loam on raised, 30-inch spaced beds at a rate of 27,500 seeds per acre. Planting dates were April 23, 1991 and April 9, 1992. Both seasons, 40 lbs/A of starter N were applied as 32% UAN in a three-inch band on the soil surface directly above the seed. Cotton was planted on May 11, 1992 on raised, 30-inch spaced beds at a rate of 50,000 seeds/A. No starter N was applied on the cotton.

All N treatments on corn were knifed at the V-6 growth stage, using UAN. All cotton N treatments (UAN) were knifed at the first square growth stage. Irrigation water treatments were applied via furrow irrigation, using poly-pipe as the water delivery method. Experimental treatments are listed in Table 2.

Variables tested for each corn plot included: ear leaf tissue N, plant height, plant biomass, chlorophyll measurement at silking and major yield components. Variables tested for each cotton plot included leaf N, petiole nitrate-N, leaf chlorophyll measurement at first bloom and yield components.

Tests not conclusive

Improved irrigation scheduling is needed before an alternate furrow irrigation/fertilization system can be developed for corn or cotton produced under mid-Southern growing conditions. It is encouraging that placing N in alternate furrows performed equivalent to every furrow N placement. The potential of the alternate furrow irrigation/fertilization system to reduce inputs and improve N-use efficiency exists, but this was not positively identified during these short studies. This system needs further study, modification and expansion.

Researchers and producers at several locations are now experimenting with the alternate furrow management system. Possible modifications and improvements in the system might include a number of areas.

1. Dual knives could be used in the fertilizer furrow to put N closer to corn and especially to cotton roots, as opposed to a single knife in the furrow center.

2. Alternating water furrows during successive irrigations could be employed, starting with the non-fertilized furrow during the first and most leachable irrigation. This system might work best in sandy soils by ensuring that each furrow receives supplemental moisture at some time during the season. This approach would also ensure that N uptake, which is a function of water uptake, would not be depressed as a result of having N placed in a dry soil.

3. Irrigation water and N could be placed in the same furrow while sup-plying no water or N to alternating furrows on extremely droughty soils. This might improve N uptake by ensuring that water and N were taken up simultaneously by the plant.

4. Other fertilizer sources could be explored.

5. On-farm trials and demonstrations could be used to test the system, selecting many soil types, crops and varying environments.

Producers considering the alternate furrow irrigation/ fertilizer placement system should do so on a limited acreage basis until they are comfortable about its effectiveness in their operation.

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