The Agriculture Program
THE TEXAS A&M UNIVERSITY SYSTEM

Nutrient Management of Subsurface Drip Irrigated Cotton

Installation of subsurface drip irrigated (SDI) in cotton fields in the Southern High Plains is expanding at a rapid rate. Information is lacking on nutrient management in these systems where 3 and 4 bale/ac lint yields are possible. This publication provides best management practices based on current knowledge of SDI cotton production in the High Plains.

Acidification and chlorination

The pH in our hard (high calcium salt) irrigation waters of the Texas High Plains should be reduced to pH 6.5 using acidification. Pumping high pH water into SDI systems without acidifying it can result in serious consequences. Problems could include scale formation and related blockage of emitters from calcium carbonate, iron oxides or manganese oxides. Additionally, precipitation of the fertilizer salts such as 10-34-0 will occur if un-acidified irrigation water is used. Sulfuric acid or phosphoric acid is often used for acidifying irrigation water, but these products are dangerous to handle, and will damage flesh and eyes very easily. Urea/sulfuric acid mixtures such as N-pHURIC are superior from the standpoint of being less hazardous to handle, but they are more expensive that sulfuric acid alone. Injecting phosphoric acid has greater potential than sulfuric acid injections to produce the salts (calcium phosphates) that can plug emitters.

The salt formed as bicarbonate ions in our irrigation waters are neutralized with sulfuric acid is calcium sulfate, which is soluble and stays in solution.

Addition of chlorine (Cl) into SDI systems with sodium hypochlorite (NaOCl) (bleach) disinfects the water and prevents algae growth. Chlorine also kills some bacteria, many of which can form slimes that clog emitters. The target concentration of "free residual" Cl in high pH irrigation water is 2 ppm. Free residual Cl test kits are available at SDI dealers.

Nitrogen

Fluid nitrogen (N) fertilizers based on urea-ammonium nitrate (32-0-0 or 28-0-0) can be injected into SDI systems, in a similar manner as they are used in center pivot systems. In center pivots, however, 25 to 30 lb N/ac is the usual rate that is possible, which means that N fertigation is performed only a few times during the season. For SDI, daily injections of small amounts of N fertilizer are possible with the daily irrigation, which is very efficient.

Annual soil testing is recommended for determination of N fertilizer requirements of cotton (Dryland fields can be sampled every 2-3 years for N). We recommend soil sampling to 24 inch depth for nitrate-N analysis. For more details on soil sampling go to:

http://lubbock.tamu.edu/soilfertility/pdfs/improvesoilsamp.pdf

Multiplying the nitrate-N content of your 24-inch soil sample by 8 gives lb nitrate-N/ac. For a 2.5 bale yield goal we recommend you subtract your soil test result of lb nitrate-N/ac from 150 lb N/ac to arrive at your seasonal N requirement. We have developed a N fertilizer requirements calculator that is available at:

http://lubbock.tamu.edu/cotton/calcinstructions.html

This calculator can be used for any yield goal, soil test data, etc. for SDI (and center pivot and dryland) cotton. Testing irrigation water for nitrate-N content is highly recommended as well, and the N calculator will adjust recommendations based on this input.

We recommend pre-plant N applications of 30 lb N/ac be applied with a ground rig in sandy soils, or loamy, clayey soils with high amounts of residue, or if soil test nitrate-N is less than 4 ppm in a 0- 6 inch soil sample. The pre-plant N application should be knifed in the bed on the wet furrow side of the seed row. The balance of the N fertilizer can be injected through the fertilizer system. In most situations, we encourage avoiding N fertilizer pre-plant or at planting, as it is far less efficient than in-season fertigation. Since most irrigation systems start up in June close to first square, N fertilization should start at this time. Cotton plants in the High Plains are small at first square and the amount of

plant N at that time is only about 15 lb N/ac. After first square, however, biomass growth and N accumulation increase rapidly, making this the best time for N fertilization

Petiole-nitrate analysis programs have been commonly practiced in cotton growing areas such the High Plains for many years. This analysis can be an effective way to determine the need for in-season N fertigations for center pivot irrigations. In SDI, they are probably less useful, since small increments of N are being added daily already. A major change, like doubling the N injection rate, based on a low petiole nitrate reading, starts doubling your N fertilizer bills. Minor changes in injection rates won't affect petiole nitrate in the short run. One feature of petiole nitrate analysis we are not comfortable with is the strong rate of seasonal decline in the readings, even in over-fertilized cotton. Analysis shows that leaf N concentration does not decline that rapidly.

Phosphorus

Phosphorus (P) management, like N management, starts with soil testing. A 6-inch sample will suffice for P analysis. Phosphorus soil testing is only needed every 2-3 years, and the same P fertilization program should be followed between soil tests. Since P fertilizer is often band applied, it is important to take the soil subsamples for P in all positions of the field, i.e. bottom of furrow, side of bed, top of bed, and composite them before analysis. The critical soil test value for Mehlich-3 or Bray P is 33 ppm, or 15 ppm for Olsen P. This means that if your soil test P level is greater than this, then you do not need to apply any P fertilizer, i.e. you will not get a yield response. Phosphorus soil tests can be confusing because of the various extracts. Mehlich-3 P works on all soils. Bray should not be used on calcareous soils (pH > 7.6 and when soils fizz if weak acid is added). Olsen works well on alkaline (pH > 7.0) and calcareous soils. Soil test labs should use Olsen instead of Bray on calcareous soils if they do not provide Mehlich 3.

The following table provides our recommendations for P fertilizer applications at different soil test P levels (all yield goals).

Mehlich 3 or Bray 1	Olsen	P fertilizer rate
---------- ppm ----------		lb P_2O_5/ac
0 –5	0 – 2.5	90
5 – 10	2.5 – 5.0	75
10 – 20	5.0 – 10	60
20 – 25	10 – 12.5	45
25 – 33	12.5 – 15	30
33+	15+	0

For maintenance of adequate soil test P levels, 30 lb P_2O_5/ac can be applied for Mehlich 3 and Bray 1 tests of 33-38 ppm (15-20 ppm Olsen P).

There is a lot of interest in injecting P fertilizer through SDI (and center pivot) systems. This can be done, but several points need to be made. First of all, banding P fertilizer (either dry or liquid) close to planting 2 to 4 inches off the seed row and 2 to 4 inches deep is the best management. Broadcasting P is not effective as the P fertilizer rapidly becomes insoluble calcium phosphates and or P fertilizer gets fixed on calcium carbonate surfaces, so the added P is not plant available. The P band in the bed will take care of early season growth and encourage rooting. We are not sure at this time (research still to be done) if the large mass of young, active roots that are present near the emitters in the wet furrow after first bloom have trouble accessing a P band in the bed. Producers with SDI systems may want to consider a second band in the bottom of the wet furrow (applied at the same time as the bed band). This would be highly effective, and definitely take care of the concern of some that the P near the emitter will "run-out". This is impossible if a P band (several hundred ppm P) is only a few inches away in the same wet zone, as mass flow and diffusion will rapidly replenish soil solution P as the roots take it up. Injecting P fertilizer through the SDI system could be done during the season, but a several warnings are in order. First, 10-34-0-0 is the fertilizer source with the strongest tendency to precipitate (salt) out in hard irrigation water. You will need to increase your acidification program to adjust the pH of the irrigation water to pH 6.0 to prevent this precipitation and emitted clogging. Another factor with 10-34-0 use is that this source is out of balance with plant needs, i.e. the cotton plants need more N than P. Therefore, additional N from 32-0-0 is needed to be pumped and injected into the system as well. Phosphoric acid (0-54-0) injection is another possibility to supply in-season P to SDI cotton. Some disadvantages of phosphoric acid (H_3PO_4) include: 1) it is hazardous to handle, 2) it is more costly per unit of P than 10-34-0, 3), calcium phosphate precipitates can form and clog the system 4), it does not supply as much plant available P in alkaline and calcareous soils as 10-34-0 does. At this time, if soil test P recommends P fertilizer, we believe that it is simplest and safest to band apply 10-34-0 at planting, if possible in both the bed and in the furrow. However, we do not discourage injection of phosphoric acid, which has the big advantages of continuous acidification and supply of P.

Zinc

The critical soil test value for Zn for cotton is 0.28 ppm. Soil testing for Zn is needed every 2-3 years. We recommend 4, 2, and 0 lb Zn/ac for soil test Zn in the range of 0 - 0.19 ppm, 0.19 – 0.28 ppm, and > 0.28 ppm, respectively. A good liquid Zn fertilizer source for SDI (or center pivot) is Zn-EDTA. This product can be injected directly or mixed with 32-0-0 or 10-34-0 without a problem. $ZnSO4{\cdot}H_2O$ is a dry source that is cheaper, and can easily be added and dissolved into acidified water. This source however has a much greater tendency to get fixed/immobilized by calcium carbonates in High Plains soils, and Zn-EDTA does not.

Multiple product injections

A final point. Many producers will find it desirable to inject multiple products at once into a SDI system, for e.g. N-pHURIC and 32-0-0. It is important that the same injection pump not be used for more than one product, unless it is a dual head pump (separate inlets and outlets). This is because precipitation will occur with many products. Even with a dual head pump, the two products should go into the irrigation line at least three feet apart. A cheaper alternative to injecting multiple products besides buying additional pumps is a Venturi system, which relies on creating a pressure differential. See your local SDI supplier for parts and more details on setting up a Venturi system for injecting fertilizers and acids.

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