

Right Fertility Components Critical In High-Yield Corn

Study includes fertilizers used and application methods.

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Summary: The rapid adoption of new methods and technologies that preserve profitability is important for the economic sustainability of farmers in the High Plains. The work and investigation summarized in this article will demonstrate the use of spatial and temporal observations to identify best management practices for multiple nitrogen (N) applications through corn development.

Corn is grown on an estimated 600,000 irrigated acres in the Texas and Oklahoma Panhandles, northern New Mexico, and southwest Colorado. Corn production in these areas involves intense management and numerous inputs to achieve yield goals. Over the past 20 years, producers in these areas have faced fluctuating markets, increased input costs, environmental shifts including extreme heat, exceptional drought, declining groundwater and surface water, and state-mandated pumping restrictions. These changes have driven corn producers to improve operational efficiencies to maintain or improve production and profits.

The adoption of new methods and technologies that preserve profitability is important for the economic sustainability of farmers in the High Plains. University

research is a traditional method of identifying best management practices that may improve grower productivity and profit. However, dissemination and implementation of research across broad geographies can be a measured process. The scientific method often precludes investigation across a diverse set of variables common within and across farms. Private industry can augment implementation of profitable best management practices, discovered in traditional research, by employing resources necessary for plot placement and demonstrations across wide geographies over multiple years. Furthermore, spatial and temporal investigations can be instrumental in prompt identification of processes and practices that improve producer efficiencies and/or profitability.

Objective

The objective of this study was to identify the fertility program components that are most critical for high yield corn. It involves:

- What fertilizer is best for high yields, especially in no-till and strip-till?
- What combinations of pop-up and 2 x 2 or 2 x 0 are best, especially in no-till or strip-till or early planting in cold weather soils?
- What form of application is best for positional availability in strip-till and no-till?

Methodology

Test plots. Plot width varied, but most strips were 6-, 8-, or 12- rows wide and spacing between rows was approximately 30 inches. Row length usually ranged from approximately 2,600

to slightly over 5,200 feet.

Trials. On-farm trials were established using cooperator field equipment and management practices, or management suggestions offered by DuPont Pioneer sales professionals. Production practices and certain environmental details, important for corn development, were recorded by DuPont Pioneer sales representatives, field agronomists, and account managers in fields where test plots were planted (Table 1).

Harvesting. Strips were harvested with cooperator or custom harvester equipment. Corn grain from each strip was weighed using a weigh wagon. These data were recorded and archived in computer programs and in written form for comparison following harvest.

Hybrids. Yield comparisons among hybrids and management practices were made to identify a hybrid or trend in a practice(s) that may improve on-farm production or efficiencies in management practices. Trends identified as practices that may enhance production were applied to multiple fields to determine the reproducibility of the plot data.

Results

Management practice revisions by Texas, Oklahoma Panhandle, Southwest Colorado, and northern New Mexico irrigated corn farmers have demonstrated the value of processes already discussed.

Banding nutrients is better than broadcasting for positional availability in strip-till and no-till. For example, numerous demonstrations comparing tillage practices have shown improved corn yield with strip-till and no-till, compared to conventional tillage. The value of reduced tillage was enhanced during periods of drought and limited availability of irrigation water owing to declining aquifer levels or state mandated water allocations.

Furthermore, these programs display soil moisture preservation, reduced soil erosion by wind, reduced soil compaction, plus aids in water filtration by leaving residue on the soil surface.

Starter fertilizer. Producers were taught (in clinics) about the importance of starter fertilizer as a component of high-yield corn, especially in strip-till and no-till systems where soils warm slowly when covered by residue. On-farm test

Table 1. Variables Recorded for On-Farm Test Plots

Planting Date	Fertilizer Rate
Seeding Rate	Fertilizer Placement
Irrigation Capacity	Fertilizer Timing
Irrigation Water Applied (inches/acre)	Fertilizer Products
Precipitation (inches)	Previous crop
High and Low Daily Temperature	Tillage Practices
Elevation	Herbicide (Product and Timing)
Soil Type	Fungicide (Applied or not Applied)
Soil Fertility Tests (Plot)	Insecticides
	Miticides

Table 2. N Rate Adjustments Based on Timing and Method of Application

N Application Timing and Method	N Rate to Produce a Bushel of Corn
100% Pre-Plant Broadcast	1.3 lbs
100% Pre-Plant Band	1.2 lbs
100% Fertigation	1.1 lbs
50% Pre-Plant and 50% Side-Dress	1.0 lbs
Pre-Plant/Starter/Side-Dress	0.9 lbs
Pre-Plant/Starter/Side-Dress/Fertigation/Post-Tassel	0.8 lbs

plot evaluations were made for surface banding starter fertilizer two inches from the seed slice (2x0 placement). The results of this study and educational efforts have increased the usage of 2x0 starter fertilizer among High Plains corn producers. Combinations of pop-up and 2x2 or 2x0 are best or pop-up and a "hot" band 6 to 8 inches below the seed applied preplant, especially in no-till or strip-till or early planting in cold wet soils. These efforts have illustrated the ease of application and low set-up costs, compared with traditional 2x2 starter fertilizer placement.

Another benefit of the 2x0 practice was that wet soils did not affect starter fertilizer placement that typically hampered traditional fertilizer coulters during planting. Precision guidance systems have made possible the latest fertilizer trend among growers. This program involves banding preplant fertilizer 8 to 10 inches deep during strip-till, followed by planting over the band and using in-furrow pop-up starter fertilizer to achieve the highest yields.

Nitrogen. Multiple applications of N are more efficient and result in higher yields (preplant, starter, pre-tassel applications through pivot or sidedress, and post-tassel applications). N rates of 1.2 to 1.3 lbs per bushel of grain, used by many soil testing labs, remain a standard when 100 percent of the N is applied prior to planting the

crop. However, the International Plant Nutrition Institute (IPNI) has emphasized the interconnectedness of the 4Rs of nutrient stewardship and how rate, time, source, and placement of fertilizer are interdependent. Thus, N rate can be adjusted based on timing and placement without affecting grain yield. Our test plot data confirm this (Table 2). Growers, who apply a portion of their N preplant followed by starter, sidedress, or via pivot at V4 to V6 stage, along with R2 to R4 stage N application via center pivot, were able to produce a bushel of grain with 0.8 lbs of N. This practice can increase producer profitability because it allows adjustment of N rates based on in-season price fluctuations of N fertilizer, corn, or growing conditions. For example, high corn yields may not be possible for producers with limited available irrigation water in the absence of favorable growing conditions and precipitation. These growers can be conservative with fertilizer inputs and make in-season adjustments of N rates when growing conditions favor increased potential for grain yield. This practice also allows producers to reduce or eliminate N application following a catastrophic weather event, such as hail. Furthermore, single high-rate application of N increases the probability of stalk rot when environmental conditions favor these diseases. Multiple application of N fertilizers through the season helps

reduce potential for stalk rot organisms to infect corn stalks. Tables 3 and 4 also witness to the importance of N timing on yield. Figure 1 shows a dramatic difference of post-tassel UAN in corn ear size compared to no late N. Post-tassel (post-flowering) applications of N can increase yields by increasing kernel depth and test weight. The newest corn hybrids use more N post-tassel than older hybrids of several years ago. Modern corn hybrids can respond well up to 33 percent of N goal going on between brown silk and dough stage. Finally, Figure 2 presents a 5-step ladder on the importance of proper corn N management.

Monitoring

Monitoring soil and plant N during the season has been a successful practice for farmers, particularly where manure or compost is the major source of N. This program entails sampling soil to a 30-inch depth from V4 to V6 and again from V14 to VT growth stages to determine nitrate and ammonia forms of N. Plant tissue samples are also collected following protocols established by Servi-Tech Laboratories.

The protocol for estimating corn yield entails collecting ears in representative areas of the field at R1 to R2 stage. The number of kernels per ear is determined by multiplying the number of kernels per row by the number of rows. The test weight is considered to determine the factor used for estimating yield for each hybrid. Other factors considered when estimating yield include insect and disease pressure, soil moisture, weed control, and the 10-day weather forecast. Additional N can be applied in cases where soil N is inadequate at VT or R1 growth stages. Our test plot results have demonstrated a yield increase when N is applied from tassel to R4 growth stages.

Monitoring N, along with R1 growth stage yield estimates, ensures the producer's crop has adequate N at critical growth stages. The benefit to producers is a potential reduction in N expenditures if tests show levels are sufficient, and the possibility of applying additional N if manure conversion provides less than expected available N. This practice also allows for additional N when yield estimates exceed the producer's original yield goal. A lower stalk nitrate test, developed by Blackmer and Mallarino, can be made on stalks

collected at black layer to three weeks after black layer to determine the success of in-season N applications.

In 2013, an N monitoring project managed by DuPont Pioneer personnel was implemented on a 6,000-acre irrigated corn farm in the Texas Panhandle. Compost and manure are used extensively as a primary N source on these acres. The yield goal across these acres was 250 bu/A. Nitrogen recommendations were based on field

and environmental conditions and lab results from soil and plant samples collected in mid-June (V5) and in mid-July (VT). Adjustments in N applications were made when needed, based on the condition of the crop. For example, fields damaged by hail received reduced rates of N and, conversely, fields with yield potential above 250 bu/A received additional N. The yield average across the 6,000 acres was 253 bu/A based on dry weight determined by a local

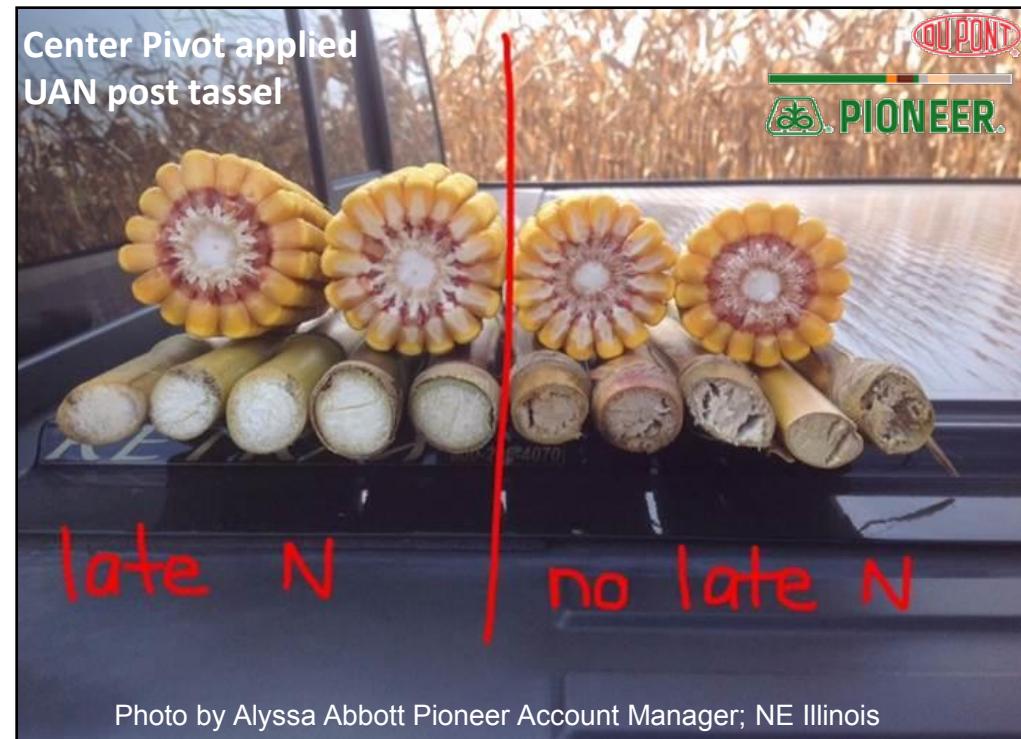


Figure 1: Center pivot applied UAN post-tassel.

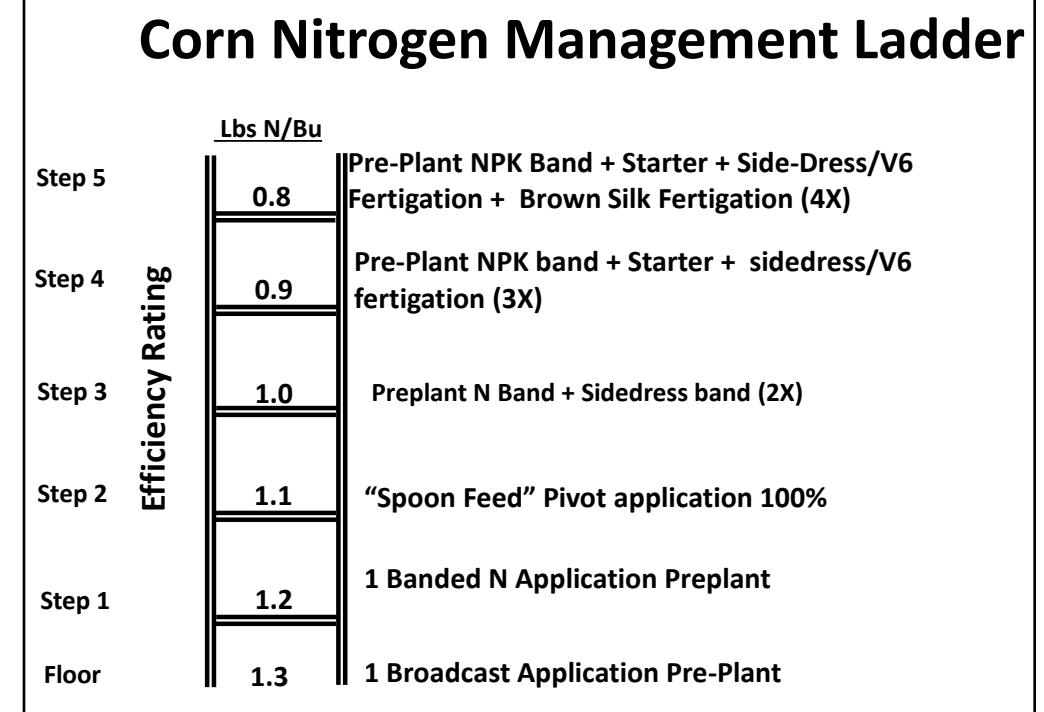


Figure 2: Corn nitrogen management ladder.

grain elevator. One 120-acre field averaged 300 bu/A. Lower stalk nitrate tests revealed the majority of fields were in optimum to slightly excessive range with only a few fields in the marginal or excessive range.

These proven principles from the Texas Panhandle have demonstrated positive results when replicated on an irrigated field in northeastern Illinois in 2013. Corn receiving the post-tassel N treatment had increased kernel depth, test weight, and stalk quality when compared with grain from the check that did not receive a post-tassel N application.

Summing up

Producer attendance at crop production clinics has increased over time through the use of private industry resources and coordination efforts with university Extension Specialists. Production clinics have facilitated high early adoption rates of practices described here, which we emphasize with our customers and include:

1. The importance of starter fertilizers in producing high yields, especially in no-till and strip-till. Combinations of pop-up and 2x2 or 2x0 are best or pop-up and a "hot" band 6 to 8 inches below the seed applied preplant, especially in no-till or strip-till or early planting in cold wet soils.
2. Banding nutrients is better than broadcasting for positional availability in strip-till and no-till.
3. Multiple applications of N are more efficient and result in higher yields (preplant, starter, pre-tassel applications through pivot and sidedress and post-tassel applications).
4. Post-tassel (post-flowering) applications of N can increase yields by increasing kernel depth and test weight. The newest corn hybrids use more N post-tassel than older

Table 3. 2010 Plot Averages by Nitrogen Timing

No Post-Tassel Nitrogen	Nitrogen Applied Brown Silk
19 Plots	21 Plots
Avg Yield 217 bu/acre	Avg Yield 248 bu/acre
Low Yield: 170 bu/acre	Low Yield: 183 bu/acre
High Yield: 269 bu/acre	High Yield: 302 bu/acre
3 Plots over 240+ bu/acre	14 Plots over 240+ bu/acre

Table 4. Nitrogen Uptake, Timing and Quantities for Old and New Hybrids

Era of Hybrid Release	N at R1	N at R6	Post-Flowering N Uptake	Increase in Post-Flowering N Uptake
Old (1940 to 1990)*			-----I b s . N / A c r e-----	%
	102	145	43	28
New (1991 to 2011)	97	152	55	
Old (1970) **	125	162	37	40
New (2000)	125	177	52	

* Ciampitti and Vyn, 2012

** Haegele, et al, 2013

hybrids of several years ago. Modern hybrids can respond well up to 33 percent of N goal going on between brown silk and dough stage.

Specific practices that have been rapidly and widely adopted include strip-till and no-till, increased starter fertilizer use as a result of 2x0 surface banding, and movement away from 100 percent preplant N application to sidedress and fertigation applications. Other practices that have shown high adoption rates include in-season N application to fine tune N inputs and an increase in banding of immobile nutrients such as P and K in lieu of broadcast applications. A promising new practice that is currently being explored is center pivot applied N fertilizer at the R2 to R4 growth

stages to improve corn yield through increased kernel depth and increased test weight. This practice allows later in-season adjustments of N application when environmental conditions favor higher yield potential, especially where water available for irrigation is limited by declining water tables or state mandated regulations.

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