HIGH YIELD IRRIGATED CORN: IMPLEMENTING RESEARCH AND ADAPTING FOR PROFITABLE PRODUCTION

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ABSTRACT

Irrigated corn producers on the High Plains are frequently confronted with issues that affect the profitability of their operations. The rapid adoption of new methods and technologies that preserve profitability is important for the economic sustainability of High Plains farmers. Traditional research is one method of identifying best management practices that may improve grower productivity and profitability. However, dissemination and implementation of research across broad geographies can be challenging. The scientific method often precludes investigation across a diverse set of variables common within and across farms. Private industry can augment implementation of scientific methods identified as profitable best management practices by employing resources necessary for wide scale spatial and temporal demonstrations. Furthermore, these investigations can be instrumental in prompt identification of processes and practices that improve producer efficiencies and/or profitability. The work and investigations summarized in this paper will demonstrate the use of spatial and temporal observations to identify best management practices for multiple nitrogen (N) applications through corn development. Also, the extension of university research on P and K starter fertilizer and its adoption and implementation by growers will be discussed.

INTRODUCTION

An estimated 600,000 acres of irrigated corn are grown in the Texas and Oklahoma Panhandles, northern New Mexico, and southwest Colorado (USDA FSA, 2013). 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 (USDC NOAA, 2013), declining groundwater and surface water (NPGWCD, 2013), 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 High Plains farmers. 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 (Cook, et al., 2013; IPNI, 2013). 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 (Cook, et al., 2013). One objective of this document is to prove the value of farm demonstrations conducted across multiple years and locations, and how these can aid in widespread adoption of best management practices identified by academia (e.g., the use of P and K 2x0 starter fertilizer). Additionally, this article will document the use of spatial and temporal investigations that have identified practices that increase production efficiency with multiple N applications on corn that result in lower total N applied without affecting yields.

MATERIALS AND METHODS

During the past 20 years, approximately 100 on-farm test plots have been planted annually throughout the Texas and Oklahoma Panhandles, northern New Mexico, and southwestern Colorado. Each plot consists of different corn hybrids planted in strips across the field. The 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. On-farm trials were established using cooperator field equipment and management practices, or management suggestions offered by DuPont Pioneer sales professionals.

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 Previous Crop
Precipitation (inches)	Tillage Practices
High and Low daily Temperature	Herbicide (Product and timing)
Elevation	Fungicide (applied or not applied)
Soil Type	Insecticides
Soil Fertility Tests (plot)	Miticides

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**). 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. 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.

Traditional university research practices showing potential for increased yield and practical adoption were presented at annual DuPont Pioneer sponsored crop production clinics with support from private agricultural industry and university Extension partners. Lead university researchers of various studies were invited to present their work directly to growers at these clinics to facilitate technology transfer and adoption. Clinics held in the region discussed in this paper are well attended, with about 600 growers addressed annually.

RESULTS AND DISCUSSION

Management practice revisions by Texas and Oklahoma Panhandle, Southwest Colorado, and northern New Mexico irrigated corn farmers have demonstrated the value of the processes discussed above. 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 due to declining aquifer levels or state mandated water allocations. Furthermore, these programs display soil moisture preservation, reduced soil erosion by wind, reduced soil compaction, and aided in water infiltration by leaving residue on the soil surface (Unger et al., 1991).

Producers were taught (in clinics) the importance of starter fertilizer as a component of high yield corn, especially in strip-till and no-till systems because soils warm slowly when covered by residue. On-farm test plots conducted by Gordon (2009) evaluated 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. 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 pre-plant fertilizer 8-10 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 rates of 1.2 to 1.3 lbs. per bushel of grain used by many soil testing labs remains a standard when 100% of the N is applied prior to planting the crop. However, IPNI (2013) 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 confirms this (Tables 2 and 4). Growers who apply a portion of their N pre-plant followed by starter, side-dress or via pivot at V-4 to V6 stage along with R2 to R4 (Ritchie et al., 1997) stage N application via center pivot were able to produce a bushel of grain with 0.8 lbs. of N (Reinart, 2013). 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

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.

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 rots when environmental conditions favor these diseases. Multiple applications of N fertilizers through the season helps reduce potential for stalk rot organisms to infect corn stalks (White, 1999).

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 at V4 to V6 and again at V14 to VT (Ritchie et al., 1997) 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 (Ritchie et al., 1997). 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 to R1 growth stages. Our test plot results have demonstrated a yield increase when N is applied from tassel to R4 growth stages (Tables 3 and 4). 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, as documented by Davis et al. (2012). This practice also allows for additional N when yield estimates exceed the producers original yield goal. A lower stalk nitrate test developed by Blackmer and Mallarino (1996) can be made on stalks collected at black layer to three weeks after black layer to determine the success of in-season N applications.

Table 3. 2010 plot averages by timing N applications after tassel.

No Post Tassel N Applied (19 Locations)	Some N Applied at Brown Silk (21 locations)
217 bu/acre	248 bu/acre
Low plot: 170 bu/acre	Low plot: 183 bu/acre
High plot: 269 bu/acre	High plot: 302 bu/acre
3 plots over 240 bu/acre	14 plots over 240 bu/acre

In 2013, a 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 bushels per acre. 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 bushels per acre received additional N. The yield average across the 6,000 acres was 253 bushels per acre based on dry weight determined by a local grain elevator. One

120 acre field averaged 300 bushels per acre. Lower stalk nitrate tests revealed the majority of fields were in the 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. Similar results have been reported by Crozier et al. (2013).

Table 4. Management practices for 2013 top 10 highest average plots.

Location (County)	Avg. Yield	Plant Date	GPM/a	Tillage	Starter	Miticide (pre-tassel)	Post-Tassel N
Sherman	285.2	5-17-13	5.5	Strip	Y	Y	Y
Hansford	284.5	5-04-13	6.0	Strip	Y	Y	Y
Hansford	282.2	5-10-13	5.3	Strip	Y	Y	Y
Moore	281.4	4-30-13	6.0	Strip	Y	N	N
Texas	280.9	5-17-13	5.6	Strip	Y	Y	Y
Ochiltree	275.0	5-17-13	6.0	Strip	Y	Y	Y
Sherman	267.2	5-13-13	5.4	Strip	N	Y	Y
Moore	265.4	4-29-13	5.0	Strip	Y	Y	Y
Texas	263.4	5-13-13	6.0	No-Till	Y	Y	Y
Hansford	262.7	5-22-13	4.5	Strip	Y	Y	Y

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 is followed by rapid wide spread adoption among High Plains farmers. Specific practices that have been rapidly and widely adopted included strip-till and no-till, increased starter fertilizer use as a result of 2X0 surface banding, and movement away from 100% pre-plant N application to side-dress and fertigation applications. Other practices that have shown high adoption rates include in-season N applications to fine tune N inputs, and an increase in banding of immobile nutrients such as P and K in lieu of broadcast applications (Vossenkemper and Shanahan, 2013). A promising new practice that is currently being explored is center pivot applied N fertilizer at the R2 to R4 growth stage to improve corn yield through increased kernel depth and increased test weight. This practice allows later in-season adjustments of N applications 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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