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KANSAS MDI STUDIES AND WATER TECHNOLOGY FARMS

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INTRODUCTION

This is an update of the paper presented in 2017 referenced under Aguilar, J. P., Rogers, D. H., I. Kisekka, A.J. Foster, B. Golden and K. Shaw. 2017. Mobile Drip Irrigation Results From Farm Demonstration Sites. In: Proc. 29th Annual Central Plains Irrigation Conference, Feb. 21-22, 2017, Burlington, Colorado. Available from CPIA, 760 N. Thompson, Colby, Kansas. pp. 44-52. As of printing, the data for the 2017 cropping season were yet to be received from various cooperating individuals.

The High Plains Aquifer of western Kansas is in decline. Each producer usually has different points of view in addressing this issue since they have different economic situations, management philosophies and locations. However, one thing is common, many producers are seeking new methodologies and technologies to extend the useable aquifer life and limit the economic impact of loss of aquifer pumping capacity, such as improved soil water conservation practices, more efficient irrigation applications and deficit irrigation management strategies. These methodologies include new mobile drip irrigation (MDI) technology systems, irrigation scheduling tools such as soil moisture sensors, and telemetry in the monitoring equipment, among others. The producers were looking for visible proof as to which of these methodologies were going to work for their particular objectives and locations.

Several producers stepped up and offered their farms to demonstrate the methodologies that they are seeking to adopt in order to address a specific objective in their operation. These producers approached the K-State Research Extension (KSRE), Kansas Water Office and other government and private entities to help them in the design, installation, and monitoring of the demonstration farms also known as the Water Technology Farms (WTFs). Thus, in 2016 cropping season three WTFs were established which also corresponds with objectives of the Kansas Water Vision. They are demonstration farms that allow the installation and testing of the latest irrigation technologies on a whole field scale. In 2017, two additional WTFs of this type were established.

Mobile Drip Irrigation

The concept of using driplines on center pivot (CP) system is not new. T-L Irrigation, Inc. experimented with this idea in the early 2000s, calling it precision mobile drip irrigation (PMDI). However, based on the studies of Olson and Rogers (2007), no yield differences between the PMDI and CP were found. They associated the lack of discernible impact to the relatively wet years of the study and inherent high variability in the field caused by factors beyond the control of the investigators. The MDI was developed with the concept of combining the high efficiency but expensive subsurface drip irrigation (SDI) technologies and the relatively low-cost simple operation and maintenance of center pivot irrigation technologies. Although, MDI should increase irrigation efficiency, a previous study on a similar product found more negative management issues than positive efficiency advantages (Olson and Rogers, 2007). However, a recent study using new MDI product lines in corn reported no significant differences in yield between MDI and in-canopy spray nozzles but better soil water storage under MDI (Kisekka et al., 2016). In addition to potential irrigation efficiency improvement with MDI, there is producer interest in MDI as a potential water application system to help alleviate wheel track rutting issues, (Rogers, personal communication, 2016) which in turn would reduce erosion and improve field conditions.

The Water Technology Farms

T&O Farms, LLC in Finney County (Figure 1) consists of 10 sprinkler systems, four equipped with MDI, and four equipped with low pressure spray nozzles. There are four circles planted to sorghum and alfalfa that are set-up as paired field comparison of MDI and spray nozzles. Each field has a soil water sensor. The systems are fully automated with water use, groundwater levels, moisture sensor data and weather station data tied to a real-time website. Other notable set-up and technology in the farm includes sorghum seeding rate plots, application of soluble polyacrylamide on soybean and corn, circular planting and the use aerial imageries for thermal and plant health assessment.

The Garden City Company/Dwane Roth Farm in Finney County (Figure 1) north of Holcomb consists of a circle with multiple modes and spacing of water application packages on its four outer spans. These application packages include MDI on 30- and 60-in spacing, i-Wob spray nozzle, and bubbler on 30- and 60-in spacing. The farm is unique as the water source is both ground and surface water. The circle is planted circle to corn managed with a precision soil zoning package, uses soil water sensors and has aerial imageries for thermal and plant health assessment.

The ILS Farm in Pawnee County (Figure 1) is comparing MDI with regular spray nozzles on a higher utilizing volume irrigation wells than those wells being studied in Finney County. Two corn circles are involved with the spray nozzles planted in typical straight rows with the other field is planted in circle. Irrigation scheduling using weather-based and soil water sensors was utilized at this farm.

The Hatcher Farm in Seward County (Figure 1) is made up of two fields that have had field mapping completed to identify management zones and locate where soil moisture probes were to be installed. The farm utilizes soil moisture probes, aerial imagery, center pivot controllers, iWob nozzles, Bubbler nozzles, MZB soils map. One pivot is the site of water application comparisons with different nozzle packages. Another field has plant-based sensors being used to manage plant stress. Aerial imagery is being collected to monitor the results and then evaluate the impacts of different water management strategies.

The Circle C Farm that straddles in the boundaries of Scott and Lane Counties (Figure 1) is comparing several technologies including EC soils mapping of all fields, soil moisture probes, variable rate irrigation, iWob and Bubbler nozzles, and aerial imagery. The goal of the farm is to maintain production while increasing water use efficiency with the use of the technology together with cover crops.

The Northwest Kansas Technology College Farms around Sherman County (Figure 1) is a public-private partnership with the goal of educating local landowners and Precision Agriculture students on how irrigation technology can be utilized for more efficient water use for irrigation and to conserve local water supplies for the future. Landowners within Water Conservation Areas (WCA) were given first priority for selection into the program. These landowners have agreed to allow students to conduct field mapping and install irrigation technology on their fields, providing students with actual in the field learning opportunities and exposing the landowners to irrigation technology and methods that it can be used. For the purpose of this paper and due to the nature of activities within this farm(s), this will not be included in further discussion.

OBJECTIVES

Each of the farms had specific objectives when these WTFs were created. Part of the principle was that each of these farms addresses a certain farming situation operating under a specific hydrologic condition.

- The T&O Farm has a general objective of identifying the irrigation technologies that will help them conserve and extend the life of the Ogallala aquifer.
- The GCC/Roth farm aims to evaluate the effectiveness of spray nozzles, i-Wob and MDI under its current water supply conditions.
- The ILS Farm is about finding the most efficient irrigation water application package that will work well with an irrigation scheduling tool.
- The Hatchers Farm would like to maintain production while increasing water use efficiency (e.g. through irrigation scheduling) and reducing wheel track issues.
- The Circle C Farm is about finding technologies and strategies (e.g. cover crop) to help maintaining production while increasing water use efficiency.

It is worth noting that the T&O and Roth Farms also have a very personal objective, to pass on the farming operations to the next generation of family members with the assurance that there is sufficient water for them to use to irrigate the crops.

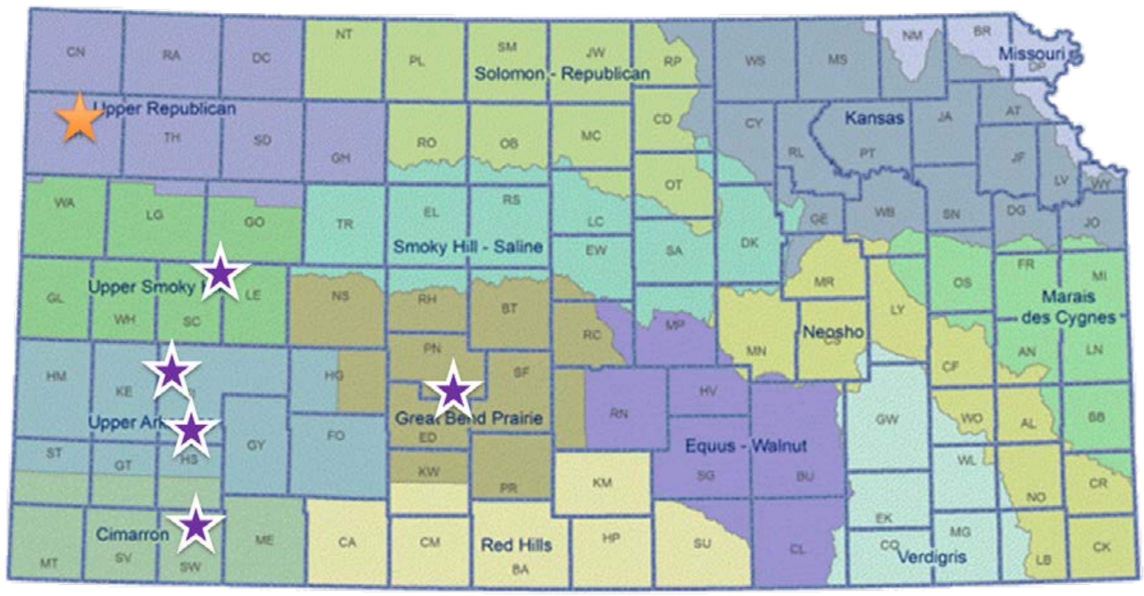

Figure 1. The location of the five research water technology farms in south central and southwest Kansas and the Northwest Kansas Technical College farms for workforce development. The Garden City Co./Roth Farm and South of it is the T&O Farm in Finney County, the ILS Farm in Pawnee County, Circle C farm straddling Scott and Lane Counties, and Hatchers Farm in Seward County.

METHODOLOGY

T&O Farms, LLC is located 10 miles south of Garden City, KS and consists of 10 sprinkler systems, four equipped with MDI, and the rest are equipped with low pressure spray nozzles. The systems are fully automated with water use, groundwater levels and soil water sensor data are transmitted to a real-time website. Each field has at least one telemetric soil moisture sensor that is being monitored by a crop consultant. For 2016, only seven of these field were directly monitored for its agronomic performance.

There are four circles in a section which are planted to sorghum and alfalfa. These fields are set-up as paired field comparisons of MDI and spray nozzles. Each circle has commercial soil water sensor and KSRE installed 5-ft access tubes for weekly manual soil water monitoring using CPN Neutron Probe. This particular section has its aerial image taken at least eight times during the season in the thermal and the NDVI bands for a general health assessment.

One field of corn is planted in a circle and is irrigated with spray nozzle. Soluble polyacrylamide (PAM) is applied throughout the irrigation systems on the east half of the circle and the other half is just water without PAM. Both sections of the circle have separate soil water sensor and neutron access tubes.

Adjacent and similar to the corn field is a soybean field also planted in a circle irrigated with MDI. Soluble PAM is applied by means of the irrigation systems on the east half of the circle and only irrigation water on the west. Both sections of the circle also have separate soil water sensor and neutron access tubes.

One of the sorghum fields has several seeding rate population plots of 40,000, 60,000, 80,000, and 100,000 seeds per acre.

The Garden City Company/Dwane Roth Farm is located 5 miles north of Holcomb in Finney County and consists of a circle with multiple modes and spacing of water application packages on its four outer spans. These application packages include MDI on 30- and 60-in spacing, i-Wob spray nozzle, and bubbler on 30- and 60-in spacing. Telemetric soil water sensors and neutron access tubes were installed and monitored in each of the spans. The farm is unique as the water source is both ground and surface water when there is water delivered through the canals. The field is planted in circle to corn using a GPS-equipped tractor.

The ILS Farm in Pawnee County is comparing MDI, to regular spray nozzles on a higher volume well than those wells being studied in Finney County. Two corn circles were involved; the South circle was fitted with spray nozzles and planted in typical straight rows and the North circle has its three outer spans fitted with two sets of application packages and planted in circle. Half of the spans has MDI and the other half has spray nozzles. To verify the discharge, four drops in each span has water meters installed. Irrigation scheduling using weather-based and soil water sensors was implemented on this farm.

The **Hatcher Farm** is located 6 miles north of Liberal off Highway 83. Two circles are involved with both fields separated only by the highway. The farms have had field mapping completed to identify management zones and locate where soil moisture probes were to be installed. Both pivots have six of their spans fitted with either fixed spray, i-Wob spray nozzle and bubbler drops. Both pivots have water application comparisons with different nozzle packages. The difference is that one is monitored by soil moisture sensors, while the other field has plant-based sensors being used to manage plant stress. Aerial imagery is being collected to monitor the results and then evaluate the impacts of different water management strategies.

One of the three **Circle Farm's** field is located 8 miles west of Healy, Kansas off Highway 4 at the intersection with N Taos Rd. The large pivot is the site of some water application comparisons with different nozzle packages and variable rate irrigation. Nine spans have equal number of either fixed spray, i-Wob spray nozzle and bubbler drops randomly distributed in the system. The other two fields are located five miles northeast of this field. One of those fields which has a very similar set-up as the large pivot except that it has only six spans involved, while the other is only using the fixed spray for the system. All three fields that make up the farm have had field mapping completed to identify management zones and locate where soil moisture proves were to be installed. The farm incorporates cover crops during fall and rotates half of the circles between corn and soybeans.

INITIAL RESULTS

NOTE: As of printing, the data for the 2017 cropping season were yet to be received from various cooperating individuals. Results and concluding remarks will be discussed during the oral presentation.

T&O Farms, LLC

The farm has significantly reduced the water used for 2016. At the end of the season, they used 1151 ac-ft of water against their allocated 1511 ac-ft or around a 23% reduction. The combination of all the technologies and management practices they employed probably helped in optimizing their use of water. The producer expressed that when they are making a decision, they had higher confidence in their decision if they could see all the parameters in one location, i.e. they could see in real time the water use, soil water status, static water level and weather conditions from their computer and mobile device.

As of writing of this report, not all yield data and other farm information has been shared by the producer yet. In particular, we do not have the data yet in the paired field comparing the two water application packages. Based on our ocular observations, there seems to be no difference in the general stand, growth and yield of both crops in the field. Part of the reason is that the area received a relatively high amount (17 in) of rainfall last year. Nonetheless, this also suggests that at the least both application packages are performing well as designed.

The field with soluble PAM showed significantly higher soil water content from 3ft below the surface and deeper (Figure 2). Apparently, the water applied with PAM infiltrates better and deeper into the soil. After the last irrigation, we took hand samples from both sides of the field to estimate corn yield. There was significant difference between the two, with the PAM side yielding 259 bu/ac while the other side has only 235 bu/ac. However, it was reported to us by the producer that by the time the field was harvested with a tractor combine, they only got a field average of 218 bu/ac. They noticed that there were some nematode issues in certain parts of the field.

The yields from the seeding rate plots were almost identical across the different rates (Figure 3). As expected with a sorghum plant, seeds per head tend to compensate depending on the density of the plants. The 40,000 seeding rate was not significantly different from 100,000 or any other seeding rates. However, we observed a notable weed pressure in the 40,000 seeding rate plots but not on any other plots.

The Garden City Company/Dwane Roth Farm

The farm received a total of 25.2 inches of rainfall during the cropping season which is more than 7 inches above normal. That factor alone made it impossible to detect any differences in soil water content and yield between the different application packages. With that amount of rainfall, the effect of water quality was also masked. Only 11 inches of irrigation was applied to the field. The field average yield was 228 bu/ac.

The producers reported to us that they learned a lot in using the technologies during the first year. They were highly impressed at the information they received from the soil water sensors which gave them confidence to shut down their system for several days when they saw adequate soil water. They noted difficulty in circular planting and despite all the adjustments that they made, the MDI driplines were still getting caught in the canopy of the corn plants.

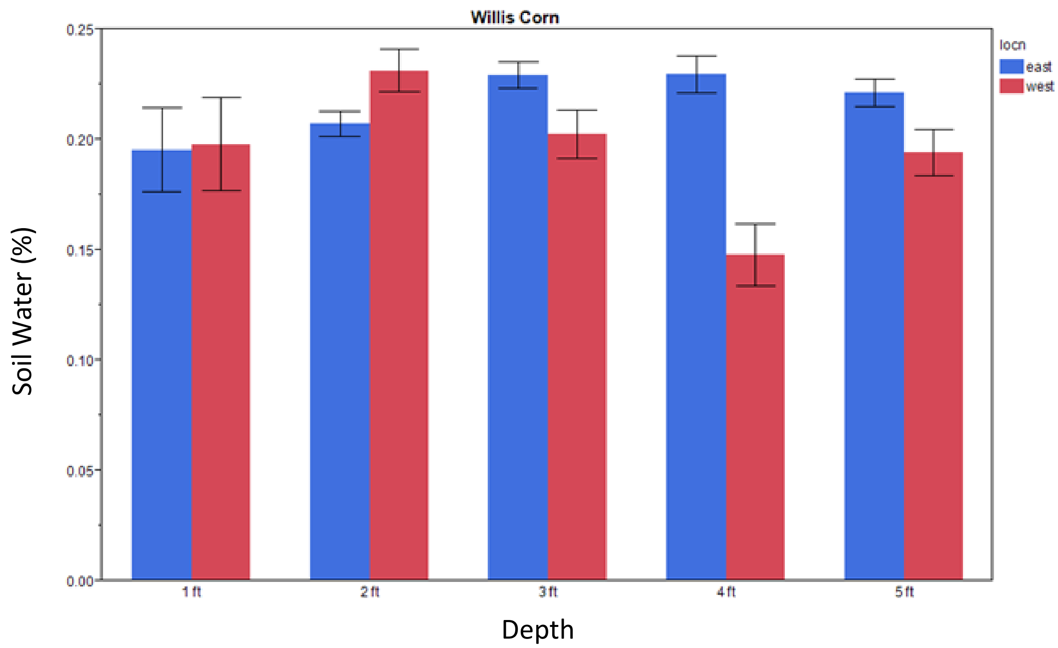

Figure 2. Soil water content (% vol) at the circle at different depths for with and without liquid polyacrylamide (PAM) application. Red (right) bars are without PAM on the west of the circle and the blue (left) bars are with PAM.

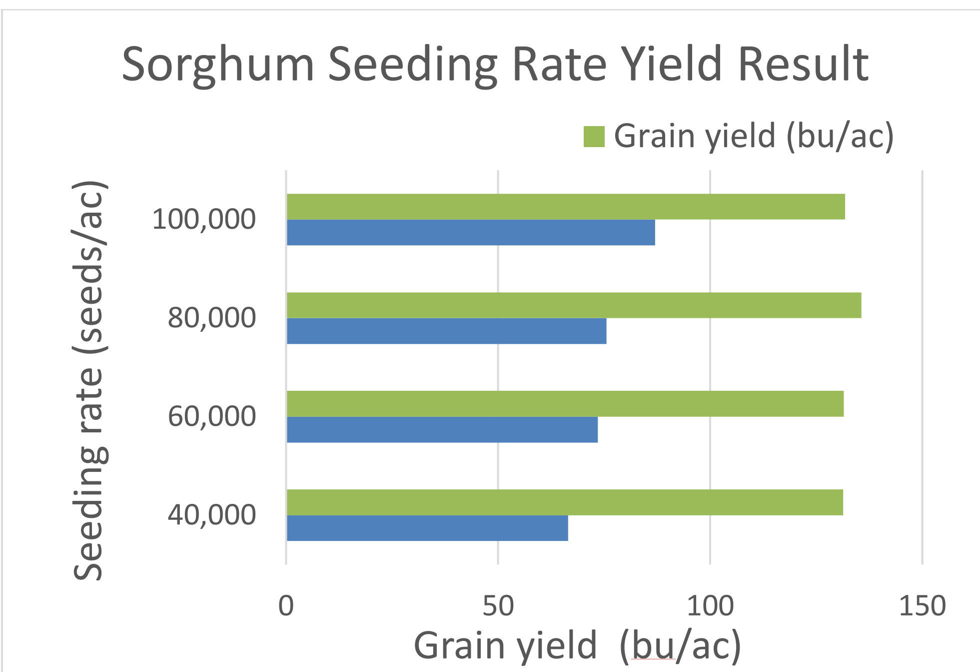

Figure 3. Grain yield of sorghum at different seeding rates.

The ILS Farm

The farm received a total of 17 inches of rainfall during the cropping season. The total depth of irrigation they applied was 13.5 inches to the South field and 14.1 inches to the North field. The yields from both fields and treatments were not significantly different (Figure 4) whose values ranged from 222 bu/ac in the South field and 235 bu/ac for the MDI in the North field. The average yield from the tractor combine was 200 bu/ac for both fields.

Looking at the soil water on both fields, it appears that irrigation applied by spray nozzles on the South field was deeper into the soil profile. However, when we checked into our notes, this disparity could be associated with the change in soil type at this depth. We noted that during the installation of the neutron access tubes, the soil changed from sandy loam to loamy sand at the depth of 3 ft and below. We decided to install the tube anyway because it was a lot better than having a completely loamy sand from top to bottom observed at several other spots of the field.

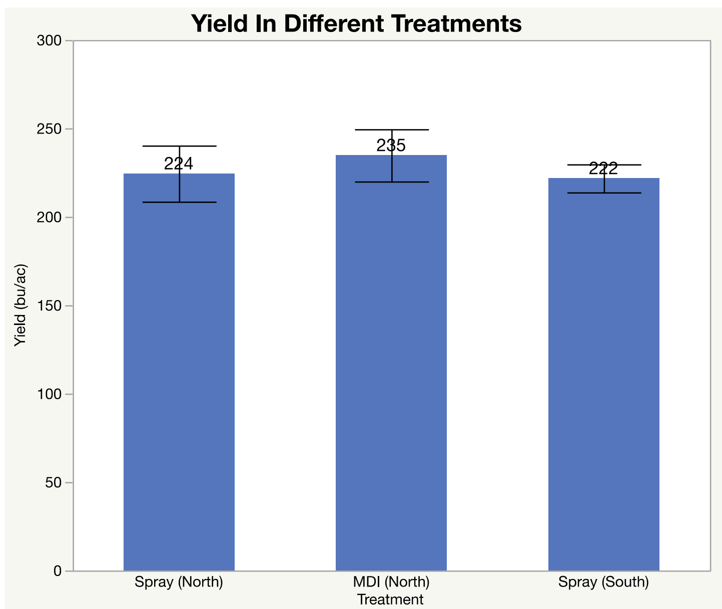

Figure 4. Corn yields at the different treatments at the ILS farm.

PRELIMINARY CONCLUSION

NOTE: As of printing, the data for the 2017 cropping season were yet to be received from various cooperating individuals. Results and concluding remarks will be discussed during the oral presentation.

The Water Technology Farm concept is a great way to showcase and assess the performance of the new technologies and management practices in the vicinity of the producers' own farms. If proven effective, producers are more receptive to change and adopt the new technologies or practice if they see it working in their area at the scale that they are operating. As researchers and extension specialists, we see water technology farms as an expansion of the research going on at our research plots and an opportunity to educate the producers about the science behind the technology and practices.

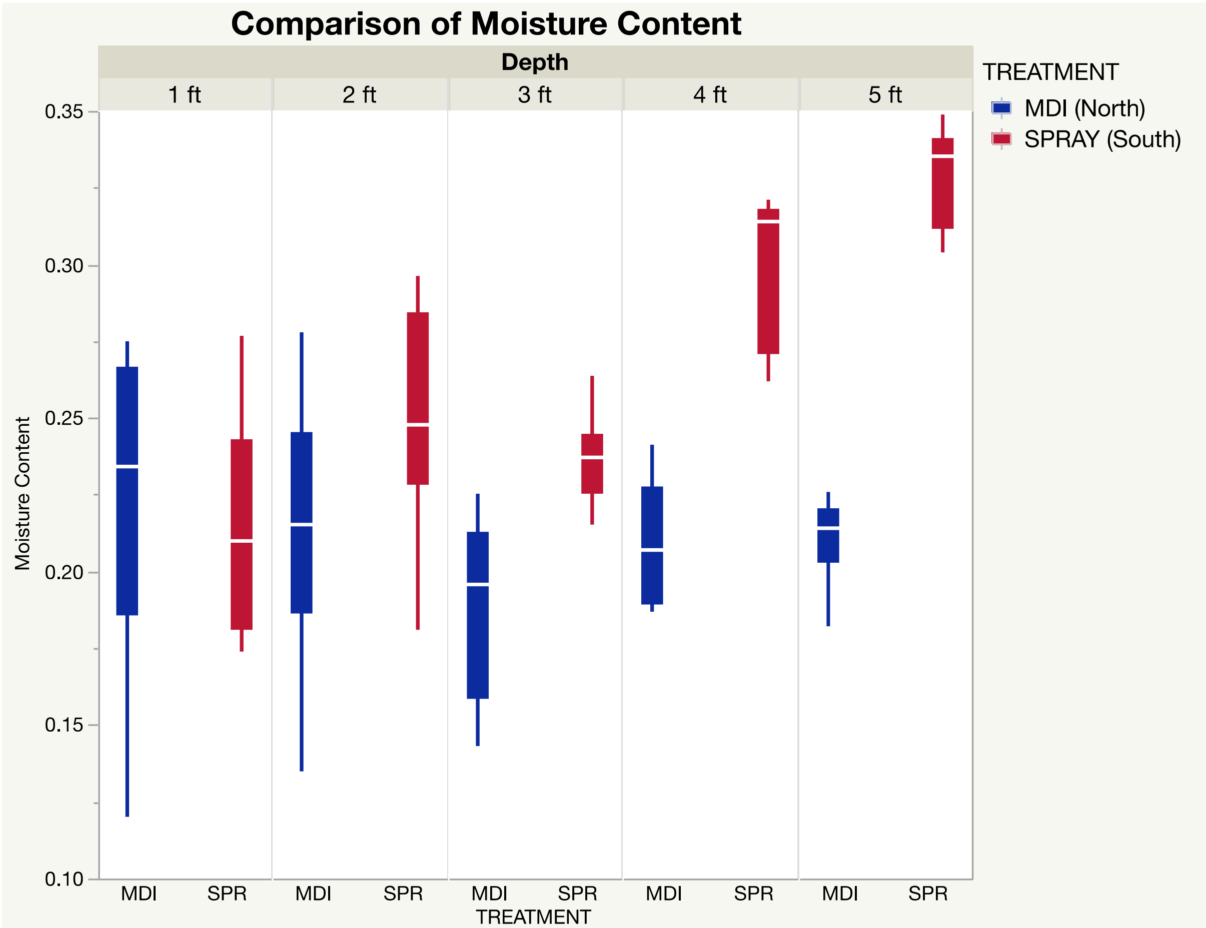

Figure 5. Water content (% vol) at the MDI and Spray treatments in the ILS farm measured using a neutron probe.

As part of the establishment of the water technology farms a field day was held on each farm as part of its educational component. Field days was deemed very successful on these farms because in addition to the large attendance, there was a general atmosphere of inquisitive attitude among all the people who were there. The field days fostered good conversation between producers and managers to the point that many remained talking in the field an hour or two after conclusion of the program.

One year of data is not enough to make conclusive statements since all three fields received normal to above normal rainfall. It is evident that all the technologies tested are performing as expected under last year's condition. But again, nothing conclusive could be said. However, one year is long enough to start identifying their advantages as well as the challenges that may have to be addressed. For example, it is imperative that to maximize the full potential of an MDI in tall row crops, fields must be planted in circles. We are seeing that despite the GPS technology installed in many tractors, some of them are not yet capable of planting precisely in a perfect circle. Improvements have to be made either on the MDI system or the GPS guided tractor, or both.

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