IMPLEMENTING SOIL-SPECIFIC SEEDING RATES TO INCREASE FIELD-SCALE COTTON LINT QUALITY

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Abstract

Precision management in cotton production can be focused on increasing profitability by decreasing inputs. Reducing seeding rates in soils, while maintaining maximum production potential will decrease input costs and has the potential to improve plant health and lint quality in drought-stressed soils. The site selected was the Texas A&M University IMPACT center, which is located on a floodplain and thus, has high soil variability. For the 2008 growing season, 27 measurement locations were selected in a 48 acre irrigated cotton field planted in DP164 BGIIRRF (Bollgard II, Round-Up Ready Flex). The sites were selected based on soil electrical conductivity (EC) values (3 EC zones). Three seeding rates (30,000; 40,000; and 50,000 seeds acre^{-1}) were established in each of the three EC categories with three replications. At each measurement location, soil texture, soil moisture (weekly), lint quantity and quality (HVI) were measured. Additional replications for each EC category and seeding rate were selected for lint quantity and quality (HVI) measurements. The EC map responded to differences in soil texture and water holding capacities. Average soil textures were clay, silt loam, and fine sandy loam for EC zones 3, 2, & 1, respectively. The ability of the clay to store more plant available water was a significant advantage for all seeding rates in EC zone 3. Reducing seeding rates did not reduce yield, while micronaire was the only lint quality parameter with significant difference among seeding rate. Electrical conductivity maps of fields with variable soils may aid producers in making management practice decisions in the future, but field-scale experiments are needed for validation. Variable rate technologies, such as varying seeding rates across a field with variable soils show promise, while fertilizer and irrigation applications could follow suit. Electrical conductivity maps and variable rate seeding applications could eventually be implemented to precision harvest higher quality cotton bales.

Introduction

Cotton lint yield and fiber quality are associated with water supplied to the crop, by the soil or by irrigation, throughout the growing season (Ping et al., 2004). Soil electrical conductivity (EC) measurements can make high resolution maps of soil variability across a field, one of which being soil water storage capacity (Sheets and Hendrickx, 1995). Reducing seeding rates in soils while maintaining production potential will decrease input costs and has the potential to improve lint yield and quality in drought stressed soils. Under drought conditions, reduced plant density may increase soil moisture late in the season, reducing water stress on the plant. This reduced stress may result in better lint quality. The overall goal of this project is to improve cotton production profitability by minimizing seeding rates, maintaining maximum yields, and improving lint quality potential in water limited soils.

The objectives of this project are the following: 1) Evaluate the effectiveness of variable rate seeding on cotton quality using soil electrical conductivity to define variable rate zones; and 2) Define the relationship between soil water storage, seeding rate, and cotton lint quality.

Materials and Methods

In 2008, a 48 acre irrigated field was selected at the Texas A&M University IMPACT center and planted in DP164 BGIIRRF (Bollgard II, Round-Up Ready Flex) cotton on 30 in. rows at three varying seeding rates (30,000; 40,000; and 50,000 seeds acre^{-1}). Prior to planting, a bulk soil electrical conductivity (EC) survey was completed of the field using an EM38 meter. After the survey was completed, three zones were delineated using the k-means classification of EC values (Ping et al., 2005). K-means classification was conducted using RGui (c-ran.r_project.org). Measurement sites were selected using a stratified random selection where stratification was made using EC zones and seeding rate. The modification was that randomly selected locations near borders were moved in towards the middle of the field about 50 ft. Twelve sites were selected in each of the three EC zones, with 4 replication per EC zone and seeding rate, totaling 36 measurement locations (Figure 1). At each measurement location, soil water storage capacity was calculated by measuring soil water content at field capacity. Soil moisture was measured weekly at 20 cm depth intervals to 120 cm deep using a neutron soil moisture meter (CPN 501DR depthprobe). At the end of the season, 1/1000th acre of cotton lint was harvested at each measurement location and lint quality was measured using high volume instrument (HVI). Lint quality, lint yield, and lint value were compared between seeding rate treatments and EC zones using the General Linear Model (SAS, 2002). Loan value was calculated using the Cotton Loan Evaluation Program from Texas AgriLife Extension and Cotton Incorporated (Falconer & Reeves, 2008).

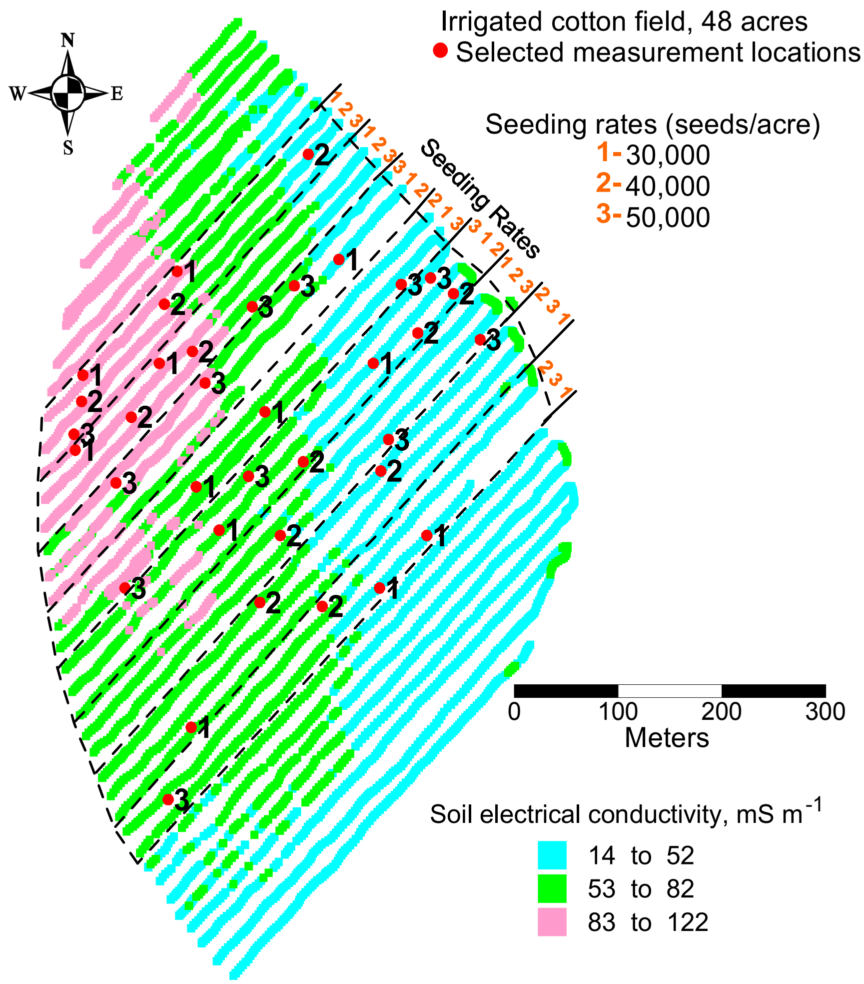

Figure 1. Soil electrical conductivity (EC) map of an irrigated cotton field. The EC is in three categories, variable rate seeding treatments indicated, and measurement locations shown. Four measurement locations for each EC zone and seeding rate.

Results and Discussion

The 2008 growing season began cool and wet, then turned to hot and dry with irrigation being applied on a weekly basis. Soil profile water content measurements obtained during the season created a strong linear correlation (r^2=0.94) with the EC values at each measurement site (Figure 2).

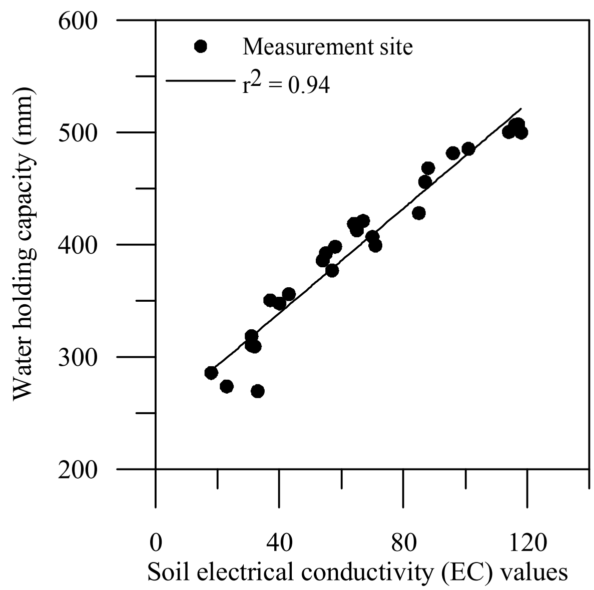

Figure 2. Water holding capacity (mm) and its correlation to the EC values of each measurement site.

Each EC zone contained distinct differences in soil water both at the beginning and end of the season. Seeding rates did cause some differences in water use throughout the season. The 30,000 seeds acre^{-1} rate in EC zone 1 used the least amount of soil water earlier in the season, making more available towards the end of the season when conditions for plant growth were unfavorable. EC zone 2 showed no difference in soil water use across seeding rates, while EC zone 3 had drainage issues early in the season due to heavy rainfall and clayey soils with low infiltration. EC zone 3 was never water limited throughout the season (Figure 3).

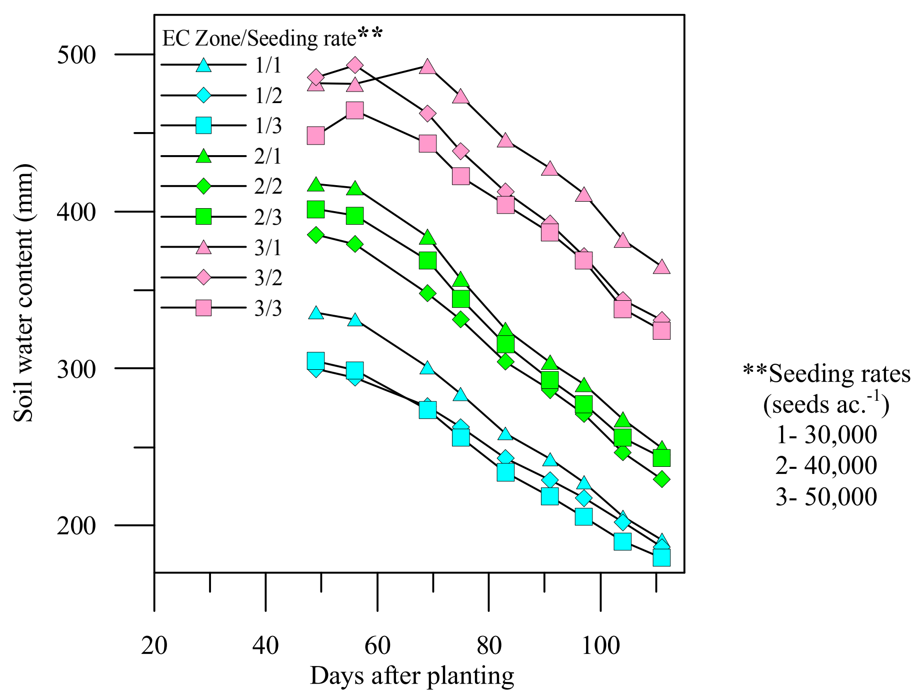

Figure 3. Soil water content (mm) and its correlation to days after planting delineated by EC zone and seeding rate.

There were differences in lint yield across EC zones. EC zone 3 produced significantly higher yields for all seeding rates when compared to EC zones 1 and 2, while no significant differences in yield were witnessed for EC zone 3 and the different seeding rates within this zone (Table 1). In EC zone 1 the 30,000 seeds ac.$^{-1}$ rate yielded significantly more than the 40,000 and 50,000 seeds ac.$^{-1}$ rates (Table 1). EC zone 2 contained no differences in yield across all seeding rates (Table 1). Loan price calculations were significantly higher in the 40,000 seeds ac.$^{-1}$ rate across all EC zones (Table 1), mainly due to micronaire values (Figure 4). All the HVI quality parameters were influential on loan price (Table 1), but when factored in, lint yield was the main influence on overall lint value (Figure 5).

Table 1. Average of lint yields and loan prices. Average values represent the four replications within each seeding rate and EC zone.

Seeding rate	EC zone 1	EC zone 2	EC zone 3
		Lint yield	
----------seeds ac.$^{-1}$----------		----lbs. ac.$^{-1}$----	
30,000	1105Ab†	973Ab	1322Aa
40,000	858Bb	934Ab	1169Aa
50,000	892Bb	1002Ab	1167Aa
		Loan price	
		----¢ lb.$^{-1}$----	
30,000	48.56Ba	45.80Bb	49.16Ba
40,000	51.70Aa	48.70Ab	52.68Aa
50,000	48.56Ba	46.26Bb	51.04Ba

† Means within a column followed by the same uppercase letter or in a row followed by the same lowercase letter are not statistically different at α = 0.05.

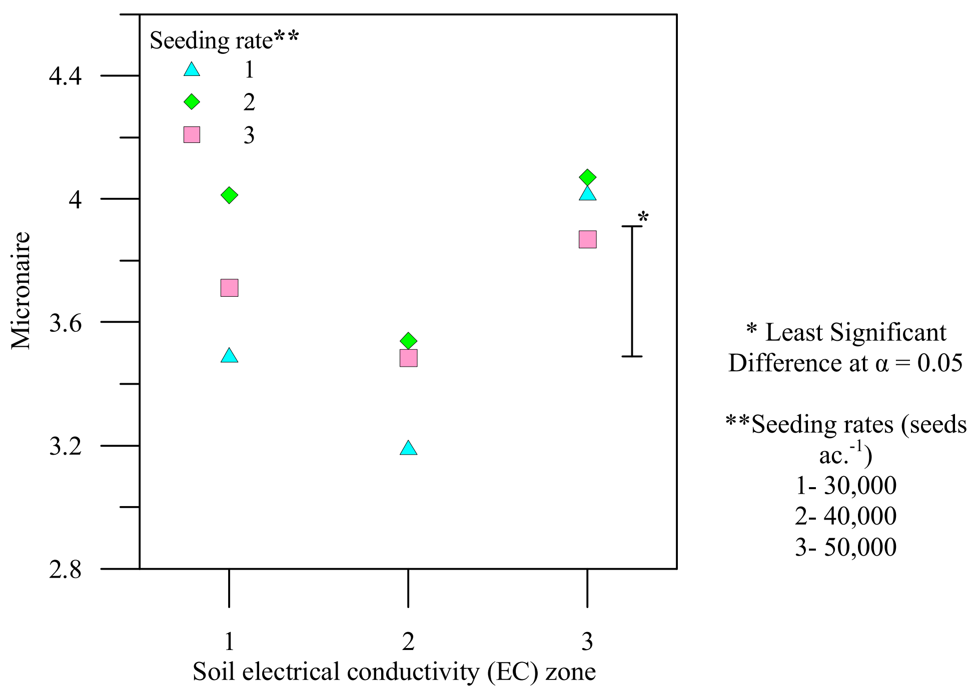

Figure 4. Micronaire value as a function of EC zone for each planting density.

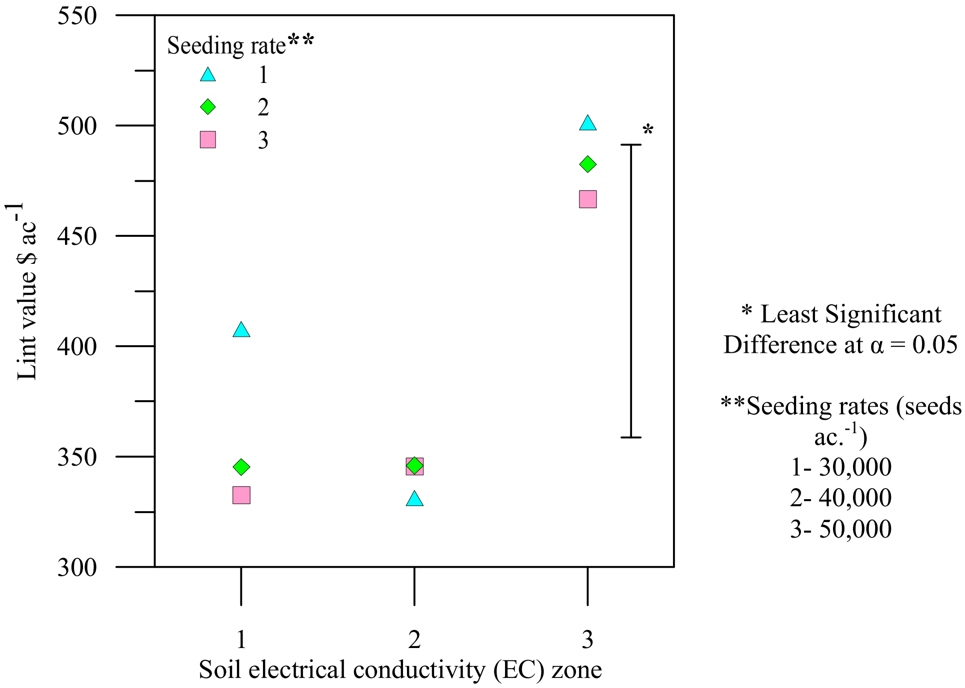

Figure 5. Lint value as a function of EC zone for each planting density.

Conclusions

Though somewhat typical weather for central Texas, 2008 weather was not favorable for plant emergence and dryland farming. Soon after planting, nighttime temperatures were close to freezing. After May, the weather turned hot and dry for the rest of the growing season. Because of cool temperatures during emergence, some loss of yield was expected from poor stand establishment in the lower seeding rates; however, a yield reduction was not observed. We did not measure stand counts to evaluate emergence percentage.

The EC measurements obtained before planting were an indicator of soil texture differences across the landscape, and also showed changes in water content that were stored in the soil. These EC measurements were a tool for delineating zones. The average soil textures were clay, silt loam, and fine sandy loam for EC zones 3, 2, & 1, respectively. The ability of the clay to store more plant available water was a significant advantage for all seeding rates in EC zone 3, since EC zone 3 contained the highest yields. Even though EC zone 3 contained poor drainage early in the season which was detrimental to emergence and plant establishment, the ability of the higher clay soil to store more water late in the season turned out to be beneficial, especially during the hot and dry summer of 2008.

Reducing seeding rates in all EC zones did not significantly reduce yields. All HVI lint parameters, except for micronaire, did not show an interaction to the reduced seeding rates. This implies that reducing seeding rates to 30,00 seeds per acre can cut your costs almost in half and still achieve maximum yields with no measurable effects on lint quality. Although differences in loan price were apparent, which suggests some differences in the HVI quality parameters across seeding rates, the driving force for lint value was still overall lint yield. Addition years of observation need to be done to validate these claims and better understand the relationship between cotton lint yield and quality, variable rate seeding, and soil properties.

Acknowledgements

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