COTTON RESPONSE TO THREE SEEDING RATES IN A HIGHLY VARIABLE FIELD IN NORTHEAST ARKANSAS: IMPLICATIONS FOR SITE SPECIFIC MANAGEMENT

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Abstract

Cotton producers across the Midsouth are searching for ways to reduce production costs and increase profitability. Reducing seeding rates, especially in field areas with low yield potential may represent one option to lower input costs. Previous research findings in Missouri, Louisiana and Georgia have suggested that seeding rates can be reduced without effecting yield. With improved reliability of rate controllers on precision planters, crop managers have the option to vary seeding rates within a field based on soil, landscape, or other production considerations. Development and validation of guidelines for prescription planting is needed to improve production efficiency and reduce costs. This paper summarizes a 2014 on-farm study in northeastern Arkansas to evaluate seeding rate and soil type on plant development and yield in a field with highly variable soils. Historical data from yield maps, soil electrical conductivity EC measurements and soil texture samples were used to sub-divide the field into three soil EC classifications: sand blow, sandy loam and clay. Treatments included seeding rates of 1.5, 3.0 and 4.5 seeds per foot, as well as a variable rate treatment with rates applied based on soil EC. One 12-row planter swath across the field was one treatment strip, and there were 6 strips per treatment. Season long plant monitoring of treatment effects included evaluations of nodal development, plant structure, and maturity. Yield and fiber quality assessments were made with hand-picked samples and use of yield monitor data. Early season assessments of stand counts indicated acceptable plant stand densities in the uniform seeding rate strips; however target stand densities for variable rate planted strips deviated from target levels at unacceptable levels indicating problems with planter control. In hand-harvested sample areas at points selected in early season to represent the 3 seeding rates and soil textures combinations within each strip, we observed no differences in yield among seeding rates. There were significant differences in yields among soil EC classes with higher yields from plants grown in sandy loam compared to plants growing in sand blow or clay soils. Yield monitor data from field length strips indicated significantly lower yields associated with the lower seeding rates compared to 3 and 4.5 seeds per foot. Results indicate seeding rates adjusted for soil type may help reduce production costs, but successful stand establishment remains a critical hurdle.

Introduction

Cotton remains a major crop for many producers in northeastern Arkansas. As is the case in the much of the US cotton belt, Arkansas producers have reduced their cotton acreage in the past 8 years, down from 1.1 million in 2006 to 335 thousand in 2014 (USDA-NASS), but producers in northeastern Arkansas still produce cotton on a large percentage of acreage. According to the USDA-NASS, Mississippi County produced 82,000 acres of cotton in 2014. There are approximately 40,000 acres in Mississippi County owned or controlled by cotton gins which often require renters to match acres of cotton, so production likely will continue in the region at high levels. With the prospect of the potentially low market prices, producers in Northeast Arkansas are seeking opportunities to reduce production costs and remain profitable while producing cotton. Although the development of transgenic Bt cottons with herbicide tolerance has provided producers with tools to help improve pest management, the cost of the biotechnology represents one of the most expensive inputs associated with USA production. Reducing input costs by reducing seeding rates appears to be a promising option.

Studies have indicated that reduced seeding rates often have no negative effect on lint yield per acre (Bednarz et al., 2005). Similar work from Missouri and Louisiana have suggested that seeding rates can be reduced without effecting yield (Siebert et al., 2006; Wrather et al., 2008). These results were derived from small plots which had been hand thinned to a uniform seeding rate, which implies that adequate yields can be obtained from reduced seeding rates as long as stands are uniform. As rate controllers on precision planters become more widely adopted, producers will have the capacity to apply multiple seeding rates based on specific management or production objectives within a field. One option to improve the efficiency and profitability of cotton may be to reducing seeding rates in field areas with different yield potential. One of the objectives of this 2014 study was to evaluate the interactions of three cotton seeding rates across a NE Arkansas production field characterized by heterogenous soils with a history of low yield potential.

Materials and Methods

A field study was conducted in NE Arkansas during the 2014 production season and represented the first year of a Cotton Inc. funded project focused on encouraging Midsouth cotton producers to expand adoption of spatial technology and management practices to increase profitability on their farms. The soil type in the field selected for the study was classed as a Routon Dundee – Crevasse Complex, and ranged from coarse sand to a fine sandy loam. All production practices including land preparation, fertilizer application, irrigation and weed and insect control were based on the cooperating producer's standard practices and using his equipment (Table 1). Prior to planting, the field was partitioned into three management zones based observations of the spatial variability of yield, soil ECa, and NDVI maps (Figure 1). Management zones based on soil electrical conductivity (EC) properties classified from measurements using a dual depth Veris® 3150 Soil Surveyor. Previous mid-season NDVI measures in 2006 as well as yield maps from 2011, 2012, 2013 also were referenced (Figure 2). Extensive plant and soil monitoring in 2012 and 2013 validated zone designations (Kelly, unpublished). Over years, the general pattern of variability was similar for all three measurements and support conclusions obtained in earlier studies designed to define the creation of field management zones (Ping et al., 2005).

Stand counts were collected to determine the accuracy of the target seeding rates planted as well as the accuracy of the variable rate prescription seeding. Prior to first flower, areas representing clay, sandy loam and sand blow soil types were identified and marked with flags and referenced with GPS coordinates. Plants from all seeding rates within each of the three soil type zones were mapped weekly to monitor the crops development. Maturity measurements from all seeding rates within each of the soil type zones were determined by weekly monitoring of nodes above white flower (NAWF) using COTMAN (Bourland et al. 1992; Oosterhuis and Bourland 2008). A 10 foot length of row from each of the seeding rate treatment within all soil type zones was hand harvested and converted to a lint yield per acre. Areas of large skip between plants were observed in plots which were planted at the lowest seeding rate, especially in the clay areas of the field. These skips were avoided when hand harvests were collected. Whole plot yields were extracted from the producers post-calibrated yield monitor files and yields were determined from the center six rows from each plot. Yield and maturity (NAWF) measurements were evaluated using analysis of variance. Means were separated using Fisher's Protected LSD test at the P= 0.05.

Table 1. Dates of planting, irrigation and harvest for the 2014 seeing rate study, Wildy Family Farms, Manila, AR.

Operation	Date	Days after planting
Date of planting	4-May, 2014	
Stand Counts	13, 20, 27 May and 4 June	9, 16, 23, 31
Insecticide	23 June 17, 28 July, 4 August	50, 74, 85, 92
Irrigation	23 June, 10 July, 12 September	50, 67, 131
Hand harvest	7 October	157
Harvest	17 October	166

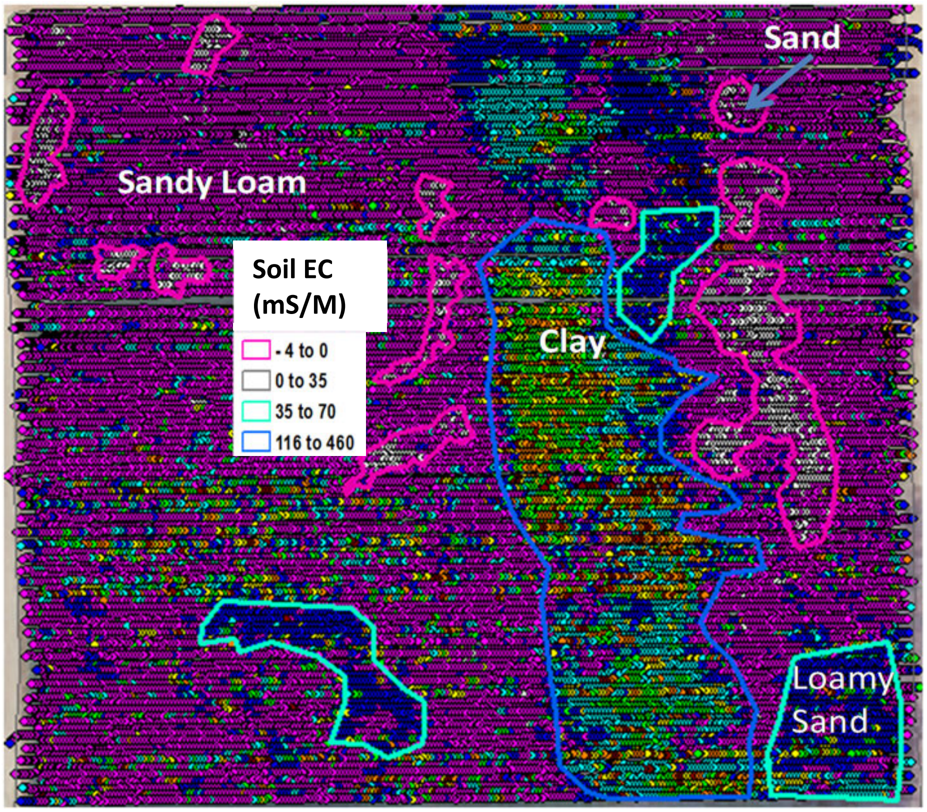

Figure 1. Soil management zones for the 35 acre study site were originally classified in 2012 based on four soil EC categories. After two years of extensive plant and soil monitoring, readings, management zones were re-classified for the 2014 seeding rate trial into three categories: sand blow, sandy loam and clay – Wildy Family Farms, Manila, AR.

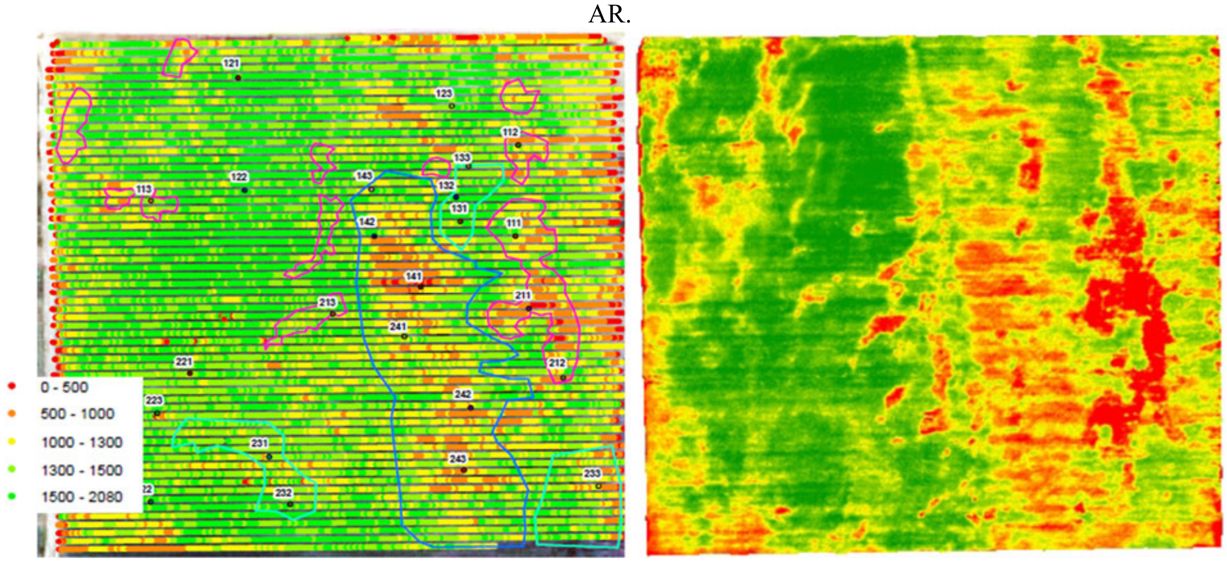

Figure 2. Yield maps (left) and NDVI imagery (right) were used to validate classification of soil EC based management zones in the 35 acre site for the seeding rate study. Shown above are 2011 yield map from (left) and NDVI image from July 2006– Wildy Family Farms, Manila, AR.

Stoneville 4747GLB2 was planted on May 4, 2014 using the producers 12-row John Deere 1720XP vacuum planter. Plots were 12-rows wide and ran the full length of the field. Treatments included 3 target seeding rates of 1.5, 3.0 and 4.5 seeds per foot. A 4th treatment included a variable seeding rate prescription based on 3 zones established by soil EC measurements and was provided by the cooperating producer's local John Deere spatial technology specialist.

The experiment was analyzed as a split plot design with seeding rates considered main plots and soil EC classes considered sub-plots. (Figure 3). Other than seeding rates, all production practices were consistent across all treatments and were based on the producer's standard production practices.

Results and Discussion

The 2014 production season in Northeast Arkansas was characterized by cool temperatures during stand establishment, with high rainfall early in the season. Stand counts from prescribed, whole plot, seeding rates were consistent across all target seeding rates (Figure 3).

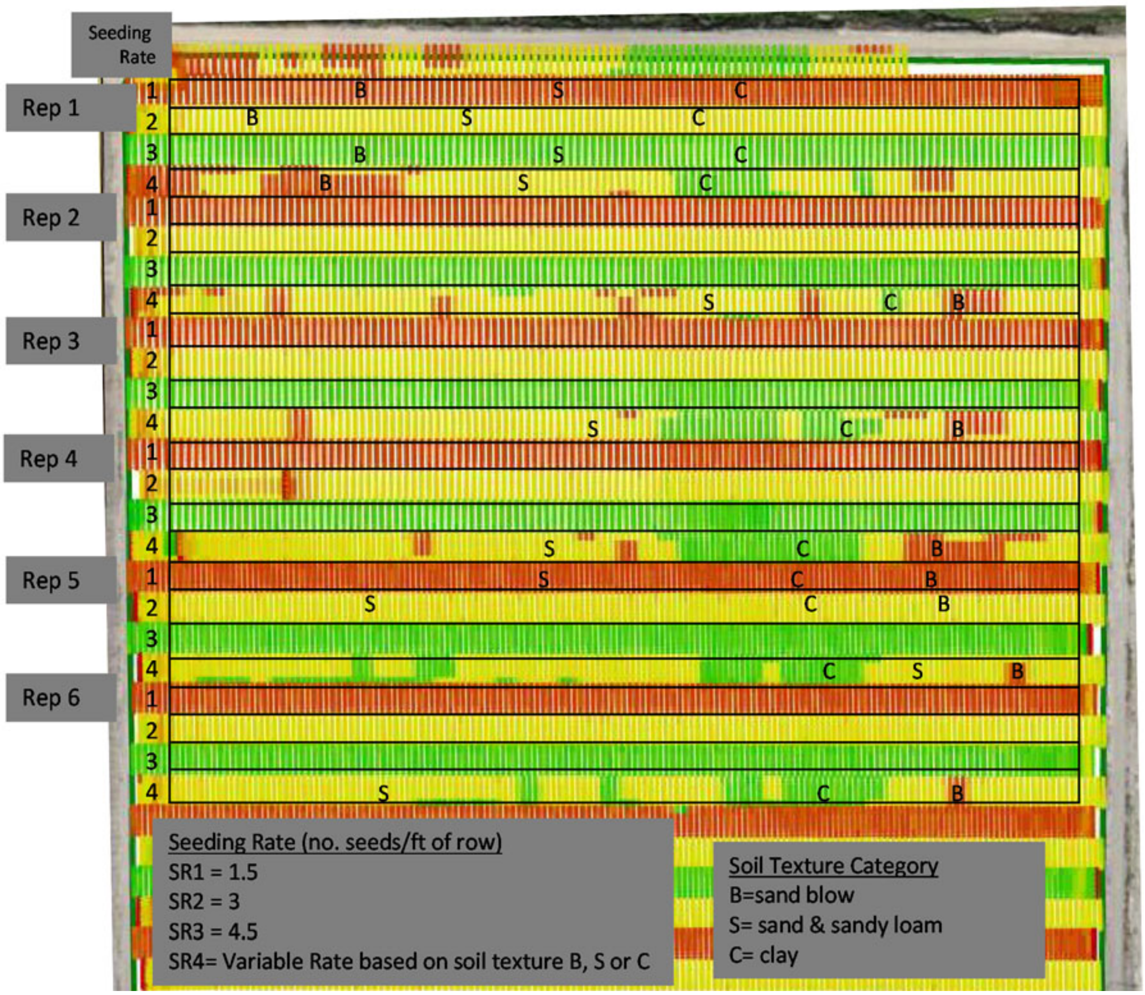

Figure 3. Planting map for 2014 seeding rate field trial – Wildy Family Farms, Manila, AR.

Stand counts from the three whole plot seeding rates followed the same trend and resulted in actual stand counts ranging from 70 – 80% of the target. Stand counts from the clay soil zones tended to have the lowest percentage of the targeted rate than stands from either the sand or sandy loam zones and was most likely due to the amount of rainfall experienced during stand establishment. Stand counts from the variable rate (soil type specific) treatment resulted in much greater deviations from the target seeding rate than did any of the uniform seeding rates (Figure 4). Within the variable rate seeding plots, the rates prescribed for the sandy loam soil types resulted in actual stand counts similar to the rate observed in the whole plot treatments. In the test field, sandy loam represented the largest area of the field. The clay and sand blow zones varied in size and frequency across the field. Stand count data from the variable rate plots supports earlier work identifying sources of error in variable rate applications (Chan, 2005) and suggest that zone size and speed and accuracy of the rate controller could affect precision agriculture practices.

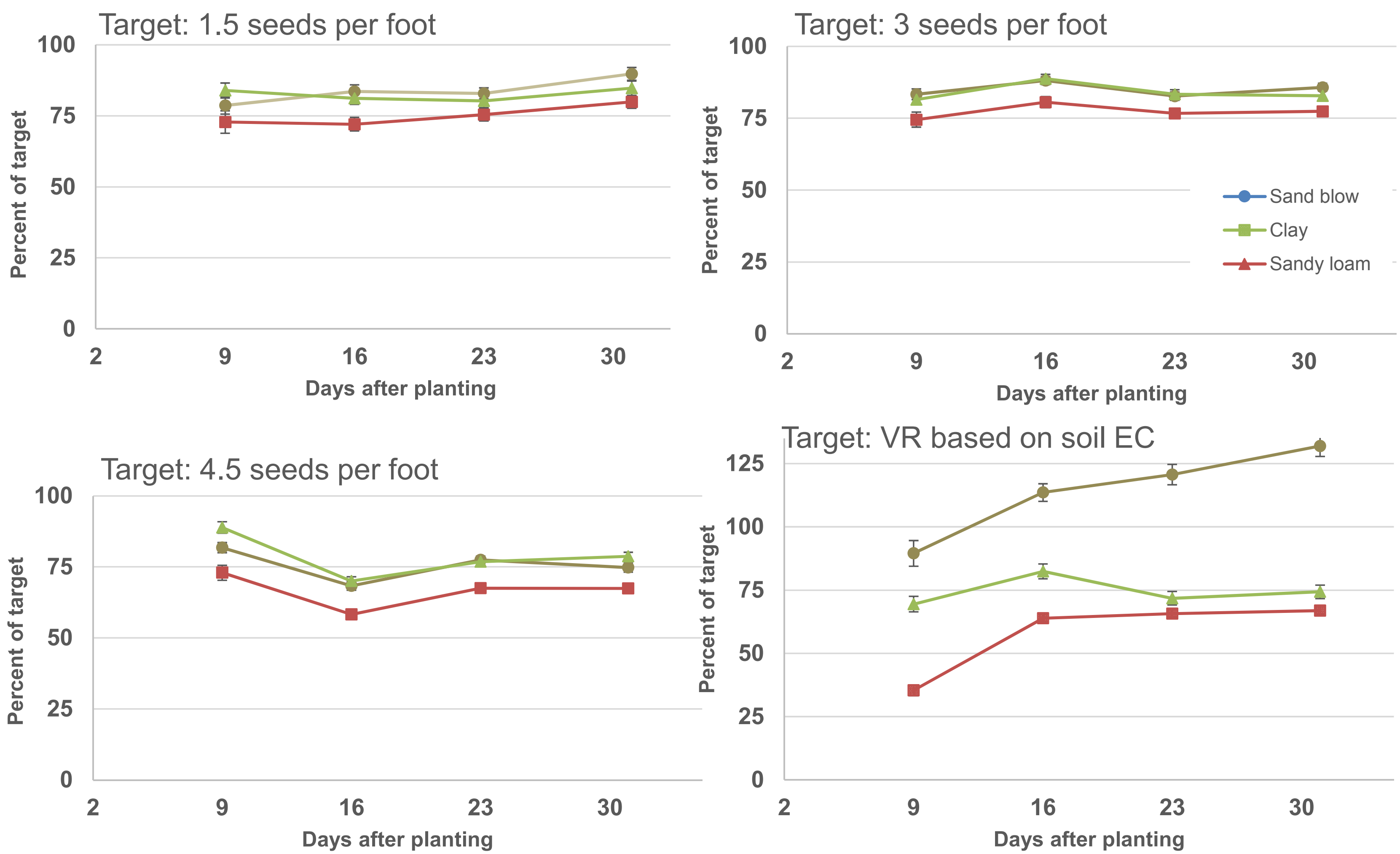

Figure 4. Observed plant stand densities determined in transect sampling across each soil EC zone over four dates in the first month after planting for each of the four seeding rates (1.5, 3, 4.5 and variable rate (VR)) expressed as a % of target seeding rate in 2014 seeding rate field trial – Wildy Family Farms, Manila, AR..

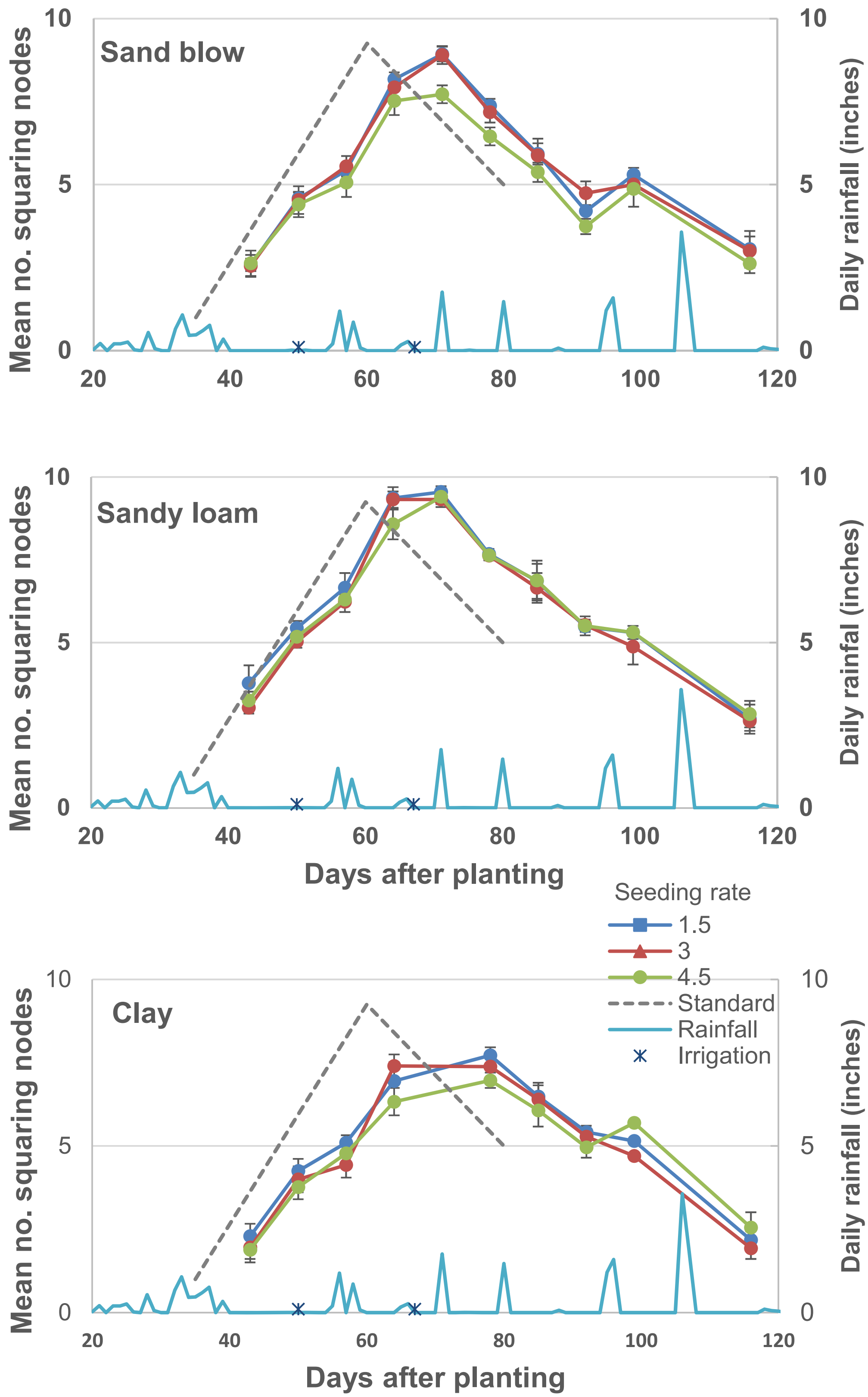

Figure 5. COTMAN growth curves for plants in soil EC zones: sand blow, sandy loam and clay planted at 1.5, 3, and 4.5 seeds per foot in the 2014 seeding rate field trial – Wildy Family Farms, Manila, AR.

Above average rainfall during the effective flowering period appeared to affect crop growth during this study. As a result of the frequency of rainfall during the 2014 season, crop growth and maturity appeared to be more affected by soil type than by seeding rate (Figure 5). COTMAN growth curves show plant response to the early season conditions with the pace of sympodial development for plants growing in sandy loam soil comparable to the COTMAN standard Target Development Curve (TDC) through the first flowers; however growth in clay and sand blow soils were delayed in relation to the TDC. The apogee of the TDC occurs at first flower with 9.25 mean no. squaring nodes (NAWF=9.25). In our samples from the week of first flowers, plants in coarse sand and sandy loam had a higher mean of 6.8 and 9.0 main stem sympodia, respectively, indicating a likely difference in yield potential for plants in these two soil texture classes. First position square shed levels at first flowers were 20% and 38% for sand blows and sandy loam, respectively. These are relatively high levels of injury resulting from feeding damage from pre-flower infestations of tarnished plant bug adults. Lower seeding rates in the sand blow zones tended to have more squaring nodes at first flower than did the highest seeding rate. Greater plant structure at first flower in the lower seeding rates may have been the result of less interplant competition, especially within sand blow area where water and nutrients may be limited.

Yields from hand harvest data resulted in no differences among seeding rate treatments (Figure 6). It should be noted however, that areas with large skips between plants were avoided during hand harvest. A more non-discriminating harvest area selection procedure would likely have affected yield results. Avoiding the excessive skips in the hand harvest areas may have contributed to the consistency in yields across seeding rates. Skips, especially in the clay areas of the field, were most likely due to the frequent rain fall and appeared to be more problematic in the lowest seeding rate treatments. Hand harvest yield was significantly lower in the clay and sand blow areas than the sandy loam area of the field. Yield from whole plots (collected from producer's yield monitor data) however, was significantly lower for the 1.5 seed/ft. treatment than for any other treatment including the variable rate plot (Figure 7). All other seeding rates were equal in this test.

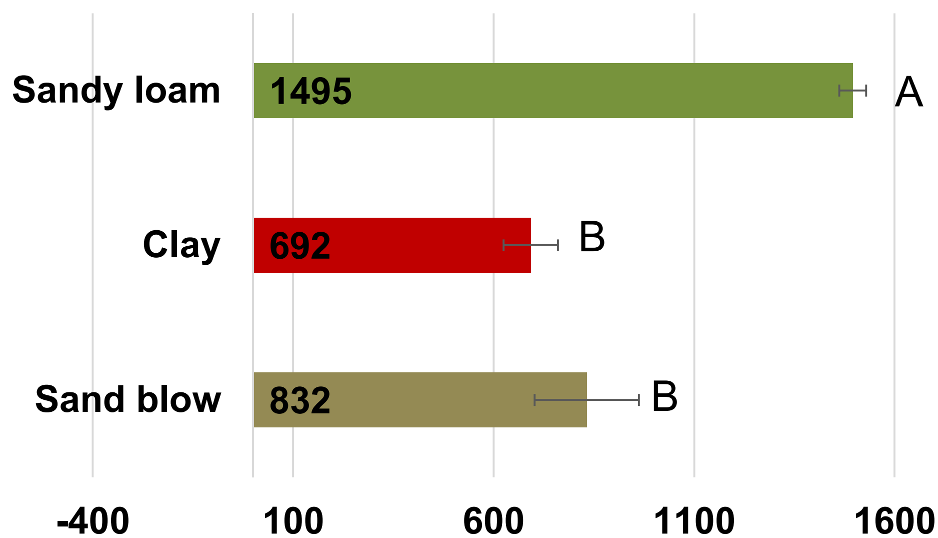

Figure 6. Yield from hand harvested plots within soil EC zones in 2014 seeding rate study in 2014 seeding rate field trial – Wildy Family Farms, Manila, AR.

Summary

Yield from hand harvested plots indicate that reducing seeding rates may provide an opportunity for producers to lower production costs, especially in low yield potential zones. Uniformity appeared to be a problem in the plots seeded at 1.5 seed per foot, especially in the clay areas of the field. Although seeding rate had no significant effect on hand harvested yield in this study, it should be emphasized that areas of excessive skips were avoided when sample sites were selected in mid-season. Additionally, soil types were consistent within each hand harvest area and may explain the differences observed between hand harvest plots and yield monitor data from field length strips. Whole strips were comprised of multiple soil types in each seeding rate treatment. The percentage of area represented by each soil type zone should be considered for future studies and will likely contribute to the classification of management zones.

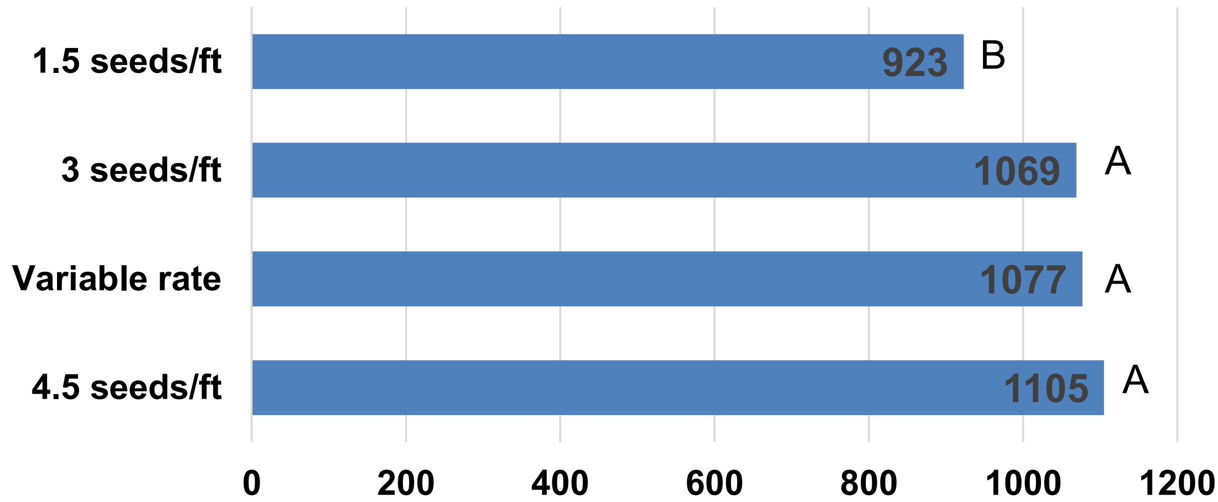

Figure 7. Mean yield derived from yield monitor data calculated from field length strip plots in 2014 seeding rate field trial – Wildy Family Farms, Manila, AR.

Acknowledgements

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