THE EFFECTS OF PLANTER PARAMETERS ON COTTON EMERGENCE, GROWTH, AND YIELD: YEAR 2

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Abstract

Data from the first year of this study has shown correlations between planter downforce and depth settings on cotton emergence, growth, and yield. There were up to 200 lb/ac lint yield differences between treatments from the 2016 study. This data coupled with advent of new planter technology has provided the ability for both researchers and producers to be more accurate and consistent with seed depth placement and planter downforce settings, thus promoting higher and more even rates of successful stand establishment. Traditionally, seed cost was seen as an incidental cost of production, however, due to the increased level of technology contained within the seeds and plant, the cost has become of major concern to producers and replanting can come at a high cost that will greatly reduce the opportunity for profitability.

The main goal of this study was to build on the 2016 study and to better define the effects of different planter depth and downforce parameters on cotton production. This study focused specifically on at planting volumetric soil moisture, planter depth, and row unit downforce. Two varieties, a small seeded low vigor variety, and a large seeded high vigor variety, were planted on May 15, 2017. Stand counts were collected at one, three, and five weeks after planting, while growth and vigor data were collected at three and five weeks after planting to aid in quantifying the planter effect on emergence rate and vigor. The trial was grown to maturity by following UGA Extension Cotton production guide recommendations. Harvest occurred on November 17, 2017 utilizing a two-row cotton picker with a weighing basket in the back. Significant differences were seen between depth and downforce treatments, pre-plant irrigation treatments, and variety. The high pre-plant irrigation treatment had reductions in emergence for too high downforce and too deep depth regardless of variety. While the high vigor variety was able to compensate for these settings in other pre-plant irrigation treatments. In most cases, this directly correlated to effects on yield.

Introduction

In 2017, Georgia ranks second in national cotton production by producing 2.3 million bales of cotton from 1.2 million harvested acres (USDA/NASS). Georgia's cotton production, valued at $770 million, is one of the major contributors to state's agricultural industry. Due to the high value of the cotton industry, producers are continually exploring ways to improve production practices and implement new technologies throughout the season to increase crop yields. Each year, producers are faced with new challenges due to unpredictable weather conditions and other crop related issues during the growing season. Inevitable challenges in the season and increasing costs of crop inputs requires planning and utilizing available resources (seed, machinery, etc.) to full potential to avoid any costly production errors. Planting machinery is one of the important equipment in cotton production; however, this piece of equipment is often neglected and is not setup and adjusted to meet the current planting conditions. Proper seed placement in the soil is the first important step to ensure uniform seed germination and high crop emergence. Correct planter setup ensures accurate seed singulation, seed placement and seed to soil contact, thus maximizing crop emergence rates and uniform stand establishment.

Recent advancements in planter technology have increased the interest among producers to utilize these newer systems for improving row-crop planter performance during seeding operations. Some of these technological advancements include electric seed metering systems for achieving high seed singulation, speed tubes for accurate seed placement even at high planting speeds, variable-rate seeding to match seeding rates to individual field management zones, and pneumatic and hydraulic downforce control systems for varying row-unit downforce with changing field conditions. These systems help in optimizing individual planter parameters for achieving high planter performance by minimizing planting errors usually incurred during planting operation. Even though these systems are highly advantageous to cotton production, utilizing correct settings for various planter parameters usually requires knowledge of existing field conditions and correct setup of these parameters to match the given field conditions. Proper knowledge and setup of planter parameters based on given field conditions provide growers with an opportunity to maximize their crop emergence by ensuring correct seed placement at the desired depth with appropriate downforce while maintaining correct seed spacing.

Seed depth is maintained on planters by placing appropriate load on an individual row-unit transferred from the planter toolbar, usually referred to as downforce. Maintaining appropriate downforce throughout the field is very critical for achieving uniform and consistent seed depth. Inherent variability usually exists within the field and field-to-field, especially due to differences in soil properties such as soil type, soil texture etc. Actual downforce requirement on a planter varies with changing field conditions especially soil moisture. Incorrect downforce setup results in poor seed placement by placing seeds shallower or deeper creating the possibility of uneven and delayed crop emergence. Limited research has been conducted in the Southeast US exploring the interaction between seed depth as it relates to planter downforce and soil moisture. The goal of this study is to explore the interaction between seed depth and downforce at different soil moisture conditions and to how these interactions affect crop emergence, growth and yield in cotton. The data will provide producers with the knowledge and information required for correct setup of their planting machinery to match the existing field conditions. Knowledge and implementation of optimized planter parameters will not only help reduce the occurrences of the need to replant, but also promote higher yields by providing each seed with the best opportunity for germination and emergence.

Objectives

The main objective of this study was to determine if depth, downforce, soil moisture, or seed vigor or a combination of these parameters had the highest level of influence on cotton emergence, growth, and yield. The secondary objectives of this study were to determine the effect of mechanical planter depth, downforce setting, and pre-plant irrigation application on cotton emergence, growth and development, and final cotton yield.

Materials and Methods

Two cotton varieties, one medium to large seed/high vigor and one small seed/low vigor variety, were planted on May 15, 2017 with a four row Monosem (Monosem Inc. Edwardsville, KS) vacuum planter (Figure 1). There was no appreciable rainfall from the period of May 5 through May 22 (no events greater than 0.25 in.). Thus, the soil was allowed to dry until the cotton was planted. Three pre-plant irrigation treatments were applied the night before planting occurred as follows the dry treatment did not receive any irrigation, the "optimal" treatment received 0.5 in., and the wet treatment received 1.0 in. of irrigation. Each treatment was blocked by pre-planted irrigation treatment under a lateral irrigation system in Tifton, GA. Thus, each linear block was irrigated independently prior to planting. Composite bulk moisture content samples were collected from each of the fields prior to planting. There were statistically significant differences in the samples, and they were 6%, 7%, and 8.5% (wet basis) moisture for the dry, optimal, and wet, respectively.

Figure 1. Four row (36 in. wide) Monosem planter used for planting the cotton.

The mechanical depth treatments for the planter were set at 0.5, 1.0, and 1.5 inches deep. This depth was set by using the adjustment knob on each planter row-unit, measured and set individually for each row prior to planting. The depth measurements occurred on a flat and level surface to aid in the isolation of depth, and it should be stated that the mechanical depth was held consistent. Actual planted depth was not measured in this trial, but based on data and results can be assumed to have changed with adjustments in downforce. The downforce on individual row-units on the planter was adjusted by adjusting a lever, which applies more or less tension on a spring. Three downforce levels were set on the planter based on the planter's manual and were set at 100, 200, and 300 pounds of force, respectively. Figures 2 and 3 represent the two drastically different treatments applied. Figure 2 was the 0.5 inch depth with low downforce, and dry soil treatment. In this case, the planter was unable to place the seeds under the soil surface as they can be seen laying on top of the soil. Figure 3 shows a deep trench that was made due to the 1.5 inch depth and high downforce being applied wet soil.

Figure 2. Seeds are visible on the soil surface as a result of the low downforce, shallow depth (0.5 in.) and dry soil.

Figure 3. A trench in the soil was formed by the 1.5 inch depth, high downforce, and wet soil.

Emergence data was collected at one (7 DAP) week after planting, and emergence data and plants were collected at three (21 DAP) and five weeks (35 DAP) after planting to evaluate treatment effects on crop emergence, growth, and development. Emergence counts were collected by counting the number of plants fully emerged from ten linear row feet of each plot. Plants were destructively harvested at ground level from one meter (3.28 ft.) of row during the three and five week after planting data collection periods. The data collected from the meter of row included the number of plants, plant height, number of nodes, leaf area, and dry weight. Physiology data is not presented in this paper.

The cotton was carried to harvest following the UGA Extension Cotton Production guide for general agronomy production practices. The cotton was harvested on November 17, 2017 using a two-row John Deere cotton picker with weighing basket attachment in the basket. Each plot was harvested and weighed independently and yield was calculated by dividing the weight of the bag over the plot area harvested and converting to pounds per acre. Average lint turnout was calculated from ginning each of the treatments and taking an average of the lint turnout results.

Results and Discussion

There were significant differences in the cotton emergence data for moisture content, depth, downforce, and variety. These trends held true for both the one and three WAP data collections. Figures 4 and 5 represent the high and low vigor varieties, respectively. The treatments are arranged in the graphs first by moisture content, and then by planting depth. The high vigor variety had an overall higher emergence compared to the low vigor variety for all treatments.

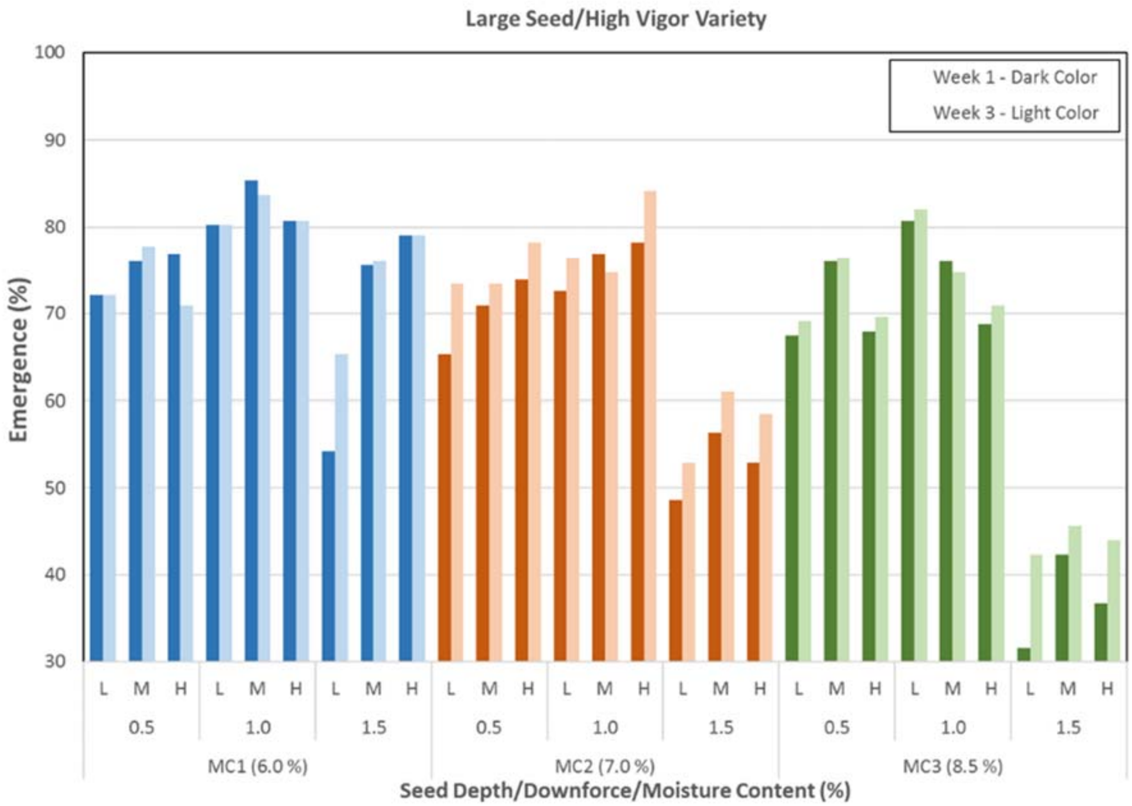

Figure 4. Cotton emergence data for the high vigor variety at one and three weeks after planting.

The high vigor variety had the highest level of emergence for the 1.0 inch depth within each moisture content treatment. Downforce did have an effect on crop emergence but was dependent upon soil moisture content. The lowest level of emergence was observed for the highest moisture content (8.5%) and 1.5 inch depth for both varieties. The low vigor variety had a much lower average emergence across all of the treatments. The highest levels of emergence were observed for the 1.0 inch depth but only for the 6.0 and 7.0 percent moisture contents. Emergence in the low vigor variety was significantly reduced when the seed was planted deeper than 1.0 inches. In both varieties, slightly higher emergence was observed during the three WAP data collection, but these data were not significantly different. Emergence was significantly reduced to very few plants per plot if the seed was planted too deep in a soil that had a higher moisture content. This suggests that a when planting a smaller seeded or low vigor variety, caution should be exercised when planting into a soil with higher moisture contents. In an on-farm situation, replanting of these treatments should be seriously considered to avoid yield penalties at the end of the year.

As represented by figures 4 and 5, if planting into non-optimal conditions such as wetter soil or depths that are too deep or a higher than required downforce, a larger seeded higher vigor variety should be used as it has the opportunity to overcome some of these problems.

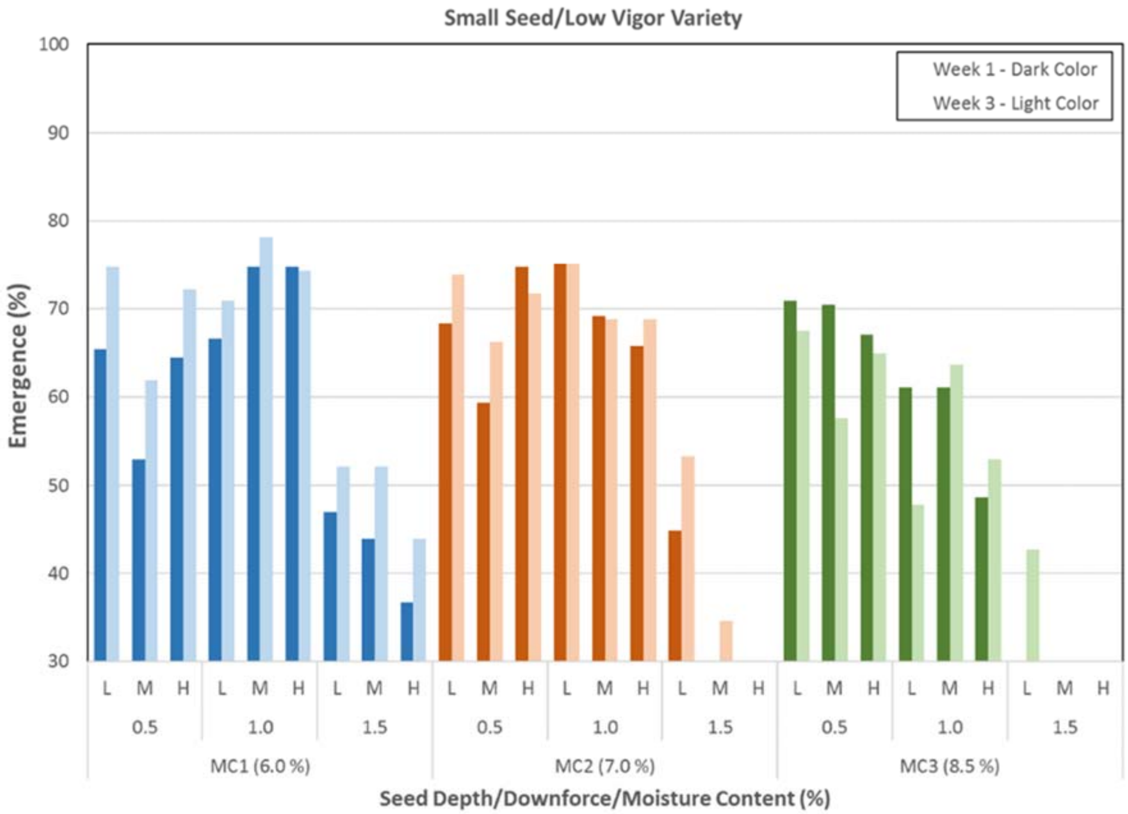

Figure 5. Cotton emergence data for the low vigor variety at one and three week after planting.

Cotton yield data followed similar trends as the emergence data. Overall, the large seeded high vigor variety had higher yields but there were treatments that the small seeded low vigor variety had either higher or similar yields. As long as the seed was planted in an optimal condition, such as a proper depth with adequate downforce, but not too high of downforce, the yields were similar. However, if the downforce was too high, the larger seeded variety had the yield advantage. There were significant reductions in yields for the small seeded low vigor variety when the seed was planted over 1.0 inch deep. This was especially true in higher moisture content soils, which was evident in the emergence data. While the larger seed had the ability to overcome these issues and established a better stand, which translated to higher yield at the end of the season, reductions in yield were observed for the small seed as downforce was increased at the 1.5 inch depth. Similar to emergence, the higher yield values were observed for the 1.0 inch depth in the 6.0 and 7.0 percent moisture contents for both varieties. There was no observed yield advantage for using a larger seed higher vigor variety when optimal planting conditions were met. Even though yield reductions were observed when non-optimal planting conditions were observed, the larger seed variety was able to perform much better than the smaller seed variety.

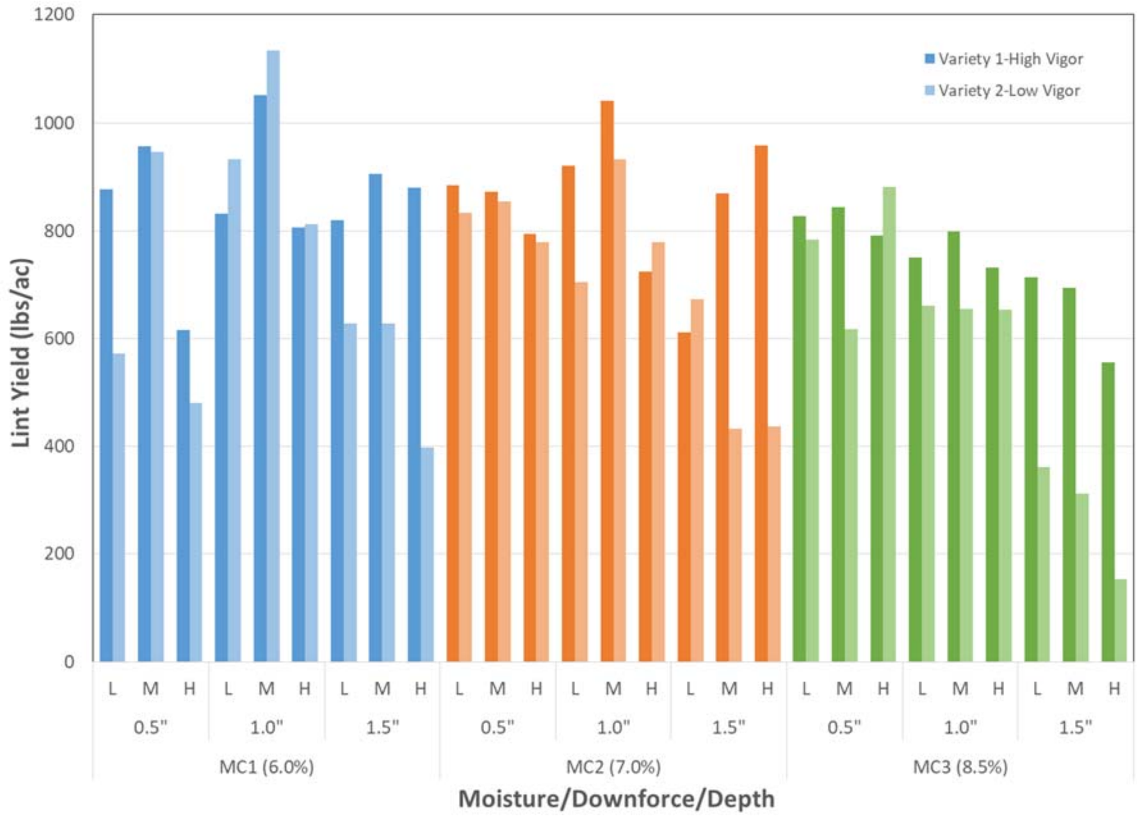

Figure 6. Cotton yield data for the high and low vigor varieties arranged by moisture content and depth.

Conclusions

The data collected from the second year of this multi-year study has provided a good base of information as to which controllable planter parameters along with seed vigor are most important in maximizing cotton germination, emergence, growth, and yield. Treatment effects were found in pre-plant irrigation treatments for emergence rate and final yield suggesting that the soil moisture in which the seed is placed should be considered when setting the planter parameters to aid in maximizing emergence. This data has shown that there is not one specific planter parameter that can provide the optimum levels of emergence and final yield for every planting situation and environmental condition. This suggests that producers should carefully evaluate their field conditions prior to planting and properly monitor planter performance to make informed decisions as to which settings they should change to ensure proper placement of the seed into the seedbed. Overall, the low vigor small seeded variety had a lower emergence than the large seeded high vigor variety. The large seeded high vigor variety had the highest level of emergence when planted at a 1.0 inch depth with low to medium downforce independent of the soil moisture content. Low emergence was observed in both varieties when they were planted at 1.5 inches deep into higher (7.0-8.5%) moisture content. The low vigor variety was not able to overcome being planted too deep independent of the soil moisture content and planter downforce. When considering yield, the high vigor large seeded variety, in extreme conditions (too wet or too high downforce) had the best performance. In more optimal conditions, the small seeded low vigor variety was able to yield similarly to the large seeded high vigor variety. Emergence was sometimes correlated to yield but not in all cases since other factors also have an impact on yield during the year. Delayed emergence has the potential to exacerbate other problems during the season such as disease, pest, and weed pressure, and fertility problems, due to weaker stands.

A depth by downforce interaction was found during this study, meaning that if the proper downforce is not selected and the planter is unable to maintain the selected mechanical depth due to an incorrect downforce, the planted depth will either be too deep or too shallow, causing both emergence and final yield penalties. Selecting and applying optimal planter downforce depends largely on at-planting field conditions, soil texture, and correct planter set-up. The results of this study suggest the need for real-time measurement and control of row-by-row downforce based on at-planting field conditions to aid in maintaining the desired planting depth.

References

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