# EVALUATION OF SEEDING DEPTH AND PLANTER DOWNFORCE FOR PLANTING COTTON IN DIVERSE FIELD CONDITIONS

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## Abstract

Cotton producers are motivated to optimize planter performance for ensuring successful stand establishment early in the season, especially when planting in adverse field conditions. A study was conducted to evaluate the effect of seeding depth and planter downforce on crop emergence and yield in cotton planted in field conditions representing different soil moisture conditions at planting. Three different field soil moisture conditions (characterized as relatively dry, nominal and wet) were attained by applying none, 0.5 and 1.0 inch of irrigation (24 hrs. prior to planting) to three treatment blocks of equal areas within the same field. Two cotton cultivars (a small-seeded and a large-seeded) were planted at three seeding depths (0.5, 1.0 and 1.5 inch) with each depth paired with three different planter downforces (none, 100 and 200 lbs.) in areas designated as dry, nominal and wet field conditions. The study was implemented as strip-split design in a factorial arrangement of cultivar x seeding depth x downforce within each area representing different field soil moisture condition. Cotton was planted using a 4-row Monosem planter equipped with a mechanical downforce system in plots that measured 12-ft wide (4 planter rows) wide by 35-feet long. Stand counts were performed at one, two, and three weeks after planting from the middle two rows and yield data was collected by harvesting the same middle two rows using a two-row cotton picker. Results indicated that crop emergence was reduced at the seeding depth of 0.5 inch in both cultivars planted in all three field soil moisture conditions. Both cultivars planted at 1.5 inch seeding depth exhibited higher crop emergence in wet field conditions than cotton planted in dry and nominal field conditions at the same seeding depth. Large-seeded cultivar exhibited significantly higher crop emergence than small-seeded cultivar in all three field conditions at planting irrespective of the seeding depth and planter downforce treatments. Planter downforce impacted crop emergence in large-seeded cultivar but it had no effect on crop emergence in cotton planted in dry field conditions. Planter downforce did not have a significant effect on crop emergence for cotton planted in nominal and wet field conditions. Cotton lint yield was not significantly affected by field soil conditions at planting, cultivar, seeding depth and planter downforce. Results from the study indicated that crop emergence can be improved by adjustments to planter parameters (seeding depth and downforce) and careful selection of cotton cultivar for prevalent field conditions at planting.

## Introduction

Cotton producers in the US face multiple challenges from planting to harvest during the growing season every year. Some of these challenges include but are not limited to adverse weather conditions, equipment issues during field operations, appropriate variety selection, upgrades to newer technology to improve planter performance, timely application of chemicals to protect crop damage, and many more. Considering these challenges every year, growers have to make critical and timely decisions to ensure a high yielding crop at the end of the season. Among different issues faced by growers early in the season, planting in less than ideal field conditions (excessively dry or wet) has become a more common practice due to unexpected weather events every year. Planting in sub-optimal field conditions can affect planter performance leading to reduced crop emergence or complete lack of stand establishment in some cases. Therefore, knowledge of field soil conditions during planting is very important to improve the functioning and performance of planting equipment to place the seeds in soil for optimum seed germination and seedling emergence. Among different field characteristics, soil moisture has been identified as the key components of soil physical environment that can effect planter performance (Bowen, 1966), and must be considered in order to attain a satisfactory crop emergence in given field conditions. Favorable soil moisture conditions helps in timely and uniform crop emergence. Cotton plants emerge rapidly, usually within 7 to 10 days after planting, when soil moisture conditions remains favorable for longer periods of time (Bowen, 1966). Soil conditions are considered to be favorable for optimum seed germination and seedling emergence when soil moisture content is at or above field capacity (Gupta, 1988; Elmore 2013). However, soil moisture conditions at planting can vary considerably as well as throughout the planting season which requires different planter adjustments specific for each situation. An accurate depiction of field soil moisture conditions through measurement and sensing is necessary in order to make desired planter adjustments. Soil moisture below or above adequate levels can create problems during planting by producing excessively dry or wet conditions, both of which can hinder seed germination and emergence. Excessively wet soil conditions can also lead to soil compaction in the field.

Field conditions especially soil moisture at planting can also influence the selection of planter depth and downforce settings used for achieving the desired seed depth in the field. Hanna et al. (2010) reported variations in crop emergence due to soil conditions in a study aimed at evaluating different planter downforces in corn. Crop emergence was rapid and uniform in moist and wet soil conditions with a low planter downforce, and in dry soil conditions with a high planter downforce. Crop emergence differences were attributed to variations in seed placement, specifically seed depth, among different soil conditions in the field. Results from the study indicated that downforce requirements on planters can vary with prevalent soil moisture conditions in the field at planting and needs to be adjusted accordingly for attaining timely and uniform crop emergence across the field. Poncet et al. (2018) also reported similar results where seeding depth variations were observed in corn due to heterogeneous soil conditions present within and among the fields. In their study, seeding depth varied with elevation change in the field but did not correlate to volumetric soil moisture content in the field. The authors suggested the need for further investigation into soil and field properties that affects in-field planter performance, and identify parameters that can explain variations in seeding depth during planting. Other recent research studies have also suggested accurate measurement and quantification of field soil properties to completely understand prevalent soil conditions at planting and to effectively utilize advanced planter systems for making real-time planter depth or downforce adjustments for achieving high planter performance in variable soil conditions (Sharda et al., 2017; Virk et al, 2018).

Technology advancements on planting equipment during recent years have provided growers with newer and better control systems for precise seed placement during planting. Availability of active downforce systems on modern planters provide real-time monitoring and control capabilities for better seed depth control during planting. Though past research suggested the need for these advanced systems on modern planting equipment, limited research exists on the proper implementation and effective utilization of these systems for improved seed placement during planting. Further, most past research on evaluation of planter depth control system has been primarily focused on corn with very limited to no research in cotton, which implies a knowledge gap on influence of planter depth and downforce on crop emergence and yield in cotton. In addition, very few studies have investigated the effect of planter settings in diverse field conditions at planting, and how the selection of optimal depth and downforce setting changes with soil moisture conditions during planting. Successful implementation of traditional and advanced planter depth and downforce technology by growers for maximizing cotton production requires understanding of how different planter settings can be adjusted to maximize emergence in less than ideal field conditions. In addition, since cotton seed size is correlated to early seedling vigor (Snider et al., 2016) and is an important considered in cotton production, cultivars differing in seed size and vigor can be evaluated along with planter settings to examine their effect on crop emergence and yield in cotton.

## Objectives

The goal of this study was to determine how to manage planter settings along with cultivar selection for different at-plant field conditions when planting cotton. The main objective of this study was to evaluate the effect of different seeding depths and planter downforces on crop emergence and yield in two cotton cultivars planted in diverse field conditions represented by different at-plant soil moisture contents.

## Materials and Methods

The study was conducted on a University of Georgia Research Center (Stripling Irrigation Research Park) located in Camilla, GA during the 2019 growing season. A 4-row Monosem NG*Plus* vacuum precision planter (Monosem Inc., Edwardsville, KS) was used for planting cotton in this study (Figure 1a). The planter row-units were configured at a row-spacing of 36 inches and the planter was equipped with a mechanically driven seed meter and a mechanical downforce control system equipped with heavy springs for applying additional force on the individual row-units. The seed depth setting on each row-unit is controlled and set by turning the knob which positions the gauge-wheel stop for attaining the predetermined seeding depth (Figure 1b). A depth positioning guide and label, adjacent to the knob, is also provided on each row-unit to help with setting different seeding depths. Seeding depths up to 3.5 inches can be attained on the planter by adjusting the gauge-wheel stop position. The downforce adjustments were made by positioning and securing the lateral arm (attached to the springs) in four different positions (Figure 1c) which changes the spring tension, thus varying the amount of load applied on the gauge wheels. The four positions of the spring-loaded arm corresponds to approximately 100, 200, 300 and 400 lbs. of applied force (Monosem NG+ Planter Operator's Manual) on individual row-unit whereas disengaging the arm results in no additional load on row-unit beside the row-unit weight plus the weight of any seed and product in the hopper. A 36-cell singulated seed disc (Part# DN3635, Monosem Inc., Edwardsville, KS) was used for planting cotton at the seeding rate 42,500 seeds/ac in this study.

(a) (b) (c)

Figure 1. (a) 4-row Monosem NG*Plus* vacuum precision planter, and (b) depth control mechanism, and (c) downforce control assembly (spring-loaded arm and pin attachment shown in the dashed box) used for attaining different downforce adjustments in the study.

A field with three center-pivot irrigation systems was selected at the research farm and split into three blocks representing equal area. These blocks were utilized to attain different pre-plant soil moisture conditions in the field by applying varying amount of irrigation 24 hours prior to any planting. The irrigation amounts applied to each block were none, 0.5 and 1.0 inch to create field soil conditions that were representative of relatively dry, nominal and wet field conditions for planting cotton. Soil samples within each block were collected to determine the gravimetric soil moisture content for each block. The mean soil moisture content (% w.b.) measured within each block is presented in Table 1. Planter treatments consisted of utilizing three seeding depths of 0.5, 1.0 and 1.5 inches with each depth paired with three different downforces of none, 100, and 200 lbs applied on each row unit. The selected seed depth and downforce values represented the nominal depth and downforce values utilized by growers across the state of Georgia for planting cotton. Each treatment combination of depth and downforce was replicated four times within dry, nominal and wet field conditions representative of different pre-plant soil moisture. Further, two cotton cultivars differing in seed size and vigor were planting using the same depth and downforce settings within each block. The study was arranged in a factorial arrangement of seeding depth x planter downforce x cultivar within each block and was planted in plots that measured 12 feet (4 rows wide) by 35 feet long. The study was implemented in a strip-split plot design where each planter pass represented combination of one seed depth treatment with different downforce treatments randomized within the same depth. Cultivar treatments were executed in a manner where both cultivars were planted adjacent to each other with left 4-rows were planted in small seeded cultivar and right 4-rows were planted in large-seeded cultivar. All cotton was planted followed by conventional tillage practices in the field and was maintained as per recommendations outlined in UGA cotton production guide (UGA, 2019a).

Table 1. Mean soil moisture content measured within each block represented as dry, nominal and wet field condition during planting.

| **Treatment** | **Irrigation Applied (inches)** | **Soil Moisture Content (% w.b.)** | |
|---|---|---|---|
| | | **Mean** | **Std. Dev.** |
| Dry | 0.0 | 7.04 a | 0.32 |
| Nominal | 0.5 | 8.63 b | 0.52 |
| Wet | 1.0 | 9.92 c | 0.19 |

For data collection, the center two rows were treated as data rows and outside two rows as buffer rows within each plot. A randomly selected 10-ft section towards the middle of the plot from within the data rows was marked using flags in each plot during first emergence data collection at one week after planting. Plant stand counts within the same 10-ft section were conducted at one, two, and three weeks after planting to record crop emergence within each plot. Stand count data was converted to percent crop emergence to standardize data analysis and for comparison among all test treatments. Yield was collected by harvesting the two data rows in each plot and lint weight was measured by ginning samples at University of Georgia's microgin located in Tifton, GA. Lint yield was calculated by dividing the weight of lint in pounds by the harvested area in acres for each plot. All statistical analyses on these data was performed using JMP Pro 13 (SAS Institute Inc., NC, 1989-2007) to determine effect of treatments and perform comparison of means using 95% significance level ($\alpha = 0.05$). An ANOVA analysis with seeding depth, planter downforce and cultivar as main effects was performed within each field soil condition to determine effect of study treatments on crop emergence and yield.

## <u>Results and Discussion</u>

### <u>Crop Emergence</u>

Table 2 provides summary statistics for the crop emergence collected at one, two and three WAP. The p-values from ANOVA analysis for the main effects of soil moisture conditions, cultivar, depth and downforce and their interaction effects on crop emergence are presented in the table. Crop emergence at one, two and three WAP was significantly ($p<0.05$) affected by the main effects of soil moisture conditions at planting, cultivar, seeding depth and planter downforce. The soil moisture x cultivar, soil moisture x depth and soil moisture x cultivar x depth interactions were also significant at the selected 95% significance level whereas all other second and higher order interactions were non-significant ($p >0.05$). The observed trend was valid for crop emergence recorded at one, two and three WAP.

Table 2. Summary Statistics for crop emergence for main effects of pre-plant soil moisture, cultivar, depth and downforce, and their interaction effects at one, two and three WAP (*α=0.05)*.

| **Effects** | **Emergence[a] (p-value)** | | |
|---|---|---|---|
| | **1 WAP** | **2 WAP** | **3 WAP** |
| Soil Moisture (SM) | <.0001 | <.0001 | <.0001 |
| Cultivar (CV) | 0.0011 | 0.0003 | 0.0002 |
| Depth (DP) | <.0001 | <.0001 | <.0001 |
| Downforce (DF) | 0.0202 | 0.0013 | 0.0017 |
| SM X CV | <.0001 | <.0001 | <.0001 |
| SM X DP | 0.0009 | 0.0004 | 0.0044 |
| SM X CV X DP | <.0001 | <.0001 | <.0001 |
| All Other Interactions | >0.05 | >0.05 | >0.05 |

[a] Effects with p-value less than 0.05 are significant at 95% probability

Since a field soil moisture x cultivar x depth interaction existed in the study, Figure 2 presents the crop emergence recorded at different planter depth settings in dry, nominal and wet field conditions for both small-seeded and large-seeded cultivar. The data is arranged by planter depth settings within each field soil conditions along the x-axis in the figure. For dry and nominal field soil conditions, it can be observed that crop emergence increased with an increase in seeding depth from 0.5 inches to 1.5 inches for the large-seeded cultivar. This can be attributed to the high temperatures (90-110º) during planting season in 2019 which resulted in extremely dry soil conditions which were unfavorable for planting cotton seeds at shallower inch seeding depths. Therefore, a deeper planted cotton (1.0 to 1.5 inch) exhibited a better emergence due to availability of adequate soil moisture at that soil depth. A similar trend was observed in wet field conditions for crop emergence in both cultivars but only for planting depths of 0.5 and 1.0 inches. The crop emergence for small-seeded cultivar was not significantly different between 1.0 and 1.5 seeding depth in all field soil conditions at planting. The mean crop emergence was, on average, lower for the small-seeded cultivar than mean emergence for the large-seeded cultivar in most field conditions with an exception of 1.5 inch seeding depth in wet field conditions. In comparison among field conditions, seeds planted at depth of 0.5 and 1.0 inch had a better emergence in wet field conditions followed by nominal and dry field soil conditions for both cultivars. This can be attributed to the presence of adequate soil moisture at planting in top soil in nominal and wet field conditions when compared to field conditions where no pre-plant irrigation was applied leading to dry soil conditions at planting. A high crop emergence was observed in large-seeded cultivar at the seeding depth of 1.5 inch regardless of field conditions whereas the highest crop emergence in small-seeded cultivar occurred at seeding depths of 1.0 and 1.5 inch in wet soil conditions. These results suggested that shallower planting depths (generally 0.5 inch or less) should be avoided to attain adequate stand establishment especially in dry field soil conditions at planting, and large-seeded cultivars can be utilized to overcome emergence issues in less than ideal field conditions at planting.

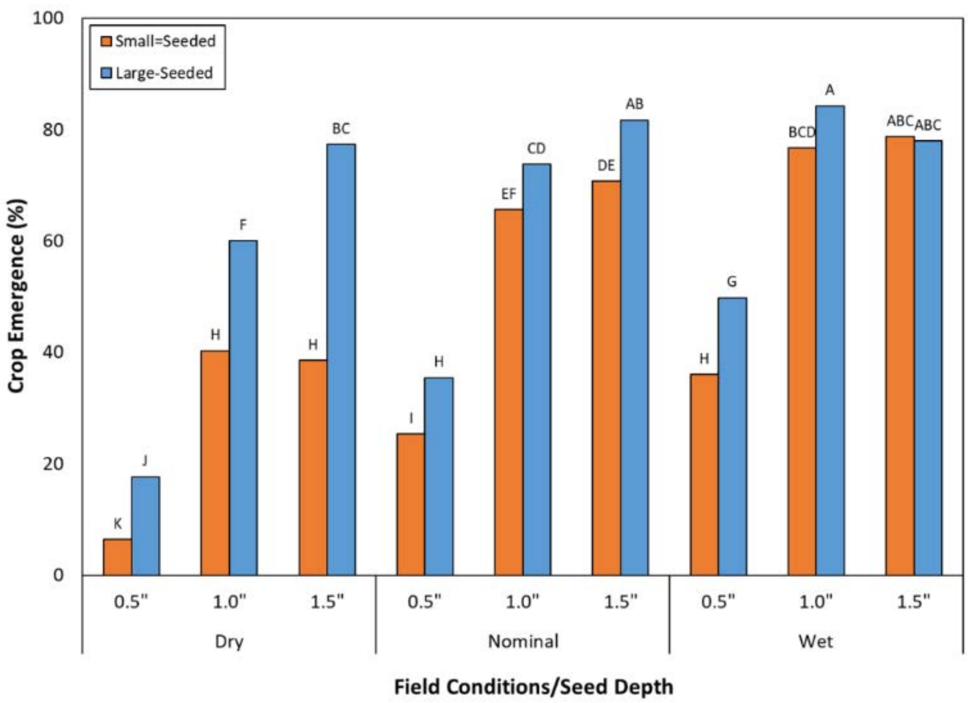



Figure 2. Mean emergence (in percent) recorded at different depth treatments in dry, nominal and wet field soil conditions for the small- and large-seeded cultivar. (Bars with same letters on bars represent treatments that are not statistically different at $p<0.05$)

**Dry Field Conditions**

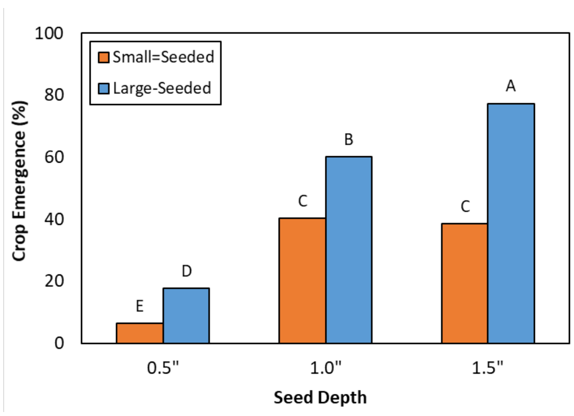
Results from ANOVA analysis for crop emergence at one, two and three WAP for main effects of cultivar, seeding depth and downforce and their interaction effects in dry field soil conditions are presented in Table 3. Results indicate that a cultivar x seeding depth and a cultivar x downforce interaction existed for crop emergence in the field with dry soil moisture conditions whereas all other interactions were non-significant at the 95% significance level. This trend was consistent for crop emergence at one, two and three WAP. For large-seeded cultivar, the crop emergence increased with an increase in seeding depth (Figure 3a) with the highest emergence (77%) observed at 1.5 inch seeding depth.

For the small-seeded cultivar, crop emergence observed at 0.5 inch seeding depth (6%) was significantly lower than the emergence at 1.0 and 1.5 inch seeding depths (39% and 40%, respectively). The crop emergence was significantly higher for the large-seeded cultivar than the small-seeded cultivar at all three seeding depths with emergence differences as large as 39% observed at 1.5 inch seeding depth. For downforce effect, the large-seeded cultivar planted using 100 and 200 lbs of downforce exhibited higher emergence than cotton planted using no additional downforce on planter row-unit (Figure 3b). No significant effect of planter downforce on crop emergence was observed in the small-seeded cultivar as indicated by similar crop emergence among different planter downforces. In comparison among cultivar, the large-seeded cultivar had a higher crop emergence at all three planter downforces used for planting cotton in this study.

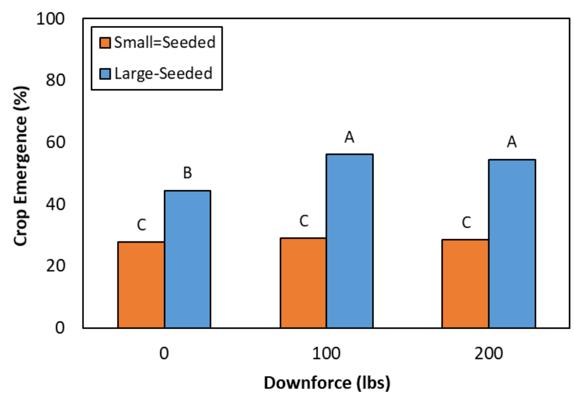
Table 3. ANOVA results (p-values) for crop emergence at one, two and three WAP for main effects of cultivar, depth and downforce, and their interaction effects (*α=0.05*) in field characterized as dry soil conditions.

| **Main and interaction effects** | **Emergence[a] (p-value)** | | |
|---|---|---|---|
| | **1 WAP[b]** | **2 WAP** | **3 WAP** |
| Cultivar (CV) | 0.0025 | 0.0014 | 0.0012 |
| Depth (DP) | 0.0002 | 0.0002 | 0.0002 |
| Downforce (DF) | 0.0216 | 0.0067 | 0.0075 |
| CV X DP | <.0001 | <.0001 | <.0001 |
| CV X DF | 0.0153 | 0.0489 | 0.0315 |
| DP X DF | 0.7991 | 0.6661 | 0.6756 |
| CV X DP X DF | 0.5825 | 0.2705 | 0.3730 |

[a] Effects with p-value less than 0.05 are significant at 95% probability
[b] WAP represents weeks after planting



(a)



(b)

Figure 3. Mean emergence (in percent) recorded at different (a) seeding depths and (b) downforces for the small-seeded and large-seeded cultivars in dry field conditions. (Bars with same letters represent treatments that are not statistically different at p<0.05)

**<u>Nominal Field Conditions</u>**

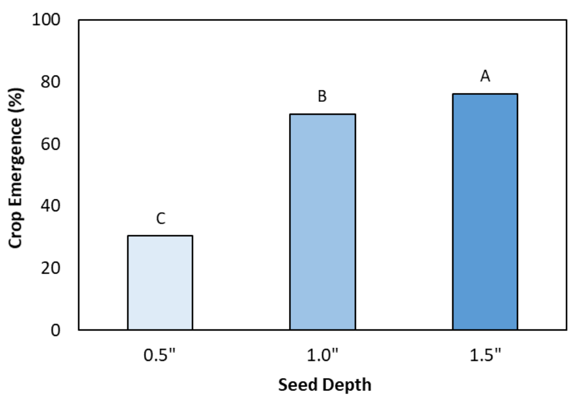
Statistical analysis results from ANOVA for crop emergence at one, two and three WAP in nominal field conditions for main effects of cultivar, seeding depth and downforce, and their interaction effects are presented in table 4. Results indicate that cultivar and seeding depth had a significant effect on crop emergence at one, two and three WAP and downforce did not have significant effect on crop emergence. No significant interactions among cultivar, seeding depth and downforce existed for crop emergence in the field with nominal soil moisture conditions at planting. Reduced crop emergence was observed at the seeding depth of 0.5 inch compared to the emergence attained at 1.0 and 1.5 inch seeding depth (Figure 4a). This was an interesting observation as it is generally assumed that applying 0.5 inch of irrigation prior to planting would provide favorable soil moisture conditions for timely seed germination and emergence. As stated earlier, 2019 planting season during the month of May was characterized by high air and soil temperatures (90-110º F) creating excessively dry top soil conditions in the field. Crop emergence observed at 1.0 and 1.5 inch seeding depth (70% and 76%, respectively) were relatively comparable, however the emergence values were significantly different from each other with 1.5 inch seeding depth exhibiting an overall higher crop emergence. Similar to the emergence trend observed in dry field conditions, the large-seeded cultivar had a significant higher crop emergence (64%) than small-seeded cultivar (54%) in nominal field conditions (Figure 4b).

Table 4. ANOVA results (p-values) for crop emergence at one, two and three WAP for main effects of cultivar, depth and downforce, and their interaction effects (*α=0.05)* in field characterized as nominal soil conditions.

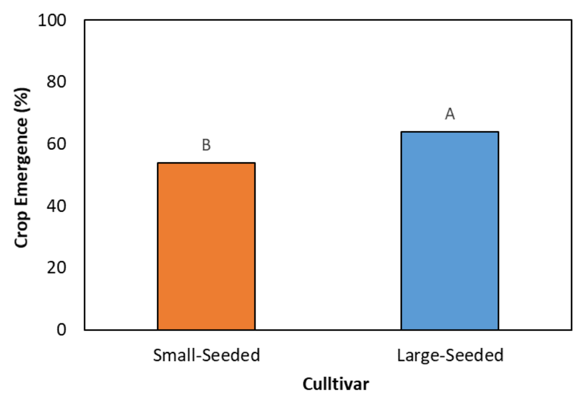
| **Main and interaction effects** | **Crop Emergence[a] (p-value)** | | |
|---|---|---|---|
| | **1 WAP[b]** | **2 WAP** | **3 WAP** |
| Cultivar (CV) | 0.0086 | 0.0053 | 0.0027 |
| Depth (DP) | <.0001 | <.0001 | <.0001 |
| Downforce (DF) | 0.0977 | 0.2099 | 0.1450 |
| CV X DP | 0.7127 | 0.5563 | 0.8551 |
| CV X DF | 0.5296 | 0.7052 | 0.5599 |
| DP X DF | 0.2757 | 0.2401 | 0.2598 |
| CV X DP X DF | 0.6985 | 0.5886 | 0.6491 |

[a] Effects with p-value less than 0.05 are significant at 95% probability

[b] WAP represents weeks after planting



(a)



(b)

Figure 4. Mean emergence (in percent) recorded at different (a) seeding depths and (b) for the small-seeded and large-seeded cultivars in field in nominal field conditions. (Bars with same letters represent treatments that are not statistically different at p<0.05)

## Wet Field Conditions

ANOVA results illustrating the effect of cultivar, seeding depth and downforce and their interaction on crop emergence at one, two and three WAP for cotton planted in wet field conditions are presented in Table 5. Statistical analysis results indicate that cultivar and seeding depth had a significant effect on crop emergence, however a cultivar x seed depth interaction existed for the crop emergence at one, two and three WAP in the field with wet soil conditions at planting. Downforce was significant for crop emergence at one and two WAP but not for the final crop emergence at three WAP. All other interactions were non-significant at 95% probability level. Similar to the emergence results obtained in dry and nominal field conditions, crop emergence was significantly reduced at 0.5 inch seeding depth in both cultivars in wet field soil conditions (Figure 5). The highest crop emergence (84%) was obtained at the seeding depth of 1.0 inch for the large-seeded cultivar whereas the lowest emergence (36%) was observed at a 0.5 inch seeding depth for the small-seeded cultivar. For cultivar comparison, crop emergence was significantly lower for the small-seeded cultivar at 0.5 and 1.0 inch seeding depths whereas similar crop emergence (78% and 79% in small-seeded and large-seeded cultivar, respectively) was obtained at the seeding depth of 1.5 inch in both cultivars.

Table 5. ANOVA results (p-values) for crop emergence at one, two and three WAP for main effects of cultivar, depth and downforce, and their interaction effects (*α=0.05)* in field characterized as wet soil conditions.

| **Main and interaction effects** | **Crop Emergence[a] (p-value)** | | |
|---|---|---|---|
| | **1 WAP[b]** | **2 WAP** | **3 WAP** |
| Cultivar (CV) | 0.0306 | 0.0393 | 0.0339 |
| Depth (DP) | <.0001 | <.0001 | <.0001 |
| Downforce (DF) | 0.0421 | 0.0392 | 0.1319 |
| CV X DP | 0.0045 | 0.0014 | 0.0057 |
| CV X DF | 0.2444 | 0.4034 | 0.3284 |
| DP X DF | 0.3606 | 0.2430 | 0.3369 |
| CV X DP X DF | 0.3054 | 0.2128 | 0.3729 |

[a] Effects with p-value less than 0.05 are significant at 95% probability
[b] WAP represents weeks after planting

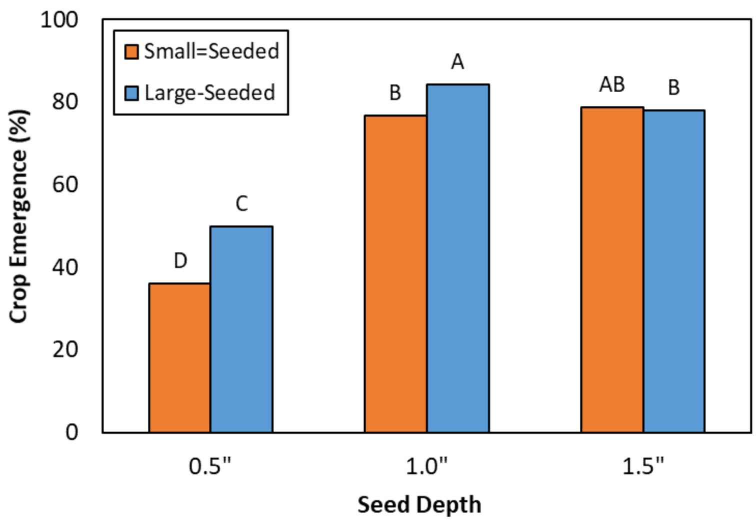



Figure 5. Mean emergence (in percent) recorded at different seed depths for the small-seeded and large seeded cultivars. (Bars with same letters represent treatments that are not statistically different at p<0.05)

**Lint Yield**

Statistical analysis results suggested that lint yield was not affected (p>0.05) by any of the study treatments: field soil moisture conditions at planting, cultivar, seeding depth or planter downforce. No other significant interactions (p>0.05) for lint yield were observed among the main effects of soil moisture conditions at planting, cultivar, seeding depth and planter downforce. In addition, cultivar, seed depth and downforce did not have any significant effect on cotton lint yield in any of the three different field soil moisture conditions at planting. These results were somewhat expected as cotton has an indeterminate growth habit and tends to compensate really well for different production factors that affects early season stand establishment. Several past studies focused on evaluation of different factors (seeding rate, spacing arrangement, seed size, and cultivar) in cotton production have also reported similar results where no treatment effects were observed on lint yield (Harrison et al., 1974; Siebert et al., 2006; Snider et al, 2014)

Table 6 lists the mean lint yield in lbs/ac for the small-seeded and large-seeded cultivar at different seeding depths and planter downforces used for planting cotton in fields characterized as dry, nominal and wet soil conditions at planting. The mean yield ranged from 1113 to 1698 lbs/ac for the small-seeded cultivar, and from 1278 to 1646 lbs/ac for the large-seeded cultivar regardless of the different field soil conditions at planting. Though not statistically significant, the mean yields were, on average, lower for cotton planted in dry soil conditions than mean yields for cotton planted in nominal and wet field soil conditions for both cultivars. It was interesting to note that cotton planted in the field with dry soil moisture conditions at planting yielded the same as cotton planted in the fields with nominal and wet soil moisture conditions at planting despite highly reduced emergence (between 10% and 30%) in the field with dry soil conditions. Similar trends were observed among the cultivars where the small-seeded cultivar with significantly lower emergence in all three field soil moisture conditions exhibited similar yields as the large-seeded cultivar. These results again reiterate that cotton can compensate for varying field and environmental conditions throughout the season. Though yield results did not show any significant effect of seeding depth, planter downforce, cultivar, and field soil moisture conditions at planting on cotton yield, these factors are an important consideration for planting cotton and must be addressed appropriately to ensure timely and uniform crop emergence across the field. Growers with both traditional and advanced planter systems can minimize variations in crop emergence across the field by considering prevalent in-field soil conditions at planting and making necessary adjustments to planting equipment, specifically planter depth and downforce, either before planting or real-time to ensure high planting performance in the field.

Table 6. Cotton lint yield (mean; in lbs/ac) for the small-seeded and large-seeded cultivar obtained at different seed depth and planter downforces in field conditions characterized as dry, nominal and wet soil moisture conditions at planting.

| Seed Depth (in.) | Downforce (lbs.) | Small-Seeded Cultivar | | | Large-Seeded Cultivar | | |
|---|---|---|---|---|---|---|---|
| | | Dry | Nominal | Wet | Dry | Nominal | Wet |
| 0.5 | 0 | 1271 | 1479 | 1476 | 1278 | 1399 | 1416 |
| | 100 | 1322 | 1356 | 1428 | 1492 | 1454 | 1633 |
| | 200 | 1217 | 1592 | 1553 | 1191 | 1343 | 1545 |
| 1.0 | 0 | 1113 | 1339 | 1451 | 1479 | 1532 | 1464 |
| | 100 | 1451 | 1542 | 1402 | 1508 | 1600 | 1646 |
| | 200 | 1335 | 1556 | 1477 | 1438 | 1403 | 1500 |
| 1.5 | 0 | 1698 | 1574 | 1588 | 1553 | 1447 | 1568 |
| | 100 | 1142 | 1495 | 1321 | 1464 | 1373 | 1525 |
| | 200 | 1448 | 1550 | 1279 | 1543 | 1364 | 1459 |

## **Summary**

Challenging weather conditions each year presents diverse field conditions to growers during the planting season. The main objective of this study was to investigate the effect of seeding depth and planter downforce on crop emergence and yield in two cotton cultivars planted in different at-plant soil moisture conditions in the field. Field conditions representative of relatively dry, nominal and wet soil moisture conditions were attained by applying different (none, 0.5 and 1.0 in.) irrigation amounts to three different blocks of equal area in the same field. Two cotton cultivars (a small-seeded and a large-seeded) were planted at three seeding depths (0.5, 1.0 and 1.5 inch) paired with three different planter downforces (none, 100 and 200 lbs.) in field conditions characterized as dry, nominal and wet soil moisture conditions at planting. Statistical analysis suggested a significant soil moisture x seeding depth x cultivar interaction ($p<0.05$) where crop emergence increased with an increase in seeding depth from 0.5 to 1.5 inch for the large-seeded cultivar, and from 0.5 to 1.0 inch for the small-seeded cultivar. Crop emergence was reduced significantly at 0.5 inch seeding depth in all field conditions at planting. Both the small-seeded and large-seeded cultivar planted at 1.5 inch in wet field conditions exhibited higher crop emergence than cotton planted in the dry and nominal field conditions. Excessively high temperatures during planting season created extremely dry field conditions unfavorable for planting cotton at shallower seeding depths (< 1.0 inch) and hindered crop emergence. In all three field conditions at planting, the large-seeded cultivar provided higher crop emergence than the small-seeded cultivar irrespective of the seeding depth and planter downforce treatments. A seeding depth x cultivar interaction existed in both dry and wet field conditions where a seeding depth x downforce interaction was also observed in dry field conditions at planting. Higher emergence differences among cultivars were observed in the dry field conditions than emergence differences observed in wet field conditions at planting. For cotton planted in dry soil moisture conditions, planter downforce impacted crop emergence in the large-seeded cultivar but it did not have significant effect on emergence in the small-seeded cultivar. The large-seeded cultivar planted using 100 and 200 lbs of downforce had better crop emergence than when no additional downforce was utilized for planting cotton. This result was attributed to better seed placement in dry field conditions at planting when appropriate planter downforce was utilized. For cotton planted in nominal field soil conditions at planting, both seeding depth and cultivar affected crop emergence but no interaction was present among these factors. Large-seeded cultivar and 1.5 inch seeding depth provided a higher crop emergence in nominal field conditions at planting. Yield data analysis indicated no significant effect of field soil moisture conditions at planting, cultivar, seeding depth and planter downforce on cotton lint yield. Mean lint yields ranged from 1113 to 1968 lbs/ac and from 1278 to 1646 lbs/ac for the small-seeded and large-seeded cultivars, respectively. Results from the study emphasize the importance of careful selection of planter parameters (seeding depth and downforce) and cotton cultivar based on prevalent in-field soil conditions at planting to maximize crop emergence potential across the field.

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