EFFECT OF CLEANING TREATMENTS ON COTTON FIBER QUALITY

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Introduction

Cotton fiber quality can be affected by various factors, such as variety, environment, and cultural practices (Brown et al., 2004). Along with other factors, cleaning during the ginning process could have a significant impact on certain fiber quality parameters (Boykin et al., 2010; Li et al., 2010). Under-cleaning would not provide clean cotton fiber and could result in price penalization to cotton growers, while over-cleaning would create excessive short fibers and lower fiber quality as well (Anthony 1990). There must be a balance between the clean cotton and long fiber. Therefore, understanding what fiber quality parameters can be affected by different ginning practices is critical to enable cotton growers to achieve the maximum profit.

The microgin at The University of Georgia Tifton Campus uses the same equipment layout used in a typical commercial gin but all machine parts are one-foot wide versus 8-10 feet wide in commercial gins. The seed cotton cleaner and lint cleaners can be bypassed in the UGA microgin. There is an option to use one, two, or even no lint or seed cotton cleaners depending on how the researcher wants the cotton to be processed. Therefore, it provides an opportunity for researchers to study the effect of certain ginning components on fiber quality.

The overall goal of this study was to utilize the UGA microgin to study the ginning effect on Cotton fiber quality. Cotton fiber quality parameters measured by the HVI, AFIS Pro, as well as Shirley Trash Analyzer were compared.

Materials and Methods

Cotton was grown in Colquitt County in Georgia and harvested in October and November, 2009. Three cotton cultivars, i.e., DL555, FM1740, PHY370, were selected in this study due to their popularity and wide availability in Georgia. Cotton samples were stored in trailers and ginned at the UGA microgin later.

The University of Georgia microgin was manufactured by Lummus (Lummus Inc., Savannah, GA) and Cherokee (Cherokee Fabrication Inc., Salem, AL), using the same equipment layout as used in a typical commercial gin. The equipment layout of the microgin was arranged in a standard configuration for spindle picked cotton (Figure 1).

During the ginning process of the microgin, seed cotton was cleaned using a six cylinder incline cleaner and a stick machine (defined as seed cotton cleaner #1), followed by an additional six cylinder incline cleaner feeding into a Trashmaster® cleaner (defined as seed cotton cleaner #2). Upon exiting the cleaners, the cotton

entered an extractor feeder and a 24-saw Lummus gin stand. After lint and seeds were separated in the gin stand, the lint was cleaned by one air jet lint cleaner and one saw type lint cleaner. Six cleaning treatments were created by various combinations of two seed cotton cleaners and the saw type lint cleaner as follows: 1) All used, 2) Bypass lint cleaner, 3) Bypass #2 seed cotton cleaner, 4) Bypass #1 seed cotton cleaner, 5) Bypass both #2 seed cotton cleaner and lint cleaner, and 6) Bypass both #1 seed cotton cleaner and lint cleaner.

When cotton samples were being ginned in the microgin, seed cotton samples from the trailer were continuously collected by the vacuum pipe and ginned by the microgin. The sample size was controlled by the ginning time: roughly 13-14 minutes were used to gin cotton samples before the vacuum pipe was shut off, which was equivalent to 80-100 pounds of lint for each sample. Three replicates were used for each treatment.

The fiber quality test was conducted in the USDA ARS Cotton Quality Research Station (CQRS) in South Carolina. Four fiber quality parameters from the HVI (Count, Leaf, Uniformity, and UHM) and five parameters from the AFIS PRO (VFM, Total count, L(w), SFC, and Neps) were measured and evaluated. The Shirley Trash Analyzer is an instrument to separate trash and foreign matter from lint by mechanical methods. It provides a more accurate trash measurement than the HVI and AFIS. Two parameters from the Shirley Analyzer were used: visible and invisible.

The one-way analysis of variance (ANOVA) was conducted to test equal means across six cleaning treatments in all quality parameters. Tukey's LSD (least significant difference) was chosen to determine the significant difference between treatments with a significance level of 0.05. Standard error was used to describe the variation of the mean. The SAS statistical software (SAS Institute, Cary, NC) was used for statistical tests and data analysis.

Results and Discussion

For HVI Trash Count (Figure 2), lint ginned by treatment 2, 5, and 6 which all bypassed the lint cleaner had higher Trash Count than the lint ginned by treatment 1, 3 and 4 which used the lint cleaner. No significant difference was observed among treatments 1, 3, and 4 which all used the lint cleaner, but used different seed cotton cleaners. This might suggest that the seed cotton cleaner may not be as efficient as lint cleaners in determining the final fiber trash content. This pattern was consistent in all three cotton cultivars. Although the Leaf grade reflected a similar pattern, the difference was not significant across six treatments. One reason is that the Leaf grade is a classer's subjective measure; the second reason is that the Leaf grade is categorical data, instead of numerical data, resulting in insignificance statistically.

For HVI Uniformity (Figure 3), lint ginned by treatments 2, 5, 6 had significant higher uniformity than that by treatments 1, 3, and 4. This pattern is consistent in FM1740 and PHY370, but not so in DP555. Among three cultivars, DP555 had lower uniformity than

the other two cultivars regardless of treatments. PHY370 had the highest uniformity among three cultivars.

For HVI UHM length, no significant difference was observed across six treatments in all three cultivars. This indicates that seed cotton cleaning and lint cleaning had an effect in creating short fibers (for most cultivars) but the UHM length was not affected significantly.

For AFIS Visible Foreign Matter (VFM), there was no significant difference across six treatments in both DL555 and FM1740 with the exception of PHY370 which exhibited a higher VFM value in treatment 6 than in other treatments (Figure 4). For Total Trash Count/g, lint ginned by treatments 2, 5, and 6 always had higher trash count values than that ginned by treatments 1, 3, and 4. This was a similar pattern to that observed in HVI trash measurement.

For AFIS length measurement (Figure 5), both the Length by weight and Short Fiber Content did not exhibit significant differences across six treatments in almost all three cultivars except for PHY370 in which treatment 5 yielded lint with higher Length than treatment 3. Among three cultivars, FM1740 had slightly higher lint than the other two cultivars, and PHY370 had the lowest Short Fiber Content.

FM1740 and PHY370 did not show a significant difference in AFIS Neps across six treatments (Figure 6). In DL555, lint ginned by treatments 1, 3, and 4 had significantly higher Neps than that ginned by treatments 2, 5 and 6. This result suggests that more Neps are likely to be created when the lint cleaner is used.

For Shirley Trash Visible (Figure 7), a very clear and consistent pattern was observed that lint ginned by treatments 2, 5, and 6 had significantly higher visible trash than that ginned by treatments 1, 3, and 4 in all three cultivars. Treatment 1 always had the lowest visible trash because all cleaners were used in this treatment. For Shirley Trash Invisible, DP555 and PHY370 did not exhibit significant differences across the six treatments. In FM1740, lint ginned by treatments 2 and 5 had significantly higher invisible trash than that ginned by treatments 1, 3, and 4.

Conclusions

Results from this study showed that cleaning treatments had more significant effect on fiber trash content than on fiber length. Treatments 2, 5, and 6 (which all bypassed the lint cleaner), were more likely to create lint with higher trash content but less short fiber content. Results suggest that the lint cleaner was crucial to reducing trash and inducing short fibers. AFIS Neps results indicated that lint had less Neps when less cleaning equipment was used. Shirley trash Visible is a better indicator than the Invisible to characterize trash on the fiber. Among three cultivars, PHY370 had the least short fiber content in these cleaning treatments.

Acknowledgements

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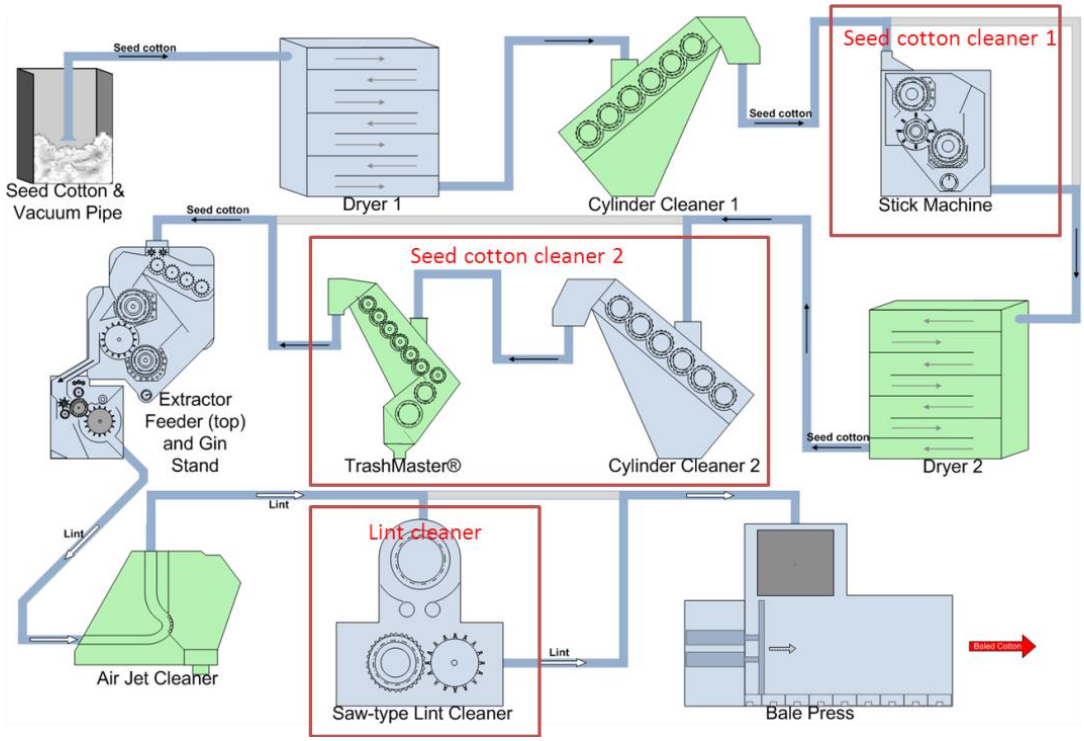


Figure 1. Diagram of the UGA microgin

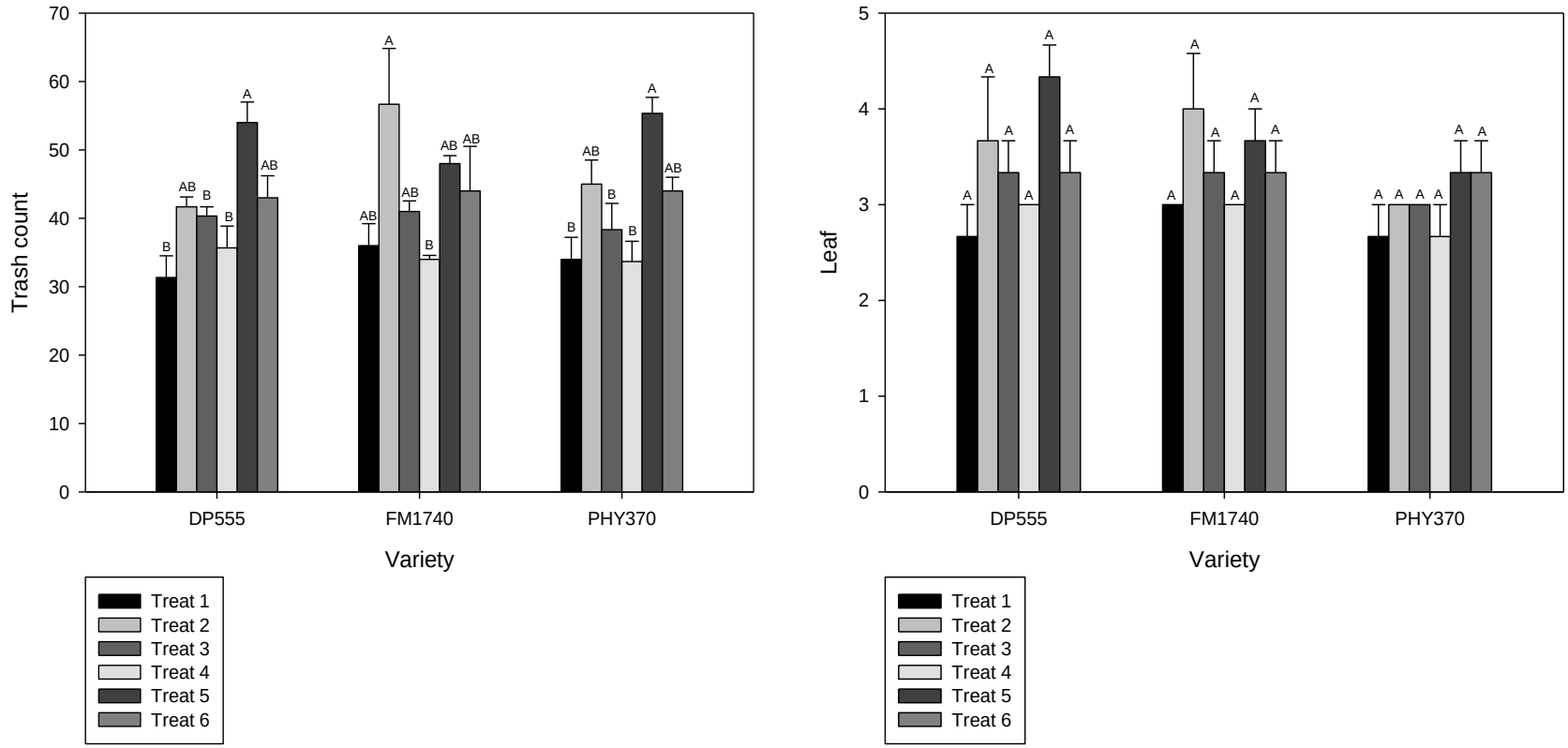


Figure 2. HVI trash measurements (Leaf and Trash Count)

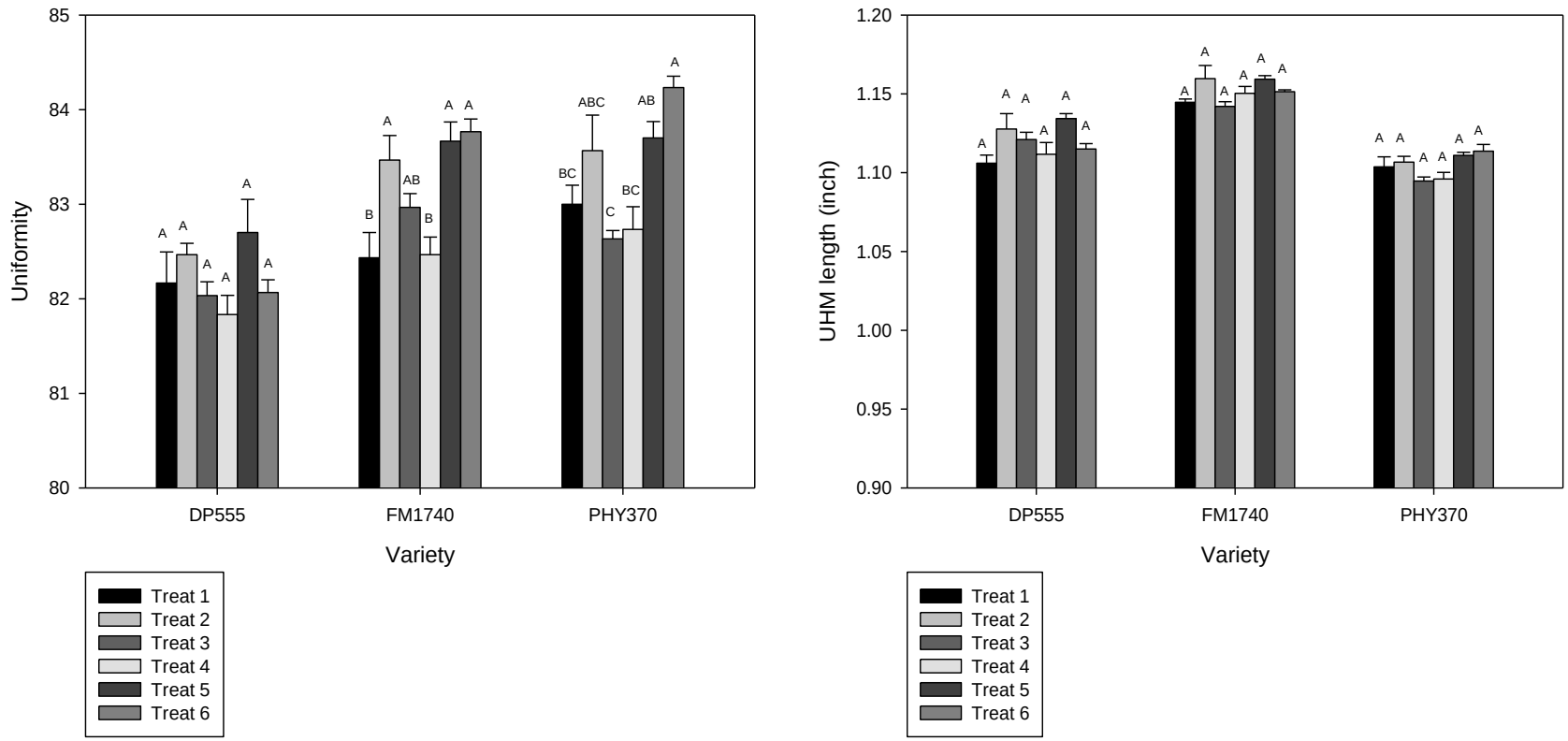


Figure 3. HVI length measurements (Uniformity and UHM length)

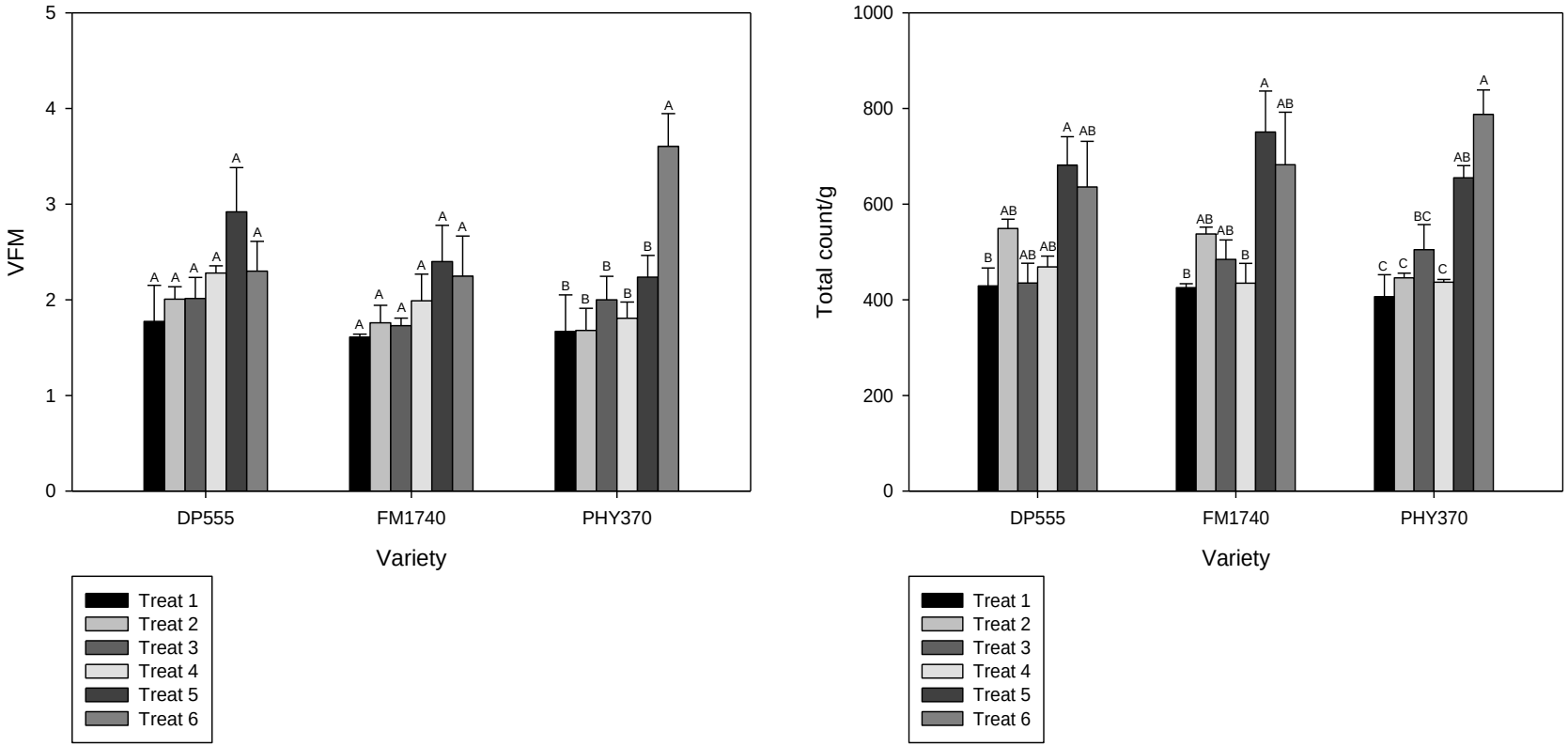


Figure 4. AFIS trash measurements (VFM and Total Count/g)

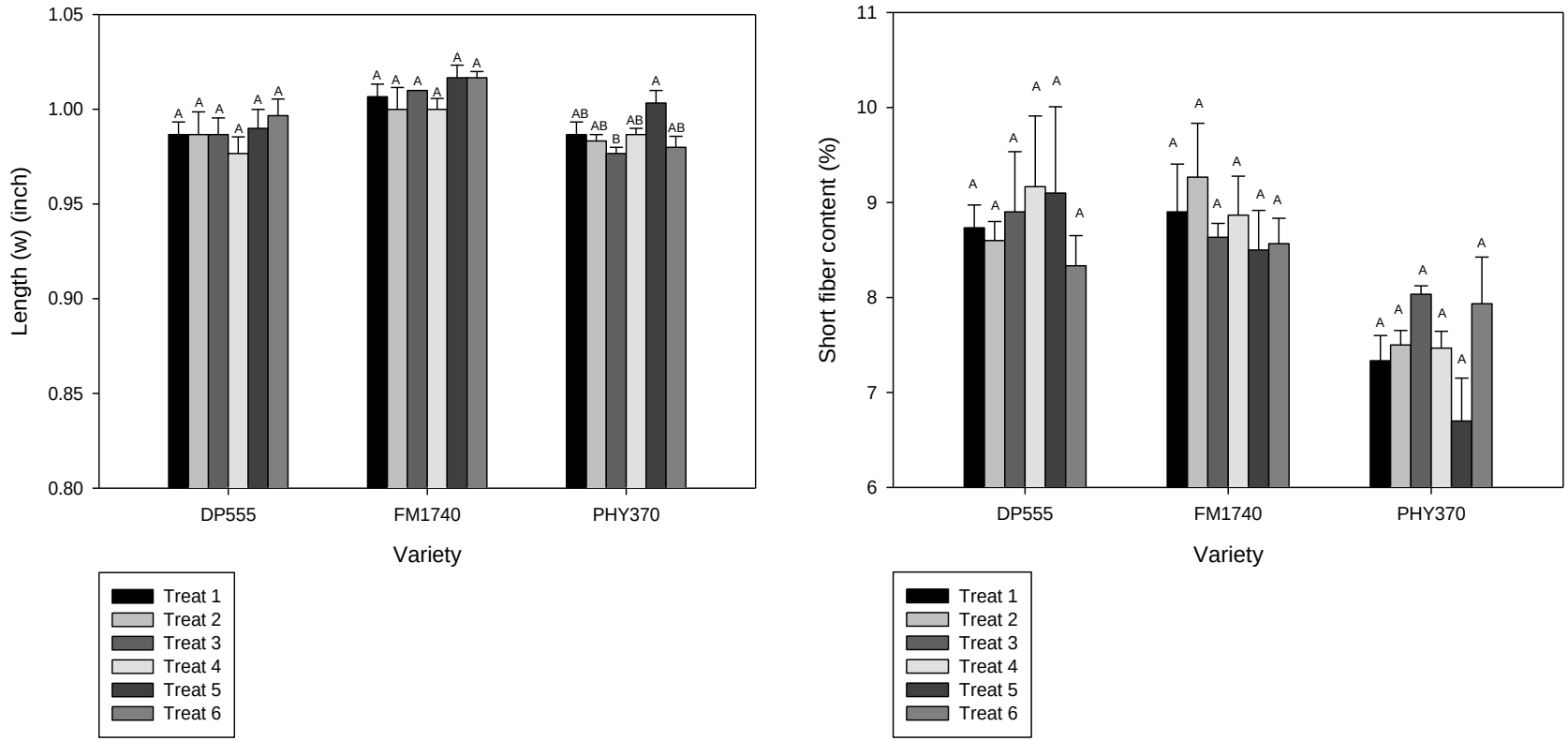


Figure 5. AFIS length measurements (L(w) and SFC)

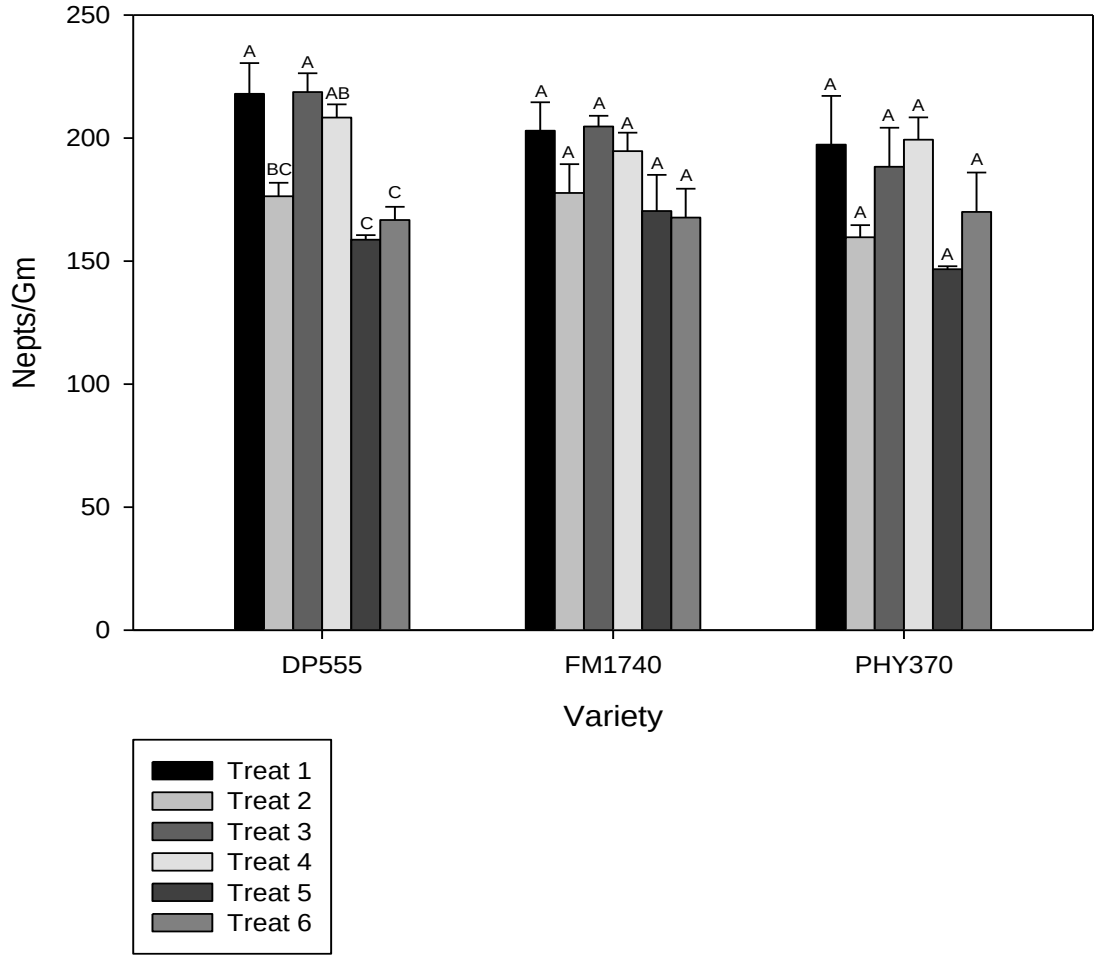
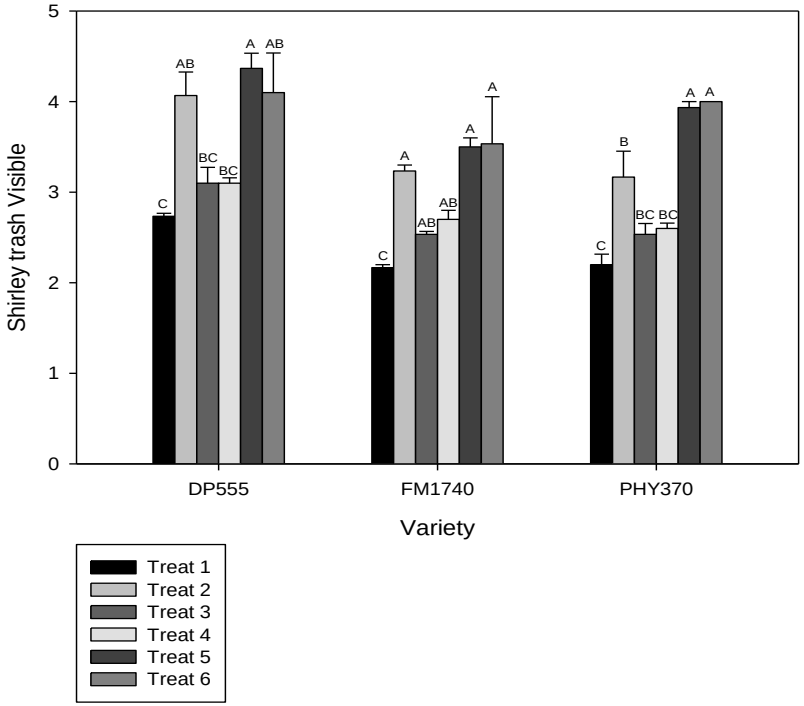


Figure 6. AFIS Neps measurements (Neps/Gm)



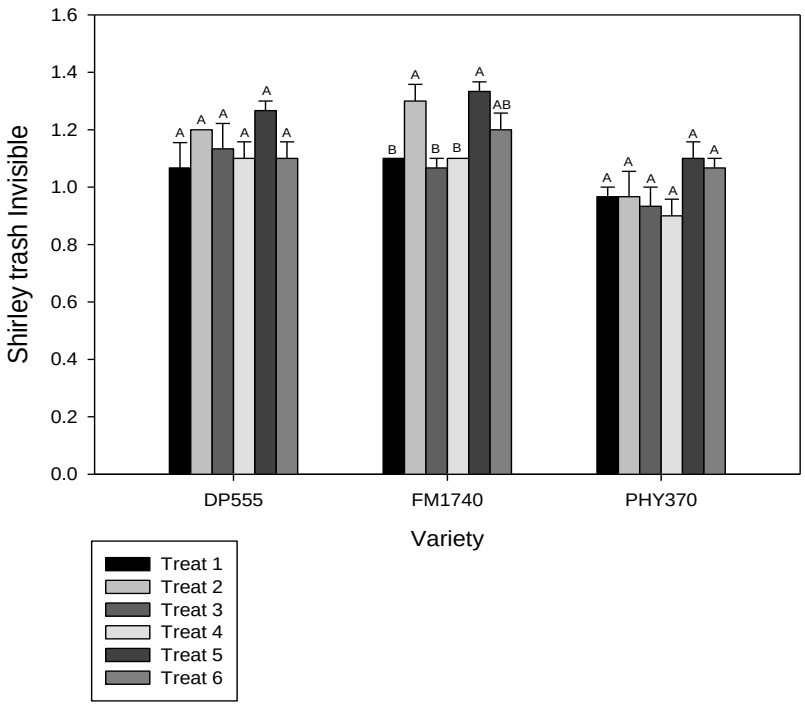


Figure 7. Shirley trash measurements (Visible and Invisible)