A Comparison of Textile Pretreatment Methods In Direct-to-Garment Printing

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Abstract

This study tested a variety of pretreatment options to determine the best method for use with the Epson Sure Color F2100 DTG printer. Pretreatments tested included hand spray options as well as fabrics pretreated by the manufacturer. Textiles consisted of a sampling of cotton and cotton blends. Each pretreatment was applied to the fabric sample (except for the manufacturer treated fabrics), and a cyan, magenta, yellow, and black test target was printed on each sample. The i1Basic Pro 3 Plus spectrophotometer was used to gather CIELAB color data. Once all color readings were compiled, each fabric sample and coating were compared, and the textile with the best overall color fastness was identified.

Introduction

The idea for this project originated from a previous study examining the color fastness of various untreated textiles using the Roland B12 direct-to-garment printer. This particular unit does not print white ink and, therefore, did not require textile pretreatment before printing (Roland, n.d.). Eight different fabric blends were tested, and overall, 100% polyester performed the best, while the viscose/bamboo/cotton blend performed the worst. In general, yellow had the poorest color fastness from the CMYK test target printed. This project led to the question of whether pretreatment would have helped maintain the color during the laundering process. Research suggests that "light garments do not technically need to be pretreated to get a good print; however, more print shops choose to use a light garment pretreat, which results in brighter, more vibrant prints as well as improved washfastness" (Donovan, n.d.). The goal of this study was to determine if pretreatment provides any improvement in color fastness in light- colored textiles.

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Pretreatments are specifically designed to be used with white inks due to their chemical makeup (Robert, 2022); however, this study sought to examine if the pretreatment provided any color improvements to CMYK inks. The research questions were: 1) Do pretreatments impact the color fastness of light shirts in direct-to-garment printing? 2) Does the type of pretreatment and application play a role in color fastness? 3) Do cotton or cotton blends perform better?

The significance of this research is two-fold. The Epson DTG printer is a newly acquired unit in the Graphic Communications Department at Clemson University. This printer will be used in the classroom in introductory and upper-level courses. The results of this research will provide both faculty and students with recommendations concerning the best pretreatment for optimal color and quality of printed textiles. Regarding industry, these findings can offer manufacturers and consumers updated recommendations related to the best overall pretreatment options for light-colored textiles in direct-to-garment printing.

Methods and Procedures

Most units that print with white ink must pretreat for the ink to adhere to the textile. Current pretreatment methods include hand spraying onto the garment (Walker, 2022). Options for pretreatment application by hand include a pressurized sprayer or aerosol can. These are relatively inexpensive methods that are best for lighter production, such as in educational institutions. Some pretreatment units also automatically spray pretreatment onto the textile (Walker, 2022). These are generally more expensive and are usually only necessary for high-volume production. Manufacturer treated garments are also options for pretreatment.

The direct-to-garment printer selected for this project was the Epson Sure Color F2100. This unit has a large platen and additional substrate capabilities. This unit also prints white ink, whereas the Roland B12 does not. The decision was made to test two different types of hand-spraying pretreatments and one brand of manufacturer pretreated. Two types of fabric, 100% cotton and 60/40% cotton/poly blend, were selected for testing. The decision was made not to test polyester because of the difficulty in acquiring manufacturer pretreated light fabrics.

There are several pretreatment options on the market today. When selecting hand spray pretreatment options appropriate for the Epson printer, it was determined that Firebird and AlbaChem would be applicable due to their inexpensive cost and the ease and time of receiving the pretreatments. CheaterTee manufacturer treated shirts were selected for testing based on similar factors and the wide range of shirt brands available. To maintain consistency in materials, all untreated and manufacturer-treated shirts, both cotton and cotton blends, were Gildan brand. Eight textile samples were tested in this research: Firebird pretreat (cotton & cotton blend,) AlbaChem pretreat (cotton & cotton blend), CheaterTee (cotton & cotton blend), and Untreated (cotton & cotton blend).

The first step in the project was to pretreat and dry the untreated shirts according to recommendations from Lawson Screen and Digital Products, where the Epson unit was acquired. A heavy spray-on coat of the Firebird and AlbaChem pretreatments was applied to each shirt. The pretreatment was then dried using a George Knight flatbed swing press. The temperature was set to 335 degrees Fahrenheit. A single sheet of paper was placed on top of the pretreatment, and the heat press hovered over the fabric for 15 seconds; then, the press was clamped at medium pressure for an additional 30 seconds. The shirts then continued to dry overnight. Based on a similar previous study, a test target was prepared that consisted of 100% cyan, magenta, yellow and black. After each sample was printed, the shirts were cured using the same heat press unit. The press was set at 335 degrees Fahrenheit and hovered over the sample for 30 seconds; then, light pressure was applied for one additional minute. The i1Basic Pro 3 Plus spectrophotometer was used to gather initial CIELAB color data readings. Samples were then laundered in home washer and dryer units according to the domestic laundering equivalency recommended by the International Organization for Standardization (ISO) standard for testing color fastness. Five total launderings were completed using the recommended temperature not exceeding 70 degrees Celsius.

Results and Discussion

After the first wash, test targets were measured using the spectrophotometer. The readings were then recorded, and the process was repeated an additional four times. Readings from the five separate launderings and eight samples were input into Microsoft Excel, where Delta E 94 for textiles calculations were recorded. Figure 1 shows Delta E readings after the first laundering for each color, textile, and pretreatment.

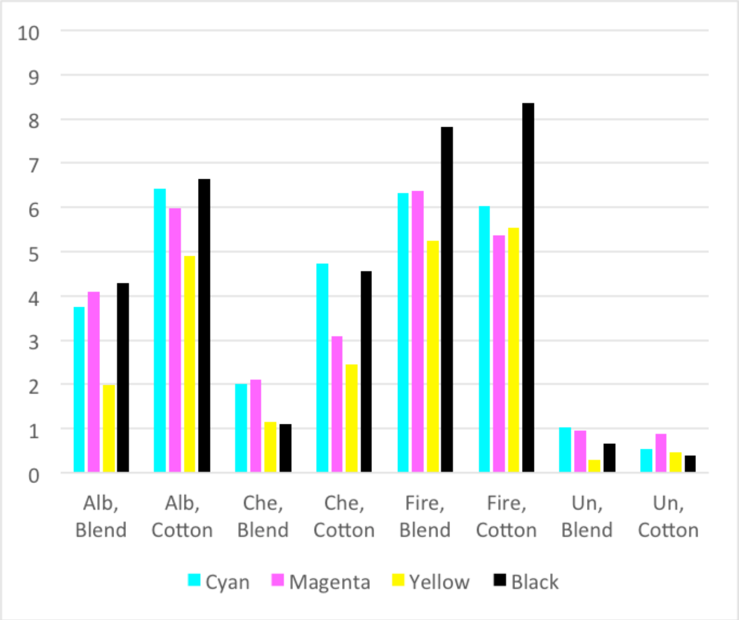

Figure 1. *DE results for each textile and pretreatment tested after laundering one.*

Both untreated shirts performed the best, followed by the manufacturer treated CheaterTee shirts. The hand pretreated shirts did not do as well, with the Firebird pretreatment having the highest readings overall. Black consistently had the highest Delta E scores in the pretreated shirts, while yellow had the lowest in all samples. This was interesting because, in the previously mentioned study using the Roland printer, results showed that yellow performed much worse than cyan, magenta, or black. The colors were also more inconsistent in the untreated and CheaterTee samples. In general, the cotton/poly blends produced better than the 100% cotton fabrics, except for the untreated shirts. Figure 2 shows the results after laundering two.

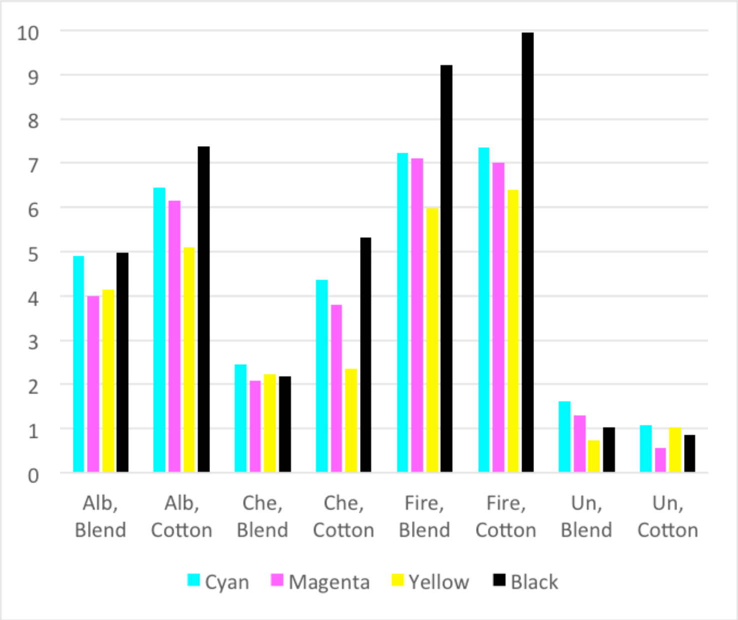

Figure 2. *DE results for each textile and pretreatment tested after laundering two.*

Delta E scores increased, indicating some color change after the second laundering. All other results remained consistent with those from wash one. Figure 3 shows the results after laundering three.

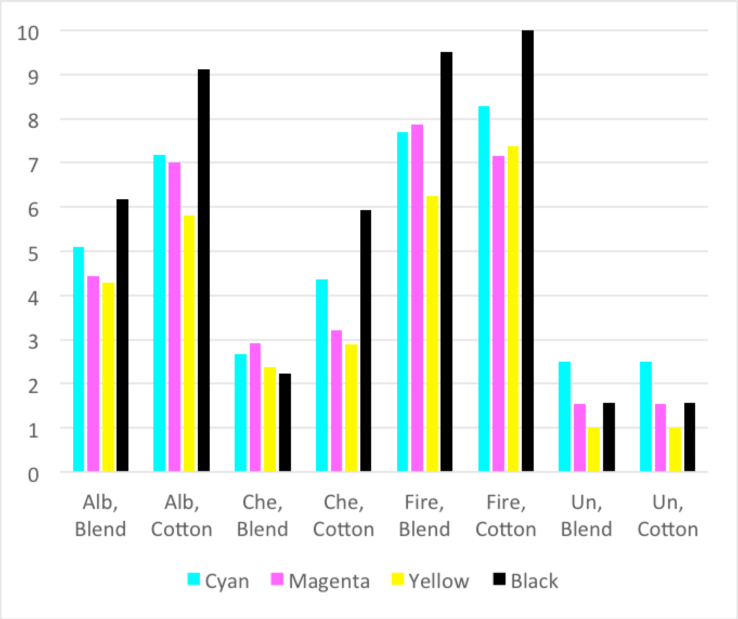

Figure 3. *DE results for each textile and pretreatment tested after laundering three.*

The researcher was particularly interested in determining if readings would eventually plateau, but that did not appear to be the case as the readings consistently went up. Again, the hand pretreated fabrics had the highest Delta E readings for color fastness, while the untreated fabrics performed more favorably. The 100% cotton did not perform as well as the cotton blends, and overall, black had the highest Delta E readings, and yellow had the lowest. Figure 4 shows the results after laundering four.

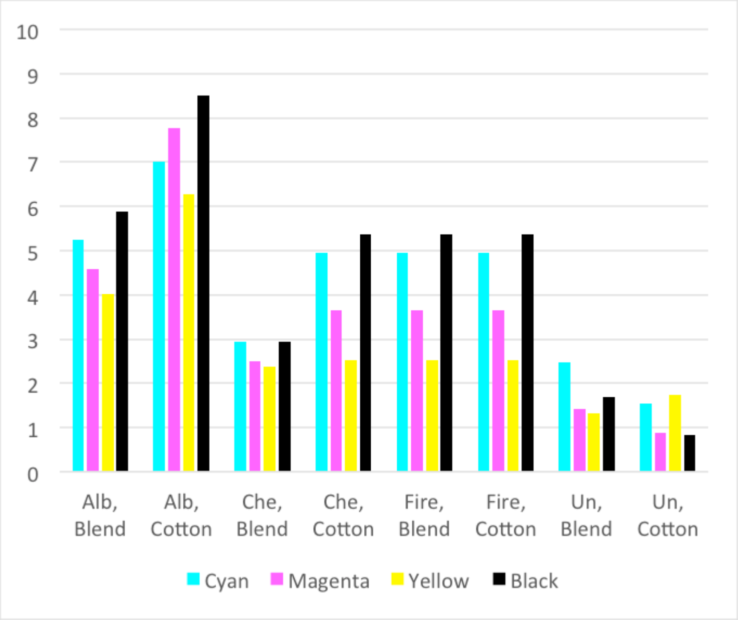

Figure 4. *DE results for each textile and pretreatment tested after laundering four.*

In wash four, the readings changed slightly, with the Firebird pretreatment outperforming the AlbaChem for the first time in testing. All Delta E readings were lower or about the same as wash three, with exception of AlbaChem. The blends continued to perform better and yellow continued to have the lowest Delta E scores. Figure 5 shows the results after the final laundering.

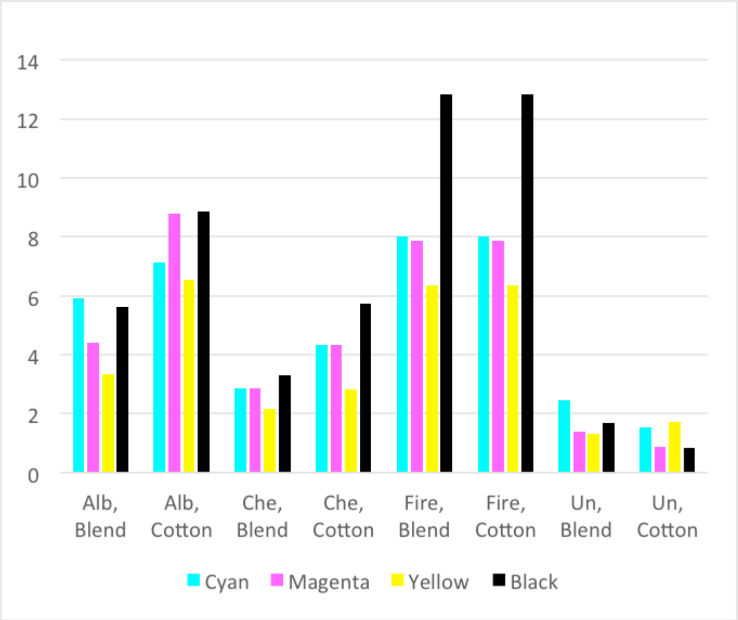

Figure 5. *DE results for each textile and pretreatment tested after laundering five.*

This chart shows the results from the final round, which was based on a 14-point scale indicating higher Delta E readings overall. The untreated fabrics had the best color fastness in all colors, though the untreated cyan blend was very close to the CheaterTee cyan reading. Overall, the Firebird pretreat had the highest Delta E scores, except for the AlbaChem magenta on the 100% cotton fabric. Among the pretreated fabrics, black performed the weakest with the most color change while yellow performed favorably with the least amount. However, this was not the case with the untreated fabric, where magenta performed better. Finally, the blends again had the best color fastness except for the 100% cotton untreated fabric. The following figures show before and after photographs of the fabrics. Figure 6 shows pictures of the hand treated (AlbaChem and Firebird) after laundering one. Figure 7 demonstrates the color change of those same samples following wash five. Figure 8 shows photographs of the manufacturer treated fabrics (CheaterTee) and the untreated fabrics following wash one, while Figure 9 shows those fabrics following wash five.

Figure 6. *AlbaChem and Firebird fabrics following laundering one.*
AlbaChem samples are on the left, and Firebird on the right.

Figure 7. *AlbaChem and Firebird fabrics following laundering five.*
AlbaChem samples are on the left, and Firebird on the right.

The color change is significant, particularly noticeable in black and cyan in the hand treated fabrics.

Figure 8. *CheaterTee and untreated fabrics following laundering one.*
CheaterTee on the left and untreated on the right.

Figure 9. *CheaterTee and untreated fabrics following laundering five.*
CheaterTee on the left and untreated on the right.

The color difference is most significantly noticeable on the CheaterTee shirts in black and cyan. The untreated shirt maintained relatively good color fastness throughout.

To summarize the findings from this study, Firebird pretreatment performed more unfavorable except for wash four where AlbaChem had higher Delta E color readings. Untreated fabrics performed better in all rounds of testing. Cotton/poly blends performed the best, except for untreated 100% cotton. Black and cyan had the poorest color fastness at the conclusion of the launderings. Yellow had the best color fastness overall.

Conclusions

To answer the initial research questions: 1) Do pretreatments impact the color fastness of light shirts in direct-to-garment printing? Yes, they do. In this particular study, they had a negative impact, which conflicts with suggestions that pretreatment creates more vibrant, longer-lasting color. 2) Does the type of pretreatment and application play a role in color fastness? Yes, it did in this specific study. The manufacturer pretreated shirts had better results than the hand pretreated ones. Finally, 3) Do cotton or cotton blends perform better? Overall, except for the untreated fabric, cotton blends had better results.

Some notable limitations in this research include the amount and application of pretreatment applied by hand. The researcher did not measure the exact amounts of pretreatment. Shirts were pretreated until saturated. Also, one pretreatment was applied with a spray bottle and the other with an aerosol can. Both factors could have impacted the overall performance of the pretreatment in preserving the overall color fastness after laundering. Another limitation relates to pretreatment drying after application and the curing process post-printing. The settings were based on recommendations from a specific manufacturer and could have, again, impacted the color quality of the prints.

Future research related to this study includes examining particular ink properties and their chemical makeup, how those factors impact color fastness in direct-to-garment printing, and their interaction with pretreatments. It would also be interesting to replicate this study using dark-colored textiles. Additional studies to be conducted include utilizing manufacturer treated garments as well as hand-treated garments. Comparisons could be made regarding the pretreatment and application, as well as comparisons with the fabrics themselves. Overall, this study adds value to the existing body of limited research on direct-to-garment printing and more specifically pretreatments and their application.

References

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