TEXTILE PROCESSING EVALUATION OF SOUTHEASTERN COTTONS

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Abstract

Six cottons were selected from the Southeast to study the influence of varieties and ginning treatments on fiber properties, spinning performance and yarn quality characteristics. Five of these cottons were selected from South Carolina and one from North Carolina. The South Carolina cottons were from the same general area and were produced using typical practices for the area. The North Carolina cotton was a UNR (ultra narrow row) cotton. It was included in the study to determine changes/modifications in ginning that might be necessary in ginning UNR cottons. From this study it appears that varieties had the most influence on fiber properties, spinning performance and yarn quality measurements. The number of lint cleaners was second most important, followed by super mote settings. Super mote settings influenced a number of fiber property measurements. However, super mote settings showed little or no influence on spinning performance and yarn quality measurements.

Introduction

Textile manufacturers are continually searching for ways to improve manufacturing performance, product quality and at the same time lower costs. They have worked within their plant, at each stage in the manufacturing process, to determine the actual level of performance and compared that to the expected level. Within their plant they have worked to identify why the actual and expected levels of performance are different. They understand that any number of factors might cause these differences, including raw materials (fibers), a machine, environmental conditions, and people.

They have also worked with machinery suppliers to upgrade technologies, replacing older less efficient machines with newer and improved processing machinery. Fiber utilization systems have become more direct and focused on meeting the specific requirements of the textile manufacturer. At the same time management systems have been implemented to educate and involve employees at every level. During the past few years, manufacturers have begun to focus their efforts on environmental conditions and its influence on the processability of fiber as the fiber moves along its journey from the beginning-to-end of the manufacturing process.

More recently, textile manufacturers have begun focused on ginning and cottons from different producers as a potential source for varying fiber quality characteristics. Perkins and Bargeron have reported that cotton varieties, growing conditions, harvesting, ginning and lint retrievers affect fiber length and short fiber content of cotton. Rogers has also reported on the influence of ginning on spinning performance and yarn quality. Results from these and other studies clearly show that fiber property measurements on bales of cotton from ginning vary. Textile manufacturers know that fiber property measurements on bales vary and that some vary more than others. It is this variation in fiber property measurements that contributes to the concerns of textile manufacturers as they seek to optimize all textile systems.

To manage variation in fiber quality measurements in mix laydowns several systems have been developed and employed. Two such systems are the EFS system and direct shipment of mix laydowns according to pre-specified requirements. These systems have contributed to a reduction in the levels of variation in mix laydowns and they have provided for a more consistent utilization of cottons.

It is essential that all segments of the cotton-textile-apparel complex understand the influence of fiber quality measurements on each segment of the industry complex. That is, each segment is (or should be) working toward a system that optimizes technical and economic efficiencies for the entire cotton-textile-apparel complex.

The focus of this study is to further develop the body of information/knowledge on fiber properties and their contributions to processability and quality of textile products produced from Southeastern cottons.

Materials and Method

Cottons for this study were selected from North and South Carolina, Table 1. In South Carolina five producers agreed to participate in the study. From each of these producers a variety was selected and a module of that variety was harvested and stored at the gin. Each variety was produced/harvested using typical practices and procedures for the region.
A module of ultra narrow row (UNR) from North Carolina was obtained to include in this study. The primary purpose for including this module was to study UNR cotton and to

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develop a set of information on ginning UNR stripper cotton at a typical South Carolina gin. Further, it was an opportunity to compare the processability and textile product quality of one UNR cotton with five conventional cottons.

Near the end of the 1997 crop year the six modules were ginned, back-to-back, using typical ginning methods and procedures – except for stages of lint cleaners and super mote settings. Two lint cleaner conditions (one lint cleaner and two lint cleaners) and two super mote conditions (with super mote and without super mote) were used to give a total of four ginning conditions. Seed cotton processing/cleaning was constant for each ginning condition. These 24 bales of lint cotton (six varieties and four ginning conditions) were shipped to the USDA, ARS, Cotton Quality Research Station in Clemson, SC. Fiber properties, spinning performance and yarn qualities were determined for each bale.

The cottons were processed into carded ring spun yarn using standard processing conditions and modern Trutzschler cleaning and carding equipment, Table 2.

PC-SAS was used to analyze the data. From PC-SAS, the General Linear Model procedure was used and the Least Square Means were computed. Results from these analyses were studied to determine significant differences in main effects and interaction effects at the 95 and 99 percent level of confidence. Also, component of variance were computed and compared to ascertain the relative contribution of each factor to total variation in the model.

Results and Discussion

Summary statistics from the analysis of variance are shown in Table 3. Data in these tables show the number of measurements that were significant at the 95 and 99 percent level of confidence. Note that the total number of measurements were 18 and 32 for yarn and fibers, respectively. It should also be noted that similar or duplicate type test measurements were included in the analysis. For example, fiber test measurements from HVI and AFIS systems were included. Similarly, yarn test measurements from the Uster Evenness Tester and Classimat were included.

For yarn results, the main effect of varieties was significant for more than 80 percent of the quality factors measured. This is more than twice the number for any other effect in the model. Similarly for fiber data, the main effect of variety was significant for more than 90 percent of the quality factors measured. This is about two times the number of factors that were significant for the number of lint cleaners main effect and the number was even smaller for the main effect of super mote settings.

Shown in Figures 1 through 18 are the relative percentages of variation attributable to each variable in the statistical model and the averages for each variety for selected quality factors included in the experiment. Also shown are CV's for the selected quality factors. Computed CV's for each of the ANOVA models give an indication of the precision of the specified statistical models.

Components of variance analysis for HVI Upper Half Mean Length (UHM) is shown in Figure 1. Variety is the primary contributor to variation in UHM Length. This is what one might expect. Results from prior studies by Bragg and others show that lint cleaners significantly affects UHM Length. No other factor in the statistical model was significant in explaining variation in UHM Length. Figure 2 shows the average UHM Length for each variety in this experiment. These length averages range from 1.0825 to 1.13 inches. Varieties 1 (HS46) and 6 (SG125) have the higher UHM Length and variety 2 (DP5415, UNR cotton) has the shorter length.

Shown in Figure 3 is the component of variance analysis for fiber strength as measured on the HVI System. These data indicate that each factor in the model (main effects, second and third order interactions) is significant except the main effect for super mote settings. Variety appears to be the main contributor to variation in fiber strength even with the large experimental error. However, since the second and third order interactions are significant for these data the contribution to variation becomes very difficult to interpret in a practical sense. Figure 4 shows the average HVI strength for each variety. The strength averages range from 27 to 29.5 grams per tex for varieties HS46 and SG125, respectively. The other four varieties have an average HVI fiber strength near 28.5 grams per tex.

Figure 5 shows the components of variance analysis for Shirley Analyzer non-lint content. Again variety is the most significant contributor to variation in Shirley Analyzer non-lint content. The number of lint cleaners was the next most important contributor followed by the variety*lint cleaner interaction. Also, significant contributors were the super mote settings main effect, the variety*super mote interaction and the variety*lint cleaner*super mote interaction. Figure 6 shows the Shirley Analyzer non-lint content for each variety. This plotted data indicates that variety 2 (DP5415) had more than twice as much trash/foreign matter as the other five varieties. These five varieties were about equal in their non-lint content. The higher amount of waste for DP5415 would most likely be attributable to it being produced in ultra narrow rows and processed under typical ginning conditions for South Carolina cottons.

Figure 7 shows that varieties and the number of lint cleaners contribute significantly to variation in opening and cleaning waste in the blow room. Since varieties selected for this experiment includes a UNR cotton and each seed cotton receiving the same gin treatments, one would expect a difference in non-lint content in the bales of ginned lint. Further, bales entering the opening and cleaning process with a higher non-lint content provides an opportunity for the opening and cleaning process to remove more waste.

The amount of waste removed during opening and cleaning is strongly associated with the amount of foreign matter in the incoming cotton. The statement has been made, “cotton may be cleaned at the gin or at the mill”. Results from this study show what prior studies have shown, i. e. the number of lint cleaners in the ginning operation are significantly related to amount of trash that enters the opening and cleaning process. Figure 8 shows the average percent of waste removed during opening and cleaning for each variety. Clearly, one variety is significantly different from the other varieties --- it has about twice as much waste. This is the UNR cotton and one might expect such a difference.

Variation in total waste removed at the card is primarily dependent on cotton variety, Figure 9. It is somewhat surprising that the number of lint cleaners and super mote conditions did not significantly influence the amount of trash removed during carding. This might be attributable to the cleaning effectiveness during opening and cleaning.

Figure 10 shows the average percent trash removed at carding for each variety. It is noteworthy that the UNR cotton appears no different from the other cottons. For these data, varieties number 4 (SG404) and 5 (SG501) have the highest and lowest percent trash removed at carding, respectively.

The number of ends down per thousand spindle hours (EDMSH) can be used to evaluate spinning performance. Figure 11 shows the components of variance analysis for EDMSH. Variety is the main contributor to variation in EDMSH. Shown in Figure 12 are the average actual EDMSH for each variety. Variety number 2 (DP5415, UNR) is a chief contributor to spinning performance, specifically EDMSH.

Shown in Figure 13 is the component of variance analysis for single end yarn strength. The main effect for super mote cleaner was the only non-significant factor in the model. The third order interaction, variety*lint cleaner*super mote is the major contributor to variation in single end strength followed by the two second order interactions. Figure 14 shows that the difference in these single end yarn strength averages is about one gram per tex. Varieties HS46 and SG501 have the higher averages and SG125 the lower average.

The components of variance analysis for yarn evenness, as measured on the Uster Evenness Tester, are shown in Figure 15. Variety is the most important factor affecting yarn evenness. Lint cleaners and the second and third order interactions are also significant. Super mote settings are not significant. Figure 16 shows that yarn produced from the UNR cotton (SG501) was less even, higher CV%, than yarns produced from other varieties in this experiment.

White specks in certain color shades of finished cotton fabric continue to be a source of off quality for many apparel manufacturers. To further study this problem, yarns produced in this experiment were knitted into fabric, dyed and evaluated for white specks. Variety is the main factor contributing to variation white specks, Figure 17. Lint cleaners and super mote settings were not significant. Data shown in Figure 18 indicates that the number of white specks is significantly higher in fabric produced from the UNR cotton (SG5415).

Conclusions

This study has shown that variety is the main factor that contributes to variation in measures of fiber properties, spinning performance and yarn quality. The number of lint cleaners would be ranked second followed by super mote settings. These data provide cotton producers, ginners and textile manufacturers an opportunity to work together in determining specific measurements (factors/variables) that are necessary in the marketing and utilization of cotton. Each segment of the cotton-textile-apparel complex continually searches for input or systems to optimize performance, quality and at the same time lower cost. Thus it seems that variety should be a factor of great interest to all segments of the industry complex.

Disclaimer

Mention of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by Clemson University or the U. S. Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

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Table 1. Varieties selected from North and South Carolina for experiment.

NUMBER	VARIETY
1	HS46
2	DP5415
3	DP90
4	SG404
5	SG501
6	SG125

Table 2. Standard processing conditions used in experiment.

PROCESS	SPEED/SIZE
CARDING:	100LB/HR
DRAWING:	BREAKER - 53 GR FINISHER - 55 GR
ROVING:	1.0 H. R.
SPINNING:	27/1 RING YARN 3.50 T. M.

Table 3. Number of Quality measurements significant in the statistical model.

TERM	STATISTICAL MODEL	NO. OF SIGNIFICANT* QUALITY FACTORS
1	Var	44
2	Lintcl	22
3	Var*Lintcl	24
4	Mote	11
5	Var*Mote	22
6	Lintcl*Mote	8
7	Var*Lintcl*Mote	22
8	Experimental Error	-

*At either the 95% or 99% confidence level.

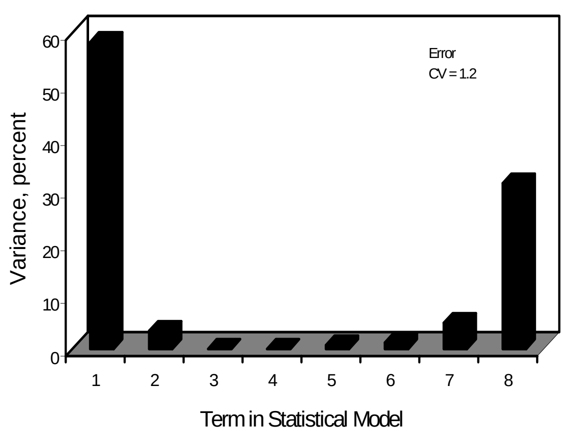

Figure 1. Relative components of variance for HVI upper half mean length measurements.

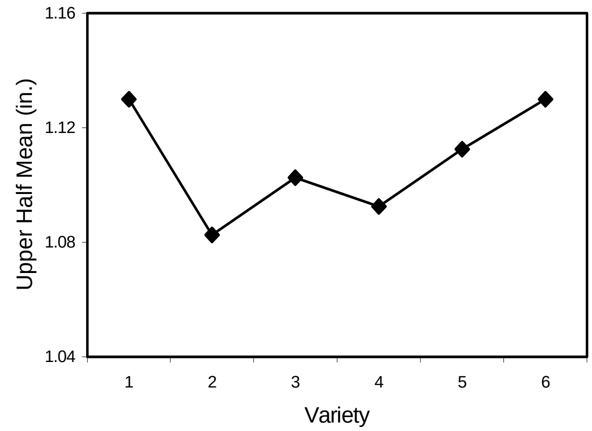

Figure 2. Average HVI upper half mean length for each variety.

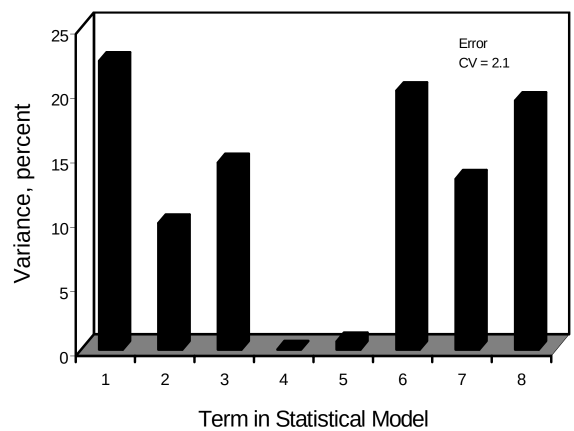

Figure 3. Relative components of variance for HVI strength measurements.

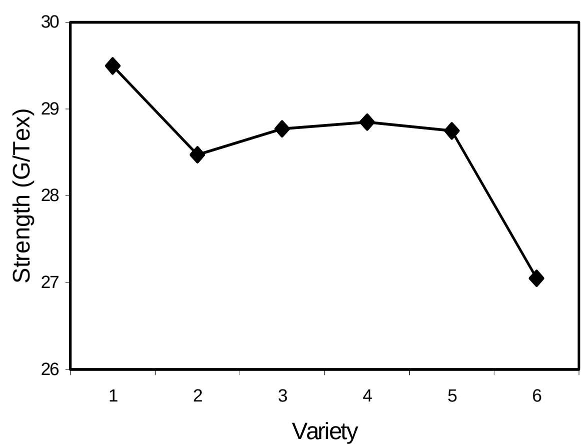

Figure 4. Average HVI strength for each variety.

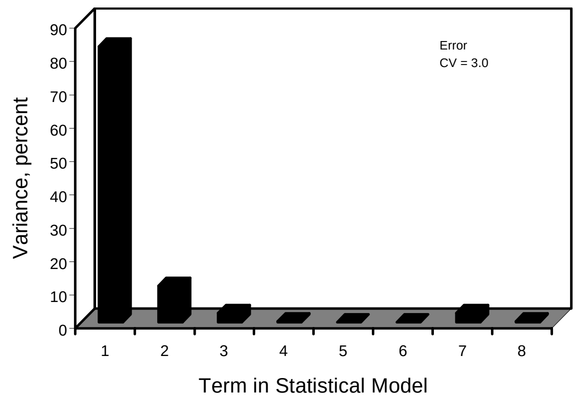

Figure 5. Relative components of variance for Shirley Analyzer non-lint content.

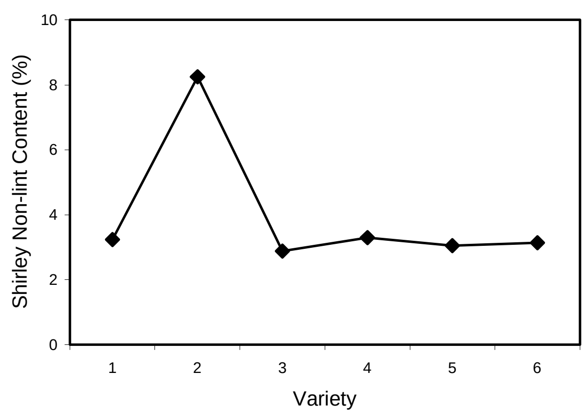

Figure 6. Average Shirley Analyzer non-lint content for each variety.

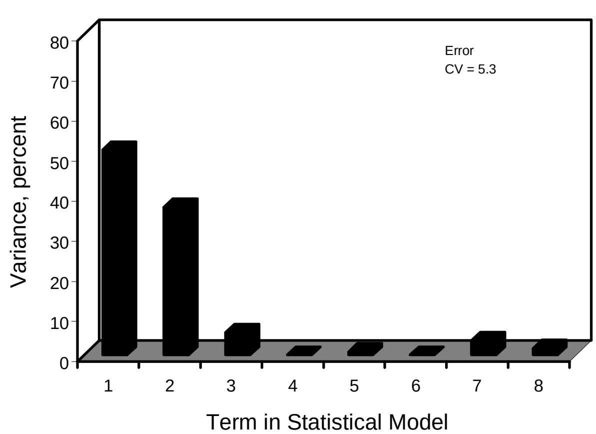

Figure 7. Relative components of variance for opening and cleaning waste.

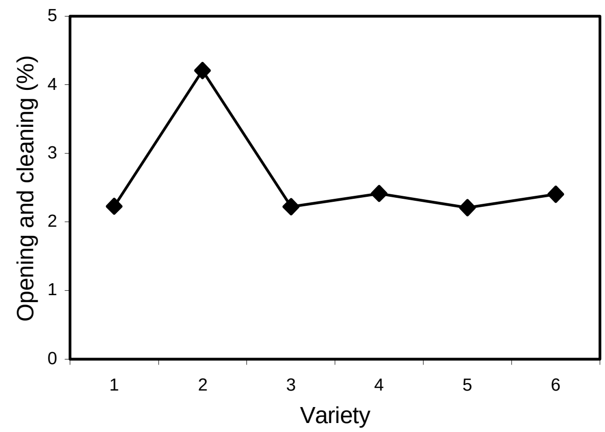

Figure 8. Average opening and cleaning waste for each variety.

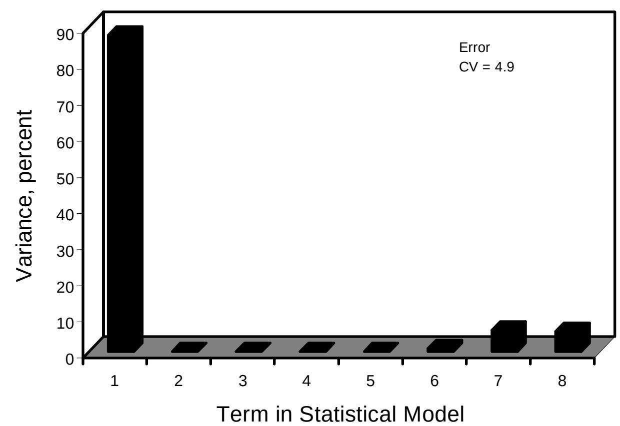

Figure 9. Relative components of variance for total card waste.

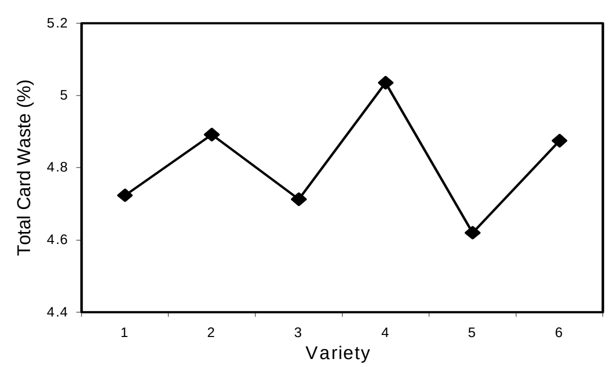

Figure 10. Average total card waste for each variety.

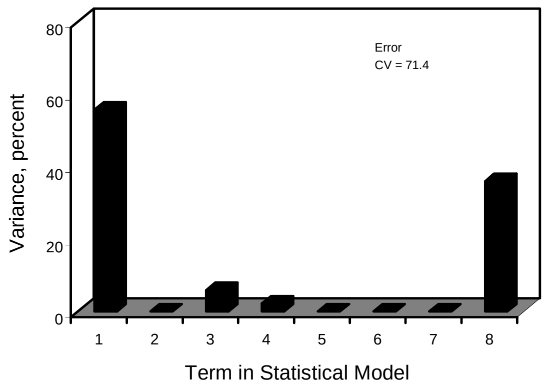

Figure 11. Relative components of variance for actual ends down.

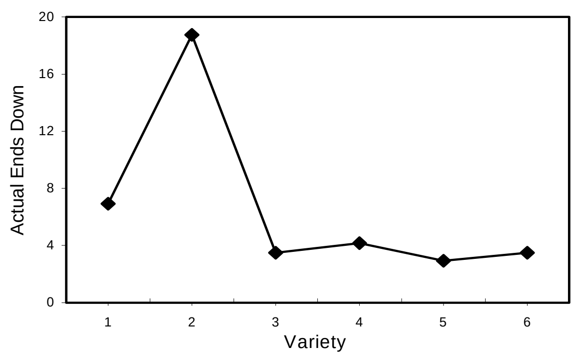

Figure 12. Average actual ends down for each variety.

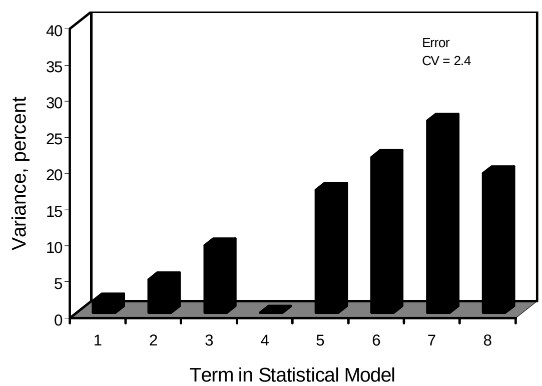

Figure 13. Relative components of variance for yarn single end strength.

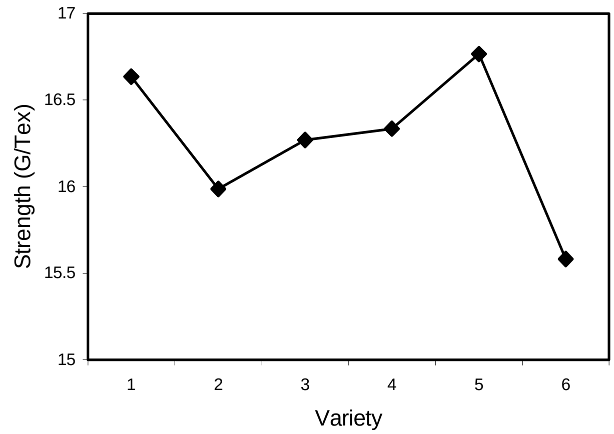

Figure 14. Average single end strength for each variety.

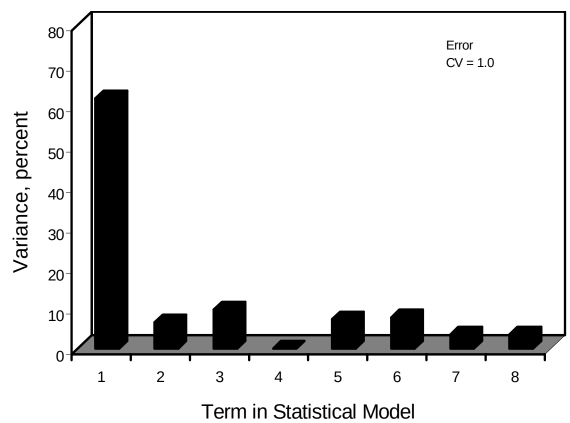

Figure 15. Relative components of variance for yarn evenness measured by Uster Evenness Tester.

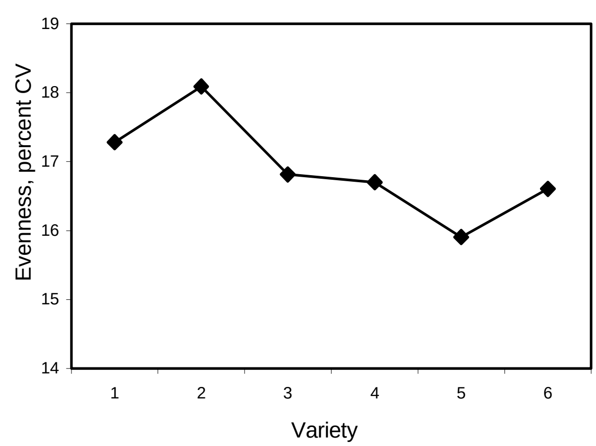

Figure 16. Average yarn evenness measured by Uster Evevnness Tester for each variety.

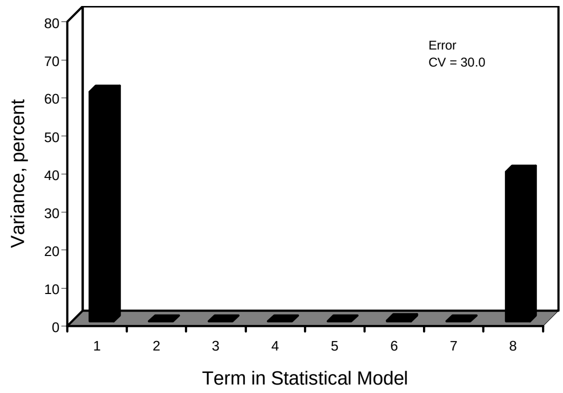

Figure 17. Relative components of variance for number of white specks in dyed fabric.

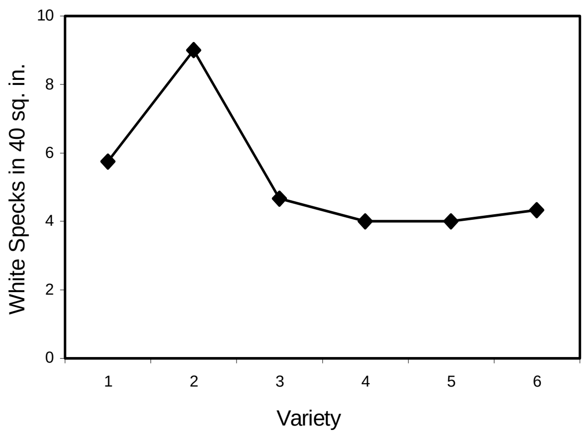

Figure 18. Average number of white specks in 40 square inches of dyed fabric for each variety.