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Mixing lint grades in relation to fiber and yarn quality of Egyptian cotton

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Abstract

This study was undertaken to investigate the effect of different mixing percentages of lint grades of Egyptian cotton varieties on fiber properties and yarn strength. Two lint grades within each variety of four Egyptian cottons from 2022 and 2023 crop seasons were used; Good to Fully Good (G/FG) and Fully Good Fair (FGF) for Giza 86, Good to Fully Good (G/FG) and Fully Good Fair to Good (FGF/G) for Giza 92, Good to Fully Good (G/FG) and Good Fair (GF) for Giza 94 and, Fully Good (FG) and Fully Good Fair (FGF) for Giza 95 with mixing percentage (30%-40%-50%) of the highest grades for each variety. Mixed lots of lint cotton grades were tested on Fiber Classifying System (FCS) instrument to measure fiber properties. Yarn strength was tested on Good Brand Lea tester at 60s and 3.6 twist factor. This experiment was conducted at Egyptian & International Cotton Classification Center (EICCC) in Cotton Research Institute (CRI), Agricultural Research Center (ARC), Giza, Egypt. Using traditional statistical analysis (normal probability distribution) with untraditional method (assumed probability distribution) illustrated that; It was remarkably increased upper half mean length,mean length, uniformity index, fiber strength, micronaire reading, maturity and linear density with increase of the percentage of the highest grade in the mixing for each studied variety. Meanwhile short fiber content showed the opposite trend, whereas, elongation had no obvious trend. Prominent improvement in yarn strength was observed when the highest lint cotton grade percentage increased from 30% through 40% and 50% in the mixing lots. Yarn strength increased from 2690 to 3170, from 2475 to 2850, from 2440 to 2845 and from 2135 to 2360 for Giza 92, Giza 86, Giza 94 and Giza 95, respectively. Generally, mixing method based on lint grades exhibited significant improvement in fiber and yarn quality properties. In the same time this method is easier than the experimental mixing methods based on micronaire reading or fiber strength. on the other hand, it is very important process in cotton production economy.

Keywords: Egyptian cotton grades; Mixing; Fiber properties; Yarn strength; Normal and assumed probability distribution

1. Introduction

Cotton is a natural fiber and has good moisture absorbency and great thermal insulation. Mainly, different treatments in or out farm give a significant effect on cotton yield variability. In terms of variability; variation will differ from bale to bale, sample to sample and plant to plant for the same cotton variety.

Consequently, different range of fiber properties measurements will be appeared. Then the several different fiber instrument testers obtained data to quantify all possible cotton fiber properties to put the used cotton sample in the correct grade and to facilitate all following other appropriate processes. Therefore, an important stage during the cotton production process is the grading of harvested cotton to evaluate its economic value, which is determined by its process ability and quality. The aftermath of incorrectly grading is leading to breakage and reducing the value added of the cotton as mentioned by [1]. All detective steps were illustrated by [2, 3].

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Most uses of cotton require the fiber to be spun into yarn and then converted to fabric. The spinning performance and yarn quality of cotton depend upon several fiber properties, including fiber length, length uniformity, strength, fineness, and maturity. All details of cotton properties were elaborated by [4,5,6,7,8,9].

Yarn quality is a complex characteristic and it is influenced by various fiber properties, inner and outer different factors such as imported material, instruments and all operations till final yarn product. Yarn quality depends on machine type and machine parameters, material type and its proportions.All details of obtaining yarn product were illustrated by [10,11,12,13]. It is a mainstream to produce reasonable quality and economy product with consistency and optimizing of the target final product.

Cotton is a highly variable natural material that is routinely mixed or blended during textile processing to create a uniform product. Garment, apparel and textile industries with blends, mixtures may have properties that differ than those obtained from only one kind fiber. Mixing and blending influences in weaving, spinning, dyeing and finishing. Specially, some functional properties such as the process performance of carding through control of neps level variation, roving and yarn twist variation, static electricity formation, end breakage and machine adjustment. It increases comfort and the properties like handling, abrasion resistance, stretch…etc. All those processes utilize the advantages of the fibers. These details were elucidated by [14,15,16].

Blending refers to be the process of mixing various lots of different fibers' kinds either natural or man-made in desired percentages. There are a certain steps to give the end product certain characteristics such as strength, crease resistance, aesthetic effects and price which are unobtainable from one fiber kind only. Then utilize the advantages of all fiber to counteract the disadvantages of every single fiber. All previous details were detected by [14,16,17,18,19].

Mixing many bales of fiber produce a homogenous mass (two or more types of the same fiber) to get the desirable properties and avoid undesirable properties. If mixing is done carefully the good qualities of the fibers are emphasized minimizing the poor qualities. Both of [20,21,22,23] investigated and tracked all the spinning performance and quality of yarn is dependent on mixing. The mixing ratio is one of the most important factors that affect the performance of the mixing matters and the quality of yarn produced.Then determining the proper mix ratio of bales so that the cost of mixed fiber is minimal and the desired quality of the mix achieves the required result. Where producing the better quality yarn products at minimal technical requirements. All discussion of cost and technical requirements was elucidated by [19,22, 24, 25].

In general; there are several types of mixing such as bale mixing, flock mixing, lap mixing, web mixing, sliver mixing, fiber mixing and roving mixing.

Specifically, the type of fiber mixing are mixing by volume, mixing by weight and mixing by cotton fiber properties such as mixing by micronaire reading, mixing by length, mixing by strength and elongation, mixing by grades and mixing by more distant fiber properties.[23].

The main objectives of mixing are getting uniform quality of yarn, improving processing performance, achieving the function and application, getting the fancy effect and finally decreasing the production cost.Any cotton to be selected for process will depend on the end product to be produced like shirting, suiting, dress material, curtain cloth etc.

A benchmark for evaluating all final products and the magnitude of models is using several different principles statistics. The reason for that there is no statistical method for answering questions about how precise an estimate must be or how large an effect must to be practically useful. Then recommendations by [15,26,27,28,29] can help to improve decisions and produce good expected results. As in selecting the elite combination of mixed using several methods such as traditional (normal distribution) and un-traditional (assumed normal distribution) methods as tools. These tools should be proven as acceptable, objective and accurate.

This experiment was aimed to determine the effect of Egyptian cotton varieties with different mixing percentages of lint grades (30%, 40% and 50%) on fiber quality and yarn strength for Giza 86, Giza 92, Giza 94 and Giza 95 cotton varieties.

2. Materials and methods

In this research, Egyptian cotton varieties (*Gossypium barbadense* L) samples were collected from gin mills around the country. Two grades of four commercial Egyptian cotton fiber varieties were selected from 2022 and 2023 seasons. Cotton varieties used for this research had a significant differences were Giza 92 (Extra-G 92; belonging to Extra-strength) and Giza 86 (Super-G 86; belonging to long staple-Delta), Giza 94 (Super-G 94) (belonging to long staple-

Delta) and Giza 95 (G 95) (belonging to long staple-upper Egypt). Cotton fiber mixing was dependent on lint cotton grades.

The available grades; Good to Fully Good (G/FG) and Fully Good Fair (FGF) for Giza 86 (G 86), Good to Fully Good (G/FG) and Fully Good Fair to Good (FGF/G) for Giza 92 (G 92), Good to Fully Good (G/FG) and Good Fair (GF) for Giza 94 (G 94) and, Fully Good (FG) and Fully Good Fair (FGF) for Giza 95 (G 95). The used material were sorted as follow: control represented as the highest grade (grade 1) and the lowest grade (grade 2), the mixing percentages; 30/70% (mix 1) for highest grade to the lowest, 40/60% (mix 2) for highest grade to the lowest and 50/50% (mix 3) of the equal two mixing grades; for both of G 92, G 86, G 94 and G 95. Herein, there were different grades for each variety; depending on the availability obtaining from grade samples.

All samples were conducted at Agricultural Research Center (ARC), Cotton Research Institute (CRI), Giza, Egypt. The standard testing conditions were 21 ± 2^0 C and 65 ± 2 % Rh. At the premises of Textile Testing Technology, the Fiber Classifying System (FCS) designed to measure all fiber properties which determine the quality and the spinnability of both, cotton and man-made fibers, used in production of spun yarns.This system can be calibrated with calibration cotton to yield High Volume Instrument (HVI). Two modules of FCS were used; Fibrotest measures length and strength traits and Wira measures fineness and maturity.

Measurements of cotton fiber properties that compliance with (ASTM: D-1776-16) [30] as follows:

- Upper Half Mean (UHML) is the average of the longer one-half of the fibers.
- Uniformity index (UI %) is the ratio between upper half mean length and mean length.
- Short fiber content (SFC) the percentage of fiber length is less than 12.7mm.
- Strength (FS) is the force in grams required to break a bundle of fibers with tex unit.
- Elongation (E %) is the fiber extension increase in terms of force.
- Micronaire value (Mic) is a measure of fiber fineness and maturity.
- Maturity ratio (MR) is the index of secondary wall cell development of the fiber.
- LD is the weight of length unit.

Cotton fiber samples were spun at 3.6 twist factor for Ne 60 count. Yarn strength (YS) in terms of Lea product in pounds count was measured by the Good Brand Lea tester. Yarn strength was performed at the Industrial secondary school-zagazig-Egypt.

Normal probability distribution, Descriptive statistics analyses, the confidence interval and regression model criteria were calculated and elucidated according to [31]. Where a confidence interval is established for the sample mean to figure out if the stated confidence is justified for each random sample and 95% level of probability.

Assumed probability distribution; Deviance is a goodness of fit of statistic for a statistical model according to [32].

SPSS [33] and Genstat [34] software were used for normal probability distribution parameters and assumed probability distribution parameter, respectively.

3. Results and discussion

Descriptive statistics can be useful for providing basic information about cotton fiber properties in a dataset by simplify and organize large amounts of data into a few numbers.

The normal distribution has two parameters; mean and standard deviation. The normal distribution is a mathematical function that gives the probabilities of occurrence of different possible outcomes for an experiment. The normal distribution is a continuous probability distribution that is symmetrical around its mean, most of the observations cluster around the central peak, and the probabilities for value further away from the mean taper off equally in both directions.

Tables 1,2,3 and 4 showed the share of cotton grades mixing with cotton fiber properties;the highest grades were for Good/Fully Good (G/FG) for Giza 86 (G86), Giza 92 (G92) and Giza (G94) and Giza 95 (G95) the highest grade was Fully Good grade (FG). The lowest grade was Fully Good Fair (FGF) for both of G86, G92 and G95 and it was for G94 the grade Good Fair (GF). This trend was more prominent when cotton grades mixing increased from 30%, 40% to 50% for both of Upper Half Mean Length (UHML), Mean Length (ML), Uniformity Index (UI), Fiber Strength (FS), Micronaire (Mic), Maturity (MR), Linear Density (LD) and Yarn Strength (YS) increased. Meanwhile Short Fiber Content (SFC) decreased and Elongation (E %) had a blear trend other than previous properties.

Yarn strength is greatly influenced by cotton fiber properties. It was noticeable when cotton grades increased both of standard error (SE) and standard deviation (SD) decreased. In general SD values larger than the parallel SE values. Yarn strength value regularly decreased from G92, followed by G86, G94 and finally G95.

In general; all cotton fiber properties are dependent on each other whether if there is a constant or in presence of all properties.

It was revealed that yarn strength increase gradually with the increase inmixing percentage of highest grade from 30%, 40% and 50% (mix1, 2 and 3) compared to the lowest single grade (grade 2) for each studied variety.

The most frequently occurring type of data and probability distribution is the normal distribution. The distortion of the symmetrical bell shaped can be calculated using skewness and kurtosis. Skewness refers the degree of symmetry. Distribution of data sets is symmetric if they appear the same on both sides of a central point; equals zero or close to zero such as in grade 2 for FS and YS in G 92, LD in grade 2 for G 86, LD and MR for G 94 and mix 2 for MR in G 95.

Kurtosis refers to the proportion of data that is heavy-tailed or light tailed in comparison with a normal distribution. Kurtosis is used to find the presence of outliers present. If the distribution is light-tailed and the top curve steeper, like pulling up distribution, it is called positive kurtosis (leptokurtosis) such as in FS for G92 in mix 1.

Confidence interval (CI) for each cotton fiber property is one of its most important features. CI in the general statistics is almost always in all types of properties. To determine whether the difference between two means is statistically significant, analyst often compare the confidence intervals for those groups. There were an intervals overlap such as UHML, ML, UI, FS, E%, Mic, MR and YS for G92, G86, G94 and G95; they conclude that the difference between groups was not statistically significant. Otherwise there was no overlap; the difference is significant such as what shown in SFC for all studied varieties as mentioned by [35,36].Normal distribution method was expressed all cotton fiber properties using parameters such as mean, standard deviation, skeweness, kurtosis and confidence interval.

The assumed distribution; the maximum likelihood estimation is a method of estimating the parameters of an assumed probability distribution given some observed data. It is a special case of an extreme estimator, with the objective function being the likelihood. Assumed mean method gives smaller numbers to work with making calculations easier and is thus suitable if a data set has large values when calculating the mean using the direct mean method, in this point obtaining significantly bigger numbers. The likelihood of making calculating errors in decreased when utilizing the assumed mean approach, also known as a shift of origin as it gives smaller numbers to work with. The main parameter in assumed probability distribution is called deviance.

Meanwhile there was a degree of lack of symmetry as in FS for G92 for mix (1 and 3).

Deviance plays an important role in both of dispersion models and generalized linear models. As long as the deviance value is minimum; it indicated the best model. The deviance was always equal zero; being zero was perfect such as in FS, Mic and YS in G92, UHM, Mic, YS in G86, YS in G94 and ML in G95. Meanwhile increasing deviance value of SFC of deviance indicated poorer model fit such as in MR for the second grade in G95. Therefore comparing models depend on the degree of deviance value as illustrated by [29]. There was severe increase in deviance for MR and SFC in G95.

Percentage variance account is a summary of how much of the variability of the data can be explained by a fitted regression models which are concluded all predictor variables such as UHML, ML, UI, SFC, FS, E%, Mic, MR and LD compared to YS gave 75.3% for coefficient of determination (R^2) and 74.9% for adjusted coefficient of determination ($R^2_{adj.}$) with highly significant (P_{value}) for Giza 95 as shown in table 5. This approach of values between R^2 and R^2_{adj}. indicated that all studied cotton fiber properties had an obvious influence on yarn strength more than any other factor out the model.

Studying each property per se gave an indicator in explaining the results as well. Collinearity is the correlation between predictors' variables or independent variables such as UHML, ML, UI, SFC, FS, E%, Mic, MR and LD as they express a linear relationship in a regression model.

Collinearity becomes a concern in regression analysis when there is a high correlation between predictors' variables, when there is a dramatic increase in p_{value} (reduction in the significant level). There are two criteria of

Table 1 Descriptive statistics for Giza 92 of 2022 and 2023 season's combination

Traits	Grade Or Mix	Descriptive			Distribution		Confidence interval	Assumed probability distribution		
		Mean	SE	SD	Skewness	Kurtosis		ML	SE	Deviance
UHML	Grade 1	33.77	0.148	1.09	-1.681	3.150	32.61-34.91	33.77	0.009	0.56
	Grade 2	29.22	0.526	1.553	0.537	0.428	28.63-30.11	29.22	0.306	0.07
	Mix 1	29.34	0.451	0.639	-1.611	4.930	29.03-29.99	29.34	0.146	3.31
	Mix 2	31.11	0.316	0.916	-0.750	-0.447	30.08-31.53	31.08	0.209	0.781
	Mix 3	32.73	0.203	1.29	0.203	-0.260	29.79-33.07	32.43	0.295	0.26
ML	Grade 1	29.77	0.334	0.791	-0.653	-1.739	25.02-29.98	29.78	0.269	0.63
	Grade 2	22.10	1.358	1.876	1.056	0.795	21.01-23.36	22.10	0.927	0.24
	Mix 1	23.78	0.862	0.903	-1.580	3.317	22.99-24.88	23.78	0.598	4.05
	Mix 2	25.88	0.632	0.834	-0.959	-0.262	24.89-26.56	25.88	0.331	5.81
	Mix 3	27.77	0.461	1.53	0.367	-0.388	26.69-28.02	27.79	0.351	0.23
UI	Grade 1	86.15	0.629	0.790	-0.741	-1.603	87.33-90.92	89.15	0.600	0.63
	Grade 2	75.63	1.597	1.96	1.063	0.422	80.88-83.95	80.42	1.11	0.37
	Mix 1	81.44	0.939	1.44	-2.109	5.94	80.73-84.66	81.44	0.829	2.48
	Mix 2	83.24	0.852	1.256	-0.304	-1.08	83.99-84.99	83.24	0.748	3.25
	Mix 3	84.84	0.603	1.71	0.417	-0.889	84.56-90.23	88.88	0.591	4.94
SFC	Grade 1	5.68	0.299	0.95	0.590	-1.76	3.62-4.73	5.68	0.129	0.55
	Grade 2	12.77	0.730	1.565	-1.08	0.690	9.00-11.36	10.77	0.610	0.26
	Mix 1	10.11	0.512	1.473	1.56	3.99	7.56-9.54	10.81	0.409	5.69
	Mix 2	8.31	0.448	0.676	0.803	-0.603	6.53-7.77	9.50	0.371	2.65
	Mix 3	7.18	0.370	1.15	-0.699	-1.184	6.01-7.00	7.00	0.263	3.91
FS	Grade 1	44.88	2.27	3.00	-0.968	-1.875	36.48-53.28	44.88	1.27	0
	Grade 2	32.67	4.46	6.03	0	-3.312	29.34-31.99	37.67	3.25	0
	Mix 1	34.33	0.987	5.02	4.24	18	32.65-38.31	30.01	0.805	0
	Mix 2	38.10	0.741	4.28	-2.047	4.99	31.98-39.90	30.99	0.668	0
	Mix 3	41.42	0.652	4.04	4.24	18	38.21-41.25	39.44	0.412	0
E%	Grade 1	7.17	0.215	0.911	0.243	-1.57	6.39-8.88	13.17	0.191	0.02
	Grade 2	7.18	3.74	4.82	-0.301	1.29	6.28-11.08	9.18	2.11	0
	Mix 1	6.61	0.992	1.24	-0.230	-1.59	6.98-9.22	8.61	0.884	0.71
	Mix 2	7.32	0.741	0.953	-0.336	0.525	6.99-10.56	9.53	0.646	0.43
	Mix 3	6.92	0.563	1.54	0.075	-0.887	6.15-9.65	8.92	0.453	1.23
Mic	Grade 1	4.32	0.114	0.279	-0.006	-2.95	4.00-4.43	4.32	0.104	0
	Grade 2	3.54	0.914	1.97	-0.006	-2.94	3.00-4.22	3.82	0.804	0
	Mix 1	3.82	0.644	1.18	0.908	-0.990	3.10-4.11	4.54	0.544	0
	Mix 2	4.11	0.583	0.119	2.22	3.89	4.01-4.23	4.11	0.419	0

	Mix 3	4.20	0.423	0.629	-0.461	1.53	4.09-4.41	4.29	0.221	0
MR	Grade 1	91.33	0.045	3.45	-0.026	-2.37	88.89-92.13	91.33	0.009	0.04
	Grade 2	79.17	1.58	3.87	-0.002	-3.13	78.01-81.56	79.17	1.44	0.01
	Mix 1	81.32	0.868	1.14	-1.139	2.96	80.99-82.45	81.34	0.661	6.04
	Mix 2	83.56	0.602	0.857	-1.26	3.38	82.15-85.61	83.66	0.496	6.37
	Mix 3	86.21	0.501	0.856	-0.441	-4.89	85.12-88.21	86.00	0.401	5.29
LD	Grade 1	156	3.33	8.17	-0.383	-1.48	155-164	161	3.04	0.05
	Grade 2	137	6.31	8.66	0.149	0.690	130-138	137	5.11	0.04
	Mix 1	143	0.602	0.857	2.17	3.99	140-151	144	0.500	0
	Mix 2	146	0.306	1.72	-1.62	-0.603	147-153	150	0.295	0.91
	Mix 3	151	0.378	1.61	1.43	-0.184	150-159	151	0.168	6.71
YS	Grade 1	3432	19.52	20.82	-0.025	-3.16	3301-3450	3431	17.82	0
	Grade 2	2355	35.82	87.75	0	-3.30	2300-2405	2255	32.71	0
	Mix 1	2690	29.78	66.32	-0.01	-0.185	2599-2699	2620	27.11	0
	Mix 2	2935	25.19	38.99	1.05	-0.956	2920-2980	2834	8.93	0
	Mix 3	3170	22.36	29.54	0.471	-0.155	2298-3190	3072	0.111	0

Table 2 Descriptive statistics for Giza 86 of 2022 and 2023 season's combination

	Grades Or Mix	Descriptive			Distribution		Confidence interval	Assumed probability distribution		
		Mean	SE	SD	Skewness	Kurtosis		ML	SE	Deviance
UHML	Grade 1	32.80	0.307	1.23	1.50	-0.585	32.00-34.19	33.56	0.095	0
	Grade 2	28.67	0.747	1.05	0.133	-0.144	27.42-29.00	28.27	0.626	0
	Mix 1	30.51	0.508	0.990	0.654	-0.147	29.59-30.55	30.07	0.422	0
	Mix 2	31.70	0.403	0.725	1.05	-0.729	29.99-31.99	3152	0.339	0
	Mix 3	32.27	0.357	0.553	0.864	1.576	30.31-33.17	30.74	0.198	0
ML	Grade 1	29.11	0.311	1.97	-0.167	-0.1728	28.13-29.74	28.41	0.113	0
	Grade 2	24.22	0.903	1.53	-0.146	1.099	21.98-25.99	22.93	0.286	0.03
	Mix 1	26.10	0.699	1.00	0.375	-1.128	24.00-26.63	25.89	0.343	3.01
	Mix 2	27.54	0.580	0.901	0.006	0.074	25.52-28.30	26.91	0.179	1.11
	Mix 3	28.11	0.411	0.811	0.320	-0.837	24.88-26.99	26.29	0.192	2.86
UI	Grade 1	88.78	0.111	1.71	0.760	0.996	86.26-89.91	83.03	0.099	0
	Grade 2	84.50	0.989	1.60	-0.806	0.211	79.98-85.00	88.08	0.649	0.55
	Mix 1	85.56	0.330	1.43	-0.010	-0.210	82.98-86.63	83.81	0.300	0.81
	Mix 2	86.89	0.281	1.71	-0.388	-0.978	83.22-86.99	83.76	0.245	1.19
	Mix 3	87.10	0.252	1.03	-0.065	-0.801	83.55-88.21	82.68	0.173	0.560
SFC	Grade 1	3.99	0.148	0.521	0.100	-1.92	1.84-2.55	9.526	0.139	1.56
	Grade 2	11.22	0.889	2.99	-0.146	-1.45	5.35-9.99	6.69	0.304	3.59

	Mix 1	9.89	0.561	2.22	-0.227	-1.45	6.74-8.19	7.71	0.448	0.568
	Mix 2	7.46	0.521	1.95	-0.177	0.071	6.00-7.11	9.49	0.141	0.689
	Mix 3	6.69	0.166	0.84	-0.475	-0.692	5.99-6.21	9.97	0.143	0.287
FS	Grade 1	42.83	0.111	3.56	-1.33	2.312	42.26-43.54	42.36	0.071	0.051
	Grade 2	32.94	0.777	2.99	1.219	-0.046	30.56-33.66	42.90	0.626	4.94
	Mix 1	36.32	0.563	2.39	1.161	1.020	33.26-37.39	32.87	0.461	9.32
	Mix 2	39.24	0.409	1.74	0.274	-0.720	33.47-40.91	36.61	0.398	1.62
	Mix 3	40.90	0.241	1.14	0.845	-1.308	38.56-41.23	39.78	0.111	4.41
E%	Grade 1	7.10	0.175	1.69	0.068	0.368	6.11-7.08	9.00	0.109	0
	Grade 2	6.37	0.998	1.96	0.357	0.192	6.00-9.26	12.25	0.434	3.19
	Mix 1	6.91	0.814	1.52	-0.617	-1.053	6.16-10.69	10.16	0.247	9.72
	Mix 2	7.33	0.656	1.38	0.455	0.306	6.16-10.59	9.97	0.287	0.30
	Mix 3	7.16	0.554	1.25	1.07	2.54	6.36-9.97	8.85	0.406	5.21
Mic	Grade 1	4.67	0.144	0.599	-0.012	-2.75	3.88-4.90	4.23	0.015	0
	Grade 2	3.99	0.858	0.910	-0.004	-3.06	3.92-4.16	4.67	0.784	0
	Mix 1	4.10	0.368	0.899	1.083	0.913	4.01-4.11	4.59	0.222	0
	Mix 2	4.20	0.325	0.859	0.744	2.89	4.00-4.41	4.37	0.219	0
	Mix 3	4.30	0.292	0.798	-0.761	-0.463	4.11-4.45	4.13	0.125	0
MR	Grade 1	90.80	0.563	1.96	-0.004	-3.06	88.18-92.16	76.16	0.881	2.56
	Grade 2	76.85	1.74	1.33	-0.004	-3.05	71.18-78.16	91.67	0.600	4.40
	Mix 1	80.93	0.711	1.26	-0.451	-1.28	71.55-79.00	71.22	0.685	2.19
	Mix 2	83.82	0.631	0.808	-0.915	-0.252	74.05-80.22	79.25	0.521	1.63
	Mix 3	86.67	0.623	0.705	-0.912	-0.923	79.63-83.56	81.81	0.500	4.51
LD	Grade 1	162	3.57	5.07	0.248	-0.014	160-180	142.2	2.11	0
	Grade 2	142	6.89	4.76	0	-0.300	140-149	166.7	5.26	0.06
	Mix 1	148	0.555	3.38	-0.229	-1.64	143-155	144.8	0.400	5.14
	Mix 2	153	0.466	1.93	-1.72	2.93	149-157	147.1	0.321	4.69
	Mix 3	156	0.391	1.15	0.717	-0.939	151-166	151.7	0.222	4.82
YS	Grade 1	3115	5.55	29.11	-0.201	-0.201	2538-3190	2192	4.65	0
	Grade 2	2340	21.88	12.90	-0.254	-0.264	2210-2410	2907	19.85	0
	Mix 1	2475	10.56	11.99	1.77	1.77	2396-2590	2157	8.75	0
	Mix 2	2680	9.59	10.99	-0.312	-0.312	2590-2850	2254	8.11	0
	Mix 3	2850	7.25	8.39	0.903	0.903	2810-3200	2406	6.92	0

Table 3 Descriptive statistics for Giza 94 of 2022 and 2023 season's combination

Traits	Grade Or Mix	Descriptive			Distribution		Confidence interval	Assumed probability distribution		
		Mean	SE	SD	Skewness	Kurtosis		ML	SE	Deviance
UHML	Grade 1	33.58	0.141	0.539	-0.299	1.022	31.87-35.29	33.58	0.609	0
	Grade 2	29.53	1.99	2.63	0.391	-1.345	28.97-30.09	29.53	1.11	0.11
	Mix 1	31.38	0.791	1.23	0.068	-1.189	31.05-32.28	31.67	0.683	1.36
	Mix 2	31.67	0.511	0.892	-0.360	0.497	30.93-33.82	31.38	0.405	0.43
	Mix 3	31.73	0.341	0.596	-0.736	1.358	31.43-34.56	31.73	0.237	0.03
ML	Grade 1	29.48	0.159	0.966	-0.162	1.295	27.27-31.69	29.48	0.133	0
	Grade 2	23.80	0.831	2.10	-1.481	0.719	23.51-24.69	24.66	2.20	1.48
	Mix 1	25.51	0.362	1.54	0.177	-0.900	25.73-27.27	26.50	0.352	2.03
	Mix 2	26.50	0.267	1.13	-0.157	-0.304	25.58-27.71	26.14	0.259	0.17
	Mix 3	27.25	0.187	0.793	-1.005	2.324	26.39-27.18	26.79	0.166	5.42
UI	Grade 1	87.79	0.238	1.92	-0.122	1.546	85.54-89.89	87.70	0.200	0.07
	Grade 2	80.61	0.883	2.05	1.947	4.454	80.00-82.38	81.65	0.758	0.38
	Mix 1	81.30	0.429	1.82	0.139	-0.491	80.71-84.52	83.62	0.317	0.40
	Mix 2	83.70	0.325	1.38	0.202	-1.167	82.60-83.98	83.29	0.316	2.85
	Mix 3	85.91	0.303	1.30	-0.870	0.055	83.76-86.05	84.41	0.099	0.780
SFC	Grade 1	5.98	0.143	1.33	-0.311	1.32	3.56-4.41	5.98	0.865	0
	Grade 2	12.98	0.936	2.31	-0.786	-1.59	9.42-11.11	11.17	0.215	1.25
	Mix 1	10.60	0.311	1.32	-0.433	-0.651	9.99-10.58	8.97	0.301	2.33
	Mix 2	8.73	0.213	0.984	-0.087	-0.490	6.25-7.73	9.28	0.207	0.88
	Mix 3	7.22	0.155	0.959	0.651	1.67	6.99-7.11	8.77	0.151	2.17
FS	Grade 1	41.30	0.211	0.819	0.175	1.694	37.52-45.08	41.30	0.199	0
	Grade 2	31.45	0.834	3.60	0.093	-2.89	30.59-32.31	33.71	0.700	0.48
	Mix 1	33.70	0.607	2.35	1.947	2.79	32.00-34.56	32.32	0.505	5.22
	Mix 2	35.62	0.576	1.89	2.588	3.51	33.56-37.58	40.63	0.414	5.30
	Mix 3	37.41	0.300	1.55	0.850	-1.076	35.61-40.56	41.68	0.213	6.82
E%	Grade 1	6.61	0.387	0.937	-1.495	2.76	6.00-9.56	11.13	0.299	0.07
	Grade 2	6.32	0.994	1.44	0.755	-0.984	6.11-9.70	8.27	0.888	0.31
	Mix 1	6.53	0.839	1.21	0.226	-0.241	6.01-10.45	9.77	0.629	1.40
	Mix 2	6.41	0.692	1.11	0.563	-0.624	6.00-9.99	8.67	0.507	5.71
	Mix 3	6.72	0.276	1.11	-0.457	-0.710	6.21-10.69	4.42	0.203	0.02
Mic	Grade 1	4.42	0.113	0.379	-0.006	-2.95	4.12-4.71	4.26	0.222	0.33
	Grade 2	4.10	0.913	1.779	-0.006	-2.94	3.72-4.31	4.23	0.623	0
	Mix 1	4.20	0.023	0.599	1.09	3.49	4.18-4.28	4.16	0.422	4.20
	Mix 2	4.31	0.023	0.498	2.62	3.59	4.11-4.44	4.23	0.316	4.08

	Mix 3	4.40	0.019	0.400	-0.744	-1.14	4.11-4.50	3.83	0.019	0
MR	Grade 1	90.33	0.762	2.37	0.030	-1.84	86.59-94.07	90.33	0.639	0.01
	Grade 2	78.00	2.56	3.56	0	-1.88	76.52-79.48	69.96	1.52	0.44
	Mix 1	80.89	1.69	4.11	0.687	1.74	79.41-82.37	75.89	0.987	4.90
	Mix 2	84.56	1.12	1.42	-1.99	3.16	78.85-85.62	79.56	0.855	5.24
	Mix 3	87.70	0.963	0.963	0.204	0.709	82.22-89.33	82.78	0.785	8.89
LD	Grade 1	162	0.025	0.707	-0.943	0.586	155-174	165	0.002	0.36
	Grade 2	135	2.81	8.94	0	-2.29	133-149	145	1.19	0.54
	Mix 1	143	0.274	6.89	0.768	0.231	136-146	129	0.211	5.28
	Mix 2	149	0.227	1.66	0.687	-0.600	140-151	131	0.199	4.01
	Mix 3	151	0.167	0.999	-1.37	4.59	146-154	138	0.167	0
YS	Grade 1	3095	12.98	31.75	-0.057	-2.93	2969-3309	2936	0.852	0
	Grade 2	2280	40.69	99.67	-0.006	-3.29	2260-2498	1899	37.16	0
	Mix 1	2440	19.29	63.77	0.212	-1.14	2430-2560	2322	1.26	0
	Mix 2	2660	18.45	55.21	1.09	0.560	2610-2655	2424	1.41	0
	Mix 3	2845	16.25	49.13	-1.01	0.357	2752-2966	2570	1.22	0

Table 4 Descriptive statistics for Giza 95 of 2022 and 2023 season's combination

Traits	Grades Or Mix	Descriptive			Distribution		Confidence interval	Assumed probability distribution		
		Mean	SE	SD	Skewness	Kurtosis		Mean	SE	Deviance
UHML	Grade 1	31.06	0.150	0.237	1.095	-1.12	30.75-31.52	31.13	0.059	0.367
	Grade 2	26.23	0.742	0.945	0.448	-2.23	26.00-28.52	27.57	0.095	1.31
	Mix 1	27.23	0.612	0.652	0.682	-1.23	26.10-29.31	28.23	0.112	0.273
	Mix 2	28.32	0.521	0.512	-1.25	4.88	28.00-30.65	29.61	0.217	0.528
	Mix 3	30.01	0.411	0.400	1.436	0.821	30.00-31.85	30.78	0.217	0.211
ML	Grade 1	27.07	0.112	0.273	1.12	-1.01	25.00-27.46	25.17	0.091	0
	Grade 2	22.61	0.521	0.861	0.456	-2.39	22.01-23.65	25.41	0.113	0
	Mix 1	23.40	0.040	0.299	0.670	-0.891	22.15-23.99	23.08	0.037	0
	Mix 2	23.61	0.213	0.293	-0.738	0.758	23.51-24.59	24.45	0.067	0
	Mix 3	25.70	0.124	0.273	1.43	1.97	24.15-25.55	24.78	0.117	0
UI	Grade 1	87.04	0.182	0.446	0.882	1.05	84.68-88.66	85.15	0.171	0
	Grade 2	80.76	2.24	1.93	0.058	-3.16	79.72-81.23	79.03	0.138	2.15
	Mix 1	85.93	0.788	0.857	-2.41	4.35	81.03-86.66	81.75	0.632	0.03
	Mix 2	83.19	0.625	0.725	-0.744	-1.15	81.45-85.99	82.33	0.526	4.28
	Mix 3	85.64	0.369	0.516	1.259	-0.337	82.12-86.56	84.00	0.231	5.94
SFC	Grade 1	7.35	0.551	0.955	-0.496	-2.01	4.68-7.12	7.35	0.213	0.30

	Grade 2	12.65	2.56	3.54	-0.548	-0.331	10.04-11.35	11.53	2.55	19.15
	Mix 1	10.22	1.52	2.54	1.96	2.81	9.97-10.00	10.22	1.64	15.05
	Mix 2	9.17	0.961	2.01	2.71	3.97	8.71-9.10	9.34	0.854	10.30
	Mix 3	8.21	0.759	1.29	-1.44	0.915	6.84-7.89	8.72	0.632	0.371
FS	Grade 1	38.71	0.397	1.22	2.44	4.98	37.21-39.21	38.71	0.311	0.19
	Grade 2	30.62	0.945	3.32	3.09	3.89	29.96-33.56	30.37	0.872	0
	Mix 1	32.74	0.623	1.96	-0.073	1.21	33.21-33.91	32.72	0.595	0.98
	Mix 2	33.91	0.525	1.86	1.89	3.38	33.11-34.99	33.54	0.314	0
	Mix 3	36.10	0.466	1.79	2.26	5.17	34.56-36.95	35.71	0.322	2.11
E%	Grade 1	6.88	0.017	0.041	-2.45	6.00	6.84-10.93	6.88	0.017	0
	Grade 2	7.12	0.889	1.17	0.038	-2.821	6.88-11.34	8.22	0.041	5.63
	Mix 1	7.02	0.479	0.141	0.542	-1.69	6.94-10.09	8.89	0.139	0.02
	Mix 2	7.02	0.042	0.137	0.312	-1.95	6.96-12.33	7.03	0.031	4.64
	Mix 3	7.03	0.021	0.125	0.669	-1.22	6.95-12.63	7.02	0.011	0
Mic	Grade 1	4.71	0.052	0.128	-0.354	-2.16	4.05-4.78	4.71	0.048	0.128
	Grade 2	4.11	0.321	0.771	-0.096	-3.09	4.02-4.40	4.23	0.311	5.08
	Mix 1	4.31	0.662	0.767	1.69	5.45	4.11-4.50	4.46	0.057	0.09
	Mix 2	4.41	0.156	0.152	1.17	2.78	4.01-4.60	4.12	0.126	4.97
	Mix 3	4.42	0.256	0.111	2.71	5.98	3.99-4.46	4.25	0.125	0
MR	Grade 1	88.20	0.342	0.837	-1.54	1.43	86.00-89.39	88.35	0.311	0.05
	Grade 2	70.61	2.56	2.86	-2.45	6	70.00-83.83	76.16	1.38	69.24
	Mix 1	82.71	0.972	1.83	0.841	-0.470	74.99-85.96	77.91	0.798	9.82
	Mix 2	84.10	0.528	1.73	0	-2.26	77.23-86.99	80.67	0.451	2.82
	Mix 3	86.63	0.412	1.01	-0.724	-0.481	78.51-87.21	82.65	0.365	2.23
LD	Grade 1	176	0.052	0.128	-0.569	-1.63	155-180	176	0.026	0.26
	Grade 2	142	3.45	4.59	0.44	-2.04	135-149	143	2.15	1.59
	Mix 1	149	2.62	3.05	-0.523	1.88	140-155	150	1.88	1.40
	Mix 2	158	1.59	1.92	-0.904	-0.963	145-162	158	0.964	2.13
	Mix 3	168	0.689	0.849	0.784	-1.23	155-176	169	0.439	1.13
YS	Grade 1	2560	16.79	9.30	-0.286	-2.58	2499-2880	3562	5.47	0.25
	Grade 2	2070	30.85	84.51	0.111	-3.02	2000-2400	2192	22.69	4.48
	Mix 1	2135	22.65	33.63	-0.937	0.573	2030-2290	1753	19.63	1.56
	Mix 2	2231	19.58	29.20	0.875	-0.795	2000-2300	1717	10.16	0.869
	Mix 3	2360	18.65	17.59	0.605	-1.05	2300-2550	1810	5.11	0.512

Table 5 Regression model criteria over all data cotton fiber grades for Giza 95

property	VIF	Tolerance	R^2	R^2	R^2adj.
UHML	1.18	0.847	86.1	75.3	74.9
ML	15.21	0.066	93.4		
UI	4.29	0.233	84.1		
SFS	2.15	0.465	53.5		
FS	3.12	0.321	67.9		
E%	2.30	0.434	56.6		
Mic	1.29	0.774	22.6		
MR	4.64	0.216	78.4		
LD	1.93	0.517	48.3		

Collinearity; the variance inflation factor (VIF) and tolerance. VIF provides a measure of the degree of collinearity where a variance inflation factor of 1 or more essentially nocollinearity as shown with almost all cotton lint properties; UHML, UI, SFC, FS, E%, Mic, MR and LD meanwhile 20 or higher showed extreme collinearity such as in ML. [37,38].

Practically, comparing among cotton fiber properties depend on the degree of increasing or decreasing in values comparing with each other not in specific scales as shown by different proven theories.

In terms of normal distribution parameters with assumed distribution parameter, the overall mean of G 92, G 86, G 94 and G 95; grade 1 had the highest mean value followed by mixed 50% (mix 3) then 40% (mix 2), then 30% (mix 1) and finally the lowest mean value (grade 2) for both of UHM, FS, Mic and YS as shown in figures 1, 2, 3 and 4. Finally, mixing method based on lint grades exhibited significant improvement in fiber and yarn quality properties.

In general; to facilitate data visualization. It allows for data to be presented in a meaningful and understandable way using untraditional method such as assumed probability distribution by its parameters with the traditional method to get clear results with a comprehensible recommendation.

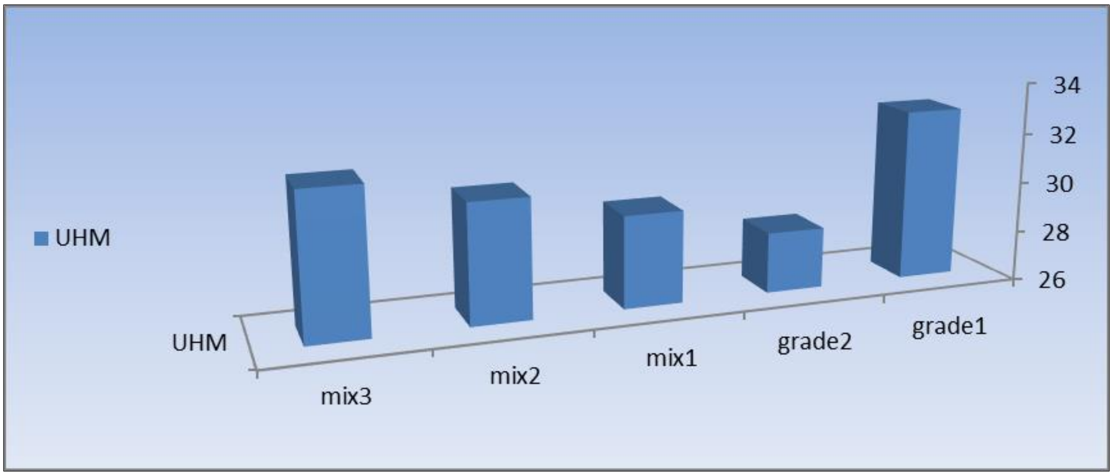

Figure 1 Relationship between lint cotton (grade and mix) and upper half mean length (UHM)

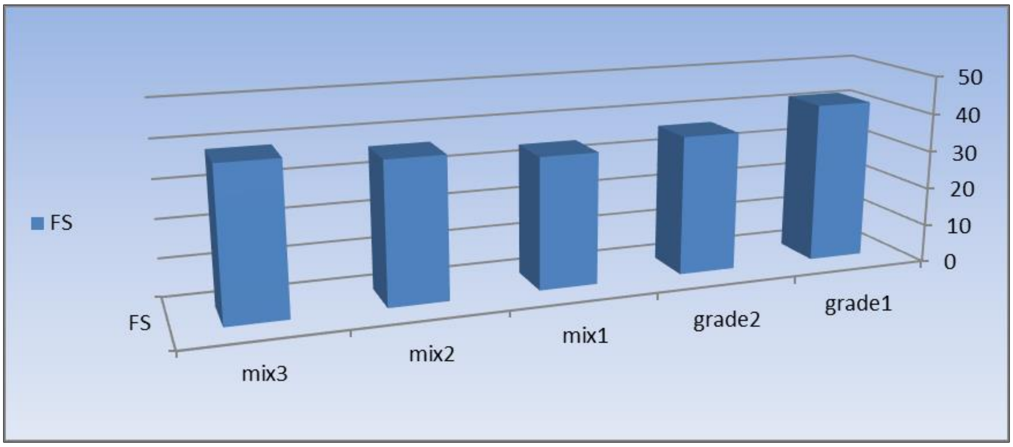

Figure 2 Relationship between lint cotton (grade and mix) and strength (FS)

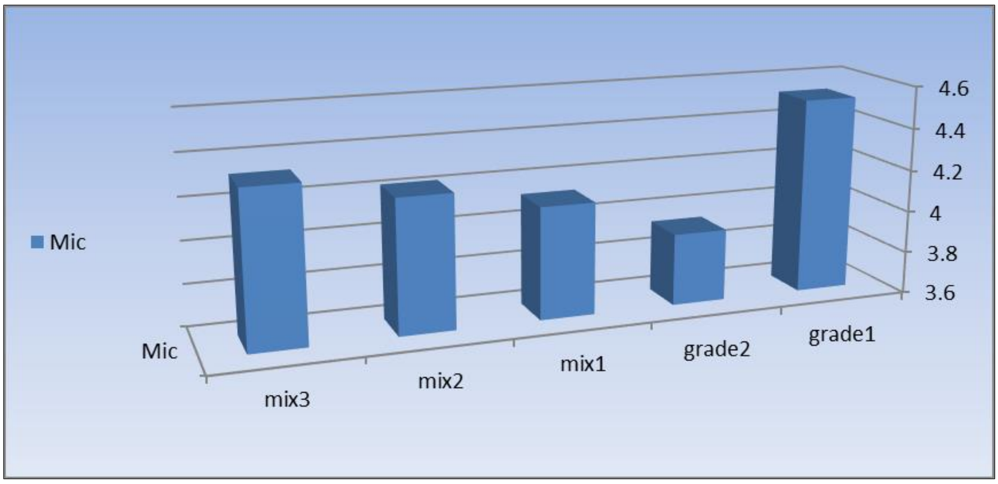

Figure 3 Relationship between lint cotton (grade and mix) and micronaire reading (Mic)

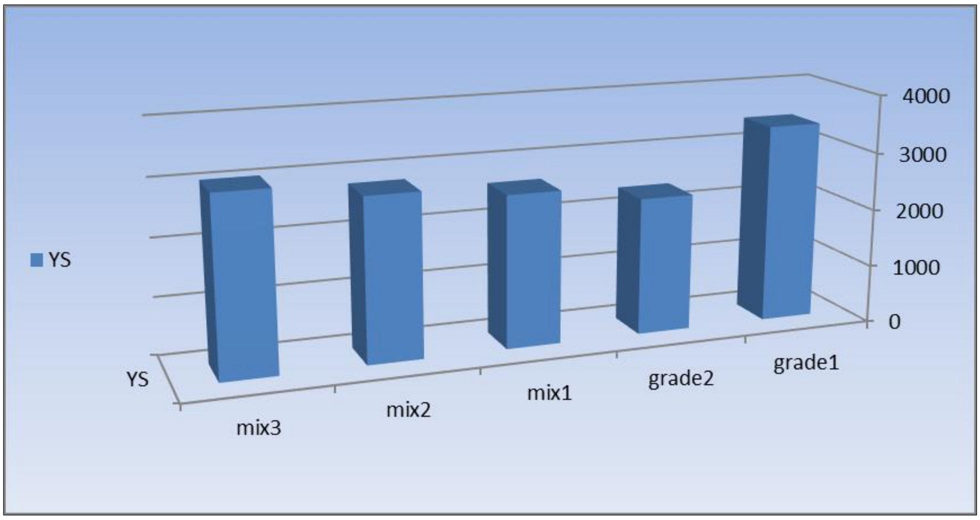

Figure 4 Relationship between lint cotton (grade and mix) and yarn strength (YS)

4. Conclusion

The experimenter often aims not only to get an estimate of a parameter value, but also some measures of the estimator's precision to get close to accurate measurements. It was obvious the more percentage of grades mixing of the highest grade, the more increasing in mean values of almost all cotton fiber properties such as UHML, ML, UI, FS, Mic, MR and YS except SFC comparing to the values of the highest grades and the values of the lowest grades. Moreover, getting firm decision depends on the target final product.

References

[1] Fisher OJ, Rady A, El-Banna AAA, Watson NJ, Emaish HH. An image processing and machine learning solution to automate Egyptian cotton lint grading. Journal of Textile Research. 2022; 39(11-12): 2558-2575.

[2] Cui X, Cai Y,Rodgers J.An investigation into the intra-sample variation in the color of cotton using image analysis. Journal of Textile Research. 2014; 84: 214-222.

[3] Lv G, Gao Y, Rigall E. Cotton appearance grade classification based on machine learning. Journal of Prcedia Computer Science. 2020; 174: 729-734.

[4] Hsien Y, Hu XP, Wang A. Single fiber strength variation of Developing cotton fibers strength and structure of G hirsutum and G barbadens. Journal of Textile Research.2000; 70(8): 682-690.

[5] Cai YX,Rodgers J,Thibodeaux D, Matrin V, Waston M,Pang S. A comparative study of the effect of cotton fiber length parameters on modeling yarn properties. 2013; Journal of Textile Research. 83(9): 961-970.

[6] Dever J. Improving fiber elongation of U. S. germplasm. Project of Texas Agrilife Research. Lubbock, Texas. 2013; WWW.cottoninc.com

[7] Long RL, Bange MP, Delhom CD, Church JS, Constable GA. An assessment of alternative cotton fiber quality attributes and their relationship with yarn strength. Journal of Crop Pasture Science. 2013; 64: 750-762.

[8] Delhom CD, Martin VB, and Schreiner MK. Textile industry needs. Journal of Cotton Science. 2017; 21(3): 210-219.

[9] Delhom CD, Wanjura JD,Pelletier MG, Holt GA, Hequet EF. Investigation into a practical approach and application of cotton fiber elongation. Journal of cotton Research. 2023a; 6(2): 1-12.

[10] Bona M. Testing quality, physical methods of product and process control. Jounal of Textilia-Eurotex. 1994; PP. 182-399.

[11] El-Mogazhy YE.Manufacture of staple yarns. Handbook of Industrial Textiles. 1995; PP. 69-83.

[12] Basu A. Yarn strength properties relationship. Indian Journal of Fiber and Textile Research. 2009; 34: 287-299.

[13] Ebaido IE,Shalaby Mona ElS. Evaluation of the interrelationship among fiber properties andyarn strength of Egyptian cotton. Journal of Polymer and Textile Engineering (IOSR-JPTE). 2019; 5(6): 01-08.

[14] Baykal PD, Babaarslan O, Erol R.Prediction of strength and elongation properties of polyester/cotton blended on rotor yarns. Journal of Fiber and Textile in East Europe. 2006; 14(1): 18-21.

[15] Yao Y, Duan J.Technical problems and research thoughts on development of multicomponent blending yarn. Journal of Advanced Materials Research. 2011; 817-822.

[16] Malik SA, Tanwari A, Syed U, Qureshi RF, Mengal N. Blended yarn analysis: Part 1- Influence of blend ratio and break draft on mass variation, hairiness, and physical properties of 15 Tex PES/Co blended ring spun yarn. Journal of Nature Fiber. 2012; 9(3): 197-206.

[17] Temel E, Celik P. A research on spinnability of 100% polyester and polyser-cotton blend sirospun yarns. TEKSTIL'L ve KONFEKSI. YON, Textile and Apparel Research& Application Center Ege University Turkey. 2010; 20(1): 23-29.

[18] Goudar IV, Kulloli SD. Effect of blend proportion on properties of cotton and flax blended yarn. Journal of Pharma Innovation. 2020; 9:378-381.

[19] Alcantara S, Moore F, Ontaneda M. A systematic review of recycled cotton fiber blending practices, challenges and recommendations. Journal of Textile and Leather Review; 2024; 7: 153-175.

[20] El-Mogazhy YE, Gowayed Y. Theory and practice of cotton fiber selection. Part 2: Sources of cotton mix variability and critical factors affecting it. Journal of Textile Research. 1995; 65(2): 75-84.

[21] Sharma SK. Cotton yarn: Quality depends on mixing strategy. Journal of Indian Textile. 2014; 6(124): 35-42.

[22] Biadgligne A K, Bonsa GB, Gebremichael HS. Optimizing cotton fiber mixing cost with respect to quality of yarn: using integer programming. Branna Journal of Engineering and Technology (BJET). 2020; 2(1): 41-58.

[23] NisarahmedST,Agrawal SA.Formulation of cotton mix: Development from indecisive to decision support systems. International Journal of Engineering Research and Applications (IJERA). 2023; 1(3): 660-665.

[24] Emon JH, Shikder AALR. Impact of blend ratio on the quality parameters of cotton-tencel blended ring-spun yarn. Australian Journal of Science and Technology. 2021; 5(4): 709-713.

[25] Delhom CD, Van der SluijsMHJ, Bange MP, Long RL, Nelson A. Yield, fiber quality and textile outcomes from in-field blending of cotton seed at planting. 2023b; Journal of Cotton Science. 27: 1-11.

[26] Patel JK,Read CB. Handbook of the normal distribution. Marcel Dekker, INC., New York, NY; 1982.

[27] Smithson M. Correct confidence intervals for various regression effect sizes and parameters: The importance of non central distributions in computing intervals. Journal of Educational and Psychological measurement. 2001; 61: 605-632.

[28] Algina J, Keselman HJ, Penfield RD. Confidence interval coverage for cohen's effect size statistics. Journal of Educational and Psychological measurement. 2006; 66: 945-960.

[29] Shalaby Mona ElS.Impact of fiber properties on yarn strength using spatial REML model for Egyptian cotton. Journal of Polymer and Textile Engineering (IOSR-JPTE). 2021; 8(1): 9-15.

[30] ASTM. ASTM Standard D-1776M-16. Standard practice for conditioning and testing textiles. ASTM International, west Conshohocken. 2016; 1-5.

[31] Steel RGD, Torrie JH. Principles and procedures of statistics. McGraw- Hill Book Co., New York; 1980.

[32] Trevor F.A closer look at the deviance. Journal of The American statistician. 1987; 41(1): 16-20.

[33] SPSS. IBM SPSS Statistics 21 Core System. User's Guide (edited by IBM ® SPSS ® statistics 21). U. S. government users restricted rights by GSA and ADP; 2012.

[34] Genstat. The guide to Genstat ®, part 2: Statistical (edited by R. W. Payne). Lawes Agricultural Trust (Rothamsted Experimental Station), Harpenden, Herts, U. K.2000.

[35] Schruben L.Confidence interval estimation using standardized time series. Journal of Operations Research Society of America. 1983; 31(6): 1090-1108.

[36] Shieh G. Confidence intervals and sample size calculations for the standardized mean differences effect size between two normal populations under heteroscedasticity. Journal of Behaviour Research. 2013; 45: 955-967.

[37] Sheather S. A modern approach to regression with R. New York, NY: Springer. ISBN: 978-0-387-09607-0; pp: 1-397, 2009.

[38] James G, Witten D, Hastie T, Tibshirani R. An introduction to statistical learning (8th ed.). Springer Science + Business Media. New York. ISBN 978-1-4614-7138-7; pp: 1-441, 2017