

RESEARCH PAPER

Identifying lint properties of some cotton genotypes (*Gossypium hirsutum L.*) using different statistical models

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ABSTRACT:

The study was conducted to compare between nine cottonseed genotypes (*Gossypium hirsutum L.*) which included, two local Iraqi genotypes Coker 310 and Lachata (which originating from America and Spanish and recorded in Iraq) and three of the Bakhtegan, Khordad, Varamin genotypes are from Iran, and four of them Cafko, Dunn 1047, Montana, Stoneville genotypes are from America (USA) which aimed to identify yield components and fiber quality properties.

The field experiment was designed with randomised complete block design using three replicates in Grdmal village, south Erbil, which is 30 km far from centre of Erbil, Iraq. Statistical analysis of the traits shown significant differences among the nine cotton genotypes, significantly maximum fiber strength, fiber elongation and protein yield (33.20 (g tex⁻¹), 6.80 % and 118.27) were recorded by the first Iraq's genotype Lachata. Highest values of fitness and fibre weight plant⁻¹(4.70 microner and 6.64 g) were recorded from Bakhtegan Iran's genotype. Maximum value for uniformity (85.10 %) was also recorded by Khordad Iran's genotype. From the principal component analysis (PCA) shows the angle value between each of the two variables elongation, uniformity and strength is $\leq 90^\circ$ it means there was significant correlation between them and via versa

KEY WORDS: Cotton genotypes; Eigenvalue; Oil yield; Protein yield; fiber quality.

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1.INTRODUCTION :

Cotton (*Gossypium hirsutum L.*), interests as a white gold due to its contribution in agricultural, industrial, and economy development. It is a major source of fiber and oil, in most of the tropical region in the world. Cotton specie is one of the world's primary fiber crops and it is widely cultivated throughout the world (Constable et al., 2015; Muhammad et al., 2017). Traditionally, ideal cotton fibers are said to be as "white as snow, as strong as steel, as fine as silk and as long as wool". Moreover, cottonseed are the second most important source of oil for human consumption and it contains about 15% oleic acid. The oil of cottonseeds regards as the preferred vegetable oil. The hydrogenate, is not necessary for increasing its oil stability (Ul -Hassan et al., 2003; Daniel, 2003).

Furthermore, cotton pie also is used in animal husbandry, marking it an excellent feed for ruminants due to its high protein level (Dogan et al., 2012).

For development of high yielding quality, genotypes there should be genetic variation within the cotton specie. Specially, it is influenced by climatic conditions and various agronomic factors, such as sowing time and genotypes etc... Genotype selection is an important factor which has a large impact on yield and quality attributes of cotton specie (Calhoun, 2005). Indeed, it mostly limits cotton growth, yield and quality (Sarwar et al., 2012; Zeng et al., 2014). Cotton genotype is mainly selected for higher yield and fiber quality, greater tolerance to adverse conditions and earlier maturity. On the other hand, Salih (2019) referred that genotypes have a significant role in production of cotton crop. There were found highly significant differences among genotypes for all qualitative and

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quantitative traits. Rabadia et al (2006) showed from their study on three genotypes of cotton that there were significant differences for number of bolls and its components (seed and lint). From a comparisons study among six genotypes Salih(2010) stated that the genotype Lachata was superior in cottonseeds are the second seed yield and ginning out turn with the values of 4.20 Mg. ha⁻¹, 5.25 g and 3.38% respectively.

The degree of variation in growth and dry matter partitioning, was explored among nine cotton genotypes of the diverse growth habit and how these, may affect crop maturity. Because cotton is indeterminate and perennial specie, the timing of crop maturity is largely determined by the capacity of the plant to continue the production of new vegetative organs and the associated fruiting sites (Khan et al., 2010). Moreover, Ali et al (2009) and Ullah et al (2019) reposted that the higher values of fiber quality were obtained between different genotypes. Furthermore, many studies have focused on the development of the fiber yield and quality (Chapman et al., 2001), the goals of the study was comparison among nine cottonseeds genotypes originated from Iraq, Iran and American on the seed oil and protein yields and fiber quality properties.

2. Materials and Methods.

2.1. Seed samples and Field trials:

Nine genotypes of (*Gossypium hirsutum* L.) were evaluated, two of them are local genotypes in Iraq “Coker310 and Lachata”, three Iranian genotypes “Bakhtegan, Khordad and Varamin” were obtained from the Seed and Plant Certification and Registration Institute, Karaj, Iran and Four of them was American “Cafko, Dunn1047, Montana and Stoneville” genotypes are commercial varieties sold in Iraq. Seed samples were stored in opaque envelopes in the dark at 5°C and 30% relative humidity, until they were used.

The field experiment was done at Grdmala (36°00'02.53"N, 44°04'59.82"E) in Erbil, Iraq. The field experiment was designed as a randomized complete block (RCBD) with three replicates. Each plot was 6 m² (3m x 2m), with intra- and inter-row spacing of (25 and 70) cm. The No of plant per plot was 32 plants. Whole cottonseeds were hand sown were hand sown with seed rate of 25 kg ha⁻¹. Moreover, the study area

is categorized as the interior Mediterranean, cold winter, dry, and hot summer. The majority of the weather stations are with-in the mountainous area. The annual rainfall average starts from 250 mm in the south of the Erbil area to more than 1200 mm in the high mountains bordering Iran in the northeast and Turkey in the north (Karim et al., 2018).

Drip irrigation methods (DIM) was used, which is one of the technical measures to increase water use efficiency. Under this method, water is delivered directly to the root zone of the crops using pipe networks and emitters. This method is entirely different from the conventional (Fattah, 2019), the amount of water applied was 1 L. hr⁻¹. Some physical and chemical properties of the studied field was determined as shown in table (1).

Ten plants were randomly selected from each plot at the mature stage (opening 60% of bolls) for measuring depending on (Khan et al., 2010).

2.2. Agronomic measurements.

The following agronomic measurements were recorded:

2.2.1. Ginning out turn (GOT), before the ginning, seed cotton samples were air dried in laboratory. Dusts and inert matter were removed from samples and then weighed and ginned separately manually. The lint obtained from each sample was weighed and its percentage was calculated by applying the following formula (Al-Hajooj, 2012).

$$\text{Ginning out turn (GOT)\%} = \frac{\text{Weight of lint}}{\text{weight of seed+lint}} \times 100$$

2.2.2. Lint Index

$$\begin{aligned} \text{Lint (Fiber)Index} \\ &= \text{Weight of Fiber Yield from 100 seeds} \\ &= \frac{(\text{Seed index} \times \text{Net Ginning})}{(100 - \text{Net Ginning})} \end{aligned}$$

(Christakis and Harrison,1955) (C. F .AL-Hajooj ,2012).

2.2.3. Oil was determined by Soxhlet extraction apparatus using hexane according to the methods described by (AOAC, 1980). Used to calculate oil yield using the formula:

$$\text{Oil Yield} = \text{oil \%} \times \text{Seed yield (Mahmood et al., 2020)}$$

2.2.4. The Total Nitrogen:

The Total Nitrogen was determined using the Kjeldahl method, then the protein percentage was determined as follow: Protein % =N% × 6.25.

then determine protein yield as follow:

Protein Yield =Protein (%)×Seed Yield
(Mahmood et al., 2020)

2.2.5. Fiber quality analyses:

Fiber quality analyses were determined by the (Seed and Plant Certification and Registration Institute (SPCRI), Karaj, Iran) using Spinlab High Volume Instrument (HVI). which includes:

1- **Fiber length (mm)** : Fiber length (mm) used staple method for determination

2-**Fiber strength (g tex⁻¹):**

Fiber strength (g.tex⁻¹) the extent of the resistance of lint for different cutting forces measured by Presley instrument on distance 1/8 inch between the jaws which calculated by (Christidis and Harrison, 1955) used stelometer instrument.

$$\text{Fiber Strength} = \frac{\text{District weight}}{\text{Sample weight}} \times 15$$

3- **Micronaire index (fineness fiber):** Were recorded using of the ASTM (1995) Stander Method, D4604-95.

Micronaire index (fineness fiber): It means capacity of lint diameter measured by Maturimeter IFE-Type F₁ -10 instrument for a sample weighted (5 g) which classifieds as bellow: were recorded using of the ASTM (1995) Stander Method, D4604-95.

4- **Effective length (mm):** measured by Pero sorter Instrument which measured by taking (5 g) of the sample then combing it by hand. .

5- **Uniformity % (Maturity %):** It means capacity of lint diameter measured by Maturimeter IFE-Type F₁ -10 instruments for a sample weighted (5 g) which classifieds as bellow: by Maturimeter instrument. IFE-Type F10 calculated from special table.

6- Elongation using stelometer instrument.

2.3. Statistical analysis

Data collected on different parameters were analysed statistically by using Statistical Package for the Social Sciences (SPSS) programmed (version 28) for analysis of variance and means were using Duncan's multiple range test at the ($P \leq 0.05$) significance level (Cochran, 1957). The principal component analysis (PCA) was

performed for comparing between the studied treatments combinations using XLSTAT-Premium Program ([https:// WWW.XLstate.com](https://WWW.XLstate.com) XLSTATE version 3.5. 2014.

3. Results and Discussion

This study showed significant effect of genotype on fiber plant⁻¹ (Figure 1). Which shows that Bakhtaran genotypes recorded the highest fiber value (8.65 g) fiber plant⁻¹ in comparing with other genotypes while the lowest value (6.48 g) that obtained from Lashata.

In the same figure, the highest net ginning (39.87 %) was recorded for the both Iraq's genotypes Coker310 while their lowest value was observed of ginning (35.40 %) the Lachata genotype.

The parameters fiber strength (g.tex⁻¹), fiber length (mm), elongation (%), maturation ratio, uniformity and fiber fineness (Micronaire index) are important traits for fiber quality of cotton and for textile industries which were observed for nine cottonseed genotypes. Mean fiber strength (Figure 2) varied from 27.00 and 33.20 for the studied nine genotypes. Furthermore, the highest value of fiber strength was observed for the one Iraq's, American and Iran's genotypes (Lachata, Stoneville and Vanamin) respectively compared to other six genotypes, but the minimum fiber fineness was observed for one Iraqis and American genotypes Lachata and Stoneville (2.30). Mean values for all genotypes were having non-significant differences for Fiber length, Maturity and Elongation these qualitative characters can be used as reliable selection for improving of cotton specie. Hence, the Khdorda Iran's genotype excelled all other genotypes having highest uniformity (85.10) by having highest fiber length (mm) (Figure 2).

Figure (3) shows that Coker 310 and Lachata obtained highest value with increase of (175.58 and 94.27) % comparing with Vanamin genotype which results in lowest oil and protein yield respectively, moreover Bakhtin recorded highest fiber index with value of 41.22 while the lowest value (28.95) obtained for Cafko. Table (2) and Figure (4) explain that the eigenvalue for three factors (F1, F2 and F3) had great influence on variability, since their values were higher than one which were (3.941, 2.921 and 1.406) respectively. Then, the cumulative variability was 90.34% while the eigenvalues for (F4 to F8) less than one or can be neglect. After F3 the slope of scree plot

will decrease then approach to zero (Figure 4). It means the effects of F4 to F8 is very low (Table 2) which can be neglected.

Table (3) explains factor loadings and if their value ≥ 0.62 it means this variable is contributing in the factor for this reason:

F1: Fiber weight, Fiber index, Protein yield, Fiber length, Microner index and Maturity.

F2: Fiber index, Fiber length, Strength and Uniformity.

F3: Elongation only

Bold values means the significant difference between parameters and factors. F_1 =Fiber weight + Fiber index +Protein yield +Fiber length +Microner index +Maturity. Moreover, the F_2 = Fiber

index + Fiber length + Strength + Uniformity.

F_3 = Only elongation.

In the PCA analysis performed with the values of lint properties of nine cotton genotypes estimated for all qualities (Figure 4-cluster 1-2-3). The first two axes for three clusters were significant (eigenvalues ≤ 90) and contributed for 68.62, 53.47 and 43.27 % of total variance. Axis 1 explained 68.62 % of total variability and was mainly correlated to F1, F2 and elongation compare to the oil yield, protein yield and strength. Axis 2, which explained 53.47 % of total variability and was mainly correlated to F1, F2 and elongation compared to the oil yield, protein yield and strength. Axis 3 explained 43.27 % of total variability and was mainly correlated to the elongation, maturity, uniformity, strength and fiber length.

Table 1. Physic-chemical analysis of the experimental site during field trials*.

Physical Properties		Value	
Particle Size Distribution			
Sand		118 g kg ⁻¹	
Silt		432 g kg ⁻¹	
Clay		450 g kg ⁻¹	
Textural Name		Silty Clay	
Chemical Properties	Value	Chemical Properties	Value
pH	7.86	Total Nitrogen	0.80 g kg ⁻¹
ECE	0.50 dS m ⁻¹	Available - P	9.3 mg kg ⁻¹
CEC	22.87 Cmolc kg ⁻¹	Total CaCO ₃	250 g kg ⁻¹
Organic Matter	9.70 g kg ⁻¹	Active CaCO ₃	15.55 g kg ⁻¹
Iron	2.98 mg kg ⁻¹	Copper	0.80 mg kg ⁻¹
Manganese	2.77 mg kg ⁻¹	Zinc	0.50 mg kg ⁻¹
Soluble cation and anion			
Chemical Properties	Value (mmol L ⁻¹)	Chemical Properties	Value (mmol L ⁻¹)
Potassium	1.14	Chloride	2.30
Magnesium	1.55	Bicarbonate	3.50
Sodium	0.95	Carbonate	0.00
Calcium	2.50	SO ₄ ⁻²	0.86

* (Fattah, 2019)

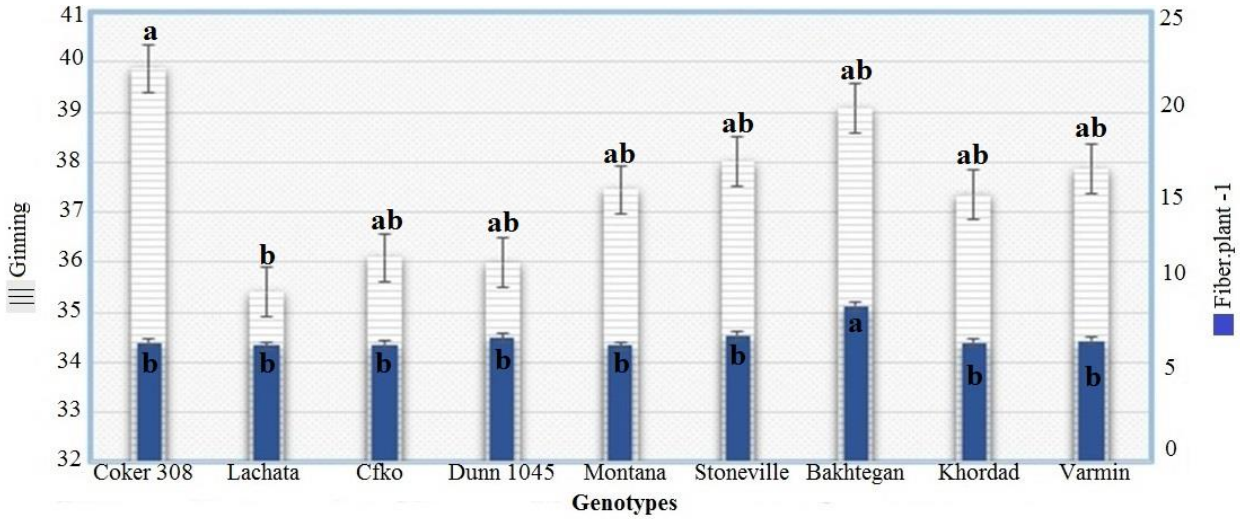


Figure 1. Effect of genotypes on ginning out turn and fiber weight plant⁻¹.

Means followed by the same letter in the bar chart indicate not significantly different Duncan's multiple tests, ($P \leq 0.0$).

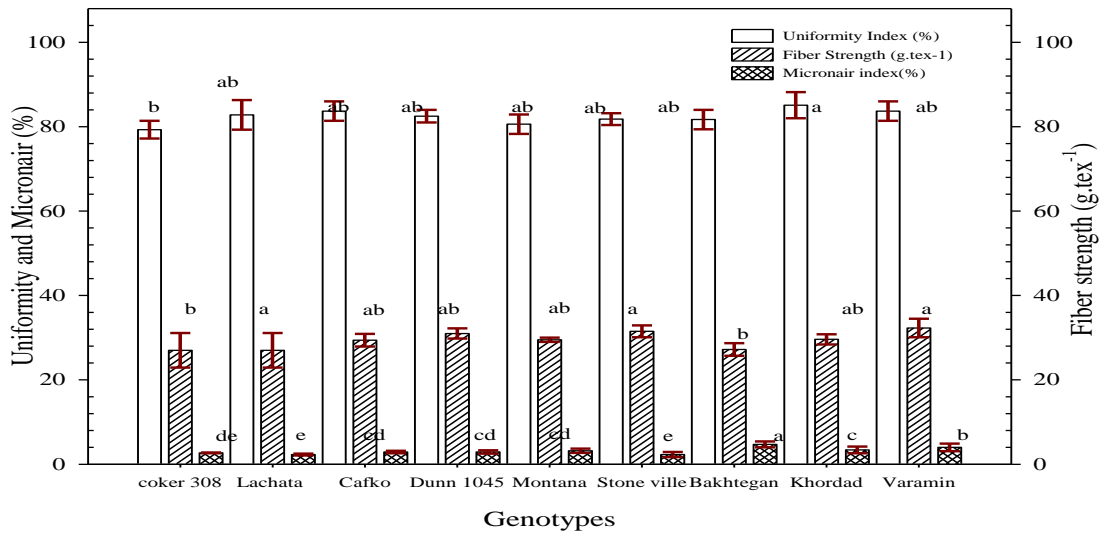


Figure 2. Mean performance for various fiber qualities of nine cottonseeds *G. hirsutum* genotypes

Means followed by the same letter in the bar chart did not significantly differ Duncan's multiple test ($P \leq 0.0$).

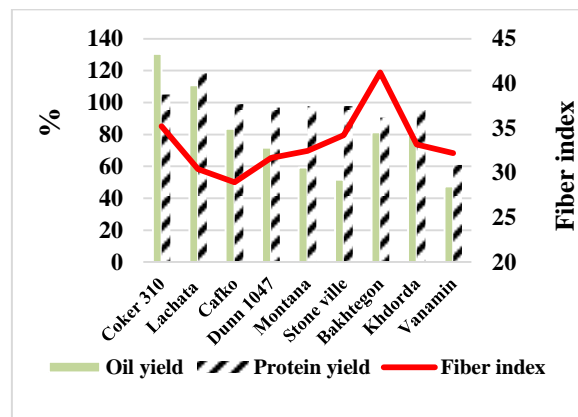
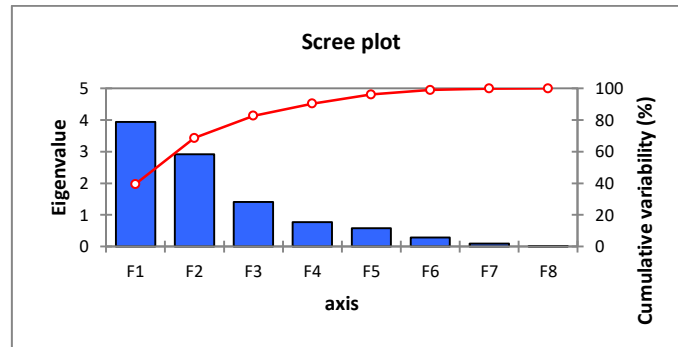


Figure 3. Oil, protein yield and fiber index as affected by cotton genotypes

Table 2. Shows the eigenvalue and the variability among the genotypes.

	F1	F2	F3	F4	F5	F6	F7	F8
Eigenvalue	3.941	2.921	1.406	0.766	0.575	0.286	0.089	0.016
Variability (%)	39.412	29.209	14.056	7.665	5.754	2.859	0.89	0.155
Cumulative(%)	39.412	68.621	82.677	<u>90.342</u>	96.096	98.955	99.845	100

**Figure 4.** Shows the decrease in slope for scree plot after F3.**Table 3.** Shows loadings or the correlation coefficient between the studied parameters and factors.

	F1	F2	F3	F4	F5	F6	F7	F8
Fiber weight	0.692	-0.560	0.258	-0.271	0.227	0.039	-0.119	0.000
Fiber index	0.602	-0.729	0.068	-0.060	0.196	-0.054	0.238	-0.007
Protein yield	-0.826	-0.432	0.215	-0.136	0.098	0.235	-0.001	-0.036
Oil yield	-0.470	-0.525	0.421	0.503	-0.187	0.194	0.027	0.015
Fiber length	0.608	0.635	-0.117	0.458	0.036	0.002	0.044	-0.023
Microner index	0.915	-0.179	-0.037	-0.071	-0.289	0.189	-0.009	0.074
Maturity	0.954	0.010	0.075	0.178	0.093	0.186	-0.070	-0.064
Elongation	0.140	0.188	0.930	0.125	0.104	-0.227	-0.033	0.021
Strength	-0.180	0.830	0.107	-0.070	0.445	0.243	0.050	0.045
Uniformity	0.169	0.672	0.462	-0.389	-0.372	0.086	0.084	-0.037

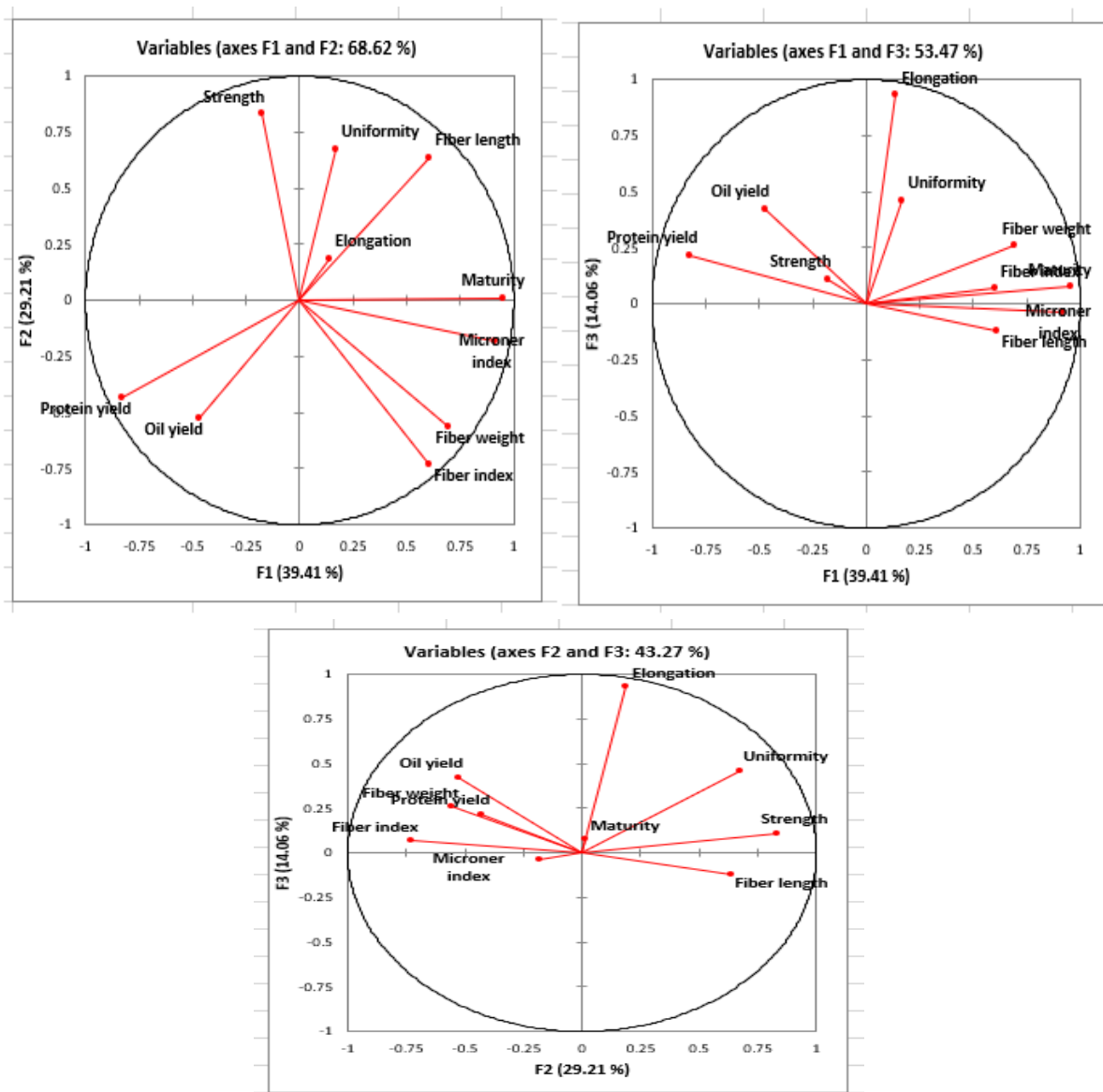


Figure 5. PCA on the parameters of lint properties of nine cotton genotypes. The negative and positive values for factors (F1, F2), (F1, F3) and (F2, F3) are limiting, the locations of vectors or variables in the circle.

4. Discussion

As shown in fig (1), the highest net ginning was recorded for Coker310 (Iraq's genotype). These results were in agreement with Others [Tabatabaei et al \(2012\)](#), [Hurmzyar \(2014\)](#), they found that differences in ginning may be due to differentiation between genotypes, the differences in total cotton lint yield may be due to ginning value as mentioned by ([Saeed et al., 2014](#)). In addition, [Sahito et al., \(2016\)](#) showed that the significantly highest ginning outturn, staple length and fiber fineness were found between eight varieties.

Furthermore, the highest value of fiber strength was observed for (Lachata, Stoneville and Vanamin) compared to other six genotypes. These results corroborate the findings of [Ali et al \(2009\)](#) and [Ullah et al \(2019\)](#). They observed that the higher values of staple length, fiber strength and micronaire were obtained between genotypes. According to [McAlister and Rogers \(2005\)](#) there were differences between genotypes for staple length, fiber strength and micronaire. [Sahito et al \(2016\)](#) was in agreement with our result Fig 2, they obtained that the fiber fineness varies from variety to another variety.

The results in fig 2 corroborate the findings of [Ali et al \(2009\)](#) and [Ullah et al \(2019\)](#). They observed that the higher values of staple length, fiber strength and micronaire were obtained between genotypes. According to [McAlister and Rogers \(2005\)](#) they reported on type of fiber fineness, Iran's genotypes Bakhtegan had to price normal for the Micronaire index (4.70^a), all genotypes mean values were having non-significant differences for fiber length, maturity and elongation (Table 2). These results were agreed with [Bradow and Davidonis \(2000\)](#). They showed that fiber length varies by fiber location on the seed, seed location within the boll, and boll location on the plant.

Furthermore, [Sahito et al \(2016\)](#) showed that the significantly highest ginning outturn, staple length and fiber fineness were found between nine genotypes.

In general, [Main et la \(2013\)](#) reported that the seed protein and oil seed content for varieties of different seed sizes were increased and decreased slightly in response to increasing amounts of soil nitrate. [Dani \(1991\)](#) and [Hassan et al \(2005\)](#) studied the mean performance of *G. hirsutum* cultivars for cottonseed oil % and observed significant variations among genotypes for cotton seed oil yield.

5. Conclusion

This study comprised of two Iraq's, three Iran's and four American's cottonseed (*G. hirsutum* L.) genotypes on the fiber quality, oil and protein. They varied in the studied parameters. It was concluded that the *G. hirsutum* genotypes were differing in their traits. Among the nine genotypes under test the response of genotype Lachata very well in terms of fiber quality, was oil, protein yield. Then, one Iran's of genotype Bakhtin has greater fiber quality, under the prevailing environmental conditions in the northern territories of Mesopotamia (Erbil). Therefore, these traits may be used to advice farmers not only about cotton specie but also other species which is understand the impact of difference genotypes on the quality and quantity of yield.

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