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Estimation of the genetic parameters of a number of pure lines Maize (*Zea mays* L.)

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Abstract :

The experiment was applied during the fall of 2022, where 10 pure lines of maize were planted using the complete random block design to identify the most influential traits in the product that can be considered as selection evidence for improving grain yields. The results of variance analysis showed significant differences in the studied traits. The genetic variation was higher than the environmental variation for all traits. The highest inheritance was found in the plant's leaf ear. The values of the genetic and phenotypic variation coefficient were close and low. The genetic correlation coefficient was high and positive between plant yields, weight of 100 grains, number of grains/rows, and number of rows/cobs.

Key words: Maize, genetic variation, inheritance, Genetic correlation .

تقدير المعالم الوراثية لعدة سلالات من الذرة الصفراء

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مستخلص:

تم تطبيق التجربة خلال موسم الخريف عام 2022 ، حيث تمت زراعة 10 سلالات نقية من الذرة باستخدام تصميم القطاعات العشوائية الكاملة لتحديد الصفات الأكثر تأثيراً في حاصل النبات والتي يمكن اعتبارها دليل انتخاب لتحسين محصول الحبوب. أظهرت نتائج تحليل التباين وجود فروق معنوية في الصفات المدروسة، وكان التباين الوراثي أعلى من التباين البيئي ولجميع الصفات. وكانت أعلى نسبة توريث لصفات أوراق النبات. وكانت قيم معامل التباين الوراثي والظاهري متقاربة ومنخفضة، وكان معامل الارتباط الوراثي مرتفعاً وموجباً بين حاصل النبات ، و النبات ووزن 100 حبة ، وعدد الحبوب/ الصفوف ، وعدد الصفوف/ عرنوص.

الكلمات المفتاحية: الذرة الصفراء، المتغايرات الوراثية، التوريث، الارتباط الوراثي .

Introduction

Maize (Zea mays L.) is a major summer crop known as the Queen of grains. With a tremendous productive potential among grains, maize leads in overall output, followed by wheat and rice (Singh *et al.*, 2017) . The goal of maize breeding programs is always to increase genetic features of economic value while keeping a reasonable level of diversity. The goal of genetic improvement is to preserve adequate variety while improving economically important features. In order to increase the genetic variety of local germplasm, it is vital to understand the amount of existing genetic variations in material (Tadesse *et al.*, 2018)heritability and genetic advance of traits in any plant population is an important prerequisite for breeding program. The experiment was conducted to assess the magnitude of genetic variability, heritability and genetic advance of 24 maize inbred lines for 16 quantitative traits. The field experiment was conducted during 2016 cropping season at Jimma Agricultural Research Center (JARC.

Maize is a field crop with cross-fertilization, making breeding and development easier. Hybridization attempts to produce novel genotypes that aid breeders in selecting high-yielding varieties(Sharif and AL-Rawi, 2019). Plant breeders utilize heritability estimates to identify potential genotypes and forecast desirable characteristics. Heritability information enables proper selection strategies to be established, as well as the prediction of any outcomes from selection, while also assisting in determining the degree of genetic effects.(Singh *et al.*, 2017). To enhance the genetic diversity of local germplasm, it is critical to understand the level of existing genetic variety in the material. Genetic diversity, or heritable differences across cultivars, is necessary at a significant level within a population to allow and sustain a successful long-term plant breeding effort. Thus, understanding the genetic component of variability is critical for improving a characteristic. Among other features, grain yield is a complicated variable that is influenced by the interplay of various growth and physiological processes throughout the life cycle (Radheshyam *et al.*, 2014). Genetic variety is a necessary and significant tool in every breeding plan. It gives not just the selection criteria, but also some useful information about selecting varied parents for use in a hybridization program.(Lal and Singh 2014).

The phenotypic coefficient of variation (PCV) showed moderate values for yield and number of ears, whereas genotypic coefficient of variation (GCV) suggested low values for all characteristics. The low amplitude of GCV, along with limited genetic repeatability for the variables under investigation, suggests that these parameters were influenced by environmental factors.(Hadi and Hassan, 2021). The correlation coefficient reveals the degree of relationship between traits when selecting acceptable characters in a breeding program. Genetic diversity and its study are critical components of every crop development effort(Rahman *et al.*, 2018).

This study intends to evaluate genetic parameters, including phenotypic, genotypic, and environmental variances, heritability, and genotypic-phenotypic coefficients of correlation, to find selection indicators to ultimately improve maize grain yield through selection.

Materials and Methods

This study was conducted at Abu-Ghraib Research Station, General Authority for Agricultural Research, Ministry of Agriculture during. The parental materials consisted of 10 maize inbred lines..

The parents were evaluated in a randomized complete block design (RCBD) with three replication sowing dates. In each replication, 10 lines were raised; each plot was prepared with three rows 75 cm apart and 5 m in length and the distance among the hills was 25 cm.

The experiment was irrigated every five days; the fertilizers were applied prior to sowing at a rate of 120 kg Nitrogen (N) ha^{-1} and 140 kg Phosphor(P) ha^{-1}; and additional side dressing of 120 kg N ha^{-1} was added at the six leaves stage. Recommended agronomic practices were followed (Khodarahmpour, 2012). Observations were recorded on five competitive randomly selected plants of each genotype of each replication including: silking date, plant height, leaf area, ear number, kernel row number per ear, kernel number per row, 100-grains weight, and grain yield per plant. Statistical analysis was processed by Excel and SAS software.

Table 1: Name of maize lines that used in this study

No.	Icon	Male (testers)
1	L1	SY-16
2	L2	Zm-17
3	L3	EXZ-34
4	L4	Dr-B-5
5	L5	O-22
6	L6	MGw-14
7	L7	SYn-7
8	L8	EXw-40
9	L9	S-90
10	L10	Dr-C5

Estimation of genetic parameters

Genetic parameters were estimated for different traits on maize genotypes as follows:

Heritability ($H_{b.s}$) in a broad sense was estimated as the ratio of genotypic variance to the phenotypic variance and expressed in percentage (Singh and Singh, 2010)

$\sigma^2 G$ = Genotypic variance (Singh and Singh, 2010)

$$\sigma^2 G = msv - mse/r$$

σ^2 E= Environmental variance

$$\sigma^2 e = mse$$

σ^2 P=Phenotypic variance

$$\sigma^2 p = \sigma^2 G + \sigma^2 E$$

CV%= Coefficient of Variance

$$CV\% = SD/\bar{Y} \times 100$$

GCV%= Genotypic Coefficient of Variance $GCV = \frac{\sigma G}{\bar{Y}} X100$

PCV%= Phenotypic Coefficient of Variance. $PCV = \frac{\sigma P}{\bar{Y}} X100$.

$$r_{gij} = \frac{\sigma g_i g_j}{\sqrt{\sigma^2 g_i \sigma^2 g_j}}$$

Results and Discussion

Genetic variation are an important factor for plant breeders, the basis of which is the selection. The election of individuals traits is usually based on their phenotypic traits. Therefore, plant breeders must know the quality and the extent to which they rely on genetic factors and are influenced by environmental factors. The selection is easy and effective if the character is slightly affected by environmental conditions (Elsahookie *et al.*, 1999). Therefore, the assessment of environmental, phenotype, and genetic variation and the coefficient of genetic and phenotype variation and inheritance broadly is one of the most important informations to know the best ways to improve crops.

Table 2 shows significant differences between the genetic structures of all studied characteristics. This is evidence of a discrepancy between the lines used in the study and that they possess different genes. this is evidence of the containment of different genes that led to the emergence of a difference between them in the studied qualities.

Table 2. Mean squares for analysis of variance of different traits of 10 inbred lines of maize.

S.O.V	D.f.	Plant height	N. of days of silking	Leaf area/cm2	Ear number	Rows number /Ear	Grains number/ Row	Weight of 100 grain/g	plant yield
block	2	40.3	6.1	1674.5	0.0018	0.0443	12.7	1.43	67.9
Treat-ment	9	106.6*	6.14*	56626.5*	0.0025*	0.548*	20.98*	194.20*	1264.18*
Error	18	8.8185	1.5815	1555.8	0.0013	0.0799	1.0189	19.285	42.270

Genotypic, environmental, and phenotypic variances and the broad-sense heritability.

The findings shown in Table 3 demonstrate that genetic variation is significantly higher than environmental variation in all the attributes investigated, except the number of days for silk appearance and the number of heads, where the environmental variation was 1.5222 and 0.0004, respectively.

Table 3 demonstrates that the leaf area had the largest genetic variation of 18356.9, followed by plant yields of 407.304. This difference in responses of genotypes to environmental input is caused by the type of genetic elements present in the lines and their response to the environment (Al-Dulaimi *et al.*, 2021).

This variation helps plant breeders to get elected in a better way. Because there is high variation, as for the yield of the plant, it has shown high values of variation compared to other traits, but the selection cannot be made on the yields of the plant that produce from a number of qualities. The weight of the grain, number of grains and the number of cobs are controlled by a large number of genes, so the election cannot be done plant yields. Inheritance is one of the most important factors contributing to the planning of plant breeding programmes by knowing the ability to contribute genes to the qualities studied. On this basis we can by inheriting a distinction between genetic compositions by their phenotypic expression. Table (3) shows that the ratio of inheritance in the broad sense of plant height, leaf area, number of rows, number of grains in a row, weight of 300 grains, and plant yield per plant were high. This could be due to the additional gene, and the increase in inheritance in the majority of traits demonstrates the superiority of genetic variation over environmental variation in several desirable characteristics associated with yields, while also providing plant breeders with an opportunity to improve these qualities through direct election. These results agreed with(Al-Rawi *et al.,* 2024).

It appears in the same table that the number of days to silk (0.490) and the number of rows in cob (0.661) were average values, but inheritance was low 0.233 to Number of cobs.

Table 3 the values of genotypic, environmental, and phenotypic variances and the broad-sense heritability.

	$\sigma^2 G$	$\sigma^2 E$	$\sigma^2 P$	$h_{b.s}$
Plant height	32.596	8.818	41.414	0.787
N. of days of silking	1.522	1.581	3.1037	0.490
Leaf area /cm2	18356.9	1555.83	19912.7	0.922
Ear number	0.0004	0.0013	0.0017	0.233
Rows number per Ear	0.156	0.0799	0.2359	0.661
Grains number/Row	6.656	1.0189	7.6755	0.867
Weight of 100 grain/g	58.307	19.285	77.592	0.751
plant yeild	407.30	42.270	449.57	0.906

Standard, genotypic and phenotypic coefficient of variance

Table 4 shows that the variation coefficient showed low values. This indicates that the experience land and services followed were homogeneous and is also an important indicator of the purity of the grains of the planted lines (Abdul Hadi *et al.,* 2013). The grain yield was highest at an average of 4.89,945 and the lowest average recipe for the leaves area was 0.8095.

The results of the same table also indicate that the phenotypic variation coefficient has a record of values comparable to those of the genetic variation coefficient (GCV) for all the characteristics studied. This indicates that the changes that emerged were not only due to genetic compositions but also due to the small environmental impact and this confirms the results of CV values. These results were in accordance with what was obtained by(Hamdi and Al-Rawi 2021; Al-Rawi *et al.,* 2023). They found that the values of the phenotypic variation coefficient were higher than those of the genetic variation coefficient.

Table 4. Standard, genotypic and phenotypic coefficient of variance

	CV%	GCV%	PCV%
Plant height	1.62451	3.123	3.52048
N. of days of silking	2.37277	2.328	3.32403
Leaf area /cm2	0.8095	2.781	2.896
Ear number	2.97775	1.642	3.40059
Rows number per Ear	1.78064	2.489	3.05999
Grain number/Row	2.74986	7.029	7.54758
Weight of 100 grain/g	2.37721	4.133	4.76831
plant yield	4.89945	15.209	15.9783

Genotypic Correlations

Studying correlation coefficients gives a better understanding of the relationship between different qualities and plant yields. Plant breeders benefit from knowing the relationship between different qualities and plant yields in plant breeding programs because they provide information on the genetic environment of associated qualities as well as for the election of plants and genetic structures that carry a range of desired qualities. If two qualities a genetic correlation coefficient, the direct election process for any trait may result in a change of the other characteristic (AL Rawi *et al.,* 2018).

Table 5 show a genetic correlation between plant yields and yield components, and other growth traits. It found an important genetic correlation between yields and the weight of 100 grains 1.019, as well as between plant yields and the number of grains/row 0.978. The correlation between plant yields and the number of flowering days was low and insignificant. This was due to low environmental variability and high genetic variation between the lines used, which resulted in an increase in the coefficient of genetic association of plant yield with plant yield component . In addition to other growth qualities (plant height, leaf area). There was no significant correlation between plant yields and components and the number of days of flowering. There was also no significant correlation between the number of cobs and plant yields, the number of rows /plant, the number of grains/rows and the weight of 100 grains.

Table 5. Genotypic Correlations

	Plant height	N. of days of silking	Leaf area / cm2	Ear number	Rows number per Ear	Grains number/ Row	Weight of 100 grain/g	plant yield
Plant height	1	0.506	0.843*	0.970*	0.958*	0.929*	0.957*	0.960*
N. of days of silking		1	0.168	0.496	0.575*	0.283	0.456	0.415
Leaf area / cm2			1	1.033*	0.746*	0.754*	0.826*	0.828*
Ear number				1	0.908*	0.751*	0.978*	0.874*
Rows number per Ear					1	0.861*	0.943*	0.940*
Grains number/ Row						1	1.0030*	0.9785*
Weight of 100 grain/g							1	1.0192*

Conclusions

The study showed that most of the maize lines were genetically similar. In general, the dominant traits had higher genetic variance than the environment, indicating that the genetic action was dominant on the qualities. Therefore, inheritance was high in most characteristics, and the characteristic for which the selection can be conducted is the weight of the grain.

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