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Sudan University of Science and Technology

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Evaluation of some forage maize (*Zea mays* L.) genotypes for some Growth and yield Characters

A Dissertation Submitted to the Sudan University of Science and Technology in Partial Fulfillment of the Requirements for B.Sc. (Honors) Degree in Agriculture, Agronomy

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الآية

قال تعالي(وَآيَةٌ لَّهُمُ الأَرْضُ الْمَيْتَةُ أَحْيَيْنَاهَا وَأَخْرَجْنَا مِنْهَا حَبًّا فَمِنْهُ يَأْكُلُونَ*وَجَعَلْنَا فِيهَا جَنَّاتٍ مِن نَّخِيلٍ وَأَعْنَابٍ وَفَجَّرْنَا فِيهَا مِنْ الْعُيُونِ* لِيَأْكُلُوا مِن ثَمَرِهِ وَمَا عَمِلَتْهُ أَيْدِيهِمْ أَفَلا يَشْكُرُونَ* سُبْحَانَ الَّذِي خَلَقَ الأَزْوَاجَ كُلَّهَا مِمَّا تُنبِتُ الأَرْضُ وَمِنْ أَنفُسِهِمْ وَمِمَّا لا يَعْلَمُونَ*)

سورة يس الآيات

(37-34)

DEDICATION

To my kind family, dear father, dear mother

brother and sisters

Who gave me hope and help.

To my supervisor Dr. Atif Elsadig Idris

Special thanks to Ebtisam Mosa Dboka.

To my friends and colleagues

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Abstrct

This experiment was conducted in the experimental farm of the Sudan University of Science and Technology, College Agricultural Studies, shambat during the winter season 2017-2018, to evaluate ten genotypes of forage maize (Zea mays). The experiment was laid out in randomized complete block design (RCBD) with three replications. The studied growth and yield characters included plant height (cm), stem diameter (cm), number of leaves, leaf area (cm^2), dry weight (K/ha) and fresh weight (K/ha). Phonotypic and genotypic variances and heritability values were measured. The results showed significant variances for all the studied characters. The highest values of phenotypic variance (3743.7) and genotypic variance (0.17) were obtained by Leaf area and Number of leaves, respectively. The highest value of heritability (0.33) for was obtained by dry weight. The genotype H1 scored the highest values of dry weights and the genotype MK1 scored the highest values of fresh weight. .

الخلاصة

اجريت هذه التجربة في المزعة التجريبيه لجامعة السودان للعلوم والتكنولوجيا خلال الموسم الشتوي للعام 2018 2017لتقييم عشرة طرز وراثيه من الذرة الشامية العلفيه تم استخدام تصميم القطاعات الكاملة العشوائية بثلاث مكررات. صفات النمو والانتاجية المدروسه تضمنت طول النبات (سم) و قطر الساق (سم^2) عدد الاوراق ومساحة الورقه (سم) الوزن الرطب والوزن الجاف. تم قياس التباينات المظهريه والوراثيه ودرجة التوريث. اظهرت النتائج فروقات معنوية لكل الصفات المدروسة. اعلي قيمة للتباين المظهري (5734.7) والتباين الوراثي (0.17) كانت لصفتي مساحة الورقة وعدالاوراق عل التوالي واعل قيمة لدرجة التوريث(0.33) احرزت بواسطة الوزن الجاف. الطرز الوراثي H1احرز اعلي قيمة للوزن الجاف والطراز الوراثي MK1احرز اعلي قيمة للوز الرطب.

CHAPTER ONE

INTRODUCTION

Maize (*Zea mays L.*) follows to family Poaceae is origin home is the Mexico and Central America. Maize is the second most cultivated crop all over the world .Maize important crop from which more than 3500 products are generated such as human food, Befoul and livestock feed. As the second most widely cultivated crop in the world , maize is cultivated across a wide range of climatic conditions for tropical to temperate diverse , maize kernels are the major edible part for human diet and livestock feed the nutritional composition and content of maize starch is the maize component in maize kernels which accounts for 75% of the fresh weight in sweet, protein 8-11%, lipids 3-6%, dietary fiber 7%, minerals and vitamins constitute about 3% the most abundant minerals are phosphorus and potassium(Ramakrisha and others 2014) , several non-traditional uses of maize are gaining importance, uses in biofuel production phytoremediation and production of pharmaceuticals ,the average world maize areas were about 176.19 million hectares producing 930.13 m metric tons with average yields estimated at 5.7.8 per hectare ,the USA production of maize nearly 377.5m MT, 224.9m MT China, Brazil (83.0m MT), India (42.3 m metric tons) and Argentina (40.0 m MT)(FAO stat data 2014).

The world is facing a problem in the shortage of fodder, especially the Arab world, especially in the summer. Maize can be cultivated in winter season in order to fill the gap that happened by shortage in forage sorghum in winter. Few studies were made in forage maize when compared with the studies done in forage sorghum, (Adel 2017).

Therefore, the main objectives of this study were:

1- to evaluate ten forage maize (Zea mays L.) genotypes for some growth and yield characters.

2- To measure genotypic and phenotypic variance and heritability for growth and yield characters in the ten grain maize genotypes.

3- To select the best genotype of forage maize that can be used as fodder.

CHAPTER TWO

LITRTURE REVIEW

2-1 Classification of maize:-

The genus Zea belonging to the tribe Mayadea of family Gramineae with 10 pairs of chromosomes which has only species (Zea mays). The maize was classified by Sturvant in 1899 into seven groups or types on the base of the endosperm milk kernel.

2-1-1 Pod corn (*Zea mays* iurnicate sturt):

The kernel is enclosed in a pod or husk the ear formed is also enclosed in husk.
Pod corn is also known as cow corn, forage corn and husk corn.

2-1-2 Pod corn (*Zea mays* eurta sturt):

Its cultivation is mainly confined to the new world which has small kernels hard corneous endosperm.

2-1-3 Filnt corn (*Zea mays* indurate sturt):

This is the type first discovered by Europeans which has an early maturity. The kernels of this type are rounded on the top.

2-1-4 Flour corn (*Zea mays* amylacea sturt):

It resembles to the flint corn in appearance and ear characteristics the grain are composed of soft starch and have little or on dent.

2-1-5 Sweet corn (*Zea mays* saccharata sturt):

The sugar and starch make the major component of the endosperm that result in sweetish taste of kernels before attain the maturity and after maturity the kernels become wrinkled.

Baby corn (*Zea mays*):

Brown for young babies (cobs) to be used for vegetable soup and salad. This is in mineral and vitamins and be harvested within 54-50 days for marketing.

2-2 Genetic and variability:-

2-2-1 Genetic:

of maize for genetics is partly due to its morphology and life cycle. The relative large size of maize plants allows maize geneticists to harvest tissues at different time points from a single plant without destroying the plant. Maize is a monoecious species with the male and female flowers on different stem. In addition, the rich collection of maize genetic mutants which are easily available for research community sets maize apart from other cereals. Maize is a preeminent model for understanding selection, genome architecture and evolution because of its striking variation in repetitive DNA content, gene order and allelic sequence. The molecular basis of maize domestication and artificial selection is being unraveled by the comparison of nucleotide polymorphism between maize and wild *Zea* species (Tian et al. 2009; studer and Doebley 2012).

2-2-2 Variability:

The study of genetic variability is that of population genetics it is the amount by which individuals in a population differ from one another due to their genes rather than their environment. Variability is different from variation in that it is the potential to vary rather than the actual variation (Yale et al 1995) the extent of the variability of possible is likely to changer other than the actual variation (Ehrich et al 2005). Genetic variability in a population is very important because without variability it becomes difficult for a population to adapt to environmental change creating a static population (zaldivar et al 2003).

2-3-Uses of maize:-

Maize is used as staple human food and feed livestock, fermentation and many in district purposes .some of the most common uses as described below.

2-3-1 Wet milling:

It produces abundant starch (65% of kernel weight) that is easily recovered (95% of all present) and that can be processed to high purity (99%). According to the National corn Growers Association (1992) used in hydrolyzed product mainly sweeteners the rest is used as industrial starch.

2-3-2 Dry milling:

In USA the dry milling industry consumes about 2% of maize production or 4.2 million tones, uses of dry milled maize products are primarily for animal feed (30%) brewing (23%) cereals (22%) other food (16%).

2-3-3 Fermentation and distilling:

Various alcoholic beverages and industrial products are produced by maize distilling and fermentation industries, Ethanol is being used both as a complete fuel substitute in gasoline engines or in a mixture of 10% ethanol and 9% gasoline e, culled gasohol.

2-3-4 Composite flours:

Use of maize flour to supplement wheat flour for making bread and biscuit is quite an-age-old practice. Dairy and poultry feed and breakfast industry.

2-3-5 Corn flakes:

Corn flakes are one of the best vegetarian sources of iron (25% RDA) and vitamin c (50% RDA).(panda 2010).

2-4 Forage maize:

An increasing demand for dairy and meat products has prompted efforts to integrate maize production with fodder production. Maize stovers with groundnut tops are an important feed resource during the dry season on which the smallholder steer-fattening and dairy schemes depend (Mtukso, Gray and pervis 1983; Addy and Thomas 1976; Mtimuni 1982; Balch 1977; Kategile 1982). Addy and Thomas (1976) recorded feed protein values of 5.43 and 8.35% for maize stover and groundnut tops respectively. National Research Council (1976) proximate-analyses values intended for beef cattle show that maize stover has a metabolizable energy (ME) content of2.13 Mcal/kg DM, marginally above the 2 Mcal/kg DM, threshold value for meeting maintenance requirements. Addy and Thomas (1977), however, reported an ME value of 1.09 Mcal/kg DM for maize stover. Maize stover is low in nutritive value. As a consequence, there have been numerous attempts to enhance the availability of energy, mainly through chemical-treatment procedures (Kategile 1982; Said 1981; Kategile and Frederiksen 1979; kiangi 1981; Kategile et al 1981; Edelsten and Lijongwa 1981). The presence of an improved pasture, such as a forage legume, provides extra dry matter and crude protein essential for animal production during the dry season. Where maize is a cash crop, the cost of pasture

establishment is absorbed by the maize crop enterprise.FAO(2013)

2-5 Maize in Sudan:

In Sudan maize is the fourth cereal crop coming after sorghum, millets and wheat. In Sudan maize is normally grown as rain-fed crop in cordovan, Darfur and southern or in small irrigated area in North states, it is grown mainly as a feed crop (both grain and forage) and rarely as food crop. (Marof 2012). Due to the increased demand for animal products driven by the accelerated process of urbanization, the average production of maize per annum in the Sudan during the eighties (2900 ton) was doubled (5900 ton) during the 2000 (Farmdocdaily) . The limited local use by user and low market price has also contributed to the less priority of maize production in Sudan agricultural development plants (FAO 2005). Cereal grains are the most important component of Sudanese diet, understanding of cereals efficient and suction able agriculture and food production (Abdel Rahman 2002). And also provides nutrients for the production of starch, oil and protein alcoholic beverages food sweeteners and move recently.

2-6 Heritability:

Heritability is the proportion of the total phenotypic variance that occurs due to gene effect (Stanfield, 1988). Johnson et al., (1955) indicated that estimates of heritability together with genetic coefficient of variation are usually useful in predicting the resulting effect of selection than heritability value alone, this mainly

because heritability estimate as a ratio of genetic to phenotypic variance, varies greatly depending on the sample size, the environment, the character, and the population.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experiment site:

Afield experiment was conducted in the winter season of 2017 in the period from November 2017 to February 2018 at College of Agricultural Studies, Sudan University of Science and Technology ,in Shambat Farm levels (23^o 35, longitude 15^o $31^,$, and altitude 288m sea leaves, within the semi-desert region (Adam, 2002) the soil of the site is described by Abdeihafiz (2001) as loam clay it is characterized by a deep cracking, moderately alkaline clays, and low permeability, low nitrogen content and PH (7.5-8) content (50-60%) and high exchangeable sodium percentage (ESP), in subsoil.

3.2 Experimental material and Design:

The genetic material used in this study consisted of ten (10) advance genetic maize lines with one local check as presented in table,1. These seeds of maize genotypes obtained from Faculty of Agriculture University of Khartoum, used in this study to determine their forage The growth and yield variation as a function of climate in winter season.

The experiment was carried out in Randomized Complete Block Design

(RCBD) with three replicates, planting was done manually in plots consisted of 4 rows, 6 meters long which spaced 0.70m between rows and 15cm between holes.

3.3 Cultural practices:

Sowing date was the third week of November (29.11.2017), after land preparation

was done as the following: deep plowing first using disc plough, harrowing by disc harrow, leveling and ridging. Three seeds per hill were sown. The irrigation each ten days. A dose of chemical fertilizer urea, 1N (30kg /ha) were applied after two weeks from sowing. Hand weeding was done to keep the plot free of weeds.

3.4 Data collection:

Sample of ten randomly selected plants from each plot throughout experiment was used to record data from reproductive traits as following:

3.4.1 Plant height (cm)

— Measured in centimeter as an average height of the random sample of ten plants in the harvest area. It was measured from the soil surface to the node bearing the upper most ears.

3.4.2 Stem diameter (cm)

Stem diameter was measured by using venire. Measurements were taken on deferent positions on the stem and the average from sample of ten plants in the harvested area.

3.4.3 Leaf Number per plant

It was determined from harvested area as ten plants taken randomly from each plot and then number of leaves per plant, as average was determined.

3.4.4 Leaf Area (cm)

I was measured an average three leaf per plant from each plot.

3.4.5 Fresh Weight (kg/ha)

The average weight was taken at random from the bulk of plant from a random samples of ears harvested in each plot by (Kg).

3.4.6 Dry Weight (kg/ha)

Taken of ten plants from each plot then was the dried via direct sun light and weight to determined its dry weight. The forage yield was obtained by converted the yield of the actual harvested to kg/h.

3.5 Statistical analysis

Analysis of the variance was carried out on data collected used statistical analysis system in accordance to analysis of variance (ANOVA), and means were separated for significant by LSD Test at 5 % level using statistic 8 computer programs.

Table (3-1): Maize genotypes used in the experiment

N0	**Genotype**	**No**	**Genotype**
1	H1	1	MK1
2	H2	2	MK2
3	H3	3	MK3
4	H4	4	MK4
5	H5	5	Mk5

Table (3-2) the form analysis (ANOVA**)**

Source of variation	**D.F**	**MS**	**EMS**
Replication	(r-1)=2	M3	
Genotypes	2(g-1)=9	M2	$\sigma^2 g+\sigma 2e$
Error	(r-1)(g-1)=18	M1	$\sigma^2 e$
Total	(rg-1)=29		

3-6 Genetic parameters estimate:

The genotypic ($\sigma^2 g$) and phenotypic ($\sigma^2 ph$) variances were obtained from the analysis of variance total according to Comstock and Robison (1952).

_Genotypic variance ($\sigma^2 g$) = M_2-M_1/r

_phenotypic variance ($\sigma^2 ph$) = $\sigma^2 g+\sigma^2 e$

Where;

r=replication

G=genotypes

Ms= means square

EMS=Expected mean square

M1.M2 and M3 mean sq6for error, genotypes and respectively.

$\sigma^2 g$= genotypic variance variance

$\sigma^2 e$= error variance

3-7 Heritability (h^2):

Heritability (h^2) broad sense was estimated according to Falconer (1989).

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Heritability (h^2) =$\sigma^2 g/\sigma^2 ph$*100

Where;

$\sigma^2 g$= genotypic variance.

$\sigma^2 ph$= phenotypic variance

CHAPTER FOUR

RESULTS

4.1 Phenotypic variability:

4.1.1 Plant height (cm):

The statistical analysis of variance revealed that there were significant differences at ($p>0.05$) between the ten maize genotype for this character (Table4-2).The highest value (143.70) and the lowest value (110.0) were obtained by genotypes 6 and 5, respectively. The coefficient of variation for this character was (14.62) (Table 4-1).

4.1.2 Stem diameter (cm):

The statistical analysis of variance revealed that there were significant differences at ($p>0.05$) between the ten maize genotypes for the character (Table4-2). The highest value (2.02) and lowest value (1.39) were obtained by the genotype 1(H1) and 9 (MK9), respectively. The coefficient of variation for this character was (14.16) (Table 4-1).

4.1.3 Number of leaves:

The statistical analysis of variance revealed that there were significant differences at ($p>0.05$) between the ten maize genotype for the characters (Table4-2). The highest value (11.9) and the lowest value (9.7) were obtained by the genotypes 2 and 9, respectively. The coefficient of variation for this character was (9.23) (Table 4-1).

4.1.4 Leaf Area (cm^2)

The statistical analysis it was clear that there were significant differences at ($p>0.05$) between the genotypes in leaf area (Table4-2). The highest value (367.14) and lowest (222.49) were obtained by genotypes 10 and 3, respectively. The coefficient of variation for this character was (23.77) (Table 4-1).

4.1.5 Fresh weight (kg/ha):

The statistical analysis of variance revealed that there were no significant

differences at ($p>0.05$) between the ten maize genotype for the characters, (Table4-2). The highest value (2.3) and lowest value (1.4) were obtained by the genotypes 6 and 4, respectively. The coefficient of variation for this character was (23.35) (Table 4-1)

4.1.6 Dry weight (kg/ha):

From the analysis of variance it was clear that there were significant differences at ($p>0.05$) between the ten maize genotype for the characters, (Table4-2).The highest value (1.06) and lowest value (0.4) were obtained by the genotypes 1 and 4, respectively. The coefficient of variation for this character was (34.07) (Table 4-1)

Table 4-1 means of different characters in 10 genotypes of forage maize evaluated at shambat farm in winter season November 2017

N	Genotype	PH	SD	NOL	LA	FW	DW
1	**H1**	138.10^{AB}	2.0247^{A}	10.767^{ABC}	307.67^{AB}	2.0667^{AB}	1.0667^{A}
2	**H2**	130.07^{AB}	1.7067^{AB}	11.900^{A}	268.47^{AB}	1.9667^{AB}	0.8333^{ABC}
3	**H3**	128.20^{AB}	1.4900^{B}	11.667^{AB}	222.49^{B}	1.7667^{AB}	0.5667^{CD}
4	**H4**	123.03^{AB}	1.5067^{B}	10.667^{ABC}	223.03^{B}	1.4333^{B}	0.4000^{D}
5	**H5**	110.00^{B}	1.4733^{B}	11.333^{ABC}	284.45^{AB}	1.5667^{B}	0.4000^{D}
6	**MK1**	143.70^{A}	1.5367^{B}	11.367^{ABC}	332.74^{AB}	2.3667^{A}	1.0000^{AB}
7	**MK2**	142.57^{AB}	1.5247^{B}	10.167^{BC}	302.14^{AB}	1.6333^{AB}	0.8000^{ABCD}
8	**MK3**	138.33^{AB}	1.4900^{B}	10.300^{ABC}	255.61^{AB}	1.5667^{B}	0.8667^{ABC}
9	**MK4**	142.97^{AB}	1.3967^{B}	9.700^{C}	266.65^{AB}	2.0000^{AB}	0.7000^{ABCD}
10	**MK5**	131.77^{AB}	1.6767^{AB}	11.367^{ABC}	367.14^{A}	2.1667^{AB}	0.6000^{BCD}
Mean		132.87	1.5830	10.923	283.04	1.8533	0.7233
CV		14.62	14.16	9.23	23.77	23.35	34.07
L.S.D		33.330	0.3845	1.7295	115.39	0.7424	0.4228

Table 4-2 means squares of general yield characters in forage maize:-

Source	D.f	Plant height	Stem Diameter	Number of leaves	Leaf area	Fresh weight	Dry weight
Replication	2	1296.3	0.009	6.08	20660.8	3.51	1.32
Genotype	9	3063.4*	0.098*	13.84*	6339.5*	0.27*	0.16*
Error	18	377.53	0.050	18.29	4525.1	0.18	0.06
F		**0.90**	**1.96**	**1.51**	**1.40**	**1.49**	**2.65**

4.2 Genetic parameters estimate and Heritability:

Estimates of phenotypic coefficient of variation (phenotypic) for most characters were including plant height, stem diameter, number of leaf, fresh weight, dry weight, leaf area, High estimates of (phenotypic) was recorded for leaf area (5734.7), low estimates of (phenotypic) was recorded for stem diameter (0.060) table(4-3).

_ High estimates of (Genotypic) was recorded for Number of leaf (0.17), and low (Genotypic) was recorded for leaf area (-604.8) table (4-3).

_ High estimates of (Heritability) was recorded for dry weight (0.33), and low (Heritability) was recorded for Number of leaves(0.14) table (4-3).

Table (4-3)phenotypic, Genotypic and Heritability different characters for 10 genotype of maize forage.

Characters	Phenotypic variance (σ^2ph)	Genotypic Variance (σ^2g)	Heritability (h^2)
Plan height	365.1	-12.3	#
Stem diameter	0.06	0.01	0.24
Number of leaves	1.19	0.17	0.14
Leaf area	5734.7	-604.8	#
Fresh weight	0.21	0.03	0.14
Dry weight	0.09	0.03	0.33

 # = these values were not measured due to the negative values of their genotypic variances

CHAPTER FIVE

DISCUSSION

In this study, significant differences were shown between ten maize genotypes for all studied characters (plant height, stem diameter, number of leaf, leaf area, fresh weight and dry weight). The variation could be attributed to genetic factors, environmental factors or to their interaction. This result is agree Rodwan (2017). The significant differences in character dry weight could be of a great value in any forage maize breeding program, the genotypes H1 and MK1 scored is highest in dry weight and fresh weight, respectively, and also H2 scored is highest number of leaf, can be used to feed animals or in any forage maize breeding program. High estimates of Genotypic was recorded for Number of leaves and high estimates of Heritability was recorded for stem diameter could be attributed to genetic factors, High estimates of (phenotypic variance) was recorded for leaf area. These characters could as indicator in any forage maize breeding program.

CHAPER SIX

Based on the results obtained from this study it could be concluded that:

1-The variability obtained between different characters in the ten forage maize genotypes could be useful of any one in any forage maize breeding program.

2- The genotype H1 was the highest of the dry weight and genotype MK1was the highest of fresh weight, therefore, they can be used by forage maize farmers in the Sudan or any forage maize breeding program.

3- This work should be repeated another season to confirm the results.

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