Sudan University of Science and Technology

College of Graduate Studies

Variability and Correlation Between Growth, Yield and Its Components in some Grain Maize (*Zea mays* L.) Genotypes

التباين والارتباط بين النمو والإنتاجية ومكوناتها في بعض الطرز الوراثية للذرة الشامية الحبوب

A Thesis submitted to Sudan University of Science and Technology in Partial Fulfillment of the Requirements for the Degree of M.Sc. in Agriculture (Agronomy)

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2007

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Nov. 2016

الآية

بسم الله الرحمن الرحيم

قال تعالى:

(وَفِي الْأَرْضِ قِطَعٌ مُتَجَاوِرَاتٌ وَجَنَّاتٌ مِنْ أَعْنَابٍ وَزَرْعٌ وَنَخِيلٌ صِنْوَانٌ وَغَيْرُ صِنْوَانٍ يُسْقَى بِمَاءٍ وَاحِدٍ وَنُفَضِّلُ بَعْضَهَا عَلَى بَعْضٍ فِي الْأُكُلِ إِنَّ فِي ذَلِكَ لَآيَاتٍ لِقَوْمٍ يَعْقِلُونَ)

صدق الله العظيم

سورة الرعد الآية (4)

DEDICATION

To my Dear parents. And every one gives me the help.

To my brothers,

To my sisters,

To my teachers,

And to my friends with respect,

Thanks with Love.

ACKNOWLEDGEMENTS

First, I would like to thank ALLAH who give me knowledge and patience to complete this research successfully, I wish to express my gratitude, deepest thanks to my supervisor. Dr. Atif Elsadig Idris for his supporting and guidance from the first steps of this research up to its end, my Thanks are extended to Prof. Yassin Dagash for his continued helping. and Thank to Dr. Mohamadien Hussain, also due to my colleagues at the department of Agronomy, Faculty Agriculture in Sudan University of Science and Technology for their support, my special appreciation and deepest. Thanks to my family and parents.

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Abstract

The study was conducted at Gezira research station farm, Agricultural research Corporation ,Wad Madni , Sudan, in the winter season in the period from November 2015 to February 2016 to study variability and correlation between growth, yield and its components in thirteen grain maize (*Zea Mays* L.) genotypes. The experiment was laid out in randomized complete block design (RCBD) with three replications.Data was collected for seven parameters included days to 50% tasseling, days to 50% silking, plant height(cm) , ear height (cm), ear length (cm) and grain yield (kg/ha). The phenotypic and genotypic variances, phenotypic and genotypic coefficient of variations, heritability and genetic advance for different characters was determined. The correlation between different characters was estimated. The analysis of variance showed that there were significant differences ($P \leq 0.01$) for plant height, ear length, ear diameter, grain yield, and days to 50% silking. Th grain yield and ear length plant height and days of flowering, respectively. The highest values of genotypic and phenotypic variances were obtained by plant height. The highest values of genotypic and phenotypic coefficients of variations were obtained by grain yield. The highest values of heritability and genetic advance were scored for ear length and ear diameter, respectively. Positive and significant correlation was observed between ear diameter, ear length (cm), ear height (cm) and grain yield (1286.3) kg/ha. The highest value of grain yield was obtained by the genotype LONGS.

خلاصة البحث

أجريت الدراسة بولاية الجزيرة بمزرعة البحوث الزراعية ود مدني ، السودان في الفترة ، من نوفمبر 2015 إلى فبراير 2016 لهدف دراسة التباين وقياس الارتباط المظهري والوراثي بين ثلاثة عشر طرز من محصول الذرة الشامية لبعض صفات النمو ومكونات الإنتاجية في هذه الطرز. استخدم في هذه التجربة تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. تم تجميع البيانات لسبعة صفات وهي: عدد أيام الإزهار، إزهار النورة المذكرة، إزهار النورة المؤنثة، طول النبات(سم)، طول القندول(سم)، عرض القندول(سم)، إنتاج الحبوب (كجم-هكتار).تم تقدير كل من التباين المظهري، الوراثي، معامل التباين المظهري والوراثي ومعامل التوريث والتقدم الوراثي للصفات المختلفة، الارتباطات المظهرية بين الصفات. أظهرت تحليل التباين وجود فروقات معنوية بين الطرز لصفات طول النبات، وعدد أيام الإزهار بينما لم تظهر فروقات معنوية بين الطرز فيما يختص عدد أيام الإزهار وطول القندول. كذلك نجد أعلى قيمة للتباينين المظهري والوراثي كان لصفة طول النبات. أما بالنسبة لمعامل التباينين المظهري والوراثى فكانت لصفة إنتاجية الحبوب. بينما معامل التوريث أعلى قيمة في عرض القندول. كما وجد ارتباط معنوي موجب بين طول النبات، طول القندول، عرض القندول. وقد أحرز أعلى قيمة لصفة إنتاج الحبوب كانت للطرزLONG وهى (1286.3))كيلوجرام للهكتار من جنوب السودان.

CHAPTER ONE

INTRODUCTION

Maize (*Zea mays L.*), Maize belongs to the tribe Maize deae of the grass family Poaceae. “Zea” was derived from an old Greek name for a food grass. The genus Zea consists of four species of which Zea mays L. is economically important. The other zea sp referred to as teosintes, are largely wild grasses native to Mexico and Central America Zea mays L. (Ferr, 2005). The third most important cereal crop after wheat and rice in Mexico. is grown widely throughout the world in a range of agro ecological environments (maize is a multipurpose crop which has wide range of uses than any other cereals where it can be utilized as human food, feed grain, a fodder (Kinaci, *2005*). and of hundreds of industrial purpose .maize grown over a wider geographical and environment range than any other cereal. It is grown at latitudes varying from the Equator to the slightly north and south of latitude 50 from sea level to over 3000 meters elevation, under heavy rain fall and semi arid conditions, cool and very hot climates, maize is very sensitive to draught . It exposed to more hazards and it is a higher risk crop in general (Eleweg, 2005).drought is an important climatic phenomena after soil infertility ranks as the second most severe limitation .maize production (Kumar, 2011). The effect of water stress on crop growth and yield depends up on the degree, duration of the stress and the developmental stage and which the stress occurs (Mohamme, 2012) .reported that 1977. Maize is susceptible to drought at flowering stage than any other crop, (Makhzer, 2000). And (Mongombe,1996). In Sudan , maize is normally grown as a rain fed crop in Kordofan, Darfur and Southern or in small irrigated area in Northern states (Ahmed and Elhag,1999). Recently they have been an increased interest maize production in the Sudan (Nour, 1997).

The use of maize varies in different countries. In USA, E.U, Canada and other developed countries, maize is used mainly to feed animals directly or sold to feed industry and as raw material for extractive/ fermentation industries (Morris, 1998; Galinat, 1988; Shaw, 1988). In developing countries use of maize is variable. In Latin America and Africa the main use of maize is for food while in Asia it is used for food and animal feed. In fact in many countries it is the basic staple food and an important ingredient in the diets of people. Globally, it has been estimated that approximately 21% of the total grain produced is consumed as food. Maize is a crop par excellence for food, feed and industrial utilization. The composition of edible portion of maize (dry) Maize is known as corn in a member of grass family Poaceae. It is believed to be originated in South America, most probably in Mexico, Guatemala, or Honduras according to the grain structure.

The main objective of this study is:

1. To study genotypic, phenotypic correlation, heritability, and genetic advance in thirteen grain maize genotypes.
2. To study the most productive genotypes grain maize most of maize cultivars in Sudan characterized with low yield.

CHAPTER TWO

LITERATURE REVIEW

2. 1. Variability in Maize:

Variability in maize in a population is of paramount importance for many successful breeding program. this is because selection of the desirable genotypes for certain will not be effective unless considerable variation is existing in the martial. Phenotypic variability in maize for the difference character is attributed to genetic as well as environmental factors (jha, 2002). For yield and other trail has been reported by many workers Singh, and Jha Plant Breeding. Variability is greater amount of genetic variability in base population higher the genetic advance the G.A. is the high with characters having high heritability, among morphological in maize for grain yield , days to tasseling and plant height(Yousif , 2003).indicated significant difference among genotype for ear neigh. Number of rows per ear and ear diameter and significant differences among genotypes in number of leaves per plant, days for 50% tasseling, cob length, number of rows per cob, grain yield per hectare, are two locations (Kara, 2001). Reported the existence of significant variation among F1 and parent of maize genotypes for grain yield, ear diameter ear height, the magnitude of the variation in character is influenced by the environment, (Math and Ganguly, 2001). In study including ten whit seed inbreed lines of maize reported significant differences in grain yield, days of maturity, and shelling percentage, (Meseka,2003). In study of six land races of maize and their 15 F1 hybrid for two years reported highly significant differences for days to 50% tasseling plant height, ear height ear length and grain yield at two years. High level of interaction is desirable Unpredictable or uncontrollable environment: difference between seasons, amount and distribution of rainfall, prevailing temperature, and low level of interaction is desirable.

2.2 Heritability and Genetic Advance in Maize:

that concept of heritability is useful in determine to what degree differences among phenotypic result from genetic cause, and it can be regarded as an index of transmission ability of characters, heritability is the proportion of the total phenotypic variance that occurs due to gene effected .indicated that estimate of heritability together with genetic coefficient of variation are usually in predicting the result effect of selection than heritability value alone **(**Moseka,2003). this mainly because heritability estimated as a ratio of genetic to phenotypic variance ,varies greatly, depending on the sample size the environment , the character and the population , heritability usually indicated the level of confidence on which selection of genotype are made ,based on the phenotypic performance, heritability is non stress environments (Hols,2001). Many investigations had carried out experiments to estimate heritability of some trails in maize (Moseka,2003). Reported that high heritability estimates were observed for ear length K/g number and kernel weight as well as that observed by (Sadig, 2001). revetment only the genetic of variation is important since only this component is transmitted to the next generation, Heritability is the ratio of genotypic variance to the phenotypic variance that is due to genotype (heritable it is generally express in percent (%) it is a good index of transmission of character from parents to their off spring), types of heritability depending upon the components of variance used as numerator in the calculation, there are two definition of heritability (Broad sense heritability, Narrow sense heritability), broad sense heritability is the ratio of genotypic variance it is calculated with the help of formula where, Vg =genotypic, Heritability(h^2)=(Vg/Vp×100=Vg/vg +Ve×100,Broad sense heritability (h^2) separates genotypic from environmentally induced variance:h2=Vg/Vp it can be estimated from both parental as well as segregating population it is express the extent to which the phenotype is determined by the genotype , so called degree of genetic determination.

2.3 Correlation:

In study of variation and correlation of yield and it is components in maize inbred lines, who reported the genotypic was positive in Ear height, plant height and grain yield per plot, number of seed/rows and per ear girth .the knowledge of the degree of relationship between yield and yield component characters will aid the breeders to lunch successful maize improvement programs (Satyanara,2001). Grain yield per plant had highest positive and significant genotype correlation with cob weight ,dry matter yield per plant ,number of grain per plant ,leaf breadth ,harvest index leaf area per plant ,number of grain per row, stem girth, ear height ,100-grain weight, shelling percentage, plant height, cob length, cob girth, number of rows per cob number of leaves per plant . Days to 50 percent tasseling,and day's to50 percent silking significant and negative association with grain yield. Grain yield is a complex character controlled by many factors , the correlation magnitude of influence of each of this independent variable on a dependent variable like yield , selection for desirable genotypes should be made base on grain yield and also other yield component character which influenced the yield , it has been generally accepted that correlation between different character pairs represses a co-ordination of physiological processes , which is often achieved through favorable gene ,knowledge of the strength and type of association is an important pre requisite for the formulation of breeding procedures , the knowledge of the degree of relationship between yield and yield component character will aid of breeders , (Khan, 2001.) number of leaves per plant was associated positively and significantly with grain yield per plant reported that (Umakant and khan,2001). reported positive correlation of cob girth was positively,(Nigussie,2001).reported that the positive correlation was found for grain weight, and prolificacy and negative correlation found in day to tasseling, (Satyanarayana,2001).and (Argannial, 2003). That grain yield was positive associated with plant height.

2.4. General:

The primary center of origin of maize is considered by most authorities to be central Africa and Mexico, where many divers type of maize are around. The discovery of fossil maize pollen with other archaeological evidence in Mexico indicates that maize was significant crop in Mexico 5,000 year ago and perhaps earlier, American Indians grew land selectivity improved maize Today maize Known in every suitable agriculture region among the cereal productivity of the maize is the highest (4.t/ha) as compared to rice (3.7 / ha) end wheat (2.5 t/ha) corn is produced largely in the western hemisphere and Europe. The Asian maize Biotechnology Network which is established in 1998 as collaborative research and information network , aiming to help maize programmes in China, India, Indonesia, Thailand(Mohamed, 2012). Awealth information regarding the improvement of maize is available (Viola, 2003). And (Kenaci,200). It is the most important grain crop in the It is the most important grain crop in the United States About 58% of the world maize production is in the developed countries as the major producer and exporter while about 22% developing countries other corn producing countries are Philippines. Maize is an important grain crop intentionally is significant in Australia limited. For example in 2008 only 387, 000 to of grain maize were produce in Australia, approximately 12,000t were exported (A BARE) the *United States* was the largest producer of corn. *China* and *Brazil* rounded off the top corn producing countries. the USA producing nearly 377.5 million MT, 377.5 million MT, China (224.9 MT), Brazil (83.0 MT), India (42.3 million metric tons), Argentina (40.0 million MT) (FAO- STAT data, 2014). In Sudan maize is the fourth cereal crop after sorghum, millet and wheat (Ahmed, 2008).

it is very popular as subsistent rain-fed crop in the Nubian mountains, Blue Nile and southern Sudan. It also grown under irrigation in central, eastern and Northern States (Ahmed, 2008). the main goal of all maize breeding programs is to obtain new open pollinated varieties and hybrid, that will outperform the existing hybrids with respect to a number of traits, by desirable dominant genes can be accumulated while the undesirable ones are eliminated (Vacil,2000). The major objectives of maize breeding with reference to the maize program have been appropriate maturity, grain yield, diseases resistance, insect pest resistance, drought tolerance). Maize is a highly cross pollinated and C4 type plant which is highly responsive to fertilizer s resulting in high per day productivity. It offers tremendous scope for the plant breeders for genetic improvement. Several million people, particularly in the developing countries, derive their protein and calorie requirements from maize (Mbuya, 2011). With its high content of carbohydrates, fats, proteins, some essential minerals and vitamins, maize acquired a well-deserved reputation as a nutria-cereal. Maize grain accounts for about 15 to56% of the total daily calories in diets of people in about 25 developing countries, particularly in Latin America, where animal protein is expensive and consequently, unavailable to a vast sector of the population Maize is commonly used in animal feed as an energy source for its high starch content (Vioald,2001). Derive their protein and calorie requirements from maize. Some of the most important traits of interest in the maize market are protein and oil content. The protein content (PC) is quantitative trait and several studies have pointed out that there is a great number of genes involved in its control (Mittel,2003). Protein is an expensive but necessary constituent of both food and feed. Grain protein quantity in ordinary maize is relatively low (80–110 g 1kg) and of poor quality because of low levels of amino acids, lysine and tryptophan (Vasil, 2000).

2.5 Historical background

Maize (Zea mays L.) ranks third behind rice and wheat as the most important cereal crop, mainly used as staple food and animal feed in most developing countries (Akande and Lamidi, 2006; Olakojo, 2007; Mboya, 2011). It is an excellent source of carbohydrates, protein and good quality oil. It is more complete in nutrients in comparison including maize tend to be low in two essential amino acids viz. to other cereals nevertheless all cereals lysine and tryptophan (Moraditochaee, 2012). And (Ali,2012). Quality protein maize, which is rich in lysine and tryptophan, provides the poor with a way they can improve their diet. The protein of has a nutritional value of nearly equivalent to cow's milk. Other Zea sp referred to as teosintes, are largely wild grasses native to Mexico and Central America Zea (Moaveni, 2011). The number of chromosomes in Mays is 2 n = 20. Tribe Maydeae comprises seven genera which are recognized, namely old and New World groups. Old World comprises Coix (2n = 10/20), Chionachne (2n = 20), Sclerachne (2n = 20), Trilobachne (2n = 20) and Polytoca (2n = 20), and New World group has Zea and Tripsacum.It is generally agreed that maize phylogeny was largely determined by the American genera Zea and Tripsacum, however it is accepted that the genus Croix contributed to the phylogenetic Mays (Radu ,1997). Breeding has been and is being, used to improve or later trails, such as plant height, ear, yield, and disease pest resistance.(Araya,2011). *And (Khodarahmpour,2011).*In additional, plant breeding is also aimed and increase nutrient content in cultivated field maize varieties (Zhu, 2007). Sweet corn shows increasing domestic and international popularity in human consumption as afresh. (Buckingham, 2007). Breeding has been and is being, used to improve or later trails, such as plant height , ear, yield , and disease pest resistance (Moshan,2000). (Sleper and Poehman,2006). In additional, plant breeding is also aimed and increase nutrient content in cultivated field

maize varieties (Hols, 2000). Sweet corn shows increasing domestic and international popularity in human consumption as afresh. (Ferral,2000) . Breeding has been and is being, used to improve or later trails, such as plant height , ear, yield , and disease pest resistance . (Moshan, 2002). In additional, plant breeding is also aimed and increase nutrient content in cultivated field maize varieties (Khan, 2007). Hybrid breeding was first used in the early 1900,s by professional breeders in the USA (Luna, 2001). Maize pollen is relatively large when compared to other grass pollen. (Khan,2005). Agro bacterium mediated transformation, through protoplast fusion, particle bombardment and silicon carbide whiskers (Luna, 2001).

2.2.1 Cultivation practices

Mays ssp, may be grown as a dry land or irrigated crop (Birch, 2003). Farrell 2007). Planting should commence when soil temperature at planting depth reach 12 c with an upward trend (Farrel, 2007). For sweet corn planting at 14-16 recommended (Moshan,2002). Planting may also occur through to summer, however , planting times which will lead to flowering during the hottest period of summer should be avoid as pollen blasting damage to pollen and consequently poor seed set may result .planting time should also try to avoid maturation during cool weather as disease and pests may cause poorer quality or lower yields. Forest should be avoided during the entire life cycle of maize as should water stress. (Farrel andMoshan,2002).maize plants grow best in well draining , nutrient ,rich soil with PH ($CaCl_2$) between 5.5 and 7.0 maize is not very tolerant of salient soils . The nutrient status of the soil is important for the productivity of maize and substantial amounts of nutrients are removed from the soil by harvesting cobs of plants (Farrell, 2007).

2.2.2 Economic importance:

Maize ranks number three among the important cereals in the world following wheat and rice (Mathio,2005). it is a multipurpose crop with a variety of food feed uses it has also various industrial uses, because of its wide genetic variability. And broad global distribution (Khwaja,2015). In Sudan the maize immature cobs are eaten after boiling or roasting. The green matter is used as fodder especially in winter (Hamid,2011). In Khartoum state, the livestock size is estimated to be around 800000 units according to the statistics of the state of ministry of Agriculture in 2010. And production of irrigated fodder represents 84.5% of the total stage production, however, the gap between the productions and was attributed mainly to 500000 animal units and stay for fattening period in the state. The maize is one of several alternative to fill the gap especially in winter to face the season low productivity of other the total stage production, however, the gap between the production and was attributed in 2002, approximately 5434 ha were used in sweet corn production area was located in (Mathio,2001).

2.2.3 Ecology and climate:

The maize earn grow within a temperature range of 14 – 40c, with optimum temperatures of 8 – 21 c. same authors added that the crop germination is reduced by 13c, and fil sat 10c. They showed that maize grown in regions that receive 500 – 500 mm/annum. Maize may be grown as dry land or irrigated crop (Farrell, 2007).in Australia in generally produced as a summer crop. An optimal water supply can be secured according to the ministry of Agriculture irrigated the large numbers of animals transported from western Sudan through Khartoum to exports, stay for fattening period, fating the demand for forage, which is originally high. The increase production gab was attributed mainly to the traditional cultural practices by the produces. Forage crops

produced is mainly sorghum cultivars like Abu 70. Varying crop in to fill the gap, especially in winter where the yield of sorghum cultivars is low. Forage maize regarded as promising substitute as a winter forage crop (Aguino, 2007). Despite an increased area of land has been dedicated to cultivate maize since the mid-2005, production per hectare is still low. The increase production gab was attributed mainly to the traditional cultural practices by the produces. Forage crops produced is mainly sorghum cultivars like Abu 70. Varying crop in to fill the gap, especially in winter where the yield of sorghum cultivars is low. Forage maize regarded as promising substitute as a winter forage crop (Khwaja , 2015). Varying crop in to fill the gap, especially in winter where the yield of sorghum cultivars is low. Forage maize regarded as promising substitute as a winter forage despite an increased area of land has been dedicated to cultivate maize since the mid-2005, production per hectare is still low. However, the yield of maize in recent years has increased significantly due several breeding programs as respond to pest and diseases such as the American rust. Improved high yielding maize Varity can express it is full genetic potential only when offered optimum management resources Hybridization is one of the many improvement methods for maize, hybrids usually have higher yields and they are more resistant to weeds, other pest and diseases The full expression of these characteristics might vary with environments in order to adopt crop Varity, it is growth as well as the yield potential in the target environment should be evaluated (Luna, 2007) .hence the objective of the work was to determine the growth and yield parameters in four open line pollinated using the best of two hybrid line Maize is an annual plant and reproduces exclusively by seed, vegetative reproduction under natural condition does not occur. And reproduce not only by seed but also vegetative by way of rhizome(Eleawean,2005).see size Varies from 4.4000/kg to 2.500 seeds/kg (Hughes .maize is grown as a grain crop for stock feed ,food processing cerial corn chips, grits , flour industrial starch and popcorn (Hanafy,2007). Green chop and ensiled maize may be used as supplementary

feed food processing for cereal corn chips, grits , flour industrial starch and popcorn (Hanafy,2007). Green chop and ensiled maize may be used as supplementary feed in the dairy industry and also as a feed for other animal, (Nemati ,2009; Gregor, 2007).in 2002, approximately 5434 ha were used in sweet corn production area was located in (Mohsan,2002).anoxic condition in the rhyzosphere are result of over flowing rivers , over irrigation , inadequate drainage , and full impoundment of reservoir (Nwosu,2013) . low soil oxygen concentration or total absences of oxygen effect the nutrient up take, synthesis and translocation of growth regulators, as well as photosynthesis, respiration and carbohydrate partitioning, decreasing the yield of crops grown in soil with inadequate daring to transient flooding (Ferrer,2005).trans species with tolerance or even resistance to hypoxia develop morphological and biochemical adaptation mechanisms which may be useful criteria for the selection or genotypes increase tolerance to water logging (Ferrer,2005).this has been attributed to biochemical and physiological adaptation that lead to stomata clsure during the stress period, (Okonkw, 2000)and (Romer, 2003).

2.2.4 Grain maize:

Grain maize usually takes approximately 130-150 days from planting to harvest. Crop density for irrigated maize grain crops in typically around 60.000- 80.000 plants per hectare. For dry land crops density mainly depends on rain fall, varying from approximately 20.000- 30.000 per hectare for dryer land in land area up to approximately 45.00 -55.000 per hectare for costal or other high rain fall areas. Seeds are planted at depth of 3-5cm in rows with spacing varying between 75 and 110cm. In dry land production systems, single or double row skipping on 100cm. Rows may increase yield, irrigated maize may be irrigated per or pos plant, depending on soil characteristics. Dry land maize should be planted into soil that is wet to depth of least one metre.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experiment site:

These experiment was conducted in Gezira season 2015, Gezira Research Station Farm (GRSF) located in the central clay plain in the Sudan (14^0 24′ N, 33^0 29′ E and 408 meters asl), the soil was characterized by heavy cracking clay vertisol, very low permeability, pH (8.5), organic matter (0.4%), nitrogen (0.038%) and phosphorus (ESP)

3.2 Experimental material and Design

The genetic material used in this study consisted of thirteen advance genetic maize with one local check presented in table. The experiment was carried out in Randomized Complete Block Design (RCBD), with three replicates, planting was done manually in plots consisted of 4 rows of 5 meters long which spaced 0.80 m between rows, 0.25 m between holes the harvested area was 16.0 m^2 .

3.3 Cultural Practices:

Sowing date was the first week of July, after land preparation was done as the followi1ng: deep plowed first using chisel, harrowed by disc harrow, leveling and ridging. Thinning was carried out two weeks after seedling emergence to one plant per hill. Dose of fertilizer application, 2N (100 kg/ha) was add in split dose after emergence of two week and before flowering. Hand weeding was done to keep the plot free of weeds. At physiological maturity, when the leaves and husks of the plant started to turn yellow and dry; the central rows was harvested in each plot then grain weight per plot after threshing.

3.4 Data collection

Data were collected on the following traits during the crop growth, maturity and harvest.

3.4.2 Days to 50% Tasseling (DT)

Number of days from sowing to 50% of tasseling. This is recorded when 50 % of plants within a plot had shed pollens.

3.4. 3 Days to 50% Silking

Number of days from sowing to 50% of silking. This is recorded when 50 % of plants within a plot had shed pollens

3.4.4 Plant Height (cm)

Measured in cm as the average height of random sample of five plants in Harvest It was measured from the soil surface up to the node of the last leaf of the plant.

3.4.5 Ear Height (cm)

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

3.4.6 Ear length (cm)

Ear length was measured in cm as an average of random sample of five ears, from the base to the tip of the ear.

3.4.7 Ear Diameter

Ear length was measured in cm as an average of random sample of five ears.

3.4.8 Grain Yield per Hectare (t/ha)

For each plot the grain yield was determined of all the harvested ears in the harvest area, threshed and weighted. The grain yield was obtained by converting the yield of the actual harvested area 4.0 m^2 to kg/ha.

3.5 Statistical analysis

Analysis of variance was carried out, with SAS version 9.1 (SAS Institute, 2003) for each season separately (Table 1). Then, the combined analysis of variance, for the RCBD (Table 2), was done for the traits in which the mean squares of error were homogeneous. The mean separations were done according to Duncan's Multiple Range Test (DMRT).

3.5.1 Phenotypic and genotypic correlation

Genotypic and phenotypic correlation coefficients between pairs of different traits were determined, according to the formula suggested by Miller *et al*. (1958).

Covariance analysis between the eight traits under study was carried out, following the same procedure as in analysis of variance. Estimates of genotypic and phenotypic covariance were used to compute the genotypic and phenotypic correlation coefficients between pairs of the eight traits done as follows:

(Genotypic correlation of coefficient) $rg = \frac{covxyg}{\sqrt{(\sigma^2 gxy)(\sigma^2 gy)}}$

Where:

Ȯgxy is the genotypic covariance between two pairs x and Ȯ2gx and ơ2gy are the genotypic variance for traits x and (Phenotypic correlation of coefficient)

$$rp = \frac{covxyp}{\sqrt{(\sigma^2 phx)(\sigma^2 phy)}}$$

Table 1. List of maize genotypic used in the study

Number	Genotype name	Origen
1	2014E 37	ARC-Sudan
2	2014E 63	ARC-Sudan
3	2014E 74	ARC-Sudan
4	2014E 79	ARC-Sudan
5	2014E 80	ARC-Sudan
6	2014E 92	ARC-Sudan
7	2014E 95	ARC-Sudan
8	2014E 98	ARC-Sudan
9	2014E 104	ARC-Sudan
10	LONGS	ARC-South Sudan
11	BOMU	ARC- South Sudan
12	GBAYA Red	ARC- South Sudan
13	HUDIBA	ARC-

CHAPTER FOUR

RESULTS

4.1. Phenotypic variability:

In this study and among the genotypes of maize the analysis of variance revealed significant differences (P≤0.01) for plant height, Ear length Ear Diameter r, day to 50% silking and grain yield on the other hand the ANOVA table revealed non significant differences for Ear Height (cm) day to 50% tasseling table (3).

4.1.1. Plant height

The results revealed the highest value given by GBYA Red was 133.6 and the lowest value was 108 obtained by the genotype 2014 E95. The overall mean was 122.2 and the coefficient of variation was (10.1 cm) table (3).

4.1.2 Ear height

The result for Ear height revealed that the highest value was 57.6 (cm) was obtained by PDU. And that the lowest value was obtained by 2014 E95 (40cm) with overall mean 50 cm and the coefficient of variation of 16.9 table (3).

4.1.3 Ear length

The result for Ear length revealed that the highest value was 17 (cm) was obtained by longs. And that the lowest value was obtained by 2014 E92 (12 cm).

With overall mean 14.4 and the coefficient of variation of (10.1 cm). .

4.1.4 Ear Diameter (cm)

The result revealed that the highest value give Bomu was (4.1 cm) and the Lowest value was (3.2 cm) by 2014E92 the overall mean was (3.7 cm) and the coefficient of variation was (9.3) cm). 4.1.5 Grain yield (kg/ha)

4.1.5 Grain yield (kg/ha)

The result revealed that the highest value given by longs was 1286.3 kg/ha and the lowest value was 426 kg/ha by 2014E92 the overall mean was 740.3 kg/ha.

4.1.6 Days to 50% tasseling

The result revealed that the highest value given by 2014E80, PDU was (73) and the lowest value was 76 and the lowest value was 71 by 2014E79 the overall mean was 74 and the coefficient of variation was (2.4%).

Table 2. Phenotypic (δ^2ph) and genotype (δ^2g) variances

Number	Character	Phenotypic (δ^2ph)	Genotypic (δ^2g)
1	Days to 50%tessling	0.5	8.6
2	Days to50%silking	0.76	4.0
3	Plant Height (cm)	48	20.2
4	Ear Height (cm)	1.2	7.4
5	Ear length (cm)	0.9	3.0
6	Ear Diameter (cm)	2.9	8.8
7	Grain yield (kg/h)	3.1	9.4

Table 3. The mean performance of thirteen maize genotypes evaluated in Gezira winter season, 2016.

Genotypes	DT 50%	DS 50%	pH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (k/ha)
2014E37	59[a]	73[bc]	108[d]	45[ab]	13.4[bc]	3.4[ab]	699.3[ab]
2014E63	69[a]	73[bc]	119.3[abcd]	53.6[ab]	14.1[bc]	4[a]	802.7[ab]
2014E74	71[a]	75[a]	125a[bcd]	48[ab]	13.7[bc]	3.7[ab]	686.7[ab]
2014E79	71[a]	71[c]	110.3[bcd]	43.3[ab]	15[ab]	3.8[ab]	712.7
2014E80	73[a]	73[abc]	124.3[abcd]	49[ab]	13.8[bc]	3.7	681.7[ab]
2014E92	71[a]	75[abc]	118.6[abcd]	52.3[ab]	12[bc]	3.2[b]	426[b]
2014E95	70[a]	74[abc]	108.3[cd]	40.3[b]	13.6[bc]	3.8[ab]	582.7[ab]
2014E98	69[a]	72[bc]	136.6[a]	51.6[a]	14b[c]	3.9[a]	946.7[ab]
2014E104	71[a]	75[abc]	109.3[cd]	50[ab]	15.8[ab]	3.7[ab]	634[ab]
LONGS	73[a]	76[a]	127.3[acd]	57.6[a]	13.8[bc]	3.7[ab]	625[ab]
BOMU	68[a]	75[ab]	135[a]	51.3[ab]	17[a]	3.7[ab]	1286.3[a]
GBAYARed	71[a]	75[ab]	133.6[ab]	56.3[ab]	15.7[ab]	4.1[a]	794[ab]
HUDIBA	70[a]	73[abc]	133.6[ab]	56[ab]	15.7[ab]	3.8[ab]	745.7
Mean	70	74	122.2	50	14.4	3.7	740.3
CV%	4	2.4	10.1	16.9	10.1	9.3	51
F value	0.78	1.9*	2.3*	1.1	2.4*	1.23*	0.9*

4.2- Phenotypic (δ2ph) and genotypic (δ^2g) variances

in this study, the result showed that phenotypic variances range from (48 plant height to 5day of tasseling) ear Diameter to 3 ear length table (4)

4.3- Phenotypic (PCV) and genotypic (GCV).

Since most of the economic characters (grain yield) are complex in inheritance and are greatly influenced by several genes interacting with various environmental conditions the study of phenotypic GCV is not on useful for comparing the relative amount of phenotypic and genotypic variation among different trails but also very useful to estimate the scope for improvement by selected for improvement by selection the reliability of parameter to be selection for breeding program among other factors is dependent of the magnitude of its coefficient of variation CV especially the GCV however the differences between genotypic and phenotypic coefficient of variability indicate the environment influence In this study, the result showed that the phenotypic coefficient ranged from 49.1 grain yield to 2.80 to 1.08 days to tussling while the genotypic variation range from 20.2 to 3.0 ear length The PCV and GCV values are ranked as low, medium high accorded to (sivasubramin and men on 1973) and are mentioned below.

0 – 10% - low

10 – 20% - moderate

> 20% - high.

Table 4. The Genotypic and Phenotypic Coefficient of Variation (GCV), of thirteen maize genotypes evaluated in Gezira Research Station Farm winter season, 2016

Character	Genotypic Coefficient of Variation	Phenotypic Coefficient of Variation
Days to50%tassiing	1.8	3.85
Days to silking	1.35	2.80
Plant height(cm)	6.55	12.09
Ear height(cm)	2.38	17.2
Ear length(cm)	7.69	12.75
Ear diameter(cm)	2.59	9.74
Grain yield (Kg/h)	10.55	49.61

Table 5. The Broad sense heritability and Genetic advance of thirteen maize genotypes evaluated in Gezira Research Station Farm winter season, 2016

Character	Broad sense heritability	Genetic advance
Days to50%tassiing	7.9	17.7
Days to silking	23.3	8.1
Plant height(cm)	29.4	47.4
Ear height(cm)	2.78	15.2
Ear length(cm)	36.4	14
Ear diameter(cm)	7.06	18
Grain yield (Kg/h)	4.61	19

4.4 Phenotypic and genotypic correlations

The values of phenotypic and genotypic correlations between growth and yield components in thirteen genotypes ware showed in table (5). For Phenotypic and genotypic corrections, positive and highly significant correlation was obverted between grain yield, ear diameter, ear length and ear high. Also positive and significant corrections were observed between grain yield and plant height. On the other side negative and non sign if cant was observed between grain yield, days to 50% teaseling and days to 50% silking.

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Table 6. Interrelationships among thirteen maize genotypes evaluated in Gezira Research Station Farm winter season, 2016

	DT	DS	PH	EH	EL	ED	GY
DT	1	0.37317*	-0.23993	-0.05415	-0.07447	-0.09885	-0.2070
DS	0.37317*	1	0.11698	0.00591	-0.10887	-0.20917	-0.22367
PH	-0.23993	0.11698	1	0.36943*	0.2608	0.3855*	0.40414*
EH	-0.05415	0.00591	0.36943*	1	0.36864*	0.19425*	0.41174**
EL	-0.07447	-0.10887	0.26080	0.36864*	1	0.55351**	0.70500**
ED	-0.09885	-0.20917	0.3855*	0.33853*	0.55351**	1	0.66276**
GY	-0.02992	-0.207	-0.22367*	0.41174**	0.73655**	0.66276**	1

DS= days to 50% silking, PH= plant height, EH= ear height, EL= ear length DT= days to 50% tasseling,
ED= ear diameter, and GY=grain yield.
*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respective

CHAPTER FIVE

DISCUSSION

5.1 Genotypic Variability

The amount of variation present is of great importance for successful application of selection this is because selection does not create variability but acts only on that already existing. considerably amount of variation way observed this variation could be attribute to genetic and environment effects, the results revealed no significant differences for the characters this implies similar rate of growth in the material under study, the result were agreed with the findings of(Khulfalla and Abdalla,1997). who reported non significant different for both characters on the other hand, it disagreed differences for the same characters, it was noticed that genotypes attained the highest mean for plant height, among the vegetative character mark difference between with those-reported-by(Ismail,2004;Badda,1995;Malik,2011).Significant differences among the materials were observed for plant height and ear length which could be attributed to genotypic as will environment factors this character might marked the differences among the martial studied and similar results to those reported by(kumar,2000).and(Kumar and Satyareyana,2001). and(yousif,2003) .were observed with it was in contrast with (Ismail,2004) . The genotype obtained the highest mean for plant height, Days to 50% tasseling and 50% silking showed positive significant differences and the existence of wide range of variability in the martial this is in accordance with the finding of (Suneetha and Netaji,2000). (Luna andVaczi,2000). (Khalfalla and Abdalla,1997), (Raddy,2002). (Meseka, 2003; Salami, 2007). (Nemati, 2009). and (Ahmed,2009). The cultivar is the earliest in flower my in both 50% tasseling and silking. Studied on the phenotypic viability for yield and other quantities traits in maize had been reported by many breeders (Agoiano, 2008;Basheeirudi, 2008).the highest mean of phenotypic variance was record

for grain yield per hector Heritability is defined as the share of the phenotypic variance in population attributed to the hereditary factors, the heist values of heritability were detected for days to 50% tassling and days to 50% silking for co taken as selection criteria will be successful similar result were found by (Abdalla,2008).contrast with the results recorded by(Meseka,2008). reported that genetic advance any character depend mainly the genetic variability, The highest genetic advance was detected for grain yield (kg/ha) this was in agreement with(Kabadal,2003).(Seconskij,2005;Ahmed,1999).in this study the yield components had lower heritability camper to morphological character that had the high, Value of genetic coefficient of variation and high value of heritability and genetic advance as for plant height and grain yield (kg/ha) the characters could be improved by selection in the tested material. (Ismail,2004 ;Ahmed, 2009).

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APPENDIX

Appendix 1: Mean squares from the individual analysis of variable

Source of variation	Replication	Genotypic	Error
Days to 50% tasseling	9,8424908	8,0747863	2,8416
D.to 50% silking	5,6116216	3,3247863	8,0747
Plant height	298,388216	154,500000	154,4999
Ear height	76,490842	72,856838	0,15333
Ear length	4,8636996	2,1625214	2,1625
Ear diameter (cm)	0,1458462	0,15465812	0,1533
Grain yield (kg/h)	1.34956.916	1.44454.940	1.4445