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Sudan University of Science and Technology
Faculty of graduate studies
Department of agronomy, shambat

Effect of Diammonium Phosphate on Some Cultivars of Maize (*Zea mays L.*) as forage crop

تأثير سماد ثنائي الأمونيوم الفوسفاتي على بعض أصناف من الذرة الشامية كمحصول علف

By:
ESRAA NASRELDIN ABAS JACKSA
B.Sc. Agri. Sudan University of science and technology

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Supervisor:
Dr. Ahmed Ali Mohammed Osman

٢٠١٧

الآيـــــــــــــــــــــــة

بسم الله الرحمن الرحيم

الذي جعل لكم الارض مهداً وسَلَكَ لكم فِيهَا سُبُلاً وأَنزَلَ من السمآءِ مآءً فأخرجنا بِهِ أَزواجامن نبات شتَّى﴿٥٣﴾كُلُوا وَارَعوا أنعامكم إنَّ فِي ذَلِكَ لأيَاتٍ لأُلولِى النُّهى ﴿٥٤﴾

صدق الله العظيم

سورة طه

Dedication

To my precious parents

To my sisters and brothers

To my friends

Acknowledgements

Above all I render my thanks to the merciful ALLAH who offer me all things to accomplish this study.

I wish to express my sincere gratitude and appreciation to my supervisor Dr. Ahmed Ali Osman for his in valuable guidance and help during the stages of the practical work preparation of this study.

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I want thanks my father, Mather who’s rearing me. And finally my sincere thanks are to my family, friends and colic for helping and their encouraging me.

I wouldn’t forget anyone help me

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ABSTRACT

This study was conducted at the demonstration farm of the faculty of agricultural studies (shambat), during late winter season ٢٠١٦, separated in to two experiments in different location; to study effect of DAP fertilizer on growth and yield of three cultivars of maize as forage crop. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement having three replications. The maize cultivars are: (heddaba١, heddaba٢, var. ١١٣) were treated with (without DAP/ha, ٢٠kg DAP/ha, ٤٠kg DAP/ha, ٦٠kg DAP/ha).

The seed were sown in the field with three seeds inplot. ٢×٢ $M^{٢}$ for the plot, and in pot ٠.٥ $M^{٢}$, The distance between the plants were ٧٠CM.

Parameters studied were: plant height, stem diameter, number of leaves, fresh and dry weight, also protein and fiber percentage.

The results showed non significant differences among the all parameters, in both experiments.

الخلاصة

أُجريت هذه الدراسة في المزرعة التجريبية التوضيحية لكلية الدراسات الزراعية جامعة السودان للعلوم والتكنولوجيا شمبات في أواخر الموسم الشتوي (٢٠١٦). منقسمة إلى تجربيتين في مكانين مختلفين، لدراسة تأثير سماد الداب على النمو وإنتاجية العلف لثلاثة أصناف من الذرة الشامية.

أُستخدم فيها تصميم القطاعات العشوائية الكاملة (RCBD), وزعت فيها الأصناف كقطاعات رئيسية وهم (حديبة ١، حديبة ٢، وصنف ١١٣) عملت بإربعة مستويات مختلفة من الداب وهي: (بدون إضافة, ٢٠ كجم داب /هكتار, ٤٠ كجم داب /هكتار, ٦٠ كجم داب /هكتار).

زرعت البذور في الحقل بمعدل ثلاث بذور في الحفرة ٢×٢ م^{٢} مساحة الحوض، ومساحة الجردل ٠,٥م^{٢} ، والمسافة بين النباتات ٧٠سم.

أُخذت القياسات الأتية : طول النبات، قطر الساق، عدد الأوراق، الوزن الرطب، الوزن الجاف، نسبة البروتين، و نسبة الألياف.

وقد أظهرت النتائج عدم وجود فروقات معنوية في جميع القياسات المأخوذة.

Chapter One

Introduction

Maize (*Zea mays L.*) belongs to the family Poaceae, it was originated in Mexico where it is the oldest known back to about ٧٠٠٠ years ago (Mangeisdorf et al., ١٩٦٤).It is the third most important cereal crop in the world after rice and wheat. It is cultivated in a wider range of environments than wheat and rice because of its greater adaptability (Koutsika-Sotiriou, ١٩٩٩).

Being a $C_٤$ plant, it is physiologically more efficient and has higher grain yield potential compared to rice and wheat, so called as Queen of cereals. Maize gives highest conversion of dry substance to meat, milk and eggs compared to other cereal grains. Maize has acquired a well-deserved reputation as a staple cereal food. It has high carbohydrates, fats, protein, some of vitamins and minerals; it is nutritious for human consumption. That is why maize has now been termed as nutricereal. The presence of a mixture of carotenoids (β carotene, cryptoxanthins and β-zeacarotene having Pro-Vitamin A activity) provides maize a specific place among cereals (Anonymous, ٢٠١٣).

Maize is used as forage and in the manufacture of livestock feed, food stuffs, Sweeteners, beverage and industrial alcohol, oil (Moyin-Jesu, ٢٠١٠), and biofuels.

In the United States and Canada, the primary use for maize is feeding livestock as forage, such as silage (made by fermentation of chopped green corn stalks), or grain. Maize is also a significant ingredient of some commercial animal food products, such as dog food.

The United States produces ٤٠٪ of the world's harvest; other top producing countries include China, Brazil, Mexico, Indonesia, India France and Argentina (FAO ٢٠٠٩).

In Sudan, maize is considered as minor crop and it is normally grown in Kordofan, Darfur and Southern States or in small irrigated areas in the Northern states, with average production of about ٠.٦٩٧ ton/ha (FAO, ٢٠٠٥). In the traditional farm of Sudan, the low productivity of maize was attributed to the low yielding ability of the local open – pollinated cultivars that are normally grown and the greater sensitivity of the crop to water stress (Saliem, ١٩٩١).

In rain-fed areas, corn is usually grown in early July with less density to avoid competition for limited water during rainy season. Whereas, under irrigation the normal practice by farmer were to grow in June using almost double the rain-fed seed rate, and irrigated every two weeks.

In Sudan, maize can be grown to produce forage in winter season to solve problem of livestock feed shortage during this period. Maize proved to be most suitable forage as it is characterized by its high energy content and considerable protein content, compared to other cereal forage crop (Ipperisiel et al., ١٩٨٩).

There has been a growing interest in forage crops in Sudan prompted by the market rise demand for animal products for both consumption and export (Kambal, ١٩٨٣).

Maize is an important forage crop for many dairy and beef animals. The crop is palatable, quick growing with a high dry matter production and relatively high nutritive value. Dry matter yield of maize is a function of numerous interacting environmental and genetic factors, with subsequent influence on leaf area development and subsequent dry matter yield (Dwyer and Stewart, ١٩٨٦).

Maize is commonly fed to livestock as fodder stove or silage (Christopher et al., ١٩٦٦). The feeding of corn fodder is popular in the semi-arid as well as in areas where corn often fails to reach the stage of mature grain. The stalks of the crop at this stage are more palatable and higher in protein than other stages (John and Warren, ١٩٦٧).

Objectives:

- ❖ To investigate the influence of different level of Diammonium phosphate (DAP) on growth, yield and quality of fodder maize under irrigation.

CHAPTER TWO
LITERATURE REVIEW

Maize is a worldwide crop for grain, and it is perfect crop for silage. Maize is highly variable, naturally cross pollinated crop markedly heterogeneous, complex species in which all forms of hybridize freely, (Purse Glove ١٩٧٢). About ٥٠ species exist and consist of different colors, textures and grain shapes and sizes. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region. It’s introduced into Africa by the Portuguese in the ١٦th century. Maize has become Africa's most important staple food crop. (IITA)

٢.١: **Classification:-**

Maize cultivars can be divided into groups according to the structure of the seed, which is usable, Purse Glove (١٩٧٢).

Maize commonly classified into six groups based on kernel characteristic**:** dent, flint, flour, sweet, popcorn, and waxy, Martin (١٩٨٤).

٢.٢. **Crop ecology**: (adaptation).

٢.٢.١. Moisture:

The moisture requirements of corn crop vary throughout the growing season. The fall of the rain factor specific for the cultivation of the crop in the tropics rate is considered. The minimum amount of rain is ٢٠٠mm, and optimum is ٤٦٠-٦٠٠ mm for the growing season, (Ali٢٠٠٧-٢٠٠٨).

٢.٢.٢Temperature:

The optimum temperature for germination is ١٨-٢١c° whereas below ١٠c°. Cold wet weather after planting favors the development of pathogens, which adversely affects germination and consequently yield.

٢.٢.٣ Soil:

Maize performs best on well drained, well aerated, deep, warm loam and silt loams soils containing adequate organic matter and well supplied with neutrons elements.

٢.٢.٤ **Crop rotation:**

Founded after many researches, the best crops planted before of maize are the winter legumes crops such as check beans, lentil, and vaba beans; and largest sowing after potatoes and cucurbits. It should not cultivate maize after sunflower, were the soil dried at deeply depths.

Corn itself is a good crop more than other cereal crops even wheat, because it can replant on the same place several years without decreasing in productivity especially under the good care.

In Sudan, Abu Hajjar project was chosen for the cultivation of maize with peanut and sunflower as production corn, Ali (٢٠٠٧-٢٠٠٨).

٢.٢.٥ **Sowing date:**

The date of sowing affected directly on the seed production. In the sub-tropical and temperate areas corn sown when the temperature of soil ranged ١٠-١٢°C. But in the tropical areas the rainfall determine factor.

٢.٢.٦ **Fertilization**:

Maize is considered as one of the crops, which is used as a guide or indicator of the lack of nutrient elements in the soil. The amount of fertilizers base on the varieties planted, and amount of rainfall or irrigation, in most African countries and Latin America, where the rate of rainfall is not sufficient and use local varieties which is characterized by low productivity. The fertilization rates are usually low. The amount of nitrogen added is ٣٠-٩٠ kg/ha. It is found in one of many experiments the rate and date of adding fertilizers affects directly seed production of maize, (Ali٢٠٠٧-٢٠٠٨).

٢.٢.٧: Irrigation:

Although the maize is drought resistant crop. But it response vary much to irrigation. An experiment has shown, that giving two irrigation productivity increased by ٣٠٠٪, and when giving four increased by ٣٥٠٪. The irrigation times and amount of water depend on the climate, soil type and density of vegetation. In the some areas have irrigated three times, in dry areas given crop ٤-٥ irrigation, and in the driest areas are given irrigation every ١٠-١٢ days, (Ali ٢٠٠٧-٢٠٠٨).

٢.٣: Importance of maize:

Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than ١.٢ billion people in SSA and Latin America. All parts of the crop can be used for food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products. Maize accounts for ٣٠–٥٠٪ of low-income household expenditures in Eastern and Southern Africa. A heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness (IITA).

٢.٤: worldwide maize production:

Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. The United state produces ٤٠٪ of the world’s harvest; other top producing countries include Chine, Brazil, Mexico, Indonesia, India, France and Argentina. Worldwide production was ٨١٧ million tons in ٢٠٠٩ more than rice (٦٧٨ million tons) or wheat (٦٨٢ million tons) (International Grain Council, ٢٠١٣).

maize production in ٢٠١٣

Country	**Production (tons)**
Sudan (PAEA)	٤٦.٣٦٨
World (Follow to FAO retrieved).	١.٠١٦.٤٣١.٧٨٣

٢.٥: Uses of maize:

٢.٥.١: human food.

٢.٥.٢: Fodder:

Maize produces a greater quantity of biomass than other cereal plants, which is used for fodder. Digestibility and palatability are higher when ensued and fermented, rather than dried.

٢.٥.٢.١: Maize as a forage crop in Sudan:

The maturity stage for harvesting is at the milk stage. In the Sudan it is expected that this crop will soon gain important as forage crop as in many part of the world. Farmers take several factors into account when choosing maize cultivars for forage. These factors include available, cost of seed, case of establishment and forage yield. Forage yield in maize increase and forage quality decrease rapidly at plant maturity, (Jung and barker ١٩٧٣, Davies ١٩٧٠, Kunelius et al, ١٩٧٤). In many production system, it is usually recommended that cutting should be taken early rather than late at the head maturity stage in order to obtain the best combination of yield and quality (Fales et al. ١٩٩٠).

٢.٥.٣: Chemicals.

٢.٥.٤: Bio-fuel.

٢.٦: Diammonium phosphate (DAP):

DAP (Diammonium phosphate) is the world's most widely used as phosphorus fertilizer. It's made from two common constituents in the fertilizer industry, and its relatively high nutrient content and excellent physical properties make it a popular choice in farming and other industries.

Ammonium phosphate fertilizers first became available in the ١٩٦٠s, and DAP rapidly became the most popular in this class of products. It's formulated in a controlled reaction of phosphoric acid with ammonia, where the hot slurry is then cooled, granulated and sieved. The standard nutrient grade of DAP is relatively high, at ١٨-٤٦-٠, so fertilizer products with lower nutrient content may not be labeled DAP.

٢.٦.١: Chemical properties:

Chemical formula:	(NH٤)٢HPO٤
Composition:	١٨٪N
P٢O٥	٤٦٪ (٢٠%P)
Water solubility (٢٠°C):	٥٨٨ g/L
Solution pH:	٧.٥ to ٨

٢.٦.٢: Agricultural use:

DAP fertilizer is an excellent source of P and nitrogen (N) for plant nutrition. It's highly soluble and thus dissolves quickly in soil to release plant-available phosphate and ammonium. A notable property of DAP is the alkaline pH that develops around the dissolving granule.

As dissolving DAP granules release ammonium, the seedlings and plant roots nearest the volatile ammonia can be harmed. This potential damage more commonly occurs when the soil pH is greater than ٧, a condition that often exists around the dissolving DAP granule. To prevent such damage, users should avoid placing high concentrations of DAP near germinating seeds.

The ammonium present in DAP is an excellent N source and will be gradually converted to nitrate by soil bacteria, resulting in a subsequent drop in pH. Therefore, the rise in soil pH surrounding DAP granules is a temporary effect. This initial rise in soil pH neighboring DAP can influence the micro-site reactions of phosphate and soil organic matter.

٢.٦.٣: Other uses:

DAP also acts as a fire retardant. For example, a mixture of DAP and other ingredients can be spread in advance of a fire to prevent a forest from burning. It then becomes a nutrient source after the danger of fire has passed. DAP is used in various industrial processes too, such as metal finishing. And, it’s commonly added to wine to sustain yeast fermentation and to milk to produce cheese cultures.

(International Plant Nutrition Institute).

CHAPTER THREE

MATERIAL AND METHODS

٣.١: The site of experiment:

The experiment was conducted in the season of ٢٠١٦ (late winter), at the Demonstration Farm of the Collage of Agriculture Studies, Sudan University of Science and Technology at shambat (located longitude ٢٣°٣٥- ١٥° ٣٢-, and altitude ٢٨٨M above sea level, within semi-desert region). The soil of the site is described as loam clay. It is characterized by a deep cracking, moderately alkaline clays, and low permeability, low nitrogen content and pH ranged between (٧.٥ and ٨).

٣.٢: Source of seeds:

The seeds used in the experiment were obtained from Agriculture Research Center, Wad Madani El-Gazzira state: Huediba١ open-pollinated variety improved by ARC, Huediba٢ open-pollinated variety improved by ARC, Var. ١١٣ local material selected by ARC.

٣.٣: Land preparation:

The land was prepared using disc plough than disc harrowed, leveled and ridded up north- south. The space between ridges was ٧٠cm and ٢٠cm between holes. The size of the plot was ٤ $M^{٢}$. The seed were sown on the first week of March ٢٠١٦. Irrigation was applied next day from sowing and sub-sequent irrigations were applied every seven days in the first three weeks then every twelve days. That depends on the environmental conditions. The first weeding was done hand, and the second after three weeks after the first. But in The pots followed by mixture of clay soil and sandy soil ٢:١, lapelled and organized Eastern- western. The size of the pot was ٠.٤٥٢ M٢. Crops were sown on ٣rd week of April ٢٠١٦. Irrigation was done immediately after sowing and sub-sequent irrigations were applied every two to three days.

٣.٤: Treatment:

The treatments used in the experiment consist of four doses of phosphate fertilizer (DAP); ٠ kg/ ha (control), ٢٠g / ha, ٤٠g / ha, ٦٠g / ha added after a week from sowing, was distributed near plants in the both experiments.

٣.٥: Parameters:

٣.٥.١: Growth attributes:

Five plants were selected randomly, tagged then the average of the five plants was the count all parameters taken from them. In the pots, sample take from three plants were selected. The parameters under study were (plant height, number of leaves, stem diameter, fresh weight and dry weight, and protein, fibber percentage) were taken from the samples and got the average, from the both experiments.

٣.٥.١.١: Plant height:

It was measured from the soil surface to the tip of the plant. The readings were taken after ٥٠٪ flowers.

٣.٥.١.٢: Number of Leaves:

It was determined by counting all leaves of the samples.

٣.٥.١.٣: Stem diameter (cm):

It was taken by thread, and then measured the length of thread by ruler.

٣.٥.٢: yield parameter:

٣.٥.٢.١: Fresh weight:

The selected plants were cut above the surface of soil after ٥٠٪ flowering, and weighted.

٣.٥.٢.٢: Dry weight

Samples were oven dried at ١٨٠c° for ٢٤hours than weighed.

٣.٥.٢.٣: Protein and fiber percentage:

After taken dry weight from the sample, it was grinded and mixtures together. And measured the protein and fiber contend.

The protein was determined in the samples by micro kjeldahl method. They use a copper sulphate - sodium sulphate catalyst according to the official method of them, (AOAC, ٢٠٠٣).

Procedure: the method consists of sample oxidation and conversion of its nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. After that, the solution is made alkaline and the ammonia is distilled into a standard solution of boric acid (٢٪) to form the ammonia-boric acid complex which is titrated against a standard solution of Hcl (٠.١N). the protein content is calculated by multiplying the total N% by ٦.٢٥ as conversion factor for protein.

Calculation:

Crude protein (%) =

$$\frac{ml\ HCl\ sample - ml\ HCl\ blank \times N \times ١٤.٠٠ \times F \times)}{sample\ wieght\ (gm) \times ١٠٠٠} \times ١٠٠٪$$

Where:

N: normality of Hcl (٠.١N).

F: protein conversion factor = ٦.٢٥.

The crude fibber is determined according to the official method of the AOAC (٢٠٠٣). The crude fibber is determined gravimetrically after the sample is being chemically digested in chemical solutions. The weight of the residue after ignition is then corrected for ash content and is considered as crude fibber.

Calculation:

Crude fibber (%) =

$$\frac{(W١ - W٢)}{sample\ wieght\ (gm)} ١٠٠٪$$

Where:

W١: weight of silica crucible with contents before ashing.
W٢: weight of silica crucible with contents after ashing.

٣.٦: statistical analysis of data:

The data analyzed by computer, using the statistic ٨ program, the means were compared using the least significant difference (LSD).

Table : the form of split plot design for four treatments between three varieties for forage.

S.O.V	**D.F**	**S.S**	**M.S**	**F-value**	**F-tabulate**
Replication	٢				
Factor A	٢				
Error	٤				
Factor B	٣				
AB	٦				
Error	١٨				
Total	٣٥				

٣.٦.١: analysis of variance equations:

٣.٦.١.١: Correction factor:

C.F= G٢/N

٣.٦.١.٢: Total squares of total deviation:

SSo= $\sum X_i^{٢}$ – C.F

٣.٦.١.٣: Total squares for deviations of coefficients:

SSt = $\sum (T_i^{٢}/r)$-C.F

٣.٦.١.٤: Total squares of deviations of sectors:

SSr = $\sum (R_i^{٢}/t)$**-C.F**

٣.٦.١.٥: Total squares of deviations for experimental error:

SSe = $SS_{\circ} - SSt - SSr$

٣.٦.٢: mean separated equation:

L.S.D= $\sqrt{\frac{2MSe}{r}} \times t_{٠.٠٥}$

٣.٦.٣: CV equation:

CV= $\sqrt{\frac{MSe}{\text{overall mean}}} \times ١٠٠$

CAPTURE FOUR

RESULTS

٤.١: Growth characters:

٤.١.١: Plant height:

The analysis of variance in (Table ١), showed that no significant difference for plant height among the different levels of DAP fertilizer, in the two experiments. The taller plants ٨٤.٢٣ cm were recorded for treatment٤٠ kg DAP/ha, While the shortest ٧٧.٤٦ cm were recorded for ٢٠ kg DAP/ha. In the second experiment the taller plants ٦٣.٦٧ cm under similar treatment ٤٠ kg DAP/ha, while the shortest ٦٢.١٢ cm were obtained for treatment ٦٠ kg DAP/ha, (Table ٢). Table (٣) revealed that Var١١٣ recorded the highest plant ٨٤.٢٦ cm compared to other two cultivars, but in second experiment heddaba٢ was taller ٦٢.٩١ compared with the others. The interaction between the treatment and the cultivars revealed, that Var١١٣ treated with ٤٠ kg DAP/ha recorded the tallest plants ٩٦.٣٣ cm. while heddab٢ under similar level (٤٠ kg DAP/ha) recorded the shortest plant ٧٢.٩ cm, the interaction between the treatment and the cultivars in the second experiment, revealed that heddaba٢ which treated by ٦٠ kg DAP/ha recorded the highest plant (٧٢.٣٦ cm), while shortest plant (٤٦.١٦ cm) was same variety without treatment,(Table ٤).

٤.١.٢: Number of leaves:

Statistical analysis revealed there was no significant difference in plants treated with DAP among the three cultivars of maize, in the two experiment. However the interaction between DAP treatments and the three cultivars of maize was not significant (Table ١). The highest number of leaves ٨.١١ was recorded for treated by ٢٠ kg DAP/ha and ٤٠ kg DAP/ha, while the lowest number of leaves ٧.٥٦ which were obtained in plants treated with ٦٠ kg DAP/ha, but in second experiment, The highest number of leaves ٧ was attained in plants treated with ٤٠ kg DAP/ha, while the lowest number of leaves ٦.٢٢ were obtained in plants treated without DAP and ٦٠ kg DAP/ha, (Table ٢). Among varieties the highest number of leaves recorded for Heddaba١ and var١١٣ was ٨, while in second experiment Heddaba١ was recorded the highest number of leaves ٦.٩٢, than other two varieties, (Table ٣). Table (٤) display the interaction between DAP treatment and the three cultivars, Heddaba١ and var١١٣ without treatments had highest number of plant leaves ٨.٣٣, while Heddaba١ which treated by ٦٠ kg DAP/ha was the lowest number of leaves ٧, but the anther experiment Heddaba١ which treated by ٤٠ kg DAP/ha was highest number of plant leaves were ٧.٣٣, through compare with the other varieties, and Heddaba٢ which treated without DAP had lowest number of plant leaves were ٥.

٤.١.٣: stem diameter (cm):

Analysis of variance (Table ١) revealed non significant differences between DAP treatments and the three cultivars of maize. However, the interaction between DAP and the cultivars of maize were not significant, also same results revealed in second experiment. The highest stem diameter ٤.٩٨ cm was attained in plants treated with ٤٠ kg DAP/ha, while the lowest stem diameter ٤.٧٧ cm were obtained in plants treated with ٦٠ kg DAP/ha, while in second experiment; The highest stem diameter ٣.٨١ cm was recorded on plants treated by ٢٠ kg DAP/ha, and the lowest stem diameter ٣.٤٠ cm were obtained in plants without DAP, (Table ٢). Heddaba١ had a highest stem diameter ٥.٠٢ cm, than other two varieties, but in second experiment Var١١٣ recorded the highest stem diameter ٣.٧٩ cm, than other two varieties, (Table ٣). The interaction between DAP and the three cultivars as shown in (Table ٤); var١١٣ was a highest stem diameter ٥.٢٣ cm which was treated with ٢٠ kg DAP/ha, while Heddaba٢ without treatment, was a lowest stem diameter ٤.٥٠ cm; Var١١٣ which treated by ٢٠ kg DAP/ha was a highest stem diameter

٤.٢٧ cm, of all other varieties, and Heddaba٢ which treated without DAP had lowest stem diameter ٢.٨٧ cm, in the second experiment; (Table ٤).

Table (١): ANOVA for different parameters used to evaluate the effect of different level of DAP on some cultivar of maize at shambat in ٢٠١٦:

		F- value					
sources	D.F	PH١	PH٢	N.L١	N.L٢	S.D١	S.D٢
Replicate	٢	٦٠٥.٧	١٠٨٦.١	٠.١١	٨.٤	١.٩١	٠.١٢
Cultivars	٢	٢٠٩.٩ NS	٦١.٣ NS	٠.١١ NS	١.٤ NS	٠.٤١ NS	٠.٢٣ NS
Error (a)	٤	٤٠١.٦	٣٩١.٩	٦	٢.٥	٠.٥٥ NS	٠.٧١ NS
DAP	٣	١١٦.٩ NS	١٧٧.٧ NS	٠.٦٣ NS	١.٣ NS	٠.١ NS	٠.٣ NS
Culti*DAP	٦	١٠٤.٧ NS	٢١٧.٢ NS	٠.٦٣ NS	١.٢ NS	٠.٢ NS	٠.٧ NS
Error (b)	١٨	١٨٢.٤	١٣٠.٢	١.٢	١.٥	٠.٣	٠.٨
Total	٣٥						

Table (٢): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Parameters / Treatment	PH١	PH٢	N.L١	N.L٢	S.D١	S.D٢
F١	٧٧.٦ A	٥٣.٩ A	٨.٠ A	٦.٢ A	٤.٨ A	٣.٤ A
F٢	٧٧.٥ A	٦٢.١ A	٨.١ A	٦.٧ A	٤.٩ A	٣.٨ A
F٣	٨٤.٢ A	٦٣.٧ A	٨.١ A	٧.٠ A	٥ A	٣.٧ A
F٤	٨٣.٢ A	٦٢.١ A	٧.٦ A	٦.٢ A	٤.٨ A	٣.٦ A
Overall means	٨٠.٦	٦٠.٥	٨	٦.٥	٤.٩	٣.٦
SE±	٧.٨	٦.٦	٠.٣٤	٠.٧١	٠.٦٤	٠.٥٣
CV%	١٦.٨	١٨.٩	١٢.١	١٨.٦	١٣.٩	٢٥.٢

Mean followed by the same letter for each parameter was not significantly different at ٥٪ level.

Table (٣): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

cultivars	PH١	PH٢	N.L١	N.L٢	S.D١	S.D٢
Heddaba١	٨١.٦ A	٦٠A	٨ A	٧A	٥.٠ A	٣.٥A
Heddaba٢	٨٤.٣ A	٥٨.٥ A	٨ A	٦.٤A	٤.٩ A	٤A
Var١١٣	٧٦.١ A	٦٣A	٧.٨ A	٦.٣A	٤.٧ A	٣.٦A

Mean followed by the same letter for each parameter was non significantly different at ٥٪ level.

Table (٤): mean of the interaction among three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Cultivars	Treatment	PH١	PH٢	N.L١	N.L٢	S.D١	S.D٢
Hedabba١	F١	٨٢.٥	٥٩.٤	٨.٣	٧	٥.١	٣.٩
	F٢	٧٧.٦	٦٣.٣	٨.٣	٧	٥.٢	٣.٢
	F٣	٨٣.٥	٥٤.٢	٨.٣	٧.٣	٥.٢	٣.٥
	F٤	٨٢.٦	٦٣	٧.٠	٦.٣	٤.٥	٣.٤
Hedabba٢	F١	٧٤.٥	٥٦	٨.٣	٦.٧	٤.٨	٣.٤
	F٢	٧٨.٧	٦٠.٩	٨.٠	٦.٣	٤.٨	٤.٣
	F٣	٩٦.٣	٦٥.٩	٨.٠	٧	٤.٨	٣.٩
	F٤	٨٧.٥	٥١	٧.٧	٥.٦	٥.٣	٣.٦
Var١١٣	F١	٧٥.٨	٤٦.٢	٧.٣	٥	٤.٥	٢.٩
	F٢	٧٦.١	٦٢.٢	٨.٠	٦.٧	٤.٦	٣.٩
	F٣	٧٢.٩	٧٠.٩	٨.٠	٦.٧	٤.٩	٣.٧
	F٤	٧٩.٥	٧٢.٤	٨.٠	٦.٧	٤.٦	٣.٩

٤.٢: forage characters:

٤.٢.١: Fresh weight (g):

Statistical analysis exposed non significant difference between DAP treatments throughout three cultivars of maize, and the interaction between DAP and the cultivars of maize (Table ٥). The highest fresh weight ١٠٦.٧٨ g was noted in plants which were treated with ٦٠ kg DAP/ ha, while the lowest fresh weight ٩٠.٥٦ g recorded by plants treated with ٢٠ kg DAP/ha, results of second experiment showed the highest fresh weight ٥١.٨٨ g was recorded in plants which were treated with ٤٠ kg DAP/ha, while the lowest fresh weight ٣٨.٣٠ g noted in plants without DAP, (Table ٦). Heddab١ had a highest fresh weight ١٠٨.٢٥ g in first experiment; but Var١١٣ was a highest fresh weight ٥٢.٧٩ g than the others, in another experiment (Table ٧). The interaction between DAP and the three cultivars of maize revealed that Heddaba١ without treatment of DAP was highest fresh weight ١٢٩.٣٣ g, While Heddaba٢ without treatment had lowest fresh weight ٧٢ g in the land experiment, but var١١٣ treated with ٢٠ kg DAP/ha, was highest fresh weight ٥٩.٧٠ g, While still Heddaba٢ without DAP had lowest fresh weight ٢٥.٣٣ g in pots experiment, as shown in (Table ٨).

٤.٢.٢: plant dry weight (g):

There were no significant difference in analysis of variance between DAP treatments, among the three cultivars of maize; and the interaction between DAP and the cultivars of maize, but there was a little difference under ٠.٠١ in second experiment (Table ٥). The highest dry weight ٣٦.١٤ g was attained in plants which were treated with ٦٠ kg DAP/ha, while the lowest one ٣١.١١ g was noted in plants which treated by ٢٠ kg DAP/ha, The highest dry weight ١٢.٨٨٩ g was attained in plants which were treated by ٤٠ kg DAP/ha, while the lowest one ٩.١٥٦ g was attained in plants which without applied DAP in the pots experiment, (Table ٦). In

(Table ٧) among the three cultivars; Heddaba١ had a highest dry weight ٣٦.١٤٢ g, over all cultivars, also in second experiment Heddaba١ had a highest dry weight ١١.٢١g. The interaction between DAP and the three cultivars of maize revealed that Var١١٣ which treated by ٦٠ kg DAP/ha was a highest dry weight ٤١.٦٠٠ g, of all other cultivars, and Heddaba٢ which treated by ٤٠ kg DAP/ha had the lowest dry weight ٢٧.٥٦٧ g, but in the second experiment Var١١٣ when treated by ٤٠ kg DAP/ha was highest dry weight ١٤.٠٣٣ g, of all other cultivars, and heddaba٢ which was without DAP given the lowest dry weight ٥.٧٠٠ g, as shown in (Table ٨).

Table (٥): ANOVA for different parameters used to evaluate the effect of different level of DAP on some cultivar of maize at shambat in ٢٠١٦:

		F- value			
sources	D.F	F.W١	F.W٢	D.W١	D.W٢
Replicate	٢	٤٨٩٣.٠٣	٤٧٥.١	٥٩٦.٦	٩.٧٣
Cultivars	٢	١٥٥٦ NS	٢٢١.٣ NS	١٥٥.٢ NS	٩.١ NS
Error (a)	٤	٢٦٦٧.٤	٧٧.٧	٢٥٠.٥	١٠.٣
DAP	٣	٤٢٥.٦ NS	٣٨١*	٤٢.٨ NS	٢٥.١ *
Culti*DAP	٦	٦٧٠.٦ NS	١٢٦.٦ NS	٨٩.٢ NS	١١.٨ *
Error (b)	١٨	١٨١٠.١	٨٠.٦	١٥١.٦٤	٥.٥
Total	٣٥				

Table (٦): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Parameters / Treatment	F.W١	F.W٢	D.W١	D.W٢
F١	٩٨.٦ A	٣٨.٣ A	٣٢.١ A	٩.٢ A
F٢	٩٠.٧ A	٥١.٧ A	٣١.٣ A	١١.٩ A
F٣	١٠٢.٣ A	٥١.٩ A	٣٢.١ A	١٢.٩ A
F٤	١٠٦.٨ A	٥٠.٠ B	٣٦.١ A	١٢.٤ B
Overall means	٩٩.٦	٤٨	٣٣	١١.٦
SE ±	٢٤.٦	٥.٢	٧.١	١.٤
CV%	٤٢.٧	١٨.٧	٣٧.٤	٢٠.٢

Mean followed by the same letter for each parameter was not significantly different at ٥٪ level.

Table (٧): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

cultivars	F.W١	F.W٢	D.W١	D.W٢
Heddaba١	١٠٨.٣ A	٤٦.٦ A	٣٦.١ A	١١.٢ A
Heddaba٢	١٠٣.٨ A	٥٢.٨ A	٣٣.٦ A	١٢.٦ A
Var١١٣	٨٦.٧ A	٤٤.٥٣ A	٢٩.٠ A	١١ A

Mean followed by the same letter for each parameter was not significantly different at ٥٪ level.

Table (٨): mean of the interaction among three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Cultivars	Treatment	F.W١	F.W٢	D.W١	D.W٢
Hedabba١	F١	١٢٩.٣	٤١.٠	٣٧.٨	١١.١
	F٢	١٠٠.٣	٤٦.٣	٣٩.٨	٣.٦
	F٣	١٠٦.٠	٥٢.٤	٣٦.٢	١٢.٤
	F٤	٩٧.٣	٤٥.٧	٣٠.٨	١١.٨
Hedabba٢	F١	٩٤.٣	٤٧.٥	٢٩.١	١٠.٧
	F٢	٨٩.٠	٥٩.٧	٣٠.٩	١٤.٠
	F٣	١١١.٠	٥٢.٩	٣٢.٧	١٣.٤
	F٤	١٢٠.٧	٥١.١	٤١.٦	١٢.٢
Var١١٣	F١	٧٢.٠	٢٥.٣	٢٩.٣	٥.٧
	F٢	٨٢.٣	٤٩.١	٢٣.٢	١٢.١
	F٣	٩٠.٠	٥٠.٤	٢٧.٦	١٢.٨
	F٤	١٠٢.٣	٥٣.٣	٣٦.٠	١٣.٢

٤.٣: Forage content (%):

٤.٣.١: protein content (%):

The crude protein extracted from leaves and stem of maize were not significantly affected by different levels of DAP, Hedabba١ which treated by ٦٠ kg DAP/ha was the highest crude of protein ٩.٣٣٪, Hedabba١ without DAP was the lowest one ٤.٩٣٪, while in the second experiment Var١١٣ which treated by ٦٠ kg DAP/ha was the highest crude of protein were ٩.٣٩٪, while Hedabba١ which treated by ٢٠ kg DAP/ha was the lowest ٥.٨٤٪, as shown in (table ٥).

٤.٣.٢: fiber content (%):

The chemical analyses showed no significant effect of different levels of DAP on leaf and stem crude fiber. Hedabba٢ which was treated by ٦٠ kg DAP/ ha gave the highest crude fiber ٢٩.٤٧٪ compared with the other levels. While the lowest crude fiber content ٢١.٤٠٪ was recorded by Hedabba٢ treated by ٢٠ kg DAP/ha. But in the second experiment the highest crude fiber content ٢٧.٠٣٪ was recorded in Hedabba١ which treated by ٢٠kg DAP/ha, while the lowest crude fiber content ٢٣.٨٣٪ in the same variety when treated by ٤٠ kg DAP/ha.

Table (٩): ANOVA for different parameters used to evaluate the effect of different level of DAP on some cultivar of maize at shambat in ٢٠١٦ in the two experiments:

		F- value	
sources	D.F	P%	F%
Cultivars	٢	١.٨	٢.٩
DAP	٣	٧.٩	١٣.٨
Culti*DAP*expeim	١٨	٤.٠	١١.٥
Error	٤٨	٠.٠١	٠.١
Total	٧١		

Table (١٠): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Parameters / Treatment	P%	F%
F١	٦.٢٢ d	٢٣.٦٠ c
F٢	٦.٤٧ c	٢٥.٤٣ a
F٣	٧.٣٧ b	٢٤.١٤ b
F٤	٧.٥٧ a	٢٥.٢٣ a
Overall means	٦.٩٢	٢٤.٦
LSD ٥٪	٠.٢٤	٠.٢٧
CV%	٤.٢٣	١.٣٤

Mean followed by the same letter for each parameter was not significantly different at ٥٪ level.

Table (١١): mean of three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

cultivars	P%	F%
Heddaba١	٧.٠٩٥٨ a	٢٤.٥٢١ b
Heddaba٢	٧.٠٣٠٨ a	٢٤.٩٨٣ a
Var١١٣	٦.٥٩٨٨ a	٢٤.٣٠٤ c

Mean followed by the same letter for each parameter was not significantly different at ٥٪ level.

Table (١٢): mean of the interaction among three cultivars of maize evaluated under four levels of DAP at shambat in ٢٠١٦:

Cultivars	Treatment	P١٪	P٢٪	F١%	F٢٪
Hedabba١	F١	٤.٩ k	٦.٢ hij	٢١.٧ mn	٢٤.٥ fg
	F٢	٦.٥ gh	٥.٨ j	٢٦.٣ c	٢٧.١ b
	F٣	٧.٢ ef	٨.٩ a	٢٣.٥ ij	٢٣.٩ hi
	F٤	٩.٣ a	٨.٠ bc	٢٢.١ lm	٢٧ b
Hedabba٢	F١	٦.٣ hij	٧.٦ cd	٢٣.٤ j	٢٥.١ e
	F٢	٦.٣ hij	٧.٢ def	٢٧.٠ b	٢٥.٧ d
	F٣	٦.٤ hi	٧.٠ ef	٢٤.٥ fg	٢٥.٤ de
	F٤	٦.٢ hij	٩.٤ a	٢٣.٠ jk	٢٥.٨ cd
Var١١٣	F١	٤.٩ k	٧.٥ de	٢٢.٦ kl	٢٤.٣ gh
	F٢	٦.١ hij	٦.٩ fg	٢١.٤ n	٢٥.١ ef
	F٣	٦.٥ gh	٨.٣ b	٢٣.٤ j	٢٤.٢ gh
	F٤	٦.٥ gh	٦ ij	٢٩.٥ a	٢٤.١ gh

Chapter five

Discussion

Application of Diammonium phosphate at the rates of ٠ kg DAP/ ha, ٢٠ kg DAP/ ha, ٤٠ kg DAP/ ha, and ٦٠ kg DAP/ ha, revealed non significant effect for plant height, stem diameter, number of leaves, fresh weight, and dry weight among cultivars of maize; heddaba١, heddaba٢, and Var١١٣. Dawelbait et al (٢٠٠٧) reported that soils of central Sudan are deficient in nitrogen (less than ٠.١٪) and available phosphorous (less than ٤٠ppm). They added that the relatively high (CEC) Cation exchange capacity, and base saturation of such soils indicate their ability to retain added nutrients, especially nitrogen and phosphorous. However, this study revealed no increases in these evaluated characters in both experiments as were expected. This could be attributed to the low nitrogen content of DAP, increase in the temperature, lack of irrigation water. While Nour (٢٠٠٥) was reported an increase in yield of maize need to application of ٨٦ Kg N/ha as urea. Saha (١٩٩٤) reported that maize, like the other cereals, requires good supply of nitrogen and phosphorous so as to give high yield.

To use the right type and amount of fertilizers along with proper package of the other factors that affect production will increase yield in variety of crops has made very significant contribution conquer to poverty around the world.

Although there were not significant for plant height which disagree with Hassan Haroun (٢٠٠٤), who reported that phosphorous ($P_{٢}O_{٥}$) gave variation in the response of the cultivars in the experiment and this might be attributed to different materials under test and differences in the environmental conditions under which the experiments were conducted. Also the heavy clay soil, in which the experiments were conducted, might have affected the availability of phosphorous, and decreases of nitrogen.

Conclusion

- According to this study doses of DAP had not sufficient to produce maize crop in Sudan, and also propose adding nitrogen beside the DAP fertilizer and provides all maize requirements and suitable weather, to get high production.
- Due to the important and nutrient value of maize, the suggestion is do more researches on maize as forage and food crop as needed to improve the yield and quality by evaluating the existing varieties, introduced adapted varieties, breeding new cultivars, and improving the cultural practices.

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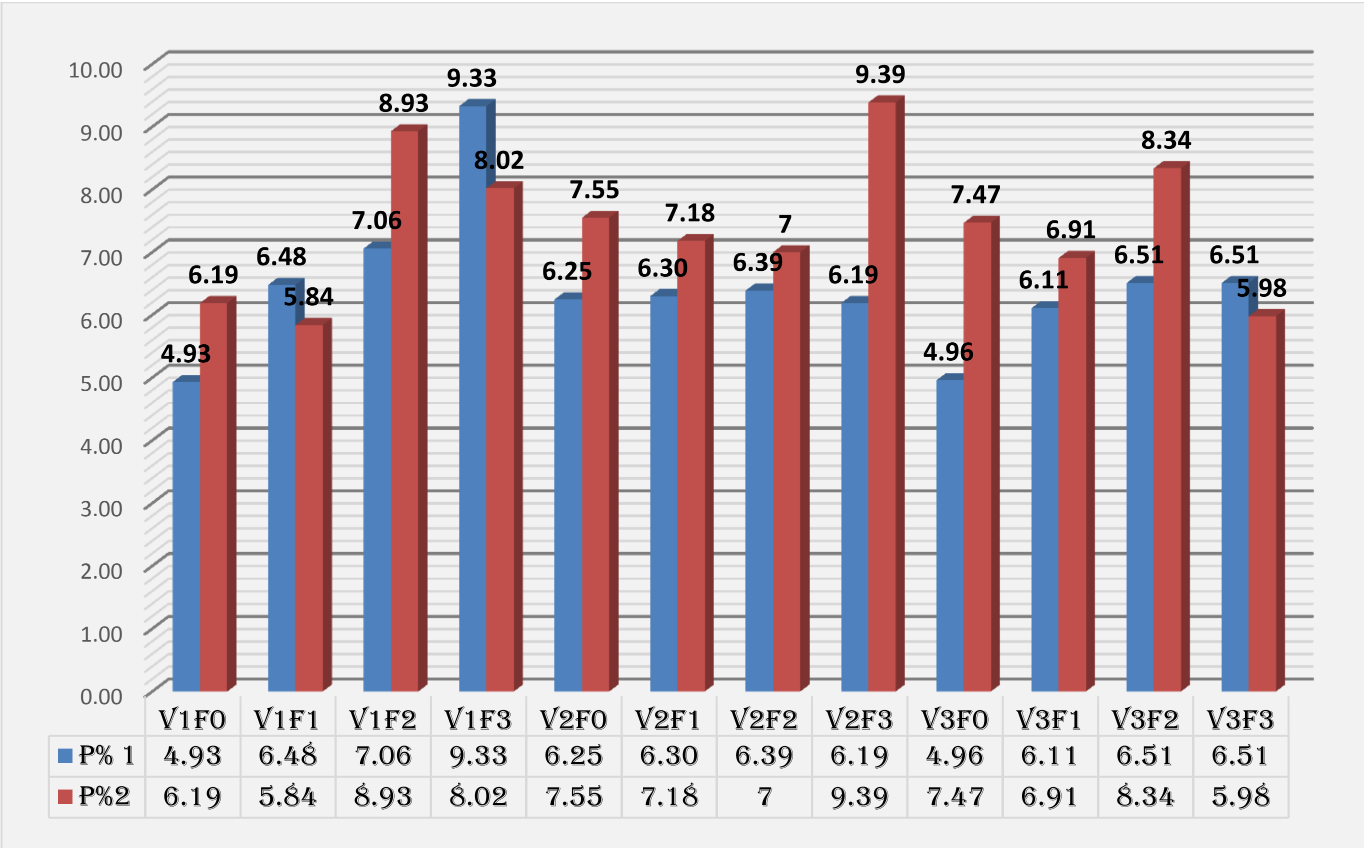
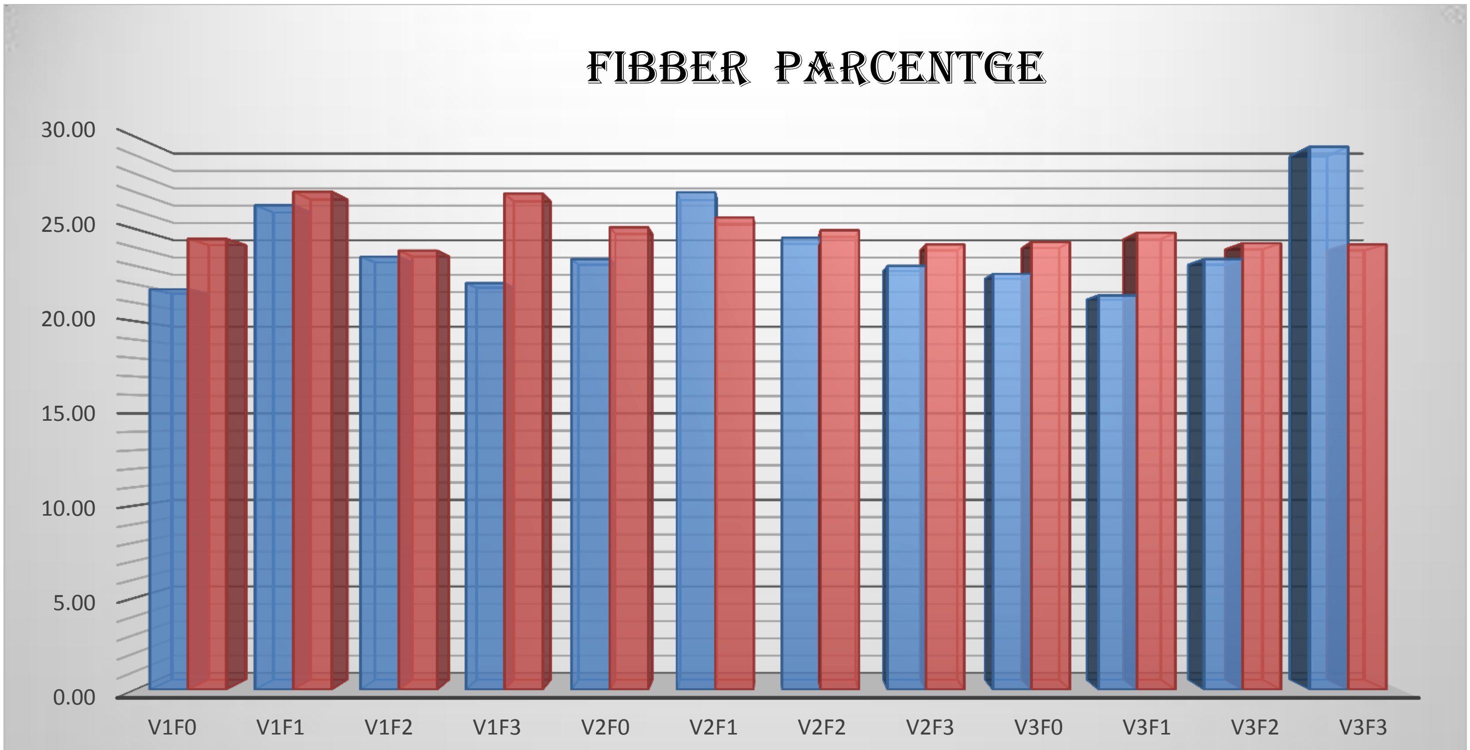
Appendix (١): vigor of protein Percentages evaluate the effect of different level of DAP on some cultivar of maize at shambat in ٢٠١٦.



Appendix (٢): vigor of fiber Percentages evaluate the effect of different level of DAP on some cultivar of maize at shambat in ٢٠١٦.



	V1F0	V1F1	V1F2	V1F3	V2F0	V2F1	V2F2	V2F3	V3F0	V3F1	V3F2	V3F3
F% 1	21.73	26.30	23.50	22.07	23.37	27.00	24.53	23	22.57	21.40	23.37	29.47
F%2	24.47	27.03	23.83	26.93	25.1	25.63	24.93	24.17	24.3	24.8	24.23	24.17

Appendix (٣): Productivity of maize in Sudan:

Season	Productivity (kg/Fadden)
٢٠٠٩/٢٠١٠	٥٨٣
٢٠١٠/٢٠١١	٥٦٨
٢٠١٢/٢٠١٣	٦٧٢
٢٠١٣/٢٠١٤	٤٢٤
٢٠١٦/٢٠١٧	٥٨١

Appendix (٤):

Sweet corn, yellow, raw
(seeds only)
Nutritional value per ١٠٠ g (٣.٥ oz.)

Energy	٣٦٠ kJ (٨٦ kcal
Carbohydrates	١٨.٧ g
Starch	٥.٧ g
Sugars	٦.٢٦ g
Dietary fiber	٢ g
Fat	١.٣٥ g
Protein	٣.٢٧ g
Tryptophan	٠.٠٢٣ g
Threonine	٠.١٢٩ g
Isoleucine	٠.١٢٩ g
Leucine	٠.٣٤٨ g
Lysine	٠.١٣٧ g
Methionine	٠.٠٦٧ g

Vitamins

Vitamin A equiv.	(١٪) ٩µg
Luteinzeaxanthin	٦٤٤ µg
Thiamine (B١)	(١٣٪) ٠.١٥٥ mg
Riboflavin (B٢)	(٥٪) ٠.٠٥٥ mg
Niacin (B٣)	(١٢٪)١.٧٧ mg
Pantothenic acid (B٥)	(١٤٪) ٠.٧١٧ mg
Vitamin B٦	(٧٪) ٠.٠٩٣ mg
Folate (B٩)	(١١٪) ٤٢ µg
Vitamin C	(٨٪) ٦.٨ mg
Cystine	٠.٠٢٦ g
Phenylalanine	٠.١٥٠ g
Tyrosine	٠.١٢٣ g
Valine	٠.١٨٥ g
Arginine	٠.١٣١ g
Histidine	٠.٠٨٩ g
Alanine	٠.٢٩٥ g
Aspartic acid	٠.٢٤٤ g
Glutamic acid	٠.٦٣٦ g
Glycine	٠.١٢٧ g
Proline	٠.٢٩٢ g
Serine	٠.١٥٣ g

Minerals

Iron	(٤٪) ٠.٥٢ mg
Magnesium	(١٠٪) ٣٧ mg
Manganese	(٨٪) ٠.١٦٣ mg
Phosphorus	(١٣٪) ٨٩ mg
Potassium	(٦٪) ٢٧٠ mg
Zinc	(٥٪) ٠.٤٦
Other constituents	
Water	٧٥.٩٦ g

- Units
- µg = micrograms • mg = milligrams
- IU = International units

Percentages are roughly approximated using US recommendations for adults.
Source: USDA Nutrient Database

Appendix (٥): Monthly status weather for Shambat in ٢٠١٦

Month	Temperature C°		Relative Humidity %	Wind speed (nods)
	Max	Min		
March			٢١	٥
April			١٩	٤
May			٢٤	٤
June			٣١	٤
July			٤٧	٥

Knot = ١.٨٥ Km/hr. = ٠.٥ m/s

Maximum temperature for the first days of March:

Day	Temperature
٧	٣٧.٨
٨	٤٠
٩	٤٢
١٠	٤٤.٥
١١	٤٤.٥
١٢	٤٤.٥
١٣	٤٣.٥
١٤	٤١
١٥	٣٩.٧
١٦	٣٧
١٧	٣٦.٥
١٨	٣٨.٥
١٩	٣٩.٥
٢٠	٤٠.٢
٢١	٣٩.٣