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FODDER GROWTH AND QUALITY OF TWO VARIETIES OF SORGHUM (*bicolor L*) IN FIVE TYPES OF SOIL AROUND KHARTOUM

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المستخلص

اجريت هذه التجربة بالمزرعه التجريبيه ، كلية الزراعه ، جامعة الخرطوم في الفتره بين 2007 و 2008 لفصلى الصيف والشتاء، لدراسة تأثير أنواع مختلفه من تربة ولاية الخرطوم على نمو وجودة صنفين من الذره العلفيه أبوسبعين والبايونير. خمسة أنواع مختلفه من التربه جمعت من حول مناطق الانتاج بولاية الخرطوم ، تربه من محمل نهر النيل (Entisols) (G) ، وتربه من الترس الثاني لمنطقة شمبات (SH) ، وتربه من الترس الثالث (مزرعة جامعة الخرطوم (UK)، وتربه من شرق النيل (الحاج يوسف ، (HY)، وتربه من مناطق الانتاج ، تربه رمليه (شرق الفتيحاب (F) وجدت فروق معنوية ($P<0.05$) بين المكونات الكيميائيه والفيزيائيه لانواع التربه المختلفه ، وطول النبات وقطر الساق وعدد الاوراق .

التربه (G) زادت من طول النبات ، قطر الساق وعدد الاوراق. كلا صنفى علف الذره المزروعه في التربه (G) سجلت قيم معنويه أعلى للبروتين الخام وهضمية الماده الجافه المعمليه ومحتوى أقل من الالياف الخام مقارنه مع الانواع الاخرى من التربة . لهذا تعتبر التربة (G) أفضل تربة بولاية الخرطوم لانتاج علف الذره بجودة عاليه .

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Abstract

An experiment was conducted at Experimental Farm, Faculty of Agriculture, University of Khartoum in the period of 2007 to 2008 in summer and winter season to study the effect of different Khartoum state soil on the growth and quality of two varieties of sorghum, bicolor L (Abu- 70) and Pioneer). Five different soils were collected from five different locations around Khartoum state production areas, soil from along river Nil (Entisols)-(G), soil from second terrace of Shambat area.(SH), soil from third terrace at the University of Khartoum farm U of K), soil from eastern Nile (EL-hajyousif area) - (HY) and soil from production area, sand soil (EL-fteehab east) (F). Significant differences ($P<0.05$) were found between chemical and physical ingredients of soil samples, plant height, stem diameter and number of green leaves
Soil (G) increase plant height, stem diameter and number of green leaves. Both sorghum varieties planted in soil (G) recorded significantly ($P<0.05$) highest values of protein content, in vitro DM digestibility and less crud fiber content compared to other soil types. Therefore, soil (G) was regarded as the best soil in Khartoum State for high quality sorghum fodder production.

Key wards: Soil, Sorghum, Digestibility, Fodder,

Introduction

Sudan is the largest agricultural country in Africa with an area 2.44 million square kilometer, extending from 10N to 22N .It has population of 25 million mostly living in rural area .Climatic condition are diverse with average rain fall varying from less than 25Mm in the north to 1500Mm in the south .The mean rainy season is between July and September. There are extensive plain of the iron stone in the south, Clay soil in the central and sandy soil in the north and west, a few mountainous areas in the south, east and west. The river Nile runs through the country from south to north a distance of 2258Km. This provides jobs for about 75% of population most important industries depend on agricultural products.

Sorghum bicolor (L) (Abu 70) and (Pioneer) fodder grown around Khartoum state were classified as moderate salt tolerant crop and presently are the most widely grown as fodder crops. Abu 70 relatively rich in carbohydrates, proteins and vitamins, Sattell et al. (1998).

Plant nutrient uptake is important component of forage diet quality for ruminant lives tock (NRC 2001) and is greatly affected by soil type and soil mineral status (Haby,1995) – Some soils may not need mineral supplementation to satisfy the requirements for dairy cattle (venuto et al.2003). This work is designed to study the effect of soil type on growth and quality of two sorghum fodder (Sorghum bicolor .L and sudangrass Hybrids).

Materials and methods

Pot experiments were carried out at the Faculty of Agriculture, University of Khartoum, Shambat area (Latitudes 15° 40`N; longitudes 32° 32`E) for two successive seasons (summer and winter) in 2007 and 2008. At the sampling site, surface soils (0–30 cm) from five locations were sampled using a auger around Khartoum state , namely, soil from first terrace river Nil (G)silty clay(Fine, mont, superactive, isohyperthermic, vertictorrifluvents), second terrace of Shambat area (SH) Clay (Fine, mont, superactive, Isohyperthermic, Vertichaploargids), third terrace -university of Khartoum farm-(UK)Silty clay loam (Fine, smectitic, superactive, isohyperthermic, Entichaplotorrert), eastern Nile EL hajyousif area - (HY) sandy clay loam (Fine loamy, mont, superactive, isohyperthermic (superactive), Vertichaplocambids) and EL-fteehab east – (F). Sandy clay (Fine loamy, mixed, isohyperthermic, typic hapltorriepts) Soil physicochemical properties data are presented in Table 1. Plastic pots were used as experimental units and each pot was filled with 10kg soil. Abu 70 and Pioneer seeds obtained from Arab company, Khartoum state and were sown in replicated experiments. Irrigation was done according to field capacity of each soil type. Two types of fertilizers were applied as a basal dressing to all treatments, according to recommended dose. First one is supper phosphate which was added before sowing process by 20 day. The

second type was urea which was added to each unit in sowing day and then after 30 days from the beginning of sown. The parameters measured were plant height, number of leaves, plant stem size (diameter) and fresh and dry yield. Plant leaves number and number of green leaves. Soil texture was measured by the hydrometer method, Soil pH was measured on the soil paste by using Analogue pH meter (model No 902), the electrical conductivity of soil extract (ECe) was obtained by conductivity meter (model No 1100). Calcium and magnesium were determined volumetrically with Ethylene diamine tetra acetate (EDTA). Sodium was determined photometrically by corning-EEL flame photometer. Total nitrogen was determined by macro Kjeldahl method (Chapman and Pratt, 1961), Available phosphorus was determined by sodium bicarbonate method (Olsen et al., 1954). Crude fiber and crude protein (CP) were determined using (AOAC 1980) while neutral detergent fiber was determined according to Van Soest et al. (1991), DM digestibility was carried out according to Tilley and Terry (1963).

Statistical analysis:
Statistical analysis was performed using SAS (1987) and means separation was performed with Least Significant Difference.

Results and Discussion

Before sowing pH ranged between (7.1 and 7.9.) Electrical conductivity (ECe) ranged between 0.47 to 1.77 Mmho/ cm. soluble cation (calcium and magnesium) ranged between 6.0 to 10.0 mg/L . Sodium Absorption Ratio (SAR) ranged between 0.05 to 5.3 mg/L. The phosphor (p) ranged between 2.9 to 5.9 ppm. The nitrogen (N) and organic carbon (OC) ranged between 0.04 to 0.1% and 0.5 to 1.2 % respectively. The cation Exchange Capacity (CEC) calcium and magnesium ranged between 8 to 22 and 2 to 12 meq/ 100g respectively.Table (1)

Soil physicochemical properties after sowing were not affected by plant varieties so the figure is one for both. After sown soil pH ranged from 7.8 to 8.0. Electrical Conductivity (ECe) ranged between 0.403 to 1.67 Mmho/ cm. soluble cation (calcium and magnesium) ranged between 2.5 to 5.5 mg/L . Sodium Absorption Ratio (SAR) ranged between 0.58 to 2.9 mg/L. The phosphor (p) ranged between 2.70 to 3.11 ppm. The nitrogen (N) and organic carbon (OC) ranged between 0.022 to 0.030% and 0.033 to 0.073 % respectively. Cation Exchange Capacity (CEC) calcium and magnesium ranged between 8 to 22 and 2 to 12 meq/ 100g respectively (Table 2).

The tallest plants were recorded for soil type (G) and in this soil Abu 70 was significantly ($P<0.05$) taller (212.7 cm and 293.3 cm) than pioneer (156 cm and 151.3 cm) in first and second season respectively, Table (3). This might be due to high level of Nitrogen (0.103%) and (0.030%) before and after sow respectively Tables (1 and 2). This result was supported by Zeyada et al (1984) and higher than that reported by Ayub., et al.(2004) who reported 100.85 cm.

Table 1: Soil physicochemical properties before sowing

Soil	pH	Ece	SAR	Available P%	Total N%	Organic carbon	CE C	clay	silt	Sand	Texture class
HY	7.1	1.77	5.28	5.27	0.037	0.78	20	40.3	8.00	51.7	sandy clay loam
F	7.9	0.76	2.02	4.08	0.075	0.55	11	41.9	3.2	54.9	sandy clay
SH	7.3	1.01	5.34	5.58	0.056	0.70	30	58.3	11.9	29.8	Clay
G	7.5	0.50	1.58	5.86	0.103	1.18	24	31	57.1	11.9	silty clay
Uk	7.6	0.47	0.05	2.89	0.084	0.75	18	33.4	44	22.6	Silty clay loam

HY = Soil from eastern Nile (EL-hajyousif area)
F = Soil from the production area ,sand soil (EL-fteehab east)
SH = Soil from the second terrace of Shambat area.
G = Soil form along the river Nile (Entisols)
UK = Soil from third terrace (University of Khartoum farm)

Table 2: Soil physicochemical properties after sowing.

Analysis / Soil	pH	ECe Mmho/ cm	Soluble Cation: Ca++ and mg++ (mg/L)	SAR	P (ppm)	N%	OC %	CEC Ca++ Meq/ 100g	CEC Mg++ Meq/100g
HY	7.8 ^{c}	0.4 ^{e}	2.5 ^{e}	1.4 ^{e}	2.8 ^{c}	0.02 ^{d}	0.04 ^{cb}	16.0 ^{c}	4.0 ^{c}
F	7.8 ^{c}	0.6 ^{c}	4.0 ^{c}	1.8 ^{c}	2.9 ^{b}	0.02 ^{bc}	0.03 ^{c}	8.03 ^{e}	3.9 ^{c}
SH	8.0 ^{a}	1.0 ^{a}	5.5 ^{a}	2.8 ^{b}	3.1^{a}	0.02 ^{b}	0.05 ^{b}	18.0 ^{b}	12.0 ^{a}
G	7.8 ^{c}	0.6 ^{d}	3.5 ^{d}	1.8 ^{d}	2.7 ^{d}	0.03 ^{a}	0.07 ^{a}	22.0 ^{a}	12.0 ^{a}
Uk	8.0 ^{b}	0.9 ^{b}	4.4 ^{b}	2.9 ^{a}	3.1 ^{a}	0.02 ^{cd}	0.05 ^{b}	12.0 ^{d}	6.0 ^{b}
Prb	***	***	***	***	***	***	***	***	**

abc =Means with the same letter are not significantly different.

G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area ,sand soil (EL-fteehab east)

** = $p < 0.01$ *** = $p < 0.001$

Table 3: Plant height of Abu 70 and Pionner in two seasons, from five soils

	Summer		Winter	
	Plant height		Plant height	
soil /Crop	Abu70	Pionner	Abu70	Pionner
F	168. 7 [b]	159.3[a]	163.3 [b]	147.3[b]
G	212. 7 [a]	156.0 [a]	293.3 [a]	151.3[a]
SH	195.0 [ab]	150.3 [ab]	191.0 [ab]	147.7 [ab]
UK	194.3 [b]	136.7 [b]	192.3 [ab]	133.3 [b]
HY	175.3 [b]	153. 7 [b]	170.3 [b]	147.0 [b]
Prb		*	**	*

abc =Means with the same letter are not significantly different.

G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area ,sand soil (EL-fteehab east)

* = $p < 0.05$ ** = $p < 0.01$

In the same trend the largest stem diameters were reported for soil type (G), (1.36cm) and (1.33cm) were recorded for Abu 70 in summer and winter season respectively, and (1.23cm) and (1.20cm) for pioneer plant in first and second season respectively, Table (5).This results were consistent with Sharma., (1973) and Ayub., et al (2004) who found 1.33 cm

Table4: Plant stem diameter of Abu 70 and Pionner in two seasons, from five soils

	Summer		Winter	
	Stem size (cm)		Stem size (cm)	
soil /Crop	Abu70	Pionner	Abu70	Pionner
F	1.13 ^{ab}	1.23 ^{a}	0.97 ^{ab}	1.20 ^{a}
G	1.37 ^{a}	1.23 a	1.33 ^{a}	1.20 ^{a}
SH	1.23 ^{ab}	1.13 ^{b}	1.17 ^{ab}	1.10 ^{ab}
UK	1.10 ^{b}	1.23 ^{a}	0.97 ^{ab}	1.67 ^{ab}
HY	1.13 ^{ab}	0.95 ^{b}	1.00 ^{b}	1.07 ^{b}
Prb	*	*	*	*

abc =Means with the same letter are not significantly different.

G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area, sand soil (EL-fteehab east)

* = $p < 0.05$

Number of green leaves of Abu- 70 was (13.6) in summer and winter season, and (13.0) and (12.3) were recorded for pioneer plant in summer and winter season respectively, were found in soil type (G) table (5). The high level of Organic Carbon (1.18%) and (0.073%) respectively (table 1 and table 2) and may explained the increases of the number of green leaves in that soil. This result was consistent with Ayub., et al (2004) who reported 12.4.

Table 5: Numbers of green leaves of Abu 70 and Pionner in two seasons, from five soils.

	Summer		Winter	
	Number of leaves		Number of leaves	
soil /Crop	Abu 70	pionner	Abu 70	Pionner
F	12.7 [b]	12.3 [ab]	12.3 [b]	11.3 [b]
G	13.7 [a]	13.0 [a]	13.7 [a]	12.3 [a]
SH	12.3 [ab]	12.7 [ab]	11.7 [b]	12.0 [ab]
UK	13.3 [ab]	12.3 [ab]	12.3 [ab]	12.0 [ab]
HY	12.7 [b]	11.0 [b]	12.3 [b]	10.7 [b]
Prb	*	*	*	*

abc =Means with the same letter are not significantly different.
G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nie (EL-hajyousif area)

F = Soil from the production area ,sand soil (EL-fteehab east)

* = $p < 0.05$

CP content were (12.93%) and (13.00%) recorded for Abu 70 in summer and winter season respectively, and is (13.96%) and (12.94%) were reported for pioneer in first and second season respectively, were found in (G) soil Table (6). This results were higher than that reported by Ayub., et al (2004) who found 9.29% CP.

Relatively the crude fiber content were low for both sorghum varieties in all soil types, with significant ($P<0.05$) lowest values 27% and 24% for Abu 70 and pioneer respectively in the second season Table (7).

Table 6: Crude protein of Abu 70 and Pionner in two seasons from five soils

	summer		Winter	
	Protein		Protein	
soil /Crop	Abu70	Pionner	Abu70	Pionner
F	11.56 [b]	8.15 [e]	7.94 [d]	5.98[c]
G	12.93 [a]	13.97 [a]	13.00 [a]	12.92 [a]
SH	7.62 [e]	8.82 [d]	12.94 [b]	6.79 [d]
UK	10.40 [d]	12.42 [b]	6.99 [e]	7.73 [e]
HY	11.02 [c]	11.47 [c]	8.35 [c]	9.53 [c]
Prb	**	*	**	*

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SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area ,sand soil (EL-fteehab east)

* = $p < 0.05$ ** = $p < 0.01$

Table 7: Crude fiber of Abu 70 and Pionner in two seasons from five soils

	Summer		Winter	
	Fiber		Fiber	
soil /Crop	Abu70	Pionner	Abu70	Pionner
F	31.43[a]	26.58 [a]	40.59 [a]	36.21 [a]
G	30.57[b]	25.18 [b]	27.98 [d]	24.07 [d]
SH	31.69 [a]	27.74 [ab]	32.28 [b]	30.85 [c]
UK	23.86 [c]	23.83 [c]	30.84 [c]	30.18 [c]
HY	28.88 [b]	27.08 [a]	32.09 [b]	33.07 [b]
Prb	*	*	*	**

abc=Means with the same letter are not significantly different.
G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area ,sand soil (EL-fteehab east)

* = $p < 0.05$ ** = $p < 0.01$

DM digestibility of Abu- 70 and pioneer in soil (G) were (75.32%) and (71.91%) in first summer, and (72.17%) and (74.17%) in winter season respectively, Table (8). These values were significantly ($P<0.05$) higher than that reported for other soil types, this may be due to high level of protein content and low level of fiber content. This result agreed with Pedersen et al. (1982) who reported negative correlation between forage fiber and in vitro digestibility and similarly supported by Sanderson et al.(1994) who found that crud protein content was positively correlated with in vitro digestibility.

Table 8: DM digestibility of Abu 70 and Pionner in two seasons from five soils

	Summer		Winter	
	Digestibility		Digestibility	
soil /Crop	Abu70	Pionner	Abu70	Pionner
F	51.64 [d]	58.05 [d]	51.76 [c]	57.58 [d]
	75.32 [a]	71.91 [a]	72.17 [a]	74.17 [a]
SH	67.27 [b]	62.32 [c]	66.66 [b]	62.10 [c]
UK	53.63 [c]	64.00 [b]	52.68 [c]	63.83 [b]
HY	63.51 [b]	68.67 [b]	60.55 [b]	68.10 [b]
Prb	*	*	*	**

abc= Means with the same letter are not significantly different

G = Soil form along the river Nil (Entisols)

SH = Soil from the second terrace of Shambat area.

UK = Soil from third terrace (university of Khartoum farm)

HY = Soil from eastern Nile (EL-hajyousif area)

F = Soil from the production area, sand soil (EL-fteehab east)

L.S.d = less significant different

* = $p < 0.05$ ** = $p < 0.01$

Conclusion:

High quality fodder was reported for soil along the river Nile (G), therefore it is regarded as best soil for sorghum (bicolor L) fodder production in Khartoum state compared with another soils selected in this study.

References

AOAC **1980** Official Methods of Analysis (13 edition). Association of Official Analysis Chemists , Washington , D.C.

Ayub.M., A.Tanveer.,M.A.Nadeen and S.M.A.Shah**..(2004)** Studies on the fodder yield and quality of sorghum grown alone and in mixture with rice bean. Pak.J.life.soc.sci. 2(1): 46 – 48.

Chapman,H.D, and P.F. Pratt.(**1961)** Methods of analysis for soil, plant and water, University of
California, Division of Agricultural sciences.

Haby, V.A**.(195)** Soil management of fertility practices for annual ryegrass.In Symposium on Annual ryegrass , Aug.31-Sept. 1, Nelson, L.R.,Ed.;Tyler, Tx,1995;24-42 .

National Research Counsel. **(2001)** Nutrient Requirements of beef Cattle,7th Rev.Ed.;Natl.Acad.Sci:Washington , D.C..

Olsen,S.R.,C.V.Cole, F.S.Watanable, and L.A. Dean. (1954) Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dep. Of Agric. Circ. 939.

Panciera , M.T .and R. G Gavlak **. (1982)** Field Crop Fertilizer Recommendation for Alaska –Forage Crop , University of Alaska , CES publication

Pedersen, J. F., H. J Gorz., F. A. Haskins, and W. W. Ross**. (1982)** Variability for quality and agronomic traits in forage sorghum hybrids. Crop Sci. 22:853-856.

Sanderson, M. A., F. R. Miller and R. M. Jones. **(1994)** Forage quality and agronomic traits of experimental forage sorghum hybrids. MP-1759. Texas Agric. Exp. Stn., College Station, TX.

SAS Institute **.(1987)** SAS users guide : Statistics .Version 6.11 .SAS Inst ., Cary , N C.

Sattell, R., R. Dick, R. Ingham, R. Karow, and D. McGrath. **(1998)** Sudangrass and sorghum-sudangrass hybrids. EM 8703. Oregon State Univ. Extension Service, Corvallis, OR.

Sharma, R.K. **(1973**) Response of maize to nitrogen fertilization .Madras Agric.J.60; 399-440.

Tilly,A and A.Terry. **(1963)** Two stage technique for invitro digestion of forage crops. J. Brgrassld,Soc., 18: 104 – 108.

Van Soest. P.J., J.B.Robertson and B.A.Lewis. **(1991)** Method for dietary fiber, Neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science. 74: 3588 - 3597.

Venuto,B.C.,J.D.Ward and E.K.Twiewell**. (2003)** Effects of soil type and soil chemical composition on nutrient content of annual ryegrass for beef and dairy cow nutrition.Journal of Plant Nutrition , vol.26(9),1789 – 1799.

Zeyada. A. H; M. S. M. Eisa**. (1984).** Effect of sowing data and nitrogen Fertilizer on tow soybean cultivars (Glycine max (L.)Merr.). Minufiya J. Agric. Res. 9: 139-155.