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Performance of some onion (*Allium cepa* L.) cultivars and different fertilizers on onion bulbs Yield and Quality

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Abstract

This study was carried out during the 2015/16 and 2016/17 summer seasons at the Experimental Farm of Shambat Research Station, Agricultural Research Corporation, Khartoum, Sudan, to investigate the performance of five onion cultivars were; Baftaim (S) (red), Saggai lmproved (red), Abu-Freaiwa (dark red), Kamleen (yellow), Texas Early Yellow Grano (Yellow) with regard to yield and quality using different types of fertilizers. The experimental design was in split plot with three replications. The vegetative growth evaluated was plant height and number of leaves. The yield components (total yield, marketable, unmarketable yield percentage of doubles and bolted bulbs). Other bulb characteristics such as bulb diameter and length, total soluble solids and dry matter content were measured. The results reflected marked variations among onion cultivars in vegetative growth. Baftaim (S) and Kamleen have the highest vigor growth; they were the tallest and high plant length, maximum number of leaves per plant and tallest leaves 90 days after transplanting. The cultivars Baftaim (S) and Texas Early Yellow Grano gave the highest total and marketable bulb yield per hectare and the lowest percentage of doubles and bolted bulbs; The cultivars Baftaim (S) with urea and Texas Early Yellow Grano with ammonium sulphate gave the highest total bulb yield, whereas Texas Early Yellow Grano with organic the highest marketable yield. Texas Early Yellow Grano exhibited the highest physical bulb characters (single bulb fresh weight (g), bulb diameter (cm) and bulb length (cm)), while Kamleen exhibited the highest dray matter percentage; also Kamleen with urea attained the highest dray matter percentage.

Keywords: Onion, fertilizers, cultivars, bulb yield and quality.

I. Introduction

Onion (*Allium cepa* L.) belongs to the Alliaceae family ([1] and [2]). Onions, leek and garlic are collectively known as alliums, as they are all species of the genus Allium. These vegetables produce organo sulphur compounds that react with the enzyme Alliinase to create the compounds which give alliums their distinctive flavors. These organo sulfur compounds are also anti-microbial and may help protect the plants from fungi and bacteria [3].

Onion is the second major important crop after tomato cultivated on large scale throughout the world. According to FAO during 2019, China ranked first in onion production

producing 17.588,267 tons. India stood second with production of 11.011,390 tons; USA was ranked third with a total production of 3.295,957 tons and Pakistan fourth with 2.031,870 tons. The total onion production worldwide is about 97.862 thousand metric tons in an-area of 5.201 thousand hectares. The world average yield is about 18.8 t/ha [4]. In the Sudan it is ranked the first vegetable with regard to the area grown and quantities produced, Naher El-Neil, Gezira, Northern Darfur, Khartoum and Western Darfur States being the main producing areas [5].

The crop is grown for consumption in green state and as mature bulbs [6]; onions are highly valued for their flavor mainly and nutritional value in supplying minor constituents such as minerals and trace elements. It is widely used for various purposes in cooking, salads, preparation of soups , sauces , stew, gravies, stuffing, fried fish , ……etc [7]. It is called the "Queen of Kitchen". Onion besides being used as food is also used as medicine for the treatment of various diseases in different parts of the world [2]. It is successfully applied on bruises and wounds for early heal – up [7].

Low yield of onion is due to improper utilization of fertilizers and growing unsuitable cultivars under the agro-climatic conditions of an area. It can be increased mainly by two ways, either extending the area under cultivation or increase the yield of unit area. Onion production and quality are greatly influenced by the environmental factors, cultivars, agronomic factors e.g. sowing date, nutrition, irrigation and harvesting time ([5], [7] and [8]). Onion composition is variable and its related to environmental factors, cultivars and management practices particularly nutrients that play significant role in productivity and quality [9].

Therefore, the present study was initiated with the following objectives:

1- To investigate the performance of different cultivars on yield and quality.
2- To evaluate different types of fertilizers on onion production.

II. Materials and methods

The field experiments were carried out during the 2015 /16 and 2016/17 summer seasons at the Experimental Farm of Shambat Research Station , Agricultural Research Corporation , Sudan , Khartoum North (Lat. 15° 40"N and long . 32° 32"E and 281m.above sea level).

The physical and chemical properties of soils are presented in (Annex I). Also temperature, relative humidity and rain fall during two growing seasons presented in (Annex II).

Five onion cultivars were sown on 60 cm ridge at the seed rate of 15g / m², cultivated and fertilized by (4.7 g/m²) of urea after 21 days, hand weeding once time and transplanted after 6-7 weeks. The five onion cultivars were; Baftaim (S) (red), Saggai lmproved (red), Abu-Freiwa (dark red), Kamleen (yellow), and Texas Early yellow Grano (Yellow). The fertilizers used were; Urea (46%N), Organic (Elshmokh as in Annex III), NPK (15:15:15), ammonium sulphate and the control (without fertilizer).

The experiment included 25 treatments combination of 5 fertilizers × 5 cultivars.

The soil was ploughed, leveled and then divided in to 60 cm ridges running North South, 3m long. Gross plot size was 4.5m × 2.4m (10.8m²) with three ridges in each plot, while the net plot size planted was (5.4 m²).

Onion seedlings were transplanted on 18 – 21 January 2016 and 20 – 23 January 2017. Seedlings were transplanted in 3 rows on each ridge, with inter raw spacing of 7.5 cm; the experiment was replanted after 10-12 day from transplanting. The experiment was irrigated (18 times) during the season at 7 - 10 days intervals. Weeds were cultivated manually twice during the season.

The organic fertilizer (Elshmokh) was added as one dose before transplanting and then irrigated, while the mineral fertilizers (urea, NPK and ammonium sulphate) were applied as two equal doses one and two months after transplanting, pest and diseases control was done as recommended when required. The experiment was harvested after the maturity symptoms (50-70 % neck falls) were observed.

Five plants were selected randomly from each plot at 90 days after transplanting to estimate the plant growth parameters (Plant characters); Plant height (cm), number of leaves and leaf length (cm).

At the harvest bulbs were collected in mesh sacks for 10-15 days to cure, and then the tops were cut and the bulb yield and yield components; Total bulbs yield (t/ha) the total yield /plot were recorded from 1.8 m² and the yield /ha was calculated as follows:

$$\text{Yield (t/ha)} = \frac{\text{plot yield(kg)}}{\text{plot area}} \times \frac{10000}{1000}$$

Marketable bulbs yield (t/ha) the total yield of sound (single) bulbs/plot was recorded and the yield/ha calculated as for total yield:

$$\text{Marketable yield (t/ha)} = \frac{\text{Marketable plot yield (kg)}}{\text{plot area}} \times \frac{\mathbf{10000}}{\mathbf{1000}}$$

Percentage of double bulbs:

The double and bolted bulbs/plot was weighed and their percentage from the yield/plot was calculated.

Bulb quality:

Sample of five bulbs were randomly taken from each plot for recording the bulb quality properties; average bulb weight (gm), bulb diameter (cm), bulb length (cm) and bulb dry matter calculated using the following equation:

$$\text{Percentage of dry matter} = \frac{\text{Bulbs dry weight}}{\text{Bulbs fresh weight}} \times 100$$

The treatments were arranged in split–plot design of three replications, where the fertilizers were randomized in the main plots and onion cultivars in the sub – plots. The data were analyzed using GenStat (Computer Program) Version4 and the means were separated using Duncan Multiple Range Test (DMRT) at $P \leq 0.05$ [10].

III. Results

A- Growth parameters (Plant characters):

Plant height (cm):

The presented data in Table 1 combined analysis for the two seasons clearly indicated that plant height reflected significant differences among onion cultivars. Baftaim (S) and Kamleen attained the highest plants (10.30 cm and 9.83 cm, respectively), whereas cultivar Texas Early Yellow

Grano gave the shortest plants (7.77cm) but no significant affects for fertilizers and the interactions of fertilizers and cultivars (Table 1).

Number of leaves/plant:

As in (Table 2) there were significant effects of fertilizers. Control and Urea were giving; the highest number of leaves 11.26 and 11.09 leaves/plant, respectively, NPK gave the lowest number of leaves per plant (10.56). Significant differences were observed among onion cultivars, Baftaim (S) and Kamleen attained 11.39 and 11.25 leaves per plant, while Texas Early Yellow Grano gave 10.37 leaves being the lowest number of leaves per plant, there were no significant effect for the interaction of fertilizers and cultivars.

Table (1): Effects of fertilizers and onion cultivars on plant height (cm) after three months from transplanting:

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	8.05 a	9.80 a	8.93 a
Urea (46%N)	8.82 a	9.70 a	9.26 a
Organic (Elshmokh)	8.11 a	9.65 a	8.88 a
NPK (15:15:15)	8.82 a	9.71 a	9.27 a
Ammonium sulphate (21%N&24%S)	8.41 a	9.55 a	8.98 a
SE±	0.284	0.391	0.205
Cultivars			
Baftaim (S)	9.42 a	11.17 a	10.30 a
Saggai lmproved	8.21 b	9.29 c	8.75 b
Abu-Freaiwa	8.65 b	8.70 c	8.68 b
Kamleen	9.53 a	10.13 b	9.83 a
Texas Early yellow Grano	6.41 c	9.13 c	7.77 c
SE±	0.229	0.298	0.205
C.V.%	10.5	11.6	12.4

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (2): Effects of fertilizers and onion cultivars on the number of leaves / plant after three months from transplanting:

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	9.75 abc	12.78 a	11.26 a
Urea (46%N)	10.23 a	11.95 a	11.09 a
Organic (Elshmokh)	9.84 ab	11.96 a	10.90 ab
NPK (15:15:15)	9.29 c	11.83 a	10.56 b
Ammonium sulphate (21%N&24%S)	9.44 b	12.21 a	10.82 ab
SE±	0.158	0.335	0.165
Cultivars			
Baftaim (S)	10.00 ab	12.77 a	11.39 a
Saggai lmproved	9.69 b	12.12 a	10.90 ab
Abu-Freaiwa	10.16 ab	11.27 b	10.72 bc
Kamleen	10.27 a	12.24 a	11.25 a
Texas Early yellow Grano	8.43 c	12.31 a	10.37 c
SE±	0.161	0.265	0.165
C.V.%	6.4	8.2	8.3

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (3): Effects of fertilizers and onion cultivars on the leaf length (cm) after three months from transplanting:

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	51.34 a	53.85a	52.60 a
Urea (46%N)	53.60 a	52.51a	53.05 a
Organic (Elshmokh)	51.93 a	50.07 a	51.00 a
NPK (15:15:15)	53.36 a	53.33 a	53.34 a
Ammonium sulphate (21%N&24%S)	55.60 a	51.76 a	53.68 a
SE±	1.899	1.540	1.135
Cultivars			
Baftaim (S)	57.24 a	55.05 a	56.14 a
Saggai lmproved	53.15 ab	52.70 a	52.93 ab
Abu-Freaiwa	51.83 b	48.21 b	50.02 b
Kamleen	56.59 ab	52.69 a	54.64 a
Texas Early yellow Grano	47.02 e	52.87 a	49.95 b
SE±	1.622	1.096	1.135
C.V.%	11.8	7.9	11.8

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letters are not significant at P=0.05 according to DMRT.

Leaf length (cm):

Table 3 showed that onion cultivars significantly differed in leaf length. Baftaim (S) attained the longest leaf length (56.14cm) and Texas Early Yellow Grano gave the shorter leaf length (49.95 cm). Leaf length was not affected by fertilizers and no interactions of fertilizer and cultivar.

B- Yield and yield components:

Total yield (t/ha):

The total yield t/ha in (Table 4), reflected that there were no significant differences among fertilizers, while significant variations were observed among cultivars, Baftaim (S) and Texas Early Yellow Grano attained the highest total yields (32.67 and 30.69 t/ha, respectively), whereas, Saggai Improved and Abu-Freiawa attained the lowest yields (22.79 and 22.21t/ha, respectively).
Interactions among fertilizers and cultivars reflected significant differences, the highest total yield was obtained by Baftaim(S) with all fertilizers Urea, NPK, ammonium sulphate and organic (35.67, 33.69, 32.98 and 32.58 t/ha, respectively) and Texas Early Yellow Grano with ammonium sulphate, Organic and Urea (35.19, 32.38 and 31.59 t/ha, respectively), while the lowest yield was attained by Saggai Improved with ammonium sulphate (19.88 t/ha) and Abu-Freiwa with urea (19.88 t/ha) (Table 4).

Marketable yield (t/ha):

As indicated in Table 5 there were no significant differences among fertilizers. However, onion cultivars differed significantly, Texas Early Yellow Grano and Baftaim (S) reported the highest

marketable yield (25.57 and 24.57 t/ha), while Abu-Freiwa and Saggai Improved (13.38 and 12.47 t/ha, respectively) gave the lowest marketable yield.
Interactions among fertilizers and cultivars reflected significant differences, Texas Early Yellow Grano with organic (28.47 t/ha) gave the highest marketable yield, it was not significantly differed from Texas Early Yellow Grano with urea, ammonium sulphate and control (26.77, 25.97 and 24.08 t/ha) and Baftaim (S) with urea, ammonium sulphate and NPK (26.72,26.66 and 24.08t/ha), while cultivar Saggai Improved with Urea, Abu-Freiwa with ammonium sulphate and Saggai Improved with ammonium sulphate (10.72,10.47 and 8.99 t/ha) were not significantly different and gave the lowest marketable yield.

Unmarketable yield:

Double bulbs (%):

The main results of the two seasons (Table 6) for double bulbs percentages reflected significant variations among onion cultivars, Texas Early Yellow Grano gave the lowest percentage of double bulbs (12.74%), whereas the Saggai Improved and Kamleen attained the highest percentages (29.22 and 29.75% , respectively). Fertilizers and the interactions between fertilizers with onion cultivars were not significantly different in double bulbs percentage.

C- Onion bulb quality:

Average bulb fresh weight (g):

Combined analysis of the two seasons, reflected marked differences among onion cultivars. Texas Early Yellow Grano gave the heaviest bulbs (73.6 g) followed by Baftaim (S) (63.3 g).,while the Abu-Freiwa gave 40.1g and did not differ significantly different from Saggai Improved and Kamleen (43.7 and 46.1g), No significant effects on the bulb fresh weight either by fertilizers or fertilizers combinations with cultivars were reported (Table 7).

Bulb diameter (cm):

As in Table 8 the results of combined analysis, indicated that the onion cultivars varied significantly in bulb diameter, Texas Early Yellow Grano had large bulb diameter (5.20 cm) but not different from Baftaim (S) (4.95cm), Abu-Freaiwa was the lowest in bulb diameter (4.43cm) but not significantly different from either Saggai Improved or Kamleen (4.61 and 4.69 cm, respectively), no significant effect on bulb diameter resulted from fertilizers or interactions of fertilizers with onion cultivars.

Bulb length (cm):

The mean of the two seasons reflected marked variations among the onion cultivars in bulb length. The longest bulb (5.21cm) attained by Texas Early Yellow Grano and the shortest bulbs reported by Abu-Freiwa and Saggai Improved (3.69cm). The effect of fertilizers and their combinations with cultivars were not significant (Table 9).

Table (4): Effects of fertilizers, onion cultivars and their interactions on total yield (t/ha):

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	25.80 a	26.96 a	26.38 a
Urea (46%N)	27.34 a	27.61 a	27.47 a
Organic (Elshmokh)	26.09 a	27.87 a	26.98 a
NPK (15:15:15)	25.09 a	28.95 a	27.01 a
Ammonium sulphate (21%N&24%S)	25.94 a	27.60 a	26.77 a
SE±	0.974	0.704	0.719
Cultivars			
Baftaim (S)	31.12 a	34.23 a	32.67 a
Saggai lmproved	21.28 d	24.29 b	22.79 c
Abu-Freaiwa	29.92 c	19.51 c	22.21 c
Kamleen	25.49 bc	27.00 b	26.25 b
Texas Early Yellow Grano	27.43 b	33.95 a	30.69 a
SE±	0.797	1.159	0.719
Fertilizers * Cultivars			
Control* Baftaim (S)	25.78 bc	31.11 a	28.44 cde
Control* Saggai lmproved	24.72 bc	24.68 a	24.70 defghi
Control* Abu-Feraiwa	26.89 bc	21.26 a	24.07 feghi
Control* Kamleen	27.50 b	25.43 a	26.46 defg
Control* Texas Early Yellow Grano	24.11 bc	32.31 a	28.21 cdef
Urea (46%N) * Baftaim (S)	36.06 a	35.28 a	35.67 a
Urea (46%N) * Saggai lmproved	16.89 e	24.87 a	20.88 hi
Urea (46%N) * Abu-Freaiwa	22.04 cd	17.04 a	19.54 i
Urea (46%N) * Kamleen	27.57 b	31.81 a	29.69 bcd
Urea (46%N) * Texas Early Yellow Grano	34.15 a	29.04 a	31.59 abc
Organic (Elshmokh) * Baftaim (S)	34.17 a	31.00 a	32.58 abc
Organic (Elshmokh) * Saggai lmproved	21.63 cde	23.38 a	22.51 ghi
Organic (Elshmokh) * Abu-Freaiwa	23.3 bcd	22.02 a	22.67 ghi
Organic (Elshmokh) * Kamleen	24.76 bc	24.78 a	24.77 defhgi
Organic (Elshmokh) * Texas Early Yellow Grano	26.58 bc	38.1 a	32.38 abc
NPK (15:15:15) * Baftaim (S)	33.48 a	33.89 a	33.69 ab
NPK (15:15:15) * Saggai lmproved	24.44 bc	27.50 a	25.97 defgh
NPK (15:15:15) * Abu-Freaiwa	26.17 bc	19.38 a	23.00 fghi
NPK (15:15:15) * Kamleen	22.44 bcd	30.13 a	26.29 defg
NPK (15:15:15) * Texas Early Yellow Grano	18.78 de	33.39 a	26.08 defgh
Ammonium sulphate (21%N&24%S) * Baftaim (S)	26.09 bc	39.87 a	32.98 abc
Ammonium sulphate (21%N&24%S) * Saggai lmproved	18.72 de	21.03 a	19.88 i
Ammonium sulphate (21%N&24%S) * Abu-Freaiwa	26.18 bc	17.41 a	21.79 ghi
Ammonium sulphate (21%N&24%S) * Kamleen	25.17 bc	22.87 a	24.02 efghi
Ammonium sulphate (21%N&24%S) * Texas Early Yellow Grano	33.56 a	36.82 a	35.19 a
SE±	1.867	2.423	1.608
C.V.%	11.8	16.2	14.6

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (5): Effects of fertilizers, onion cultivars and their interactions on marketable yield (t/ha):

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	19.46 ab	18.47 a	18.97 a
Urea (46%N)	20.73 a	17.38 a	19.06 a
Organic (Elshmokh)	18.99 ab	17.04 a	18.02 a
NPK (15:15:15)	17.93 ab	19.18 a	18.55 a
Ammonium sulphat (21%N&24%S)	16.83 b	17.78 a	17.30 a
SE±	1.026	0.977	0.621
Cultivars			
Baftaim (S)	24.58 a	24.57 b	24.57 a
Saggai lmproved	14.24 c	10.69 d	12.47 c
Abu-Freaiwa	15.14 bc	11.62 d	13.38 c
Kamleen	16.88 b	14.95 c	15.91 b
Texas Early Yellow Grano	23.10 a	28.03 a	25.57 a
SE±	0.752	0.806	0.621
Fertilizers * Cultivars			
Control* Baftaim (S)	22.32 cde	23.61 cd	22.96 bc
Control* Saggai lmproved	18.07 efgh	11.39 efg	14.73 defg
Control* Abu-Freaiwa	18.54 efgh	13.61 ef	16.08 de
Control* Kamleen	18.00 efgh	15.98 e	16.99 de
Control* Texas Early Yellow Grano	20.39 defg	27.7 bc	24.08 abc
Urea (46%N) * Baftaim (S)	30.11 ab	23.33 cd	26.72 ab
Urea (46%N) * Saggai lmproved	10.89 jk	10.56 fg	10.72 gh
Urea (46%N) * Abu-Freaiwa	12.39 ijk	13.98 ef	13.19 efgh
Urea (46%N) * Kamleen	19.52 efgh	16.26 e	17.89 d
Urea (46%N) * Texas Early Yellow Grano	30.76 a	22.78 cd	26.77 ab
Organic (Elshmokh) * Baftaim (S)	21.89 cdef	22.37 d	22.18 c
Organic (Elshmokh) * Saggai lmproved	16.24 ghi	10.98 efg	13.61 defg
Organic (Elshmokh) * Abu-Freaiwa	17.91 efgh	5.00 h	11.45 fgh
Organic (Elshmokh) * Kamleen	16.54 fghi	12.22 efg	14.38 defg
Organic (Elshmokh) * Texas Early Yellow Grano	22.28 cde	34.65 a	28.47 a
NPK (15:15:15) * Baftaim (S)	25.44 bcd	23.24 cd	24.34 abc
NPK (15:15:15) * Saggai lmproved	15.67 ghij	12.87 efg	14.27 defg
NPK (15:15:15) * Abu-Freaiwa	16.98 fghi	14.44 ef	15.71 def
NPK (15:15:15) * Kamleen	15.68 ghij	16.11 e	15.90 def
NPK (15:15:15) * Texas Early Yellow Grano	15.87 ghij	29.21 b	22.54 bc
Ammonium sulphate (21%N&24%S) * Baftaim (S)	23.04 cde	30.28 ab	26.66 ab
Ammonium sulphate (21%N&24%S) * Saggai lmproved	10.33 k	7.65 gh	8.99 h
Ammonium sulphate (21%N&24%S) * Abu-Freaiwa	9.89 k	11.06 efg	10.47 gh
Ammonium sulphate (21%N&24%S) * Kamleen	14.67 hjik	14.16 ef	14.42 defg
Ammonium sulphate (21%N&24%S) * Texas Early Yellow Grano	26.20 abc	25.7 a	25.97 abc
SE±	1.820	1.885	1.388
C.V.%	15.5	17.4	18.5

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (6): Effects of fertilizers and onion cultivars on percentages of doubled bulbs:

Fertilizers	Seasons		Mean
	2015/16	2016/17	
Control (without fertilizer)	17.00 a	26.16 a	21.58 a
Urea (46%N)	18.10 a	29.21 a	23.65 a
Organic (Elshmokh)	17.13 a	28.66 a	22.90 a
NPK (15:15:15)	17.95 a	28.42 a	23.19 a
Ammonium sulphate (21%N&24%S)	20.03 a	26.27 a	23.15 a
SE±	2.496	2.83	1.558
Cultivar			
Baftaim(S)	16.50 b	23.87 ab	20.19 b
Saggai Improved	19.81 b	38.62 c	29.22 c
Abu-Freaiwa	19.39 b	25.74 b	22.56 b
Kamleen	26.49 c	33.02 c	29.75 c
Texas Early Yellow Grano	8.10 a	17.47 a	12.74 a
SE±	1.285	2.46	1.558
C.V.%	27.6	34.4	37.3

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (7): Effects of fertilizers and onion cultivars on average bulb fresh weight (g):

Fertilizers	Seasons		Mean
	2015/16	2016/17	
Control (without fertilizer)	48.3 a	55.8 a	52.0 a
Urea (46%N)	53.7 a	60.6 a	57.1 a
Organic (Elshmokh)	49.1 a	57.9 a	53.5 a
NPK (15:15:15)	50.1 a	53.3 a	51.7 a
Ammonium sulphate (21%N&24%S)	56.5 a	48.2 a	52.4 a
SE±	3.59	4.87	8.70
Cultivar			
Baftaim(S)	55.9 ab	70.6 b	63.3 b
Saggai Improved	45.9 bc	41.4 c	43.7 c
Abu-Freaiwa	44.0 c	36.2 c	40.1 c
Kamleen	47.8 bc	44.4 c	46.1 c
Texas Early Yellow Grano	64.1 a	83.1 a	73.6 a
SE±	3.60	4.15	8.70
C.V.%	26.7	28.8	31.8

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (8): Effects of fertilizers and onion cultivars on bulb diameter (cm):

Fertilizers	Seasons		Mean
	2015/16	2016/17	
Control (without fertilizer)	4.63 a	5.00 a	4.81 a
Urea (46%N)	4.80 a	4.99 a	4.89 a
Organic (Elshmokh)	4.51 a	4.91 a	4.71 a
NPK (15:15:15)	4.70 a	4.76 a	4.73 a
Ammonium sulphate (21%N&24%S)	4.79 a	4.67 a	4.73 a
SE±	0.141	0.182	0.269
Cultivar			
Baftaim(S)	4.74 a	5.16 b	4.95 ab
Saggai Improved	4.61 a	4.60 cd	4.61 c
Abu-Freaiwa	4.56 a	4.29 d	4.43 c
Kamleen	4.67 a	4.71 c	4.69 bc
Texas Early Yellow Grano	4.84 a	5.56 a	5.20 a
SE±	0.112	0.114	0.269
C.V.%	9.1	9.0	11.0

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Table (9): Effects of fertilizers and onion cultivars on bulb length (cm):

Fertilizers	Seasons		Mean
	2015/16	2016/17	
Control (without fertilizer)	4.14 a	4.28 a	4.21 a
Urea (46%N)	5.00 a	4.17 a	4.33 a
Organic (Elshmokh)	4.25 a	4.11 a	4.18 a
NPK (15:15:15)	4.22 a	4.12 a	4.17 a
Ammonium sulphate (21%N&24%S)	4.45 a	4.88 a	4.17 a
SE±	0.127	0.105	0.259
Cultivar			
Baftaim(S)	4.68 b	4.61 b	4.45 b
Saggai Improved	3.81 c	3.57 c	3.69 c
Abu-Freaiwa	3.90 c	3.48 c	3.69 c
Kamleen	3.93 c	3.71 c	3.82 c
Texas Early Yellow Grano	5.24 a	5.19 a	5.21 a
SE±	0.130	0.123	0.259
C.V.%	11.6	11.5	12.0

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

Dry matter percentage:

Significant variations in dry matter were found among onion cultivars, combined analysis of the two season (Table 10) revealed significant differences with respect to dry matter percentage among onion cultivars, Kamleen attained the highest total dry matter percentage (16.88), followed by Saggai Improved and Abu-Freaiwa were not varied significantly they gave 15.22

and 14.89, while Texas Early Yellow Grano attained the lowest Texas Early Yellow Grano (7.28), no significant effect on bulb diameter resulted from fertilizers.

Interactions among fertilizers and cultivars reflected significant differences, Kamleen with urea (20.44) gave the highest dry matter percentage, followed by Abu-Freaiwa with NPK (16.44), whereas, Kamleen with organic, control, NPK and ammonium sulphate (16.03, 15.99, 15.81 and 15.79) and Saggai Improved with NPK (15.91) it were not significantly differed. Texas Early Yellow Grano with urea, ammonium sulphate and control gave (7.47, 7.36, 7.30, 7.28 and 6.99) the lowest dry matter percentage (Table 10).

Table (10): Effects of fertilizers, onion cultivars and their interactions on percentage dry matter of bulbs:

Fertilizers	Season		Mean
	2015/16	2016/17	
Control (without fertilizer)	14.26 a	12 58 a	13.42 a
Urea (46%N)	13.90 a	14.07 a	13.98 a
Organic (Elshmokh)	14.17 a	12.87 a	13.52 a
NPK (15:15:15)	13.72 a	13.66 a	13.69 a
Ammonium sulphat (21%N&24%S)	13.63 a	12.61 a	13.16 a
SE±	0.285	0.601	0.328
Cultivars			
Baftaim (S)	13.93 c	13.24 c	13.58 c
Saggai lmproved	15.18 b	15.25 ab	15.22 b
Abu-Freaiwa	15.73 b	14.06 bc	14.89 b
Kamleen	17.32 a	16.29 a	16.88 a
Texas Early Yellow Grano	7.52 d	7.04 d	7.28 d
SE±	0.285	0.601	0.328
Fertilizers * Cultivars			
Control* Baftaim (S)	14.28 a	13.28 bcd	13.78 cde
Control* Saggai lmproved	15.53 a	14.27 bcd	14.90 bcde
Control* Abu-Freaiwa	15.18 a	15.69 b	15.43 bcd
Control* Kamleen	19.43 a	12.55 bcd	15.99 bc
Control* Texas Early Yellow Grano	6.85 a	7.12 ef	6.99 f
Urea (46%N) * Baftaim (S)	14.04 a	10.95 cde	12.49 e
Urea (46%N) * Saggai lmproved	14.87 a	14.57 bcd	14.72 bcde
Urea (46%N) * Abu-Freaiwa	15.27 a	14.62 bcd	14.95 bcd
Urea (46%N) * Kamleen	17.45 a	23.34 a	20.40 a
Urea (46%N) * Texas Early Yellow Grano	7.85 a	6.86 ef	7.36 f
Organic (Elshmokh) * Baftaim (S)	14.84 a	13.48 bcd	14.16 bcde
Organic (Elshmokh) * Saggai lmproved	15.70 a	15.15 bc	15.42 bcd
Organic (Elshmokh) * Abu-Freaiwa	15.82 a	13.23 bcd	14.52 bcde
Organic (Elshmokh) * Kamleen	16.70 a	15.37 bc	16.03 bc
Organic (Elshmokh) * Texas Early Yellow Grano	7..82 a	7.13 ef	7.47 f
NPK (15:15:15) * Baftaim (S)	13.77 a	12.25 bcd	13.01 de
NPK (15:15:15) * Saggai lmproved	14.96 a	16.86 b	15.91 bc
NPK (15:15:15) * Abu-Freaiwa	16.66 a	16.22 b	16.44 b
NPK (15:15:15) * Kamleen	16.35 a	15.27 bc	15.81 bc
NPK (15:15:15) * Texas Early Yellow Grano	6.87 a	7.69 ef	7.28 f
Ammonium sulphate (21%N&24%S) * Baftaim (S)	12.72 a	16.24 b	14.48 bcde
Ammonium sulphate (21%N&24%S) * Saggai lmproved	14.84 a	15.40 bc	15.12 bcd
Ammonium sulphate (21%N&24%S) * Abu-Freaiwa	15.71 a	14.06 def	13.12 de
Ammonium sulphate (21%N&24%S) * Kamleen	16.66 a	14.92 bcd	15.79 bc
Ammonium sulphate (21%N&24%S) * Texas Early Yellow Grano	8.21 a	6.40 f	7.30 f
SE±	0.637	1.344	0.735
C.V.%	7.9	17.7	18.5

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letter (s) in the same column are not significant difference at P=0.05 according to DMRT.

IV. DISCUSSION

A. Vegetative growth:

The variation in plant growth among cultivars may be depending on genetic makeup's. These results confirmed by many researchers, [11], [12], [13] and [14] reported that onion cultivars varied in plant growth characters (plant height and number of leaves). Also in Sudan [15] reported significant variation among local cultivars in plant growth characters. Also [15] stated marked variation among introduced and local cultivars; Baftaim (S) has vigorous growth characters (plant height and leaf length).

B. Yield and yield components:

The variations in yield and yield components (total yield, marketable yield and doubled bulbs percentages) varied markedly among introduced and local cultivars.

High total yield per hectare was attained by Baftaim (S) and Texas Early Yellow Grano compared to local cultivars. Kamleen ranked the second and local cultivars Saggai Improved and Abu-Freiawa reflected the lowest total and marketable yield. Texas Early Yellow Grano gave the lowest double bulbs percentages, whereas local cultivar Saggai Improved attained the highest percentage. The significant differences among cultivars perhaps may be to genetic variations or due significant performance in some other traits such as plant height, number of leaves and other growth characters.

These findings agree with [17] who observed significant differences with respect to total and marketable yield among onion cultivars and [18] reported that marketable yield was significantly varied among onion cultivars, whereas [12] and [10] were found that total and marketable yield and double bulbs weight differed markedly among onion cultivars. Also these results agree with [18] and [13] who reported significant variations in yield, marketable and unmarketable (double and early bolters) yield among onion cultivars. Similar results were found by [20], [21], [22], [23] and [24] who reported that onion cultivars varied significantly in bulb yield and quality. [25] observed variations in bulb yield among introduced and local cultivars, some of introduced cultivars has a potential and out -yielded the local cultivars.

Results reported here indicated that there were variations among introduced and local cultivars, these finding confirmed with Sudanese studies. [26], [16] and [27] found that cultivar Baftaim (S) out- yielded other introduced and local cultivars with respect to total and marketable yield. Also the cultivar Baftaim (S) gave the lowest un-marketable yield (doubles and bolted bulbs) compared to other cultivars, whereas the local cultivar Abu-Feriawa had the lowest total and marketable yield and the highest un-marketable yield. [15] reported marked variations in total, marketable and un-marketable yield among some Sudanese local cultivars.

C. Onion Bulb quality:

As shown in the results significant variations were detected among onion cultivars in physical characters (single bulb fresh weight, bulb diameter and bulb length) of onion bulbs, Texas Early Yellow Grano attained the highest physical characters.

The variations in physical characters among onion cultivars agree with the findings reported by [11], [25], [12], [13] and [18] they reported significant variations in single bulb weight. Also these

results agree with some Sudanese studies; [27] and [16] reported that Baftaim (S) had the heaviest bulbs and maximum bulb diameter. [15] found that the cultivar Kamleen produced heaviest bulbs and maximum bulb diameter than other local cultivars.

The dry matter content varied among local and introduced cultivars, local cultivars recorded the high percent than introduced cultivars Baftaim (S) and Texas Early Yellow Grano the medial and low percentage of dry matter content, respectively. These results agree with many researches, dry matter in onion bulbs varies from low levels (7-10%) to high levels (15-20 %). Onion with high dry matter (≥ 20%) is preferred for processing [25]. In Sudan, [16] reported that dry matter percentage varied significantly among local and introduced cultivars, the highest dry matter was attained by Abu-Freaiwa (24%) while Baftaim Improved -1 attained Kamleen and Saggai Improved 18% and 14%, respectively.

V. Conclusions

From the results obtained of study, the following conclusions can be drawn:

1- Cultivars Baftaim (S) and Kamleen have the highest vigor growth; they were the tallest and high plant length and maximum number of leaves per plant 90 days after transplanting.
2- The highest total and marketable yield per hectare obtained by cultivars Baftaim (S) and Texas Early Yellow Grano, while the lowest percentage of doubled bulbs recorded by Texas Early Yellow Grano followed by Baftaim (S).
3- Texas Early Yellow Grano was the highest in physical characters (single bulb fresh weight, bulb diameter and bulb length).
4- Cultivar Kamleen recorded the highest percentage of dry matter content, while Texas Early Yellow Grano gave the lowest percentage.
5- There were significant effects due to fertilizers on all studied parameters except number of leaves.
6- Interactions Baftaim (S) with urea and Texas Early Yellow Grano with ammonium sulphate obtained the highest total yield per hectare, also Grano with organic the highest marketable yield per hectare.
7- The highest dry matter content gave by the interaction of cultivar Kamleen with urea.

BIBLIOGRAPHY

[1] Mishu, H. M., Ahmed, F., Rafii, M. Y., Golam, F. and Latif, Md. A. (2013). Effect of sulphur on growth, yield and yield attributes in onion (*Allium cepa* L.). *Australian Journal of Crop Science*. **7** (9): 1416-1422.
[2] Farooq, M., Shah, A. H., Malik, A. A., Ali, N., Khan, U., Majid, A. and Ahmed, H. (2015). Nutrient management for improving onion productivity. *American-Eurasian Journal of Agricultural and Environment Science*. **15** (2): 220-225.
[3] Brown, R. and Leclaire-Conway, N. (2014). Effect of sulfur amendments on yield and quality in alliums. University of Rhode Island, Rhode Island Agricultural Experiment Station Bulletin, College of the Environment and Life Sciences.
[4] FAOSTAT. (2019). Food and Agriculture Organizations.
[5] Nourai, A. H. (2005). Studies on onion production in northern Sudan. Effects of sowing date, nitrogen nutrition and watering regime on yield, quality and storage of the red onion (*Allium cepa* L.) variety "Saggai Improved". A paper submitted to the 38 Crop Husbandry Committee, Agricultural Research Corporation, Wad Medani, Sudan.
[6] Siddiquee, M. S. H., Rahim, M. A. and Mohiuddin, K. M. (2008). Effects of potassium on growth and yield of two summer onion varieties. *Journal of Agro forestry and Environment*. **2**(1): 1-6.

[7] Faruq, M. O., Alam, M. S., Rahman, M., Alam, M. S. and Sharfuddin, A. F. M. (2003). Growth, yield and storage performance of onion as influenced by planting time and storage condition. *Pakistan Journal of Biological Sciences*. **6** (13): 1179-1182.

[8] Lee, J., Ha, I., Kim, H., Choi, S., Lee, S., kang, J. and Boyhan, G. E. (2016). Regional differences in onion bulb quality and nutrient content, and the correlation between bulb characteristics and storage loss. *Korean Journal of Horticultural Science and Technology*. **34**(6): 807-817.

[9] Al-Fraihat, A. H. (2009). Effect of different nitrogen and sulphur fertilizer levels on growth, yield and quality of onion (*Allium cepa* L.). *Jordan Journal of Agricultural Science*. **5**: (2). pp. 155-166.

[10] Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research second edition, John Wile and Sons. Inc. New York, pp: 680.

[11]Dawar, N. M.; Wazir, F.K.; Dawar, M. D. and Dawar, S. H. (2007). Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar. *Sarhad Journal of Agriculture*, **23**(4):911-9118.

[12] Geries, L. S. M.; Elgizawy, E. S.; Abo-Dahab, A. M. A. and Karam, S. S. (2012). Productivity and quality of two onion cultivars under organic, slow release and mineral fertilizers. *Journal of plant production, Mansoura University*. **3**(5): 835-846.

[13] Mousa, A. A. M. (2015). Control of doubling and early bolting Bulbsof onion genotypes by sizes of sets and irrigations systems. *Life Science Journal*, **12** (1):61-74.

[14] Ghaffoor, A. M. S.; Jilani, G.; K. and Waseem, K. (2003). Effect of different NPK levels on the growth and yield of three onion varieties. *Asian Journal Plant Science*, **2**: 342-346.

[15] Eltayeb, M. A. (2006). Evaluation and characterization of six Sudanese onion cultivars. M.Sc. Thesis, Khartoum University.

[16] Idriss, H. A. (2007). Evaluation of some introduced and Sudanese onion genotype (*Allium cepa* L.) for bulb yield, quality and storability. M.Sc. Thesis, Sudan Academy of Science.

[17] Benti, G. (2017). Influence of nitrogen rate and varieties on storage periods on onion (*Allium cepa* L.) in fedis district, eastern Ethiopia. *International Journal of Information Research and Review*. **04**:4097-4105.

[18] Gautam, I. P.; Khatri, B. and Paudel, G. P. (2006). Evaluation of different varieties of onion and their transplanting times for off-season production in Mid Hills of Nepal. *Nepal Agriculture Research*. **7**:21-26.

[19] Jillani, M. S., Ghaffoor, A., Waseem, K. and Farooqi, J. I. (2004).Effect of different levels of nitrogen on growth and yield of three onion varieties. *International Journal of Agricultural Biology*. **6** (3):507-510.

[20] Pakyurek, Y.; Abak, K.; Sari, N.; Guler, h. Y.; Babik, I. and Rumpel, J. (1994). Effect of sowing dates and plant densities on the yield and quality of some onion varieties in Southeast Anation. 7th international symposium on timing Heled production of vegetative Skerniewice, Poland, 23-27 August *Acta Horticulturae*; **371**: 209-214.

[21] Rumpel, J. and Felezynski, K.(1997). Effect of plant density and cultivar on yield responses in onion (*Allium cepa* L.) grown from seeds. *Acta Agrobotaniea*. **50**(1-2):221-229.

[22] Singh, S. R. and Sachan, B. P. (1999). Evaluation of different bulb size, spacing and varieties for higher seed yield and yield attributing traits on onion (*Allium cepa* L.). *Crop Research Hisar*.**17** (3):351-355.

[23] Rumpel, J.; Felezynski, K.; Stoffella, P. J.; Cantliffe, D. J. and Donialo, G. (2000). Effect of plant density on yield and bulb size of direct sown onions. 8th international symposium on liming of field production in vegetative crops, Bari, Italy. *Acta Horticulture*. **533**:179-185.

[24] Vanparys, L. (1999). Onions. Winter cultivation of onion for harvesting as ripe onions. Proeftuinnieuws. **9** (16):33-34.

[25] Kimani, P. M.; Peters, K. R. and Rabinowitch, H. D. (1993). Influence of the environment on the performance of some onion cultivars in Kenya. African *Crop Science Journal*, **1**(1):15-23.

[26] Mohamedali. G. H. (2007). A proposal for the release of Baftaim (S) as a high yielding red onion (*Allium cepa* L.) in Sudan submitted to the: Variety Release Committee.

[27] Ali, A. M.; Abdel Rahim, A. O. S. and Mohammedali, G. H. (2010). Effect of inter and intra row spacing on yield and quality of two onion cultivars grown under Kassala and Gash conditions. A paper submitted to the Crop Husbandry Committee, Agricultural Reseaporation, Wad Medani, and Sudan.

Annex (I): Monthly mean maximum and minimum air temperature (C°), relative humidity (%) and rainfall at Shambat during growing seasons 2015/16 and 2016/17:

Months	2015/16				2016 /17			
	Mean temperature (C°)		Relative humidity (%)	Rain fall (mm)	Mean Temperature (C°)		Relative humidity (%)	Rain fall (mm)
	Max.	Min.			Max.	Min.		
November	34.1	20.5	27	0.0	36.0	21.4	31	0.0
December	28.7	14.2	31	0.0	33.4	17.5	34	0.0
January	30.4	12.6	32	0.0	34.2	16.7	30	0.0
February	33.3	15.7	29	0.0	31.6	14.9	23	0.0
March	38.9	19.2	21	0.0	36.6	17.6	18	0.0
April	40.9	21.4	19	0.0	40.9	24	17	TR
May	42.8	26.0	24	1.0	41.6	26.3	28	5.3
June	41.5	26.2	31	TR	42.4	26.4	30	1.5
July	37.9	25.6	47	72.5	39.9	26.5	42	40.4

Source: Ministry of Environment, Forestry and Physical Development Meteorological Authority Weather – climate data. Shambat Metrological Station.

Annex (II): Analysis of field soils at different depth:

Depth	pH paste	ECe	Soluble Cations Meq /L			SAR	Soluble Anion Meq /L		
			Na	K	Ca+ Mg		CO3	HCO3	CI
0-30	7.8	0.88	4.5	0.3	4.0	3	0.0	1.2	0.6
30-60	7.9	0.79	4.6	0.3	3.1	4	0.0	1.3	0.6

Depth (cm)	O.C %	N %	P Ppm	Ex. Ch.Cations Meq /100g			CEC Meq/100g	ESP	CaCo3	Texture%			Saturation %
				Na	K	Ca+Mg				Clay	Silt	Sand	
0-30	0.4	.0.05	8	12.3	2.3	42.4	57	22	4	53	19	28	65
30-60	-	-	-	15.8	1.8	32.4	50	32	5	61	17	22	67

***Annex (III): Compost Elshomokh Analysis*:**

Humidity	31
Ph	7.65
ECe	1.7
Ca%	4
Pass Particale 2mm	53.27
Mg%	3
Na%	3
K%	5.27
P%	2.05
O.C%	26
O.M%	44.7
N%	1.4
C/N	18.8
Cu ppm	0.536
Fe ppm	149.725
Mn ppm	4.953
S ppm	141.773

Data source: Project of Shomokh Eltabya Organic fertilizer factory.