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Effect of Sustainability of Sudan Grass Genotypes for Water Irrigation Deficiency on Yield and its Component

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ABSTRACT

Two water regimes were applied (control) irrigated every 15 days and irrigated every 30 days. The results showed that water stress and genotypes had significantly affected drought tolerance. The highest genotypes estimate of drought tolerance indices were Giza 1 and Giza 2 which its water stress at 30 days in the two summer seasons 2019 and 2020 respectively. While the lowest one was genotype IS 3382. There was a wide range of drought tolerance among the twenty-one tested genotypes. Correlation among forage yield components indicated that fresh forage yield was positively correlated with all forage yield components under normal and water stress. Dry forage yield was positively correlated with all forage yield components under normal and water stress. Path analysis revealed that dry forage yield exhibited the highest positive direct effect on fresh forage yield as well as showing significant and positive correlation with fresh forage yield. Stem diameter showed the highest negative direct effects on fresh forage yield which was followed by plant height. The results concluded that Sudan grass tolerance the drought at 30 days and the best yield obtained by genotype Giza 1. The genotype Giza 1 followed by the genotype Giza 2 gave the highest tolerance to water stress, while the genotype MV1 followed by the genotype IS 3382 gave the highest sensitivity to the lack of irrigation water periods for Sudan grass under the conditions of this study.

***Keywords*:** Sudan grass, water deficit, abiotic stress, correlation, path coefficient, cluster analysis.

INTRODUCTION

Decrease in productivity in summer forage crops in Egypt (Semi-arid environment) mainly resulting from rain fall decline and drought. Water deficit stress is considered as one of the most important environmental stresses which is more harmful to strategic crops, as it reduces the final crop yield by up to 40%. Drought is a complex phenomenon and it's considered one of the most important factors limiting crop yields in Egypt. Thus, it resulted in increased vulnerability of smallholder farmers in marginal areas of Egypt, where there is limited capacity to adapt or transform to climate-smart agriculture.

In recent years, the interest in this crop is growing globally since sustainable yields can be produced in the condition of water deficit and high temperature stress (Swith and Frederiksen 2000).

Sudan grass forage yield is one of the most important fodder crops due to its high nutritive value and relatively few input requirements (Torrecillas *et al.* 2011). It can be harvested as pasture, green chop, hay or silage. It can be ready for harvest in about 45 days after planting. Sudan grass can be grazed any time after the plant has reached a height of 18 inches which is usually 5 to 6 weeks after planting. To avoid HCN poisoning Sudan grass should not be pastured until it is 45-60 cm high (Khurd *et al.* 2018). This crop has a higher green yield and can resist arid climatic conditions (Sowinski and Szydelko, 2011). Water scarcity has demanded drought tolerant cultivars of all cultivated crops (Ali *et al*., 2011b, c). Forage sorghum [*Sorghum bicolor* (L). Moench] has become popular crop of water deficient areas of the world where most of the farmer's earnings has obtained through products of live stocks (Mohammed and Maarouf, 2009, Tariq *et al.* 2012).

Drought can be defined as the absence of adequate moisture necessary for plant to grow normally and complete its life cycle (Moosavi *et al*. 2011). Drought stress is one of the most important abiotic factors in reducing the growth, development and production of crops.

Drought stress reduces both nutrients uptake by the roots and their transport from root to the shoat, due to restricted transpiration rates and impaired active transport and membrane permeability.

The application of various irrigation strategies with improved drought stress (Beis and Patakas 2015). The greatest impression of this water stress is forecast on field crops (Alghabari *et al.* 2016). Sudan grass has several characteristics that make it well adapted to water shortages. It has waxy bloom on smaller leaf area, twice as many secondary roots per unit of primary root. These characterizes make Sudan grass a suitable emergency forage source to fill the feed shortage gap during the lean summer period in arid and semi-arid regions (Elward, *et al.*, 2016).

The decreasing supply of irrigation water has increased its cost, so, to remain viable, dairy farmers need to adapt new strategies to improve the water productivity of both irrigated and rain agriculture fodder feed for farm animals has been vigorously increased for animal production (Al-Solimani *et al.* 2017). Water deficit reduces productivity to the level up to 40–50% (Tawfik and El-Mouhamady 2019).

The diversity of varieties expresses a wide range of adaptability to different environments, different genotypes from early to late maturing and dwarf to tall Water scarcity and an increase in demand are predicted in the future (Al-Solimani *et al.* 2017). It is expected that in irrigated

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agriculture, forage crops will face severe drought stress as their vegetative growth is totally depended on moisture availability. In the future, a greater incoming challenge will be to increase forage production with decreased irrigation supply (Bazitov, 2020).

Climate change has serious negative effects on water resources (Gonulal, 2020).

Among the environmental water stress (drought) abiotic drought is one of the most severe stresses for plant growth and productivity. Water stress affects virtually every aspect of plant morphology, physiology and metabolism.

Considering the gradual shortage in freshwater resources and increasing demand for forage in the dairy industry the current experiment was designed to evaluate some genotypes Sudan grass under water stress condition.

The general objectives of this study were:

1- to estimate the drought effects of water stress by selecting some deficit irrigation scheduling practices on drought tolerance of twenty- one Sudan grass genotypes,and

2- to select the best genotype for droughts tolerant.

MATERIALS AND METHODS

The present study was conducted on the experimental farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt (31° 05´ 20.43″ N and 30° 56´ 9.29″ E).

The main objective of that recent study was to screen twenty-one Sudan- grass (*Sorghum bicolor var sudanense*) with respect to drought tolerance. Origin and source of the examined genotypes were presented in Table 1.

Table 1. Sudan grass genotypes, Origin and Source

No.	Genotype	Origin	Source
B1	Giza 1	Egypt	Forage Breeding Program ARC
B2	Giza 2	Egypt	Forage Breeding Program ARC
B3	Serw 1	Egypt	Forage Breeding Program ARC
B4	Serw 3	Egypt	Forage Breeding Program ARC
B5	Piper black	Egypt	Forage Breeding Program ARC
B6	Sids 1	Egypt	Forage Breeding Program ARC
B7	Sids 2	Egypt	Forage Breeding Program ARC
B8	Sids 3	Egypt	Forage Breeding Program ARC
B9	Selected 15	USA	USA
B10	Sudan grass	FAO	United Nation
B11	Pioneer malcp	FAO	United Nation
B12	IRAT 204	FAO	United Nation
B13	MVI	Australia	Australia
B14	Port Said	Egypt	Forage Breeding Program ARC
B15	IS 3112	Indian	ICRISAT
B16	IS 3191	Indian	ICRISAT
B17	IS 3192	Indian	ICRISAT
B18	IS 3193	Indian	ICRISAT
B19	IS 3203	Indian	ICRISAT
B20	IS 3214	Indian	ICRISAT
B21	IS 3382	Indian	ICRISAT

Growing season was confined to 129 days. Drought was expressed by irrigation intervals. Two irrigation intervals were used. There were every 15 days (6 irrigation/ season) and every 30 days (3 irrigation/ season). Experiments were conducted during the summer seasons of 2019 and 2020. A split – plot design was adopted with three replicates. Irrigation treatments were assigned to the main-plot, whereas Sudan-grass genotypes were – the sub-plots.

Sowing dates were the 20th of May and the 22nd of May for the first and the second seasons, respectively. Sub-plot area was 1.8 m2 (one ridge, three meter long and 0.60 meter apart. Seeding rate was 20 kg. faddan^{-1}, on hills at 12.5 cm apart. Super- phosphate (15.50 % P2O5) was applied at the rate of 100 kg. faddan^{-1}, during soil preparation. Nitrogen was applied as ammonium nitrate (33.5% nitrogen/ as 60 kg. faddan^{-1} at three settlements, for each studied cutting. Three cutting were harvested at 45, 87 and 129 days from sowing.

Used water for irrigation was estimated by the following equation

$$\text{Water quantity} = \frac{ETc}{Irrigation\ system\ efficiency}$$

ETc = Crop evapotranspiration, mm period^{-1},

Kc = Crop coefficient as quoted from standard tables (FAO, 1998 Irrigation & Drainage paper No. 56)

$$ETc = ETo * Kc$$

$$ETo = Ep * Kp$$

Where: ETo = Reference evapotranspiration, Ep = Pan evaporation, and Kp = The area coefficient of the pot is approx. = 0.8

Productivity of irrigation water (PIW) was calculated according to Ali *et al.*, (2007).

$$PIW = \frac{Y}{IW}$$

Where: PIW= productivity of irrigation water (kg m^{-3}),

Y= Yield (sum yields of first cut, second cut and third cut, kg), and IW; Irrigation water applied (m^3).

The agro-meteorological data of Sakha Experimental Station for the two growing season were presented in Table 2.

Table 2. The meteorological data of Sakha Area Agro-meteorological Station in 2019 and 2020 seasons.

Season	Month	Mean Air temperature (C°)	Mean Relative humidity(%)	wind sped m.sec^{-1}	Pan Evap. mm/month	Rain, mm/month
2019	May	28.3	57.2	0.79	6.8	0.00
	June	30.0	65.7	1.19	8.5	0.00
	July	30.9	70.5	0.97	9.4	0.00
	Aus.	31.7	70.8	0.80	6.8	0.00
	Sep.	30.2	68.2	0.89	5.9	0.00
	Oct.	28.5	70.8	0.66	3.8	0.00
2020	May	27.9	53.7	1.32	7.7	0.00
	June	28.2	60.3	1.29	8.4	0.00
	July	30.5	67.7	1.18	8.3	0.00
	Aus.	31.4	67.5	1.07	8.0	0.00
	Sep.	30.9	68.2	1.08	6.2	0.00
	Oct.	26.8	68.5	0.64	3.4	0.00

Source: Agro-climatological Station at Sakha Agricultural Research Station.

Physical and Chemical properties of the experimental site were taken before sudan- grass cultivation presented in Tables (3 and 4) as mean values in both growing seasons as described by (klute 1986 and Jackson 1973). The texture of the experimental field soil is Clay.

Table 3. Some physical properties of the studied site before cultivation.

Soil depth, cm.	Particle size distribution			Texture Classes	Soil field capacity %	Permanent wilting point %	Available water%	Soil bulk density Mg/m³
	Sand%	Silt %	Clay %					
0 – 30	17.7	22.2	60.1	Clay	45.3	24.6	20.7	1.17
30 – 60	19.3	24.0	56.7	Clay	39.1	21.3	17.9	1.26
Mean	18.5	23.1	58.4	Clay	42.2	23.0	19.3	1.22

Table 4. Some chemical properties of the studied site before cultivation.

Soil depth, Cm	Ec ds/m	PH 1: 2.5 soil water suspension	Soluble ions meq/l							
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO3^{-}$	HCO3⁻	Cl^{-}	SO4⁻
0-30	4.51	8.09	12.0	7.5	17.1	8.8	0.00	5.8	16.1	23.4
30-60	5.11	8.02	16.4	6.1	15.3	8.6	0.00	5.4	15.7	30.1
Mean	4.81	----	14.2	6.8	16.2	8.7	0.00	5.6	15.9	26.8

Note: SO4⁻ was determined by the difference between soluble cations and onions.

Statistical analysis

Data were statistically analyzed according to (Gomez and Gomez 1984). MSTAT Computer V4 (1986). Test of homogeneity of error was performed before combined analysis of the two seasons according to (Bartlett' s, 1937). Least significant difference (LSD) was used at 5 % level of probability as described by (Snedecor & Cochran 1980).

RESULTS AND DISCUSSION

Fresh and dry forage yield

Main effects of irrigation intervals Sudan- grass genotypes and their interaction were presented in Table 5.

Table 5. The impact of irrigation period on fresh and dry forage yields of Sudan grass over the two seasons.

Treatment		fresh forage yield (kg/plot)				Dry forage yield (kg/plot)			
		cut1	cut2	cut3	total	cut1	cut2	cut3	total
Irrigation periods (A)	A1	12.21	10.78	9.53	32.52	1.398	1.342	1.311	4.050
	A2	9.19	7.88	6.45	23.53	1.141	1.063	0.939	3.144
F test		**	**	**	**	**	**	**	**
LSD 0.05		0.16	0.38	0.15	0.51	0.001	0.048	0.022	0.059
Sudan grass genotypes (B)	B1	14.23	11.65	9.47	35.35	1.820	1.628	1.419	4.867
	B2	13.81	11.66	8.88	34.35	1.771	1.530	1.300	4.601
	B3	13.06	11.24	8.97	33.27	1.586	1.519	1.347	4.453
	B4	12.63	10.40	9.26	32.29	1.540	1.355	1.362	4.257
	B5	12.24	10.59	8.75	31.57	1.455	1.345	1.236	4.036
	B6	12.03	9.60	8.70	30.33	1.447	1.247	1.258	3.953
	B7	9.76	8.72	7.60	26.08	1.144	1.094	1.036	3.274
	B8	10.06	8.17	7.39	25.62	1.180	1.045	1.008	3.233
	B9	11.22	9.82	8.72	29.76	1.314	1.290	1.257	3.861
	B10	11.17	8.89	7.39	27.46	1.278	1.136	1.109	3.523
	B11	9.73	8.60	7.27	25.61	1.139	1.108	1.031	3.278
	B12	9.17	8.35	7.09	24.61	1.087	1.045	0.963	3.095
	B13	8.61	7.81	6.80	23.22	0.937	0.969	0.905	2.811
	B14	11.27	9.52	8.47	29.26	1.381	0.251	1.178	3.809
	B15	11.08	9.27	8.53	28.88	1.282	1.199	1.170	3.651
	B16	9.73	9.08	7.75	26.57	1.150	1.167	1.061	3.377
	B17	9.62	8.75	7.52	25.90	1.130	1.104	1.014	3.253
	B18	8.77	8.32	7.27	24.35	1.001	1.042	0.981	3.023
	B19	9.06	8.65	7.50	25.21	1.033	1.072	1.027	3.131
	B20	8.74	8.33	7.49	24.56	0.999	1.038	1.023	3.060
	B21	8.76	8.50	7.02	24.28	0.982	1.067	0.942	2.990
F test		**	**	**	**	ns	**	**	**
LSD 0.05		0.11	0.10	0.10	0.17	-	0.017	0.017	0.029
A*B	A1B1	15.79	12.83	10.15	38.78	1.903	1.707	1.445	5.056
	A1B2	14.75	12.27	10.08	37.09	1.795	1.505	1.406	4.706
	A1B3	14.54	11.90	10.23	36.67	1.692	1.517	1.550	4.759
	A1B4	13.96	11.17	9.96	35.08	1.646	1.382	1.440	4.467
	A1B5	13.21	11.01	10.12	34.34	1.482	1.308	1.385	4.175
	A1B6	13.32	10.17	9.41	32.89	1.554	1.272	1.325	4.151
	A1B7	11.76	10.42	9.50	31.67	1.345	1.275	1.251	3.872
	A1B8	11.93	10.25	9.42	31.59	1.371	1.260	1.267	3.898
	A1B9	12.21	10.50	9.63	32.33	1.360	1.359	1.332	4.051
	A1B10	12.72	10.45	9.14	32.30	1.400	1.284	1.359	4.043
	A1B11	11.97	10.30	8.94	31.21	1.365	1.297	1.238	3.900
	A1B12	11.28	10.50	8.96	30.75	1.305	1.275	1.202	3.782
	A1B13	10.68	9.71	8.79	29.19	1.130	1.177	1.156	3.463
	A1B14	12.43	10.52	9.53	32.47	1.503	1.354	1.296	4.152
	A1B15	12.90	10.75	9.54	33.19	1.460	1.366	1.286	4.112
	A1B16	10.84	10.45	9.36	30.65	1.248	1.296	1.253	3.797
	A1B17	10.52	10.38	9.65	30.55	1.200	1.293	1.279	3.772
	A1B18	10.47	10.15	9.68	30.29	1.161	1.240	1.289	3.690
	A1B19	10.91	10.81	9.49	31.20	1.202	1.317	1.285	3.804
	A1B20	9.56	10.75	9.65	29.95	1.060	1.325	1.302	3.687
	A1B21	10.79	11.05	8.97	30.80	1.173	1.368	1.180	3.720
	A2B1	12.67	10.48	8.78	31.93	1.738	1.549	1.393	4.679
	A2B2	12.88	11.05	7.68	31.61	1.747	1.554	1.194	4.495
	A2B3	11.58	10.58	7.71	29.88	1.480	1.552	1.144	4.146
	A2B4	11.29	9.64	8.57	29.50	1.434	1.328	1.284	4.047
	A2B5	11.28	10.17	7.37	28.81	1.428	1.383	1.086	3.897
	A2B6	10.75	9.03	8.00	27.77	1.341	1.223	1.191	3.755
	A2B7	7.77	7.03	5.70	20.49	0.942	0.914	0.820	2.676
	A2B8	8.20	6.08	5.36	19.64	0.988	0.830	0.750	2.568
	A2B9	10.23	9.14	7.81	27.18	1.268	1.220	1.182	3.670
	A2B10	9.63	7.34	5.64	22.62	1.156	0.989	0.858	3.003
	A2B11	7.50	6.90	5.61	20.01	0.913	0.919	0.824	2.656
	A2B12	7.05	6.20	5.22	18.47	0.869	0.815	0.725	2.409
	A2B13	6.53	5.90	4.82	17.25	0.743	0.760	0.655	2.159
	A2B14	10.11	8.53	7.41	26.05	1.259	1.147	1.060	3.466
	A2B15	9.27	7.78	7.52	24.57	1.104	1.032	1.053	3.190
	A2B16	8.63	7.72	6.14	22.49	1.052	1.037	0.869	2.958
	A2B17	8.73	7.12	5.40	21.25	1.071	1.914	0.749	2.735
	A2B18	7.07	6.48	4.86	18.41	0.841	0.844	0.673	2.357
	A2B19	7.22	6.50	5.50	19.22	0.863	0.826	0.768	2.457
	A2B20	7.92	5.92	5.33	19.16	0.938	0.752	0.745	2.434
	A2B21	6.73	5.95	5.08	17.76	0.971	0.765	0.703	2.260
F test		**	**	**	**	**	**	**	**
LSD 0.05		0.40	0.37	0.36	0.62	0.063	0.063	0.063	0.108

**** and ns; Highly significant at 0.01 level probability and non- significant of level probability.**

Over irrigation treatment, the B1 (Giza 1) genotype significantly enjoyed the highest total fresh forage yield of 35.35 $kg.plot^{-1}$, followed by the genotype B2 (Giza 2) with value of 34.35 kg. $plot^{-1}$. Superiority, of B1 (Giza 1) genotype was also expressed by total dry forage yield of 4.867 kg. $plot^{-1}$ followed by B2 genotype (Giza 2) with value of 4.601 kg. $plot^{-1}$. B3 and B4 genotypes represented significantly the third and the fourth studied sudan- grass genotypes, significantly expressed less than 30 kg.plot-1 fresh forage and less than four kg.plot-1 dry forage yield.

Both of B1 (Giza 1) and B2 (Giza 2) with irrigation regime A1 significantly expressed the highest fresh and dry forage yields 38.78 and 37.09 fresh forage kg. $plot^{-1}$ and 5.056 and 4.706 dry forage (kg. $plot^{-1}$) for the former and the latter, respectively. Whereas, the two genotypes significantly maintained superiority of dry forage yield scoring 31.93 and 31.61 $kg.plot^{-1}$ fresh forage and 4.679 and 4.495 $kg.plot^{-1}$ dry forage with irrigation regime A2 (every 30 days). The magnitude of significant reduction in fresh and dry forage yields of other studied sudan-grass genotypes due to changing irrigation regime from frequent (A1, each 15 days) to infrequent (A2, each 30 days) were about 1.5 folds, the reduction obtained with superior genotypes B1 (Giza1) and B2 (Giza 2).

The significance superiority of short irrigation interval (A1) every 15 days expressed by fresh forage yield, amounted to 32, 37 and 47 % for the three successive over the respective fresh forage yield of spaced irrigation intervals (A2) every 30 days as a total fresh yield, frequent irrigations (every 15 days) surpassed infrequent irrigations (every 30 days) by about 38 % more yield, dry forage yields for frequent irrigation regime (A1) significant surpassed those recorded for infrequent irrigation (A2) by 22.5, 26.3 and 39.6 % for the three successive cuttings, respectively. Over all, cutting the total dry forage of (A1) irrigation, significantly surpassed the corresponding yield of (A2) irrigation by 28.8 % Table 6.

Table 6. Reduction percentage of fresh and dry forage yields affected by irrigation periods for Sudan grass genotypes over the two seasons.

Treatment	Fresh forage yields kg/ plot				Dry forage yields kg/ plot			
	cut1	cut2	cut3	total	cut1	cut2	cut3	total
A1 vs A2	32.9	36.8	47.8	38.2	22.5	26.2	39.6	28.8
B1 vs B13	65.3	49.2	39.2	52.2	94.2	68.0	56.8	73.1
A1B1 vs A1B13	47.8	32.1	15.5	32.9	68.4	45.0	25.0	46.0
A2B1 vs A2B13	94.0	77.6	82.2	85.1	133.9	103.8	112.7	116.7

The percentage of reduction in fresh and dry forage yields in Sudan grass over two seasons can be shown in (fig 1).

The aforementioned results suppose that Sudan – grass genotypes Giza 1, Giza 2 and Serw 1 might be tolerant to infrequent irrigation regime (every 30 days). In the meantime, the recent results indicated that genotypes vary in the level of tolerance to watering pattern. Abd El- Maksoud *et al.*, 1998 and Abd El-Twab and Rashed, 1985 presented similar results with Rady 2018.

Quantity of applied water during each of the studied irrigation regimes were presented in Table 7.

Infrequent irrigation regime applied about 84.0 % of the quantity applied infrequent irrigation regime (3975.4 vs 4727.1 m3. Faddan-1, as an average of the two study seasons)

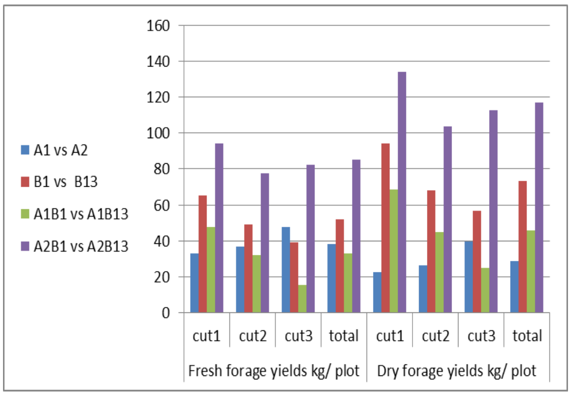


Fig. 1. Reduction percentage of fresh and dry forage yields affected by irrigation water period for over two seasons

Table 7. Quantities of applied irrigation water (m3. $Faddan^{-1}$) during the two seasons of the study and as an average over the two years.

Irrigation regime	Applied water ($m^3 fed^{-1}$)					
	2019 Season		2020 Season		over the two seasons	
	Cm	$m^3 fed^{-1}$	Cm	$m^3 fed^{-1}$	cm	$m^3 fed^{-1}$
Frequent 15 days	110.2	4626.8	114.9	4824.2	112.6	4727.1
Infrequent 30 days	94.2	3958.4	95.1	3995.6	94.7	3975.3

Data of fresh and dry forage yields were used to estimate productivity of applied irrigation water (PIW) Table 8. Under frequent irrigation regime (every 15 days) productivity of elite Sudan-grass genotypes (Giza 1, Giza 2 and Serw 1) were 19.14, 18.31 and 18.10 kg of fresh forage per cubic meter of applied water. The corresponding dry forage values were 2.50, 2.32 and 2.35 kg.m3 of applied water under infrequent irrigation regime (every 30 days). The intolerant Sudan-grass genotypes expressed about 14-15 kg fresh forage.m3 of applied water, along with 1.3 – 1.9 kg dry forage.m3 of applied water.

Superiority of B1 (Giza 1), B2 (Giza 2) and B3 (Serw 1) genotypes irrespective of the applied irrigation regime (15 days or 30 days regime) as might be due to physiological responses that were related to genetic make- up, which reflected tolerance to drought. Similar results were reported by Ejeta *et al.*, 2014, Afshar *et al.*, 2014 and Johanson *et al.*, 2014.

Plant characters

Regarding Table 9 revealed that highly significant effect in plant height and stem diameter by using irrigation periods.

Means of plant characters (plant height (cm) and stem diameter (cm) combined over seasons as affected by irrigation regime and sudan-grass genotype. Average of plant height and stem diameter over the three studied cuttings was reduced by about 8% due to infrequent irrigation regime (131.5 vs. 121.5 cm and 1.25 vs.1.16 cm for frequent (every 15 days) and infrequent (every 30 days) regimes. Also, genotypes B1 (Giza 1), B2 (Giza 2) and B3 (Serw 1) enjoyed the highest plant height over irrigation regimes (141.8, 138.6 and 136.0 cm, respectively.

This was also trac for stem diameter (1.32, 1.24 and 1.24 cm, respectively). The superior sudan grass genotypes (Giza 1, Giza 2 and Serw 3) significantly expressed the highest values of plant height and stem diameter when exposed to frequent irrigation regime. Plant height was much affected by infrequent irrigation rather than stem diameter indicating a responsive character. In addition to, when comparing (A1B1) with (A1B13) recorded the reduction percentage in plant height and stem diameter (32.3 and 10.8 %). Meanwhile (A2B1) comparing with (A2B13) observed reduction percentage (25.4 and 22.6 %) for plant height and stem diameter over the two seasons, respectively, Table 10.

The percentage of reduction in plant height and stem diameter in Sudan grass over two seasons can be shown in (fig 2).

Table 8. Productivity of irrigation water for fresh and dry forage yields.

Treatments		Over two years					
Irrigation period	Sudan grass genotypes	Total Fresh yield, kg fed $^{-3}$	Irrigation water quantities, m^3 fed^{-1}	PIW, kg m^{-3} fresh yield	Total Dry yield, kg fed $^{-3}$	Irrigation water quantities, m^3 fed^{-1}	PIW, kg m^{-3} dry yield
15 days	B1	90486.7	4727.1	19.14	11797.3	4727.1	2.50
	B2	86543.3	4727.1	18.31	10980.7	4727.1	2.32
	B3	85563.3	4727.1	18.10	11104.3	4727.1	2.35
	B4	81853.3	4727.1	17.32	10423.0	4727.1	2.20
	B5	80126.7	4727.1	16.95	9741.7	4727.1	2.06
	B6	76743.3	4727.1	16.23	9685.7	4727.1	2.05
	B7	73896.7	4727.1	15.63	9034.7	4727.1	1.91
	B8	73710.0	4727.1	15.59	9095.3	4727.1	1.92
	B9	75436.7	4727.1	15.96	9452.3	4727.1	2.00
	B10	75366.7	4727.1	15.94	9433.7	4727.1	2.00
	B11	72823.3	4727.1	15.41	9100.0	4727.1	1.93
	B12	71750.0	4727.1	15.18	8824.7	4727.1	1.87
	B13	68110.0	4727.1	14.41	8080.3	4727.1	1.71
	B14	75763.3	4727.1	16.03	9688.0	4727.1	2.05
	B15	77443.3	4727.1	16.38	9594.7	4727.1	2.03
	B16	71516.7	4727.1	15.13	8859.7	4727.1	1.87
	B17	71283.3	4727.1	15.08	8801.3	4727.1	1.86
	B18	70676.7	4727.1	14.95	8610.0	4727.1	1.82
	B19	72800.0	4727.1	15.40	8876.0	4727.1	1.88
	B20	69883.3	4727.1	14.78	8603.0	4727.1	1.82
	B21	71866.7	4727.1	15.20	8680.0	4727.1	1.84
30 days	B1	74503.3	3975.3	18.74	10917.7	3975.3	2.75
	B2	73756.7	3975.3	18.55	10488.3	3975.3	2.64
	B3	69720.0	3975.3	17.54	9674.0	3975.3	2.43
	B4	68833.3	3975.3	17.32	9443.0	3975.3	2.38
	B5	67223.3	3975.3	16.91	9093.0	3975.3	2.29
	B6	64796.7	3975.3	16.30	8761.7	3975.3	2.20
	B7	47810.0	3975.3	12.03	6244.0	3975.3	1.57
	B8	45826.7	3975.3	11.53	5992.0	3975.3	1.51
	B9	63420.0	3975.3	15.95	8563.3	3975.3	2.15
	B10	52780.0	3975.3	13.28	7007.0	3975.3	1.76
	B11	46690.0	3975.3	11.75	6197.3	3975.3	1.56
	B12	43096.7	3975.3	10.84	5621.0	3975.3	1.41
	B13	40250.0	3975.3	10.13	5037.7	3975.3	1.27
	B14	60783.3	3975.3	15.29	8087.3	3975.3	2.03
	B15	57330.0	3975.3	14.42	7443.3	3975.3	1.87
	B16	52476.7	3975.3	13.20	6902.0	3975.3	1.74
	B17	49583.3	3975.3	12.47	6381.7	3975.3	1.61
	B18	42956.7	3975.3	10.81	5499.7	3975.3	1.38
	B19	44846.7	3975.3	11.28	5733.0	3975.3	1.44
	B20	44706.7	3975.3	11.25	5679.3	3975.3	1.43
	B21	41440.0	3975.3	10.42	5273.3	3975.3	1.33

Table 9. Means of plant characters (plant height (cm) and stem diameter (cm) as an average of the two seasons as affected by irrigation regime and Sudan grass genotypes.

		plant height (cm)				stem diameter (cm)			
Treatment		**Cut1**	**Cut2**	**Cut3**	**Mean**	**Cut1**	**Cut2**	**Cut3**	**Mean**
Irrigation	A1	142.1	130.6	121.8	131.5	1.34	1.24	1.17	1.25
periods (A)	A2	132.4	121.4	110.6	121.5	1.23	1.17	1.08	1.16
F test		**	**	**		**	**	**	
LSD 0.05		1.3	1.1	1.0		0.04	0.03	0.03	
	B1	152.7	142.4	130.3	141.8	1.45	1.30	1.20	1.32
	B2	149.7	140.0	125.9	138.6	1.36	1.32	1.20	1.29
	B3	150.5	133.5	124.0	136.0	1.40	1.29	1.16	1.28
	B4	147.0	132.6	122.0	133.8	1.34	1.28	1.16	1.26
	B5	141.4	131.3	118.8	130.5	1.35	1.24	1.14	1.24
	B6	143.7	133.4	122.1	133.1	1.33	1.22	1.12	1.22
	B7	134.0	120.6	116.4	123.7	1.32	1.18	1.09	1.19
	B8	134.6	120.3	112.3	122.4	1.26	1.19	1.11	1.19
	B9	143.4	130.7	124.4	132.8	1.28	1.23	1.13	1.21
Sudan grass	B10	142.5	123.6	113.5	126.6	1.29	1.20	1.11	1.20
genotypes	B11	132.4	120.5	113.6	122.2	1.24	1.18	1.12	1.18
(B)	B12	125.1	118.1	109.5	117.6	1.20	1.16	1.09	1.15
	B13	115.2	109.9	104.7	109.9	1.19	1.13	1.07	1.13
	B14	141.3	129.5	120.0	130.3	1.30	1.21	1.14	1.21
	B15	138.6	126.4	115.9	127.0	1.27	1.22	1.14	1.21
	B16	137.6	130.2	113.5	127.1	1.26	1.18	1.14	1.20
	B17	135.7	121.3	113.1	123.3	1.25	1.19	1.13	1.19
	B18	131.4	118.1	108.6	119.4	1.21	1.14	1.10	1.15
	B19	130.7	122.3	111.3	121.4	1.22	1.17	1.13	1.17
	B20	129.8	122.0	112.1	121.3	1.22	1.16	1.12	1.17
	B21	124.6	119.5	108.9	117.7	1.20	1.15	1.08	1.14
F test		**	**	**		*	**	**	
LSD 0.05		1.0	0.5	0.6		0.03	0.02	0.01	
	A1B1	163.6	151.3	134.7	149.9	1.53	1.30	1.17	1.33
	A1B2	157.1	146.6	132.0	145.2	1.37	1.35	1.18	1.30
	A1B3	154.2	139.3	129.8	141.1	1.42	1.28	1.18	1.29
	A1B4	150.1	136.8	126.5	137.8	1.36	1.30	1.18	1.28
	A1B5	147.9	132.3	121.3	133.8	1.43	1.25	1.18	1.29
	A1B6	147.0	137.2	130.0	138.1	1.40	1.23	1.15	1.26
	A1B7	139.5	124.0	123.6	129.0	1.40	1.23	1.13	1.25
	A1B8	143.1	123.4	116.3	127.6	1.34	1.25	1.18	1.26
	A1B9	147.5	136.9	131.8	138.7	1.32	1.25	1.15	1.24
	A1B10	141.4	131.8	118.1	130.4	1.36	1.23	1.18	1.25
	A1B11	133.2	126.6	119.8	126.5	1.31	1.23	1.18	1.24
	A1B12	128.6	122.6	113.8	121.6	1.27	1.24	1.18	1.23
	A1B13	119.4	112.6	107.9	113.3	1.28	1.18	1.15	1.20
	A1B14	147.9	132.1	125.5	135.2	1.35	1.23	1.18	1.25
	A1B15	143.3	126.7	120.8	130.2	1.31	1.26	1.18	1.25
	A1B16	141.6	135.3	118.3	131.7	1.31	1.23	1.19	1.24
	A1B17	136.4	125.3	119.0	126.9	1.30	1.23	1.18	1.23
	A1B18	140.0	122.4	114.2	125.5	1.28	1.20	1.18	1.22
	A1B19	135.8	126.8	115.3	126.0	1.28	1.23	1.23	1.24
	A1B20	134.2	126.0	120.3	126.8	1.28	1.23	1.22	1.24
A*B	A1B21	131.8	127.3	118.5	125.9	1.25	1.23	1.15	1.21
	A2B1	141.8	133.4	126.0	133.7	1.38	1.30	1.24	1.30
	A2B2	142.4	133.5	119.8	131.9	1.35	1.29	1.22	1.28
	A2B3	146.9	127.8	118.2	131.0	1.37	1.31	1.15	1.27
	A2B4	143.8	128.3	117.5	129.9	1.33	1.25	1.14	1.24
	A2B5	134.8	130.3	116.4	127.2	1.28	1.22	1.10	1.20
	A2B6	140.4	129.5	114.3	128.1	1.26	1.22	1.09	1.19
	A2B7	128.5	117.3	109.3	118.4	1.23	1.13	1.05	1.14
	A2B8	126.1	117.1	108.3	117.1	1.18	1.13	1.05	1.12
	A2B9	139.3	124.5	117.0	126.9	1.24	1.21	1.12	1.19
	A2B10	143.7	115.5	109.0	122.7	1.23	1.18	1.05	1.15
	A2B11	131.6	114.4	107.5	117.8	1.17	1.13	1.07	1.12
	A2B12	121.7	113.6	105.3	113.5	1.13	1.08	1.00	1.07
	A2B13	111.0	107.2	101.5	106.6	1.12	1.08	0.99	1.06
	A2B14	134.6	126.9	114.5	125.3	1.24	1.18	1.10	1.17
	A2B15	133.9	126.2	111.1	123.7	1.23	1.18	1.11	1.17
	A2B16	133.5	125.1	108.8	122.5	1.21	1.14	1.10	1.15
	A2B17	134.9	117.3	107.2	119.8	1.20	1.15	1.09	1.15
	A2B18	122.8	113.8	103.0	113.2	1.13	1.09	1.01	1.08
	A2B19	125.6	117.8	107.3	116.9	1.16	1.12	1.03	1.10
	A2B20	125.5	118.1	103.0	115.5	1.16	1.10	1.03	1.10
	A2B21	117.3	111.8	99.3	109.5	1.13	1.07	1.01	1.07
F test		**	**	**		Ns	*	**	
LSD 0.05		3.7	1.7	2.2		-	0.07	0.05	

***, ** and ns; significant, highly significant at 0.05 and 0.01 levels probability and non- significant of level probability.**

Table 10. Reduction percentage of plant height and stem diameter affected by irrigation periods for Sudan grass genotypes over the two seasons

Treatment	Plant height cm				stem diameter cm			
	Cut1	**Cut2**	**Cut3**	**Mean**	**Cut1**	**Cut2**	**Cut3**	**Mean**
A1 vs A2	7.3	7.6	10.1	8.2	8.9	6.0	8.3	7.8
B1vs B13	32.6	29.6	24.5	29.0	21.8	15.0	12.1	16.8
A1B1vs A1B13	37.0	34.4	24.8	32.3	19.5	10.2	1.7	10.8
A2B1 vs A2B13	27.7	24.4	24.1	25.4	23.2	20.4	25.3	22.6

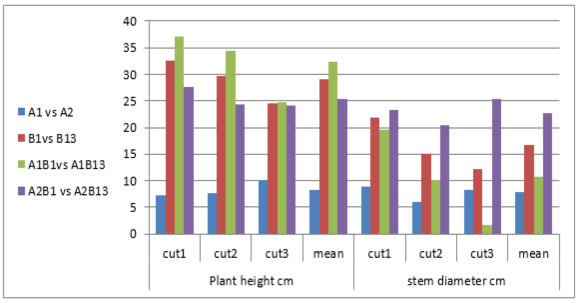


Fig. 2. Reduction percentage plant height and stem diameter of Sudan grass over two seasons

Number of stems (0.15 m^2)

The results obtained in Table 11 illustrated that No. of stems were highly significantly effects in irrigation periods . In addition to, the results reveled that irrigation period 15 days (A1) was the highest average values (8.76). While irrigation period 30 days (A2) was the lowest average value (7.43). The reduction percentage by using irrigation period 15 days (A1) compared with irrigation water period 30 days (A2) had estimated 17.9 %) for No. of stems over the two seasons, respectively.

Table 11. The impact of irrigation periods on number of stems of Sudan grass genotypes over the two seasons

Treatment		Number of stems (0.15 m2)			
		Cut1	Cut2	Cut3	Mean
Irrigation periods (A)	A1	10.21	8.51	7.57	8.76
	A2	8.72	7.38	6.18	7.43
F test		**	**	**	
LSD 0.05		0.21	0.02	0.31	
Sudan grass genotypes (B)	B1	12.21	9.99	8.14	10.11
	B2	11.40	9.83	7.89	9.71
	B3	11.25	9.16	7.89	9.43
	B4	9.96	8.96	7.99	8.97
	B5	10.26	9.22	7.30	8.93
	B6	9.85	8.57	7.53	8.65
	B7	8.93	7.40	6.31	7.55
	B8	8.93	7.30	6.50	7.58
	B9	9.81	8.63	7.58	8.67
	B10	9.80	7.44	6.56	7.93
	B11	8.93	7.70	6.45	7.69
	B12	8.37	7.24	6.21	7.27
	B13	7.89	6.48	5.63	6.67
	B14	9.94	7.70	7.08	8.24
	B15	9.22	8.08	7.18	8.16
	B16	9.40	7.41	6.63	7.81
	B17	8.87	7.58	6.53	7.66
	B18	8.47	6.88	6.00	7.12
	B19	8.69	7.24	6.63	7.52
	B20	8.70	7.10	6.21	7.34
	B21	7.99	6.93	6.14	7.02
F test		**	**	**	
LSD 0.05		0.11	0.19	0.12	
A*B	A1B1	13.13	10.96	8.92	11.00
	A1B2	12.88	10.25	8.88	10.67
	A1B3	12.63	9.67	8.63	10.31
	A1B4	10.63	9.67	8.73	9.68
	A1B5	11.13	9.96	7.82	9.64
	A1B6	10.47	8.92	8.17	9.19
	A1B7	9.38	7.85	7.25	8.16
	A1B8	9.50	7.88	7.38	8.25
	A1B9	10.50	9.23	8.29	9.34
	A1B10	10.58	7.78	7.23	8.53
	A1B11	9.38	8.28	7.50	8.39
	A1B12	9.21	7.75	6.90	7.95
	A1B13	8.13	6.96	6.50	7.20
	A1B14	10.38	8.18	7.50	8.69
	A1B15	9.96	8.90	7.63	8.83
	A1B16	10.46	7.73	7.03	8.41
	A1B17	9.71	7.75	7.15	8.20
	A1B18	9.08	7.39	6.58	7.68
	A1B19	9.38	7.88	7.38	8.21
	A1B20	9.63	7.71	6.75	8.03
	A1B21	8.38	7.98	6.88	7.75
	A2B1	11.29	9.03	7.36	9.23
	A2B2	9.92	9.40	6.90	8.74
	A2B3	9.88	8.65	7.15	8.56
	A2B4	9.29	8.25	7.25	8.26
	A2B5	9.40	8.48	6.78	8.22
	A2B6	9.23	8.23	6.90	8.12
	A2B7	8.48	6.95	5.38	6.94
	A2B8	8.35	6.73	5.63	6.90
	A2B9	9.13	8.03	6.88	8.01
	A2B10	9.03	7.10	5.90	7.34
	A2B11	8.48	7.13	5.40	7.00
	A2B12	7.53	6.73	5.53	6.60
	A2B13	7.65	6.00	4.75	6.13
	A2B14	9.50	7.23	6.65	7.79
	A2B15	8.48	7.25	6.73	7.49
	A2B16	8.35	7.10	6.23	7.23
	A2B17	8.03	7.40	5.90	7.11
	A2B18	7.86	6.38	5.43	6.56
	A2B19	8.00	6.60	5.88	8.83
	A2B20	7.78	6.50	5.68	6.65
	A2B21	7.60	5.88	5.40	6.29
F test		**	ns	**	
LSD 0.05		0.42	-	0.44	

**** and ns; highly significant at 0.01 levels probability and non- significant of level probability.**

Regarding the results obtained in Table 11 showed that genotypes for all cuts had highly significant effects in No. of stems. Giza 1 (B1) had the highest average value (10.11). Meanwhile MV1 (B13) was the lowest average value (6.67) stems over the two seasons, respectively.

In addition to, when compare the highest average Sudan grass genotype (B1) with the lowest average (B13) mentioned that reduction percentages was (51.6 %) more than B1 for No. of stems over the two seasons, respectively. The results obtained in Table 11 reported that the 1st and 3rd cuts were highly significant effects, but the 2nd cut was insignificant effect. Consequently, the interaction (A1B1) was the maximum average value for No. of stems (11.00), while (A1B13) was the minimum average value (7.20) for No. of stems over the two seasons, respectively. Although (A2B1) had higher average value (9.23) than (A2B13) which had lower average value (6.13) for No. of stems over the two seasons, respectively.

In addition to, when comparing (A1B1) vs. (A1B13) recorded the reduction percentage in No. of stems (52.8 %). Meanwhile (A2B1) comparing with (A2B13) observed reduction percentage (50.6 %) for No. of stems over the two seasons, respectively, Table 12.

Table 12. Reduction percentage of No. of stems affected by irrigation periods for Sudan grass over the two seasons. No. of stems

Treatment	Cut1	Cut2	Cut3	Mean
A1 VS A2	17.1	15.3	22.5	17.9
B1 VS B13	54.8	54.2	44.6	51.6
A1B1 VS A1B13	61.5	57.5	37.2	52.8
A2B1 VS A2B13	47.6	50.5	54.9	50.6

The percentage of reduction in the number of stems in Sudan grass over two seasons can be shown in (fig 3).

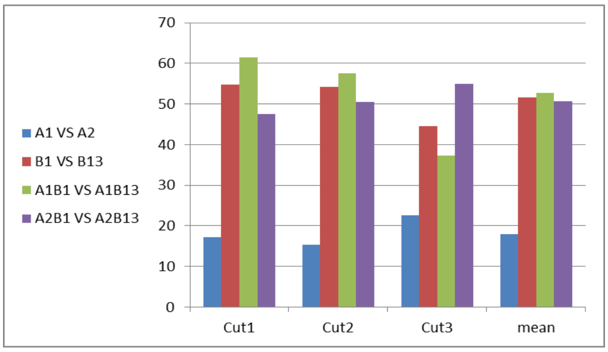


Fig. 3. Reduction percentage of No of stems of Sudan grass over two seasons.

Correlation

Correlation among forage yield components

Simple correlation coefficients show the existence of very strong to almost complete statistically very significant positive relations, and these effects were expected.

In general, in a forage crop, the fodder yield, which is ultimately harvested, is influenced by number of vegetative plant characters.

Correlation studies increases the possibility of indirect selection for different traits. This provides information to the breeder about importance of any trait. Results pertaining to correlations among various forage yield components are presented in the Table 13 under normal and water stress conditions. Green fodder yield showed positive and significant correlation with all forage yield components i.e. plant height, stem diameter and number of stems under both normal and water stress conditions. This indicated that any selection based on these traits may be helpful for the improvement of forage Sudan grass. Positive and significant correlation of green forage yield has also been reported by (Shinde *et al*., 2012, Tariq *et al*. 2012 and Amare *et al*. 2015).

The correlation studies Table 13 revealed that, the characters *viz.*, fresh forage yield showed significant positive correlation with dry forage yield (r=0.997**), plant height (r=0.957**), stem diameter (r=0.972**) and No. of stems (r=0.991**). Meanwhile dry forage yield reveled significant positive correlation with plant height (r=0.962**), stem diameter (r=0.977**) and No. of stems (r=0.993**). While Plant height showed significant positive correlations with stem diameter (r=0.938**) and No. of stems (r=0.970**). Stem diameter showed significant positive correlations with No. of stems (r=0.976**). These results are in harmony with (Anup and Vijaykumar 2000) noticed significant and positive correlations of plant height with green forage yield in forage sorghum. Similarly, (Ahmed and Magda Rajab 2017) and (Badawy *et al.* 2018) who found that positive correlations of such traits to obtain high productive for fresh forage yield with these traits.

Table 13. Correlation coefficients among forage yield components under normal as well as water stress

	Fresh yield	Dry yield	Plant height	Stem diameter	No. stems
Fresh yield	1	0.997**	0.957**	0.972**	0.991**
Dry yield		1	0.962**	0.977**	0.993**
Plant height			1	0.938**	0.970**
Stem diameter				1	0.976**
No. stems					1

***, **. Correlation is significant at the 0.01 level.**

The results of the present investigation agree with (Jain *et al.* 2011) and (Jain and Patel 2012). Who reported Positive and significant relationship of dry yield with fresh yield, plant height, stem diameter and number of tillers suggested that the dry yield production can be increased by simple selection of these characters.

In general, in a forage crop, the fodder yield, which is ultimately harvested, is influenced by number of vegetative plant characters.

Correlation studies increases the possibility of indirect selection for different traits. This provides information to the breeder about importance of any trait. Results pertaining to correlations among various forage yield components are presented in the Table 13 under normal and water stress conditions. Green fodder yield showed positive and significant correlation with all forage yield components i.e. plant height, stem diameter and number of stems under both normal and water stress conditions. This indicated that any selection based on these traits may be helpful for the improvement of forage Sudan grass. Positive and significant correlation of green forage yield has also been reported by (Shinde *et al*., 2012, Tariq *et al*. 2012 and Amare *et al*. 2015).

Path coefficient analysis

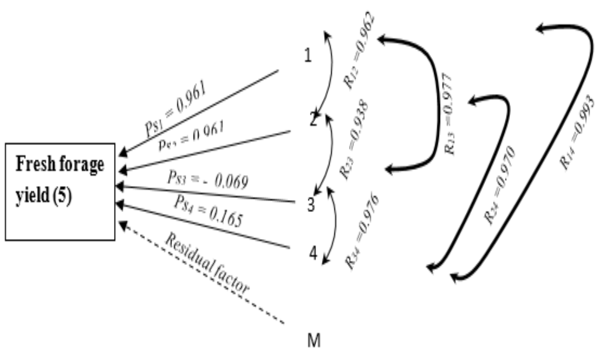
Path- coefficient analysis Table 14 was used to evaluate the direct and indirect effects and measure estimates the relative importance of the causal factor individually (Dewey and Lue 1959).

Table 14. Path coefficient analysis (direct) and indirect effects of the studied traits on fresh forage yield for 21 Sudan grass genotypes estimated over the two seasons

Traits	Dry forage yield	Plant height	Stem diameter	No. of stems	Total correlation
Dry forage yield	(0.961)	-0.060	-0.068	0.164	0.997
Plant height	0.924	(-0.062)	-0.065	0.160	0.957
Stem diameter	0.939	-0.059	(-0.069)	0.161	0.972
No. of stems	0.954	-0.061	-0.067	(0.165)	0.991

The obtained data were used to construct a path diagram, showing caused relationships among four variables with response variable as fresh forage yield, dry forage yield and plant height represented a direct caused of fresh forage yield with direct effect of 0.961, stem diameter was the least direct influential variable with direct effect of 0.165. Correlation among the four studied variables were positive and storage with values over 0.9. Those results were accordance with those reported by Sankarapandian, 2000, Paroda *et al.*, 1976, Zhan and Qiang 2004, Sukhchain, 2008, Shinde *et al*, 2012, Tariq *et al.*, 2012 and Amare *et al.*, 2015.

The effects of the studied morphologic traits on fresh forage yield in these genotypes and their complex mode of action in forming total yield can be a significant backbone of further Sudan grass breeding (Figure 4).



(1) Dry yield, (2) Plant height, (3) stem diameter and (4) No. stems

Fig. 4. Path diagram showing causal relationships four predictor variables with the response variable of fresh yield one directional arrow represent direct path (p) and two directional (↔) represent correlation (r).

Grouping of genotypes with reference to drought tolerance.

Cluster analysis

Cluster analysis might divide the twenty-one studied sudan- grass genotypes to groups with variable levels of drought tolerance. The dendogram provided in fig 5 divided the studied genotypes to two major groups. Internally each group was divided to much closer genotypes. It was clear that both of B1 (Giza 1) and B2 (Giza 2) genotypes were sat in one group indicating their genetic similarity, the most closer genotypes to the former group were genotypes B3 (Serw 1), B4 (Serw 3), B5 (Piper black), B14 (Port Said), B8 (Sids 3) and B9 (Selected 15). The other studied genotypes were sat another differed group. This dendogram explained most of the obtained characters that were related to forage yield or plant characters. That map might help researchers and breeder that seak genetic materials of good or lowtolerance to drought. Similar findings were reported by (Esmail *et al.* 2016, Ramadan *et al.* 2016, Khatab et *al*

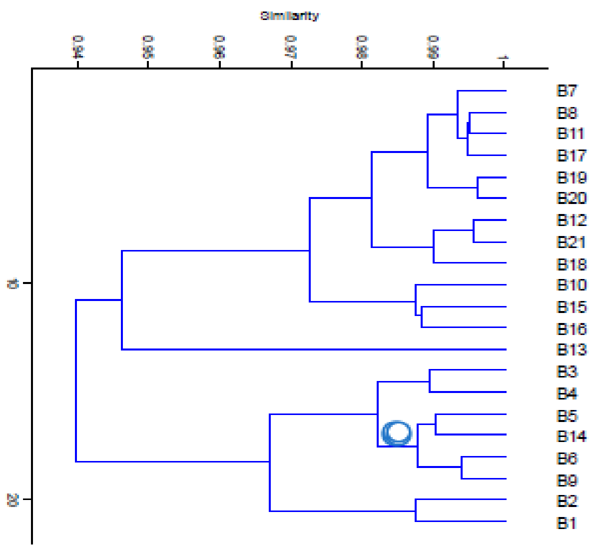


Fig. 5. Dendrogram representing the genetic relationship among the twenty-one Sudan grass genotypes using cluster analysis.

Generally, Sudan- grass genotypes that were of wide genetic-base provided levels of response to drought expressed by forage yields and plant characters. Also, the recent martials represent a good base for breeders to develop new populations of resistant- responses to drought or sensitive to drought depending on the main objectives of future studies.

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تاثير تحمل تراكيب وراثية من حشيشة السودان لنقص مياه الري على المحصول ومكوناته

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الملخص

اقيمت تجربتان حقليتان فى المزرعة البحثية بمحطة بحوث سخا الزراعية بكفرالشيخ, مصر فى موسمي صيف 2019, 2020 يهدف البحث الى دراسة تأثير نقص المياه على مجموعة من التراكيب الوراثية من حشيشة السودان . صممت التجربة في قطع منشقة بثلاث مكررات للموسمين، كانت (فترات الري 15، 30 يوم) في القطع الرئيسية وتم وضع 21 تركيب وراثي من حشيشة السودان في القطع تحت الشقية. اظهرت التراكيب الوراثية في التحليل المشترك للموسمين تباينا معنويا في كل من حاصل العلف الاخضر والجاف في كل حشة ومجموع الحشات الثلاث. تفوق التركيب الوراثى حشيشة السودان جيزة 1 تفوقا معنويا على الصنف حشيشة السودان جيزة 2 وبزيادة قدرها 34,3 , 24,42% لحاصل العلف الاخضروالجاف. اعطي التركيب الوراثي حشيشة السودان جيزة 1 اعلي قيم فى المحصول العلف الاخضر الكلى, والجاف, وطول النبات, سمك الساق وعدد السيقان فى (0.15 م2), يليه التركيب الوراثى حشيشة السودان جيزة 2, بينما اعطى التركيب الوراثى اى اس 3382 اقل قيم لهذة الصفات. لوحظ وجود ارتباط معنوي موجب بين حاصل العلف الاخضر مع الحاصل الجاف و ارتفاع النبات وسمك الساق وعدد السيقان وكانت قيم هذا الارتباط هي 997., 957., 972., و 991., علي الترتيب ومن ثم يكون افضل التراكيب الوراثية من حيث حاصل العلف الاخضر و الجاف هوحشيشة السودان جيزة 1. كشف تحليل المسار أن محصول العلف الجاف أظهر أعلى تأثير مباشر إيجابي على إنتاجية الأعلاف الطازجة. أظهر سمك الساق أعلى التأثيرات المباشرة السلبية على محصول العلف الطازج يليه ارتفاع النبات. وخلصت النتائج الى ان تحمل حشيشة السودان للجفاف بواقع 30 يوما وأفضل محصول حصل عليه التركيب الوراثي حشيشة السودان جيزة 1 يليه التركيب الوراثى حشيشة السودان جيزة 2, بينما اعطى التركيب الوراثى اى اس 3382 اعلى حساسيه لنقص فترات مياه الرى لحشيشة السودان تحت ظروف هذه الدراسه.