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Evaluation of Growth and some Growth Analysis Components in Sugar beet Genotypes Grown under Low Nitrogen Fertilizer Levels in Khartoum State- Sudan

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Abstract

This investigation was carried out at the Demonstration Farm of the College of Agriculture- University of Bahri during 2018/2019 winter season to evaluate growth (morphological) and growth analysis (physiological) components in some sugar beet (*Beta vulgaris L*) genotypes under different nitrogen levels to know how well sugar beet plant performs during the growing season, Thus, to provide information to assist producers in identifying and introducing superior genotype and good management of nitrogen application in AlKadro area. The experiment was laid out in split plot design. The genotypes used were namely, Blaladi. Strube Sudan 01/14, Strube Sudan 02/14, Strube Sudan 04/14, Strube Sudan 05/14 and Strube Sudan 06/14, and the nitrogen levels were viz, 0, 80 and 120 kg urea per ha; applied twice (at the sowing and then 4 weeks after sowing). The evaluated components were; leaf number/plant, leaf area index (LAI), root length, root diameter, fresh and dry weight of foliage/plant, fresh and dry weight of root/plant; all determined at 5 terms. While Crop Growth Rates (CGR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR); determined at different periods of growth (intervals). The analysis of variance (ANOVA) revealed that at 4 weeks after sowing (WAS): leaf number (14.33- 17.03) , root length (19.05 – 21.75 cm), root diameter (7.93- 8.40 cm) foliage fresh (186.93 – 292.06 g) and dry (69.00 – 94.10 g) weight per plant, root fresh (72.66 – 108.88 g) and dry weight (12.54 – 22.08 g) per plant differed significantly ($P \leq 0.05$); at 7 and 10 WAS leaf number (22.39 -35.73 and 26.91 – 38.47, respectively), LAI (3.725 -5.645) , fresh and dry root weight per plant (586.78 – 913.81an 189.06 – 326.43 g, respectively) differed significantly; at 13 WAS: dry foliage weight (69.00 – 94.10 g), LAI (2.603 – 4.744), root diameter (10.09 – 11.92 cm) differed significantly; at 16 WAS only dry foliage (44.34 – 73.48 g) weight reflected significance. All other cases reflected insignificant differences among the evaluated genotypes. Moreover, all the studied components reflected insignificant differences among the nitrogen fertilizer

levels and likewise genotype x nitrogen interaction (G x N) at the 5 sampled terms. Nevertheless, CGR, RGR and NAR displayed insignificant effect on the studied components in the evaluated periods.

Introduction

Sugar beet (*Beta vulgaris L*) is a biennial, which is included in family *Chenopodiaceae*. It is one of the major crops that was not grown in prehistoric times, but has been developed from superior fodder beet types used to be grown as forage in Europe about two centuries ago[1].

Today it became an important issue in world trade by providing about 45% of the world's sugar of commerce. The percentage of its sucrose ranges from 13–18% with some higher or inferior to this range depending on variety, culture, and climate in which is grown [1]. Cultivated beets are grown worldwide in regions without severe frosts (in temperate climates as a summer crop and in subtropical climates as a winter crop)[2]. Sugar cane is a main source of sugar production in the Sudan at the moment as it delivers about 50% of Sudan needs for sugar, thus, increase in sugar production is required to reach self satisfaction [3]. The Sudanese sugar industry has been suffering from sugar production decline and dropped in 9 years by 32% from 775000 t in 2008 to 526000 t in 2017at the six sugar mills. Such situation necessitates sugar source diversification. However, sugar beet is an important complementary and alternative for sugar production source (sugar [4] and can be popularly cultivated in a variety of agriculture conditions [5].

Sudan has meager information about beet production although scientific research on the crop is going back to 1930s when the first trials were carried out at Gezira Research Farm. Thus, much attention should be paid to the most important nutritive element, nitrogen fertilizer (N) which is in short supply in nearly all arable soils and wherever the crop is introduced in new areas brought into intensive farming. Combined with improved and adapted variety; a great effect on sugar beet performance is expected. In some instances it is necessary to know how well a plant is growing in a particular area and a measure of some characters can often be made, which reflects the performance of a plant. These measures include morphological and physiological parameters. Therefore, evaluating the sugar beet growth at different times during the growing season can exhibit when certain factor may affect the growth development of the plant through the season [6]. Therefore, this work was carried out to meet the following objectives:

To evaluate growth and some growth analysis components in six sugar beet genotypes under AlKadro agro-climatic conditions through the growing season.

To evaluate growth and some growth analysis components in some sugar beet genotypes under low nitrogen fertilizer levels at different terms through the growing season.

Materials And Methods

A field experiment was carried out during 2018/2019 at Demonstration Farm of University of Bahri at Al Kadro on latitude 15° 45′N, longitude 32° 39′E and altitude of 398 m above sea level, in Khartoum State, Sudan. In a semi-arid zone with maximum and mean temperature of 45°C and 30°C during summer, 25°C and 10°C during winter, respectively, the annual rainfall ranges from 0 mm to 100 mm, with relative humidity ranging from 16% to 50% [7]. The soil is a mixture of sand ≥ 40%, silt ≤ 32% and clay ≤ 36%[8]. The land was properly prepared and divided into four blocks running perpendicular to the gradient. Each block contained 4 plots randomized with six sugar beet genotypes, namely, Blaladi. Strube Sudan 01/14, Strube Sudan 02/14, Strube Sudan 04/14, Strube Sudan 05/14 and Strube Sudan 06/14, and each plot was divided into three subplots randomized with nitrogen fertilizer levels in form of urea viz., 0. 80 and 120 kg/ ha in two times; one at sowing and the other after 4 weeks from sowing date.

The design used was split plot. The seeds were sown manually, three seeds per hill and then thinned to a plant in 3 to 4 weeks after sowing The spacing was 20 cm plant to plant and 70 cm between ridges. Weeding was done manually and insects were sprayed with Melthion. The experiment was irrigated immediately after sowing and then every 7- 10 days depending on the weather conditions. The collected data composed of growth attributes from 3 plants randomly taken per subplot at 5 terms of sampling namely; 4, 7, 10, 13 and 16 weeks after sowing (WAS).

The growth parameters were: leaf number/plant, leaf area index, fresh and dry weight of leaves/ plant(g/p), length and diameter of root (cm), fresh and dry weight of foliage per plant (g), fresh and dry weight of root (g) and some growth analysis parameters:, crop growth rate (CGR), root crop growth rate (RCGR), relative growth rate (RGR), root relative growth rate (RRGR) and net assimilation rate (NAR) were computed using the following formulae:

$$1.\,CGR = \frac{(W2 - W1)}{P(t2 - t1)}$$

The method was suggested by [9]. The CGR explains the dry matter accumulated per unit land area per unit time (g m^{-2} day^{-1})

Where, W1and W2 are whole plant dry weight at time t1– t2 respectively, ρ is the ground area on which W1 and W2 are recorded. CGR of a species are usually closely related to interception of solar radiation.

$$2.\,RGR = \frac{(\ \log e\,W2\ -\ \log e\,W1)}{(t2\ -\ t1)}$$

Relative Growth Rate (RGR). The term was coined by [10] RGR expresses unit dry weight / unit dry weight / unit time ($gg^{-1}day^{-1}$). Where, W1and W2 are whole plant dry weight at t1 and t2 respectively t1 and t2 are time interval in days.

$$3.\ NAR = \frac{(W2\ -\ W1)\ (\log e\,A2\ -\ \log e\,A1)}{(t2\ -\ t1)\ (A2\ -\ A1)}$$

The term, NAR was used by [10]. NAR is defined as rate of increase of dry weight per unit time per unit area of leaf surface ($gcm^{-2}day^{-1}$). Where, W1and W2 is dry weight of whole plant at time t1 and t2 respectively, L1 and L2 are leaf weights or leaf area at t1 and t2 respectively t1 –t2 are time interval in days.

Statistical analysis of experimental data was carried out by using the SPSS software package and the means were separated by Duncan's multiple range test with at least $P \leq 0.05$.

Results And Discussion

Results

The data analysis of this study is presented in the tables (1-6): listed below:

Table 1, G0, G1, G2, G3, G4 & G5 designate for; Blaladi StrubeSudan 01/14, Strube Sudan 02/14, Strube Sudan 04/14, Strube Sudan 05/14 and Strube Sudan 06/14 genotypes. N0, N1, & N2 designate for 0, 80 & 120 Kg urea per ha., while Sy- designates for standard error., NS, * and ** designate for non significant, significant at 5%.,and highly significant at 1%, respectively. Means followed with the same

Table 1. Averages of leaf number per plant and leaf area index of some genotypes of sugar beetas affected by three levels of nitrogen fertilizer during 2018-2019 Winter season in Khartoum State - Sudan

SV	Leaf number per plant					Leaf area index (LAI)				
	Terms of sampling					Terms of sampling				
Factor	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
G0	16.74 a	30.09 b	47.04a	44.8a	31.30	1.420a	4.28a	5.638a	3.779a b	1.638 ab
G1	14.33 b	22.39c	27.10c	32.13a	26.77a	1.329a	3.258a	4.284 bc	2.603c	1.380 a
G2	17.03 a	27.29 b	26.91c	45.80a	35.64a	1.698a	4.291a	4.914 b	4.747a	1.989 a
G3	15.92 b	30.92 b	35.12b	39.06a	34.10a	1.635a	5.007a	5.645a	3.722a b	1.808 a
G4	17.43 a	35.73a	38.47b	45.19a	33.75a	1.493a	4.377a	4.915 b	3.748a b	1.698 a
G5	16.61 a	26.23 b	28.55c	41.08a	31.81a	1.513a	3.585a	3.725c	3.519 bc	1.698 a
Sy^{-}	0.80	1.80	2.41	3.58	2.47	.118	.419	.416	.432	.161
F test	*	*	*	Ns	Ns	Ns	Ns	*	*	Ns
N0	17.14 a	28.84a	33.45a	43.31a	33.42a	1.634a	3.983a	4.711a	3.893a	1.760 a
N1	15.76 a	29.04a	34.80a	41.53a	31.63a	1.490a	4.140a	4.761a	3.698a	1.675 a
N2	16.13 a	28.44a	33.34a	39.19a	31.64a	1.420a	4.245a	4.599a	3.467a	1.793 a
Sy^{-}	4.81	1.27	1.71	2.53	1.75	.0.083	.296	.294	.305	.114
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS`	NS
GxN Sy^{-}	1.81	3.11	6.19	6.19	4.28	.204	.726	.721	.747	.279
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. 1,2,3,4,&5 designate for 4 ,7,10, 13 & 16 weeks after sowing date (WAS).

letter (s) within a column indicate non-significant effect at 5% level.

Considering table 6, 2-1, 3-2and 4-3 stand for time between 7-4 WAS, 10-7WAS and 13 -10 WAS, respectively. PCGR, RCGR, PRGR , RRGR and NAR stand for plant crop growth rate, root crop.

Discussion

Means of leaf number per plant as affected by genotype, low nitrogen fertilizer rates and interaction between genotype and nitrogen fertilizer (G x N) are presented in Table 1.The analysis of variance for leaf number per plant revealed significant differences among the studied genotypes at three sampling terms (4, 7 and 10 WAS), while at 13 and 16 WAS showed no significant differences. This implies that the studied genotypes had varietal difference in their response to the growing conditions for initiating leaves at the beginning of the season. However, this genotype significant effect disappeared when the maximum leaf number reached. The highest leaf number scored by G2 at 13 WAS although; it was not significantly different from the other genotypes at this stage. This indicates that the evaluated genotypes do not have

Table 2. Averages of fresh and dry weight of leaves (g/plant) of some genotypes of sugar beet as affected by three levels of nitrogen fertilizer during 2018- 2019 Winter season in Khartoum State –Sudan

S V	Fresh weight of leaves per plant (g)					Dry weight of leaves per plant (g)				
	Sampling Terms					Sampling Terms				
Factors	1	2	3	4	5	1	2	3	4	5
G0	199.01a	663.49b	528.27a	363.05a	178.62a	23.55a	57.84a	69.49a	70.27a	31.77a
G1	176.76a	663.49b	559.42a	334.39a	170.85a	22.19a	58.46a	72.13a	62.18a	31.87a
G2	253.28a	764.27a	464.37a	367.68a	192.41a	27.08a	57.68a	67.27a	66.77a	31.74a
G3	193.35a	648.28b	650.85a	495.18a	229.36a	23.66a	61.33a	69.93a	60.43a	35.01a
G4	215.45a	568.64b	514.70a	321.68a	209.60a	24.92a	56.13a	69.30a	57.33a	33.09a
G5	192.47a	732.92a	525.56a	338.33a	190.13a	21.33a	60.61a	63.27a	51.63a	34.63a
Sy⁻	18.04	41.92	63.21a	76.27	19..47	1.67	3.44	3.86	4.27	2.19
F test	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
N0	210.94a	666.48a	504.03a	432.40a	200.68a	24.82a	57.28a	62.73a	59.99a	.33.10a
N1	208.94a	674.17a	510.73a	347.41a	191.92a	23.74a	58.64a	71.68a	63.55a	32.85a
N2	195.50a	666.39a	606.82a	330.34a	192.88a	22.80a	60.11a	70.80a	60.76a	33.10a
Sy⁻	12.76	29.68	44.7	53.93	13.76	1.18	2.43	2.73	3.02	1.55
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gx N Sy⁻	31.25	72.71	109.49	132.11	33.72	2.9	5.95	6.68	7.39	3.8
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. see the foot note of Table 1.

Table 3. Averages of fresh and dry weight of foliage (g/plant) of some genotypes of sugar beet as affected by three levels of nitrogen fertilizer during 2018- 2019 Winter season in Khartoum State – Sudan

SOV	Fresh Weight of foliage (g/plant)					Dry Weigt of foliage (g/plant)				
	Sampling terms					Sampling terms				
Factors	1	2	3	4	5	1	2	3	4	5
G0	219.05b	743.58a	608.93a	478.68a	324.48a	24.73a	65.75a	90.23a	94.10a	63.41a
G1	186.93bc	686.8a7	632.20a	435.84a	339.93a	23.96a	6a5.63a	90.32a	85.83a	73.33aa
G2	272.06ba	787.96a	531.77a	482.65a	331.49a	29.52a	6a4.19	81.96a	91.09a	63.12a
G3	205.51b	706.74a	653.13a	468.61a	423.79a	25.34a	64a.03	91.33a	89.34a	73.48a
G4	230.72a	622.58a	597.76a	493.18a	370.57a	27.68a	65.5a3	83.64a	80.62a	69.43a
G5	204.60b	765.78a	606.04a	418.55a	302.43a	23.32a	69.52a	76.84a	69.00b	44.34b
Sy⁻	19.02	47.39	40.07	51.76	31.57	1.96	5.08	6.14	6.29	7.29
F test	*	NS	NS	NS	NS	NS	NS	NS	*	*
N0	228.36a	729.75a	575.44a	446.19a	348.31a	26.45a	63.51a	82.69a	83.40a	66.34a
N1	222.73a	708.80a	611.28a	496.63a	356.20a	26.31a	65.04a	88.61a	8a8.38a	62.74a
N2	208.35a	718.20a	628.20a	445.94a	341.84a	24.51a	68.78a	85.62a	83.21	64.45a
Sy⁻	13.45	33.51	28.33	36.6	22.33	1.39	3.59	4..34	4.45	5.16
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gx N Sy⁻	32.94	82.09	69.4	89.65	54.68	3.4	8.79	10.63	10.89	12.63
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. see the foot note of Table 1.

Table 4. Averages of root length and root diameter (cm) of some genotypes of sugar beet as affected by three levels of nitrogen fertilizer during 2018- 2019 Winter season in Khartoum State - Sudan

Source of Variation	Root Length (cm)					Root Diameter (cm)				
	Sampling Terms					Sampling Terms				
Factors	1	2	3	4	5	1	2	3	4	5a
G0	19.05b	26.14 a	26.83	25.54a	27.41 a	4.01a	8.12b	9.05a	11.92a	11.18a
G1	21.75a	26.21 a	27.28	26.82a	27.44 a	4.03a	7.93b c	9.88a	10.58a b	10.86a
G2	20.55a b	27.38 a	27.25	28.13a	26.86 a	4.07a	9.48a	10.82 a	11.57a	11.54a
G3	21.73a	28.94 a	29.85	29.12a a	28.75 a	4.38a	8.20b	9.66a	10.40a b	11.02a
G4	20.70a b	28.16 a	27.66	26.79a	27.43 a	4.40a	8.25b	9.26a	10.09b	10.36a
G5	19.93a b	27.13 a	26.99	25.93a	29.62 a	4.06a	8.40b	9.83a	10.83a b	10.83a
Sy⁻	0.89	0.86	1.04	1.37	1.41	1.91	0.34	0.26	0.49	0.30
F test	*	NS	NS	NS	NS	NS	*	NS	*	NS
N0	21.33a	27.54 a	27.43	26.97a	27.55 a	4.42a	8.64a	9.54a	10.68a	11.17a
N1	20.25a	27.01 a	26.93	27.49a	27.21 a	4.27a	8.28a	9.61a	10.88a	10.96a
N2	20.28a	27.43 a	28.58	26.71a	28.49 a	4.10a	8.27a	9.70a	10.86a	10.77a
Sy⁻	0.63	0.81	0.73	0.97	1.00	1.35	0.24	0.18	0.35	0.21
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gx N Sy⁻	1.54	1.49	1.79	2.73	1.99	0.33	0.59	0.45	0.85	0.51
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. see the foot note of Table 1

Table 5. Averages of fresh and dry weight of root (g/plant) of some genotypes of sugar beet as affected by three levels of nitrogen fertilizer during 2018- 2019 Winter season in Khartoum State - Sudan

S V	Fresh weight of root (g/ plant)					Dry weight of root (g/ plant)				
	Sampling Terms					Sampling Terms				
Factors	1	2	3	4	5	1	2	3	4	5
G0	86.59b	487.43a	586.78b	1326.57a	1189.39a	17.64ab	128.43a	189.06c	413.00a	268.22a
G1	72.66b	405.36a	741.00b	999.21a	1003.46a	15.29bc	108.84a	283.73ab	396.18a	240.79a
G2	105.24a	538.58a	734.58b	1185.21a	1092.93a	19.09ab	167.98a	252.14b	420.24a	274.43a
G3	106.67a	532.45a	913.81a	1183.17a	1247.88a	18.34ab	175.60a	326.43a	432.18a	263.03a
G4	108.88a	503.89a	726.90b	1070.14a	1123.32a	22.08a	148.74a	251.52b	355.44a	240.40a
G5	79.28b	509.68a	702.93b	844.84a	943.19a	12.54c	146.98a	222.81b	286.46a	221.11a
Sy¯	9.19	54.55	63.58	156.65	102.83	1.63	19.02	23.9	37.81	20.2
F test	*	NS	*	NS	NS	**	NS	**	NS	NS
N0	102.78a	527.77a	724.62a	1070.26a	1127.59a	18.79a	158.00a	247.18a	384.84a	281.78a
N1	90.22a	494.82a	735.01a	1225.32a	1146.93a	17.32a	140.62a	257.94a	388.65a	258.70a
N2	85.15a	466.10a	743.37a	1008.98a	1020.56a	18.38a	139.67a	257.72a	378.27a	233.51a
Sy¯	6.5	38.63	44.95	110.77	72.72	1.15	13.45	16.9	26.74	14.28
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Gx N Sy¯	15.91	94.49	110.11	271.33	178.77	2.82	32.94	41.4	65.99	34.99
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. see the foot note of Table 1

Table 6. Averages of growth analysis components in some genotypes of sugarbeet as affected by three levels of nitrogen fertilizer during 2018-2019 Winter season in Khartoum State - Sudan

S V	Growth Analysis Parame-ters									
	Period between sampling terms									
	RCGR (g cm-2 day-1)			RGR (g g -1day-1)			NAR(g cm -2 day-1)	PCGR (g cm-2 day-1)		
Factors	02-Jan	03-Feb	04-Mar	02-Jan	03-Feb	04-Mar	2 – 1	02-Jan	03-Feb	04-Mar
G0	0.004	0.003	0.007	0.04	0.019	0.013	0.007	7.169	4.222	7.741
G1	0.003	0.007	0.005	0.04	0.018	0.008	0.008	6.427	9.15	5.518
G2	0.005	0.004	0.005	0.045	0.015	0.011	0.01	6.729	5.263	7.857
G3	0.005	0.006	0.004	0.016	0.013	0.006	0.009	9.571	8.899	5.928
G4	0.004	0.004	0.005	0.039	0.014	0.009	0.008	7.873	5.757	5.742
G5	0.005	0.003	0.004	0.045	0.012	0.01	0.008	8.481	4.238	5.589
Sy	0.001	0.001	0.001	0.003	0.003	0.002	0.001	1.06	1.833	2.277
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
N0	0.005	0.004	0.006	0.044	0.012	0.01	0.009	8.374	5.18	6.697
N!	0.004	0.005	0.005	0.041	0.018	0.008	0.007	7.673	4.076	6.453
N2	..005	0.004	0.005	0.043	0.016	0.01	..008	4.978	6.264	5.572
Sy¯	0	0.001	0.001	0.002	0.002	0.001	0.001	0.75	1.296	1.61
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GxNSy¯	.006.	0.005	0.003	.006.	0.005	0.003	0.002	1.838	3.167	3.943
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NB. see the foot note of Table 1.

same reaction to the local conditions at the beginning of season resulted in significant deviations on leaf number while non – significant at the end of the season, means that sugar beet compensated leaf initiation rate of growth during the growing season. This point of view was in agreement with [11]. On the other hand, nitrogen fertilizer level and interaction of genotype x nitrogen effects were insignificant on number of leaves per plant. These findings were in line with [12,13]. Who had reported no significant effect of nitrogen and interaction (GXN) on the leaf number trait in the 1st year of their study.

The mean values of leaf area index (LAI) as affected by genotype, nitrogen and their interaction are presented in Table 1. LAI in the first growth stage was low for both treatments, but rapidly increased and reached a maximum at 10 WAS stage. The analysis of variance for mean values of LAI throughout the sampling terms exhibited insignificant difference at 4, 7and 16 WAS, while significant effect exhibited at

10 and13 WAS terms among the studied genotypes. The mean values of LAI increased gradually up to the 10 WAS term where reached the peak and then declined (highest was attained by G3, 5.645). There is a progressive increase in area of the successive early leaves that produced by the plant, but a point reached beyond which leaves subsequently grew progressively smaller and consequently LAI as shown in Table 1. This could be attributed to the phenomenon of genotype by environmental interaction causing genotype to produce different results and ranks under the local environmental conditions. Similar point of view was reported by [14]. On the other hand, the nitrogen levels showed insignificant difference among the studied genotypes. This may indicate that none of the applied levels of nitrogen caused substantial effect on LAI. Due to low nitrogen available in the soil, there was neither variation in utilization of accumulated nitrogen nor variation in in uptake efficiency of nitrogen. Similarly [13,15] stated that neither shortage nor excess of nitrogen at any stage of sugar beet growth affected its vigorousness' while soil nitrogen was low. The genotype x nitrogen ii0interaction displayed insignificant effect; this is line with [16].

Means of fresh and dry weight of leaves per plant as affected by genotype, low nitrogen fertilizer levels and their interaction are shown in Table 2.The analysis of variance for fresh weight reflected insignificant difference among the studied genotypes at four sampling terms except at 7 WAS stage showed significant difference, at this stage the fresh weight reached the maximum fresh weight and the highest fresh weight scored by G2 (764-27 g/plant) .This may indicate that there was a high competition among the genotypes for growth requirements at this stage to attain the maximum weight that resulted in the variation. Then, gradually the fresh weight declined to reach the least amount of weight scored by G1 (170. g/plant) at 16 WAS stage with no significant difference. This is may be due to a progressive expansion and weight of leaves up to 7 WAS , but at 10, 13 and 16 WAS the leaf growth declined. This result is in harmony with [17]. Nitrogen fertilizer and interaction between GXN gave insignificant effect on fresh weight of leaves per plant at all the 5 sampling stages. This may be due to low nitrogen fertilizer levels applied which not reached the extent of producing substantial effect on the fresh weight of leaves per plant. On the other hand, the analysis of variance for dry weight of leaves per plant gave statistically insignificant effect of genotype, nitrogen fertilizer and interaction between GXN at all sampling stages. Similar results were found by [18,19]. Means of fresh and dry weight of foliage per plant as affected by genotype, nitrogen fertilizer and the interaction between genotype and nitrogen are presented in Table 3.The analysis of variance for fresh foliage weight exposed significant difference among the evaluated genotypes at 4 WAS and insignificant effect thereafter at 7, 10, 13, and 16 WAS. Thus the significant difference at 4 WAS could be attributed to different response of genotypes at the beginning of seedling growth before the 4-leaf stage to environmental conditions. Similar results were reported by [20]. Then the foliage weight reached its peak at 7 WAS and continued declining as the result of progressively produced smaller leaves but insignificantly different. Nitrogen fertilizer and the interaction G X N exhibited insignificant effect on foliage fresh weight per plant. This may be due to under applied nitrogen or lack of differences in nitrogen use efficiency. These findings were parallel with those reported by [21] who found that increasing nitrogen levels from 0, 35, 70, and 105 kg N/fed showed significant effect. Also [22] reported similar findings as found 60 and 80 kg N/ha gave significant effect. On the other hand, the analysis of variance for foliage dry weight at 4, 7, and 10 WAS stages indicate that the studied genotypes indifferently responded to growing conditions at the beginning of the growing season. The dry weight of foliage progressively increased up to maximum weight at 7 WAS, thereafter from 10 WAS stage onward the rate of dry matter accumulation declined, but with significant differences among the genotypes at 13

and 16 WAS. Similarly [19] reported significant results. Nitrogen fertilizer and interaction between genotype and nitrogen manifested insignificant effect at the sampling terms. This may be attributed to low nitrogen levels applied which failed to stimulate a substantial accumulation of dry matter on the foliage. These results were in harmony with those reported by [23].

Mean values of root dimensions (length and diameter) obtained from the six sugar beet genotypes grown under low N fertilizer levels are shown in Table4. Analysis of variance for mean values of root length reflected insignificant effect among the evaluated genotypes in four out five sampling stages but at 4WAS manifested significant effect. So this variation among the studied genotypes may be attributed to variation in seedling growth. While, thereafter, the non- significant effect at the other sampling stages indicates that the genotypes had very similar root length growth, and noted that root length from 7 WAS through 16 WAS became stable. These findings were in line with those reported by [24]. The different levels of N fertilizer and interaction between GxN exhibited non - significant effect on root length at all sampling stages. These results were in line with those detected by [25]. Also, [26]. The analysis of variance for root diameter means revealed non - significant effects at 4, 10 and 16 WAS sampling stages among the evaluated genotypes which indicate similar expansion of cells which enhance root diameter, while the sampling at 7 and 13 WAS reflected significant effect on the root diameter. This could be attributed to variation among the evaluated genotypes at the existing climatic conditions at these terms (7 and 13 WAS). Because various types of sugar beet genotypes may not have the same requirements and reactions to the local environmental effects. Such results were found by [16]. Also, similar idea was reported by [24]. Regarding the significant and insignificant effect of the genotype at different growth stages were reported by [27,19] found significant and non- significant effect among different cultivars. However, the different rates of N fertilizer and their interaction with the genotypes were non - significant. This indicates that N fertilizer rate and GXN had not [28] who found insignificant effect on both root length and root diameter in the second season of their experiment.

Means of fresh and dry weight of root per plant as affected by genotype, nitrogen fertilizer rate and interaction between genotype and nitrogen fertilizer (GXN) are presented in Table 5.The analysis of variance for fresh weight of root per plant revealed significant difference among the evaluated genotypes at 4 and 10 WAS stages. The variation among the tested genotypes may be ascribed to the efficiency of utilization of growing conditions variability at these two stages. Similar results were observed by [29,16]. The other three stages 7, 13, and 16 WAS showed non - significant effect which implies no genotypic variation on root fresh weight among the studied genotypes. Similarly [27] reported significant and non - significant results in the first and second seasons of their experiments, respectively. It was noted that the fresh weight of root increased until reached its peak at 13WAS as it was increased at expense of the top growth then declined. Moreover, the N fertilizer levels and the interaction among genotypes and N fertilizer were non-significant which indicate similar response to low N fertilizer and no interaction (GXN) effect on the trait. In line to this, [13] found non - significant effect in the second season of their experiment also [30] noted the same. The analysis of variance for mean values of root dry weight revealed highly significant effect at 4 and 10 WAS sampling stages among the evaluated genotypes. This indicates that at these two growth stages the evaluated genotypes showed variation in their response to the growing conditions in developing dry root weight accumulation. This is in line with [14]. Who stated that the phenomenon of the genotype by environment interaction is always present in the crop production causing genotypes to have different results and ranks in various environmental conditions, also These findings were in line with those highly significant differences among the cultivars reported by [16]. While at 4, 13

and 16 WAS the mean values reflected non-significant effect on root dry weight which implies that the genotypes had similar root development and in turn the root dry weight in early and late growth stages, similar results were found by [27] in the second season of their experiment. This inconsistency could be attributed to the ability of sugar beet genotypes to compensate their growth throughout the growing stages especially in early stages of development. The N fertilizer levels and their interaction with genotypes produced no significant effect on root dry weight per plant. These findings were in agreement with [31]. Who observed that root dry weight started accumulation of dry matter from 7 WAS increasingly to 16 WAS due to translocation of assimilates towards the root, which enhanced root length, diameter, root fresh weight as well as root dry weight.

Growth analysis as the first step in the analysis of primary production being a link between merely recoding plant productions and analyzing it by means of physiological methods. However, biomass increments in plant or root stands expressed in ground area basis (Crop growth rate = CGR), The rate of increase in biomass per unit of biomass present (Rate growth rate=RGR) and the rate of increase of dry weight per unit time per unit area of leaf surface (Net assimilation rate= NGR) are presented in Table 6.With regard to root and plant crop growth rate (RCGR and PCGR, respectively), data in Table (6) showed that crop growth rate was insignificantly increased with different applied treatments. Here, the highest plant crop growth rate values were 9.571, 9.150, 7.857 (g)/cm2/day; scored by G3, G1 and G2 at three different stages of growth namely 7-4, 10-7 and 13-10 WAS, respectively, while its highest values were 8.374, 6.264 and 6.694 g/cm2/day with nitrogen fertilizer level; No, N2 and No, respectively, at the same stage periods of growth season. Meanwhile the highest root crop growth rate mean values were; 0.005, 0.007 and 0.007 (g)/ cm2 /day with G3&G2, G1 and G0 genotype, respectively and its highest values were 0.005, 0.005 and 0.006(g)/ cm2 /day with No, N1 and No fertilizer level, respectively. At the same consecutive different periods of growth mentioned ahead. These results were in harmony with [32, 22] who found insignificant CGR at elect stages of growth.

Concerning relative growth rate (RGR) data in Table 6.exhibited that relative growth rate was insignificantly increased with the studied treatments. The highest mean values were 0.045, 0.019 and 0.013 gg-1 day-1, scored by G2, G0 and G0 genotypes, respectively, meanwhile the highest mean values were 0.044, 0.018 and 0.010 obtained from No, N1 and N2 fertilizer levels, respectively, These values were determined at consecutive times of growth stages 7-4, 10-7 and 13-10 WAS, respectively. Similarly (2000) [33] reported insignificant difference.

Moreover, with regard to Net assimilation rate (NAR), data in Table (6) reflected that Net assimilate rate was insignificantly increased with different applied treatments. Here, the highest net assimilate rate value was 0.010 g cm-2 day-1 determined at 7-4 WAS growth period, scored by G2 and its highest value was 0.009 g cm-2day-1, with N0 fertilizer level. This is in line with El-Zayat (2000)[33] who reported non – significant effect.

In the light of the present study, It could be assumed that tested genotypes may have the same requirements and reactions to the local environmental effects genetically. Therefore, these physiological components indicated that the evaluated genotypes did not differ in the proportion of photosynthetates partitioned into dry weight. Moreover, the non – significant effect of the nitrogen fertilizer level on all the studied growth and some growth components indicates that the low nitrogen fertilizer levels applied may not enhanced the uptake of nitrogen increased (N1 & N2) and the slight unsubstantial variations among the levels could be due to utilization of accumulated nitrogen. This view is in agreement with [34]

who reported that the response of sugar beet depended on the N available in the soil. Nevertheless, no crossover interaction occurred for the fore mentioned parameters, there to be no specific suitability of the tested genotypes to environmental stress condition. The interaction between genotype and N fertilizer level effect on all the evaluated parameters was absent or insignificant. These findings were in line with those reported by [24].

In this study of six sugar beet genotypes; the variation in root and plant growth rate, relative growth rate (RGR) and net assimilation rate (NAR) revealed no substantial differences among the genotypes or tested Nitrogen levels. This is probably arises because the beet is a vegetative storage organ and has no clear growth stages that particularly susceptible to unfavorable environmental conditions. Nevertheless, no significant interaction between genotype and N fertilizer level indicates a similar response of genotypes; not depending on N level. These findings were in line with those reported by [24]. Nonetheless, the growth evaluating techniques are good indicators for relating sugar beet growth to climatic conditions and information on crop growth during each growing stage is one of most important indexes of optimum cultivation and management, although, these results exhibited no significant difference at the different growth periods.

It has been noticed that sugar beet has ability of compensating its morphological growth components through the season. This could be fortified by the significant effects in some stages and insignificant in others among the studied genotypes.

Conclusion And Recommendations

To this end, it could be concluded that all the studied genotypes could be cultivated successfully under Al Kadro, Khartoum North climatic and soil conditions. The tested low nitrogen fertilizer levels coupled with very low available nitrogen and organic carbon in the soil; ranged between 0.00-0.003 % and 0.002-0.01%, respectively, not enhanced nitrogen uptake and no substantial interaction (GxN), also, the growth analysis components reflected non-significant effect among the studied genotypes, nitrogen levels and their interaction. Therefore, further research is needed to fix outstanding genotype and optimum rate of nitrogen for benefit of the farmer, environment and developing local sugar and fodder industry in the area.

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