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INFLUENCE OF PLANTING DENSITY AND NITROGEN FERTILIZER LEVELS ON FRESH FORAGE YIELD AND QUALITY OF SOME FORAGE SORGHUM GENOTYPES

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ABSTRACT

Two field experiments were conducted during two successive summer growing seasons 2013 and 2014 in an administration field at Meet Gaber village, Belbais District, Sharkia Governorate, Egypt. The experiment aimed to study the effect of four planting densityies (D1:70000 plants/fad., D2: 105000 plants/fad., D3:140000 plants/fad.; D4: 210000 plants/fad.) and three nitrogen fertilizer levels (N1: 15 kg N/fad./cut; N2:30 kg N/fad./ cut; N3: 45 kg N/fad./cut) on fresh weight /plant, fresh forage yield/fad., as well as crude protein and fiber contents in leaves and stems at 1st and 2nd cut of three forage sorghum genotypes (G1: Sudan grass (*Sorghum sudanense (Piper*) Stapf, cv. Giza 2),G2: sweet sorghum (*S. bicolor* L. Moench, cv. Giza 1), and G3: sorghum (*S. bicolor* L. Moench) x Sudan grass (*S. sudanense (Piper)* Stapf, cv. Surdan) as an interspecies hybrid. The obtained results could be summarized as follows: Sudan grass was superior in fresh weight /plant, fresh forage yield /fad., where sweet sorghum was superior in crude protein and fiber contents. Using planting density 70000 plants/fad., had a significant increase in fresh weight /plant, crude protein and fiber content in leaves and stems. Fresh forage yield/fad., was significantly increased due to increasing planting density up to 140000 or 210000 plants/fad., at 1st and 2nd cut in both seasons and their combined analysis. The increase of N level up to 45 kg N/fad., caused a significant increase in the aforementioned characters, except crude fiber content which significantly decreased at 1st and 2nd cut in both seasons and their combined analysis.

Key words: Forage sorghum genotypes, planting density, nitrogen, sudan grass, sweet sorghum, crude protein, crude fiber.

INTRODUCTION

In Egypt, animal production is suffering scarcity because of the competition between the production of human food and animal feed. The insufficiency in forage production is more svere in summer season. Thus, increasing the forage production in the summer period is one of major target of the government to overcome the livestock production problem in order to face human needs.

Concerning the effect of forage sorghum genotypes, Almodares *et al.* (2009) stated that fiber content of sweet sorghum was higher than corn. Sweet sorghum bagasse had lower crude protein and higher crude fiber than both corn and sweet sorghum. Ayub *et al.* (2010) showed that variety F-9603 of sorghum, significantly produced higher crude protein percentage (7.62%) and lowest crude fiber percentage (28.37%). Bozorgvar *et al.* (2013) showed that the sugar graze hybrid of sorghum produced the highest forage and dry matter yield. Mahmood *et al.* (2013) reported that sorghum cultivar 'Goliath' (*Sorghum bicolor* × *S. bicolor hybrid*) had a higher biomass yield than Bovital (*S.*

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bicolor × *S. sudanense* hybrid) while, cultivar Bovital had a greater protein content than 'Goliath'. Soleymani and Shahrajabian (2013) pointed out that sweet sorghum cultivar Keller produced the maximum stalk, leaf and total dry matter than cultivar Rio.

Regarding plant density, El-Naggar (1983) found that increasing seeding rate decreased the percentage of protein in leaves, stalks and whole plant. Abd-Alla (1994) showed that increasing planting distance to 20 cm between hills decreased crude protein content in the plant and its parts. Yousef (2002) showed that fresh and dry weight/plant increased consistently and significantly as planting densities increased. Turgut *et al.* (2005) indicated that yield of sweet sorghum (*Sorghum bicolor* L. Moench) decreased with increasing intra-row spacing. Five- or 10 cm intra-row spacings gave more than 80 tonnes/ha., forage yield. Soleymani and Shahrajabian (2013) reported that the maximum stalk, leaf and total dry matter of sweet sorghum were achieved under planting density of 600000 plants/ha., Mahmood *et al.* (2013) showed that Planting density had no clear influence on most of the quality parameters of sorghum.

Abd-Alla (1994) and Bahrani and Deghani (2004) showed that increasing N levels (0, 40, 60 and 80 kg N/fad.) increased percentage and production of crude protein and crude fiber. Almodares *et al.* (2009) evaluated the effects of four nitrogen treatments (50, 100, 150 and 200 kg urea/ha.) on crude protein and crude fiber contents of three fodders (corn, sweet sorghum and sweet sorghum bagasse), they showed that treatment of 200 kg urea/ha., had the highest protein content (8%) and the lowest fiber content (31.90%). Afzal *et al*. (2012) stated that addition of N up to 57.5 kg N/ha., enhanced significantly fresh and dry weights/plant, total green forage yield and total dry matter yield and crude protein content of sorghum. Abou-Amer and Kewan (2014) revealed that increasing nitrogen fertilizer levels up to 120 kg N/fad., had a significant increase in fodder yield (13.14 t/fad.), dry matter yield (2.12 t/fad.) and crude protein (11.45%), while crude fiber was the highest (37.08%) as average of three cuts at 100 kg N/fad., of sorghum (*Sorghum bicolor* L.). Hussein and Sabbour (2014) reported that increasing nitrogen fertilization up to 60 or 80 kg N/fad., caused pronounced increases in fresh matter yield and dry matter yield of the 1st and 2nd cuts. Elshafey (2015) indicated that fresh and dry forage yields and crude protein content of sudan grass were significantly increased with increasing nitrogen level from 50 to 75 and 100 kg N/fad., and significantly decreased due to increasing nitrogen rate from 100 to 125 kg N/fad., over both seasons. Therefore, the experiment aimed to study the effect of planting density and nitrogen fertilizer levels on fresh weight / plant, fresh forage yield /fad., as well as crude protein and fiber contents in leaves and stems at 1st and 2nd cut of three forage sorghum genotypes.

MATERIALS AND METHODS

Two field experiments were conducted during two successive summer growing seasons 2013 and 2014 in an administration field at Meet Gaber village, Belbais District, Sharkia Governorate, Egypt. This investigation was carried out to study the effect of four planting densities which were D1:70000 plants/fad., using planting distance of 20 cm on one side of the ridge and two plants/hill.; D2: 105000 plants/fad., using planting distance of 20 cm on one side of the ridge with three plants/hill.; D3:140000 plants/fad., using planting distance of 10 cm on one side of the ridge with two plants / hill and D4: 210000 plants / fad., using planting distance of 10 cm on one side of the ridge with three plants / hill. Also, to study the effect of three nitrogen fertilizer levels (N1: 15 kg N/fad./cut; N2:30 kg N/fad./cut and N3: 45 kg N/fad./cut) on fresh weight g/plant, fresh forage yield ton/fad., crude protein and fiber contents in leaves and stems at 1st and 2nd cuts of three forage sorghum genotypes (G1: Sudan grass (*S. sudanense (Piper)* Stapf, cv. Giza 2), G2: sweet sorghum (*S. bicolor* L.) Moench, cv. Giza 1), and G3: sorghum (*S. bicolor* L.) Moench) x Sudan grass (*S. sudanense (Piper)* Stapf, cv. Surdan) as an interspecies hybrid. The experiments were laid out in a split-split plot design in three replicates, where forage cultivars were assigned to the main plots and the planting densities occupied the first order sub plots. However, nitrogen fertilizer levels were allocated to the second order sub plots. The plot area was 10.5 m^2 (2.5 m in length and 4.2 m in width) *i.e.,* 7 ridges each of 60 cm width.

Seeds (6 grains/hill) were sown on May 12th for both summer successive seasons (2013 and 2014) with skillful workers. To obtain the four planting densities as mentioned above the thinning was made after three weeks from sowing to leave two or three plants/hill. The preceding crop was wheat (*Triticum aestivum* L.) and soil texture was clay in both seasons. Basal dose of 31 kg P_2O_5/fad., in form of calcium super phosphate was added at seedbed preparation, while potassium in the form of potassium sulphate (48% K_2O) was added in two equal doses, at seedbed preparation and two weeks after planting, whereas N fertilizer was added in the form of ammonium nitrate (33.5% N) before the first irrigation and after the first and second cut. Weeds were controlled by hoewing. Other cultural practices were done as recommended in farmer fields.

Recorded Data

Fresh farage weight/plant and fresh forage yield /fad.

Fresh forage weight/plant and yield/fad., were recorded at cutting time (57 days after sowing for the first cut and 35 days later for the second cut). An area of 4.5 m^2 (the inner three ridges of 2.5 m length × 60 cm width) was cut where, plots were hand clipped to a height of about 10 cm and weighted in kg/plot to determine fresh forage yield, then converted to estimate fresh forage yield in ton/fad. Immediately after harvest, the whole plant dry matter and moisture content of all samples were determined by keeping 500 g of each sample in a laboratory drying oven set at a constant temperature of 105^0C for 48 hours.

Forage quality

Crude protein content (CP%) in leaves and stems was estimated with modified kjldahal method and multiplying the nitrogen content by factor of 5.75 to obtain the protein content (AOAC, 1990). Crude fiber content (CF%) in leaves and stems was determined according to AOAC (1990).

Statistical Analysis

Statistical analysis of each experiment was performed as the methods outlined by Steel *et al.* (1997). Significance of differences between the various means of different characters under study were compared with the help of Duncan's multiple range test (1955). The combined analysis of variance was also computed for all traits recorded after establishing by Bartlett's homogeneity test, where the error variance of the individual season was homogeneous. In the interaction Tables, capital and small letters were used for comparison among row and column means, respectively.

RESULTS AND DISCUSSION

Fresh Forage Weight / Plant and Forage Yield/fad.

Tables 1 and 2 as well as Figs. 1, 2 and 3 show fresh weight / plant and fresh forage yield/fad., as affected by three forage sorghum genotypes, planting density and N fertilizer levels and their interactions at 1st and 2nd cut in both seasons and their combined analysis.

Forage sorghum genotypes effect

Results presented in Tables 1 and 2 indicate that the three forage sorghum genotypes varied significantly. These differences play a major role in determining not only a plant's ability to survive in the ecosystem, but also its potential productivity. Sudan grass the superem genotype in aforementioned traits, interspecies hybrid sorghum ranked the second and followed by sweet sorghum at 1st cut in the 1st and 2nd seasons as well as in the combined analysis, while at 2nd cut in the 1st and 2nd seasons as well as in the combined data, sudan grass was superior in aforementioned traits, sweet sorghum ranked the second and followed by interspecies hybrid sorghum. Higher fresh weight /plant and fresh forage yield/fad., of sudan grass were recorded by Almodares *et al*. (2006, 2009), Ayub *et al.* (2010), Afzal *et al*. (2012), Mahmood *et al.* (2013) and Soleymani and Shahrajabian (2013).

Planting density effect

It is evident from Tables 1 and 2 that the lowest Planting density (70000 plant/fad.) produced significantly the maximum fresh weight /plant at the two cuts in both seasons and their combined, except at 2nd cut in the 1st and 2nd seasons, where the differences among planting densities did not reach the level of significance.

Table 1. Fresh weight /plant (g) of sorghum as affected by forage sorghum genotypes, planting density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotype (G)						
Sudan grass (Giza2)	749.19 a	329.89 a	733.61 a	322.78 a	741.40 a	326.33 a
Sweet sorghum (Giza1)	212.85 c	172.89 b	210.28 c	170.83 b	211.56 c	171.86 b
Inter species Hybrid sorghum (Sx17)	238.99 b	147.92 c	236.67 b	141.94 c	273.83 b	144.93 c
F. test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	411.20 a	220.93	404.07 a	218.15	407.64 a	219.54 a
105000 plants/ fad.	404.63 a	219.48	397.41 b	214.07	401.02 ab	216.78 a
140000 plants/ fad.	401. 19 a	214.59	395.19 c	207.04	398.19 b	210.82 a
210000 plants/ fad.	384.36 b	212.59	377.41 d	208.15	380.89 c	210.37 b
F. test	**	NS	**	NS	**	**
Nitrogen fertilizer level (N)						
15 kg N/ fad. / cut	353.57 c	191.58 c	348.06 c	187.5 c	350.81 c	189.54 c
30 kg N/ fad. / cut	392.98 b	213.31 b	385.83 b	210.28 b	389.41 b	211.79 b
45 kg N/ fad. / cut	454.49 a	245.81 a	446.67 a	237.78 a	450.58 a	241.79 a
F. test	**	**	**	**	**	**
Interactions						
G x D	**	NS	NS	NS	**	NS
G x N	**	NS	**	NS	**	*
D x N	NS	NS	NS	NS	*	NS

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 2. Fresh forage yield/fad., (ton) of sorghum as affected by forage sorghum genotypes, plant density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotype (G)						
Sudan grass (Giza2)	38.24 a	18.37 b	36.07 a	17.09 b	37.15a	17.73 b
Sweet sorghum (Giza1)	19.93 c	22.10 a	17.82 c	20.75 a	18.88 c	21.43 a
Inter species Hybrid sorghum (Sx17)	25.83 b	16.16 c	23.69 b	15.45 b	24.76 b	15.81 c
F.test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	27.19 b	18.58 b	24.97 b	17.55 b	26.08 b	18.06 b
105000 plants/ fad.	27.15 b	19.59 a	24.94 b	18.38 a	26.04 b	18.98 a
140000 plants/ fad.	29.08 a	19.65 a	26.58 a	18.60 a	27.83 a	19.12 a
210000 plants/ fad.	28.59 a	17.68 c	26.95 a	16.53 c	27.77 a	17.11 c
F. test	**	**	**	**	**	**
Nitrogen fertilizer level (N)						
15 kg N/ fad. / cut	23.74 c	16.26 c	21.59 c	15.30 c	22.66 c	15.78 c
30 kg N/ fad. / cut	28.01 b	18.74 b	25.95 b	17.70 b	26.98 b	18.22 b
45 kg N/ fad. / cut	32.26 a	21.63 a	30.04 a	20.29 a	31.15 a	20.96 a
F. test	**	**	**	**	**	**
Interactions						
G x D	NS	NS	**	**	**	**
G x N	**	NS	**	NS	**	NS
D x N	NS	NS	NS	NS	NS	**

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

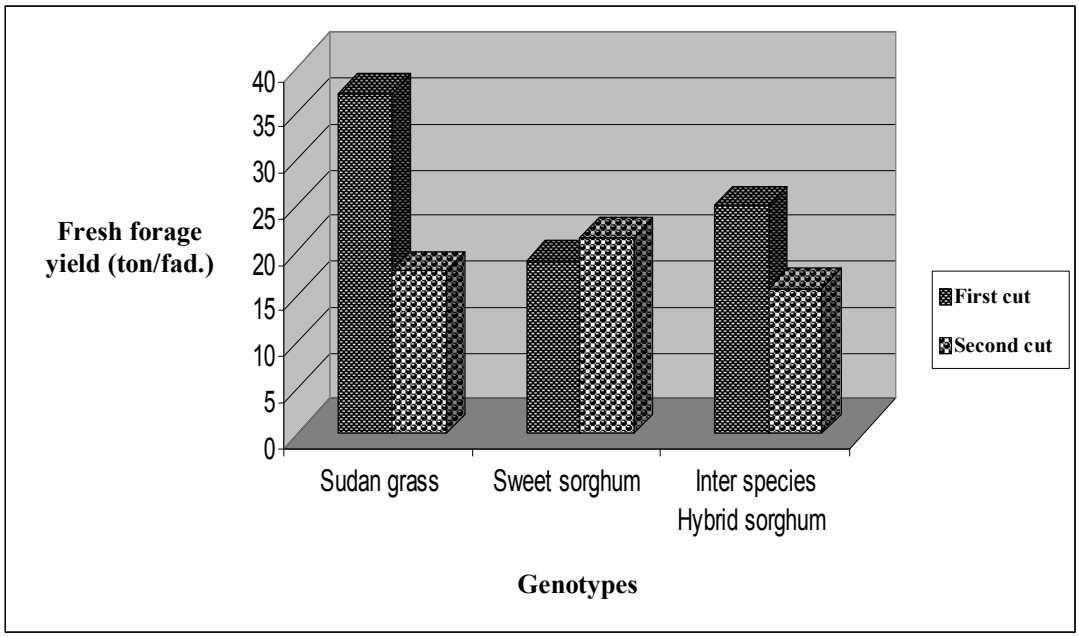

Fig. 1. Fresh forage yield (ton/fad.) of sorghum as affected by forage sorghum genotypes

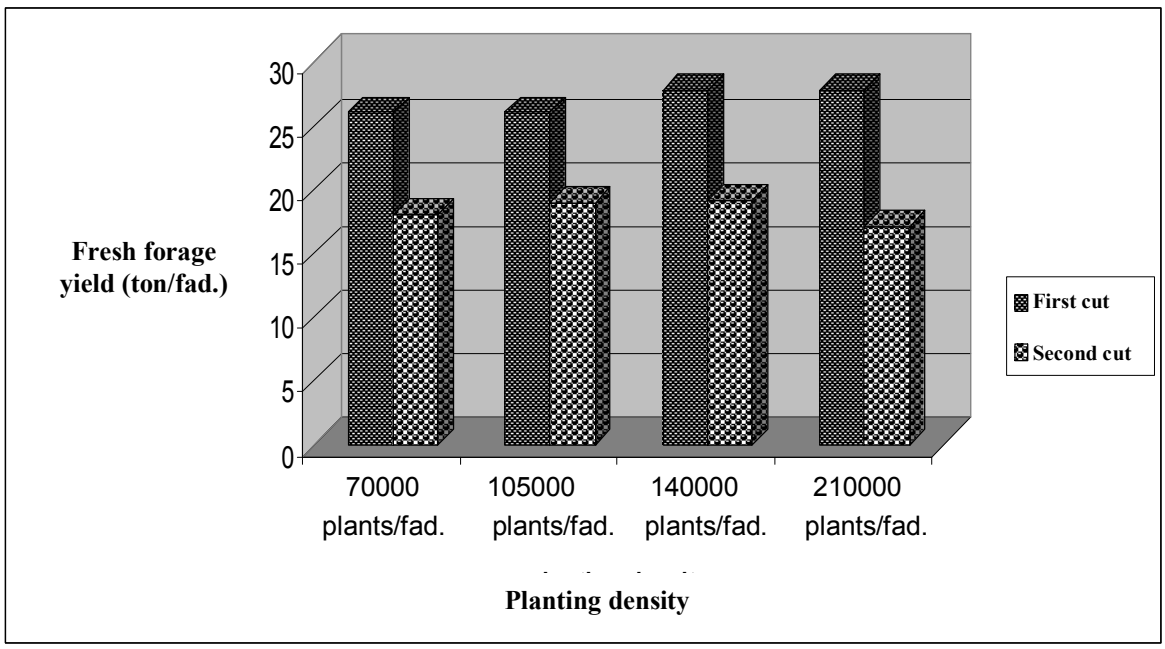

Fig. 2. Fresh forage yield (ton/ fad.) of sorghum as affected by planting density

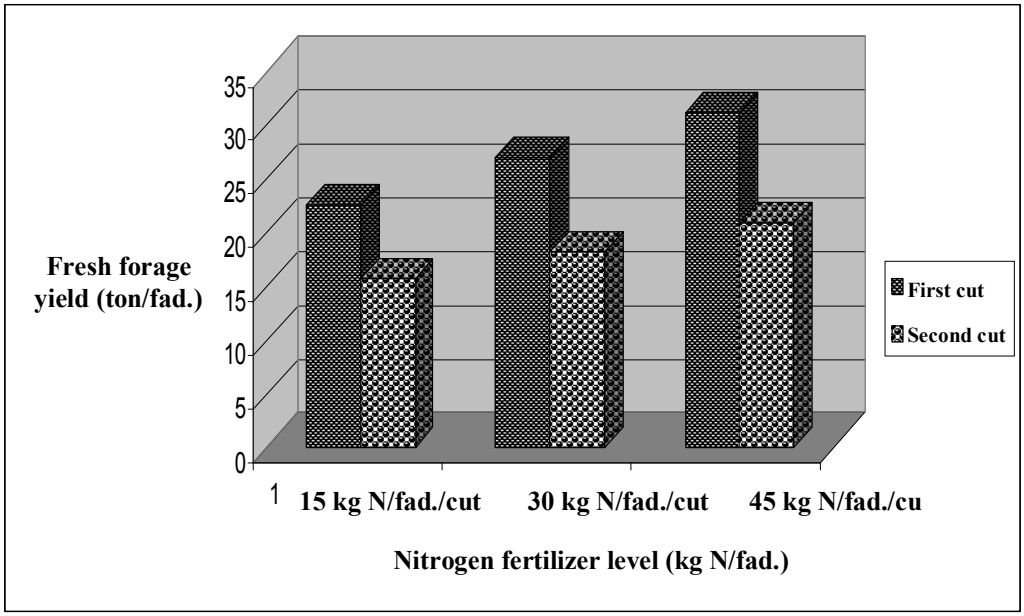

Fig. 3. Fresh forage yield (ton/ fad.) of sorghum as affected by N fertilizer level

On the other hand, 140000 plants/fad., produced the highest value of fresh forage yield./fad., and the difference did not reach the level of significant compared with the planting density 210000 plants/fad., (Table 2). It could be concluded that the dense plants suffered from competition for light, water and nutrient absorption. These results are in a good connection with those reported by El-Naggar (1983), Abd-Alla (1994), Mahmoud (1997), Bahrani and Deghani (2004), Turgut *et al.* (2005), Afzal *et al*. (2012), Mahmood *et al.* (2013) and Soleymani and Shahrajabian (2013).

Nitrogen fertilizer levels effect

It is evident from results (Tables 1 and 2) that increasing N level, resulted in a significant increase in fresh weight /plant and fresh forage yield/fad., where, the maximum value of aforementioned traits were obtained at the highest N level (45 kg N/fad./cut) at 1st and 2nd cut in both seasons and their combined analysis. The average increase for the mean of both seasons for 1st and 2nd N- increment reached about 11.0 and 28.4% for fresh weight (g/plant), and 19.1 and 37.5% for fresh forage yield (ton/ fad.) at 1st cut and 11.7 and 27.6% for fresh weight (g/plant) and 15.5 and 32.8% for fresh forage yield (ton/fad.) at 2nd cut, respectively, in the combined analysis. According to these results, forage sorghum genotypes plants were in need for N fertilization. However, the aforementioned traits were highly responsed to this addition, where each N increment was accompanied by a significant increase in aforementioned traits. These results are interesting as they clearly indicate the positive and enhancing effect of nitrogen on the yield of forage sorghum plants. These results are in accordance with those found by Bahrani and Deghani (2004), Turgut *et al.* (2005), Afzal *et al*. (2012), Soleymani and Shahrajabian (2013), Abou-Amer and Kewan (2014) and Elshafey (2015).

Interaction effect

The interaction effect between forage sorghum genotypes (G) and planting density (D) was highly significant on fresh weight /plant and fresh forage yield / fad., at 1st cut in the combined data. Results in Tables 1-a and 2-a, at the 1st cut show that, the maximum value of aforementioned traits (761.78 g/plant, 39.37 ton/ fad.) were recorded by planting sudan grass with 70000 plants/fad., for fresh weight/plant and at 210000 plants/fad., for fresh forage yield /fad., respectively, while the minimum values of aforementioned traits (200.93 g/plant, 18.47 ton/ fad.) were produced by planting sweet sorghum at planting density 210000 plants/fad. for fresh weight/plant and at 70000 plants/fad., for fresh forage yield /fad.

Table 1-a. Total plant fresh weight (g) of forage sorghum as influenced by the interaction between forage sorghum genotypes (G) and planting density (D) at 1st cut (combined data)

Forage sorghum genotype (G)	Planting density (plant/fad.)			
	70000	**105000**	**140000**	**210000**
	A	A	A	B
Sudan grass	761.78a	751.22a	739.08a	713.53a
	A	A	A	B
Sweet sorghum	218.92c	217.69c	208.71c	200.93c
	A	AB	A	B
Interspecies hybrid sorghum	242.21b	234.14b	246.78b	228.19b

Table 2-a. Fresh forage yield (ton/fad.) of sorghum as influenced by the interaction between forage sorghum genotypes (G) and planting density (D) at 1st cut (combined data)

Forage sorghum genotype (G)	Planting density (plant/fad.)			
	70000	**105000**	**140000**	**210000**
	C	C	B	A
Sudan grass	35.27a	35.20a	38.78a	39.37a
	A	A	A	A
Sweet sorghum	18.47c	18.52c	19.42c	19.10c
	A	A	A	A
Interspecies hybrid sorghum	24.50b	24.40b	25.30b	24.85b

The interaction effect between forage sorghum genotypes (G) and nitrogen fertilizer levels (N) was highly significant on fresh weight /plant and fresh forage yield /fad., at 1st cut, in the combined data. Data in Tables (1-b and 2-b at the 1st cut) show that, the maximum value of aforementioned traits (827.06 g/plant, 42.18 ton/fad.) were produced by planting of sudan grass and adding 45 kg N/fad./cut., while, the minimum value (180.14 g/plant and 16.44/fad.) were recorded by planting sweet sorghum under 15 kg N/fad./cut.

The significant interaction effect between planting density (D) and nitrogen fertilizer levels (N) on fresh weight/plant (combined data, Table 1-c at 1st cut) indicate that the maximum value of fresh weight (459.03 g/plant) was produced at lowest planting density (700000 plants/fad.) under 45 kg N/fad./cut., while the minimum value of fresh weight (329.73 g/plant) was obtained at 210000 plants/ fad., under 15 kg N /fad./cut.

Crude Protein (CP%) and Crude Fiber Contents (CF%) in Leaves and Sstems

Results in Tables 3, 4, 5 and 6 show crude protein content (CP%) and crude fiber contents (CF%) in leaves and stems of three forage sorghum genotypes as affected by planting density and N fertilizer levels and their interactions at 1st and 2nd cut in the two seasons and their combined analysis.

Table 1-b. Total plant fresh weight (g) of forage sorghum as influenced by the interaction between forage sorghum genotypes (G) and nitrogen fertilizer levels (kg N/fad./cut) at 1st cut (combined data)

Forage sorghum genotypes (G)	Nitrogen fertilizer levels(kg N/fad./cut)		
	15	**30**	**45**
	C	B	A
Sudan grass	670.49a	726.66a	827.06a
	C	B	A
Sweet sorghum	180.14c	208.08c	246.48c
	C	B	A
Interspecies hybrid sorghum	201.81b	233.48b	278.20b

Table 2-b. Fresh forage yield (ton/fad.) of sorghum plants as influenced by the interaction between forage sorghum genotypes (G) and nitrogen fertilizer levels (kg N/fad./cut) at 1st cut (combined data)

Forage sorghum genotypes (G)	Nitrogen fertilizer levels(kg N/fad./cut)		
	15	**30**	**45**
	C	B	A
Sudan grass	31.72a	37.56a	42.18a
	C	B	A
Sweet sorghum	16.44c	18.40c	21.80c
	C	B	A
Interspecies hybrid sorghum	19.83b	24.98b	29.48b

Table 1-c. Total plant fresh weight (g) of forage sorghum as influenced by the interaction between planting density (D) and nitrogen fertilizer levels (kg N/fad./cut) at 1st cut (combined data)

Planting density (plant/fad.)	Nitrogen fertilizer levels(kg N/fad./cut)		
	15	**30**	**45**
	C	B	A
70000	360.00a	403.88a	459.03a
	C	B	A
105000	361.49a	396.81a	444.76ab
	C	B	A
140000	352.03a	385.39a	457.14ab
	C	B	A
210000	329.73b	371.54b	441.38b

Table 3. Crude protein content (CP%) in leaves of sorghum as affected by forage sorghum genotypes, planting density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotypes (G)						
Sudan grass (Giza 2)	13.34b	12.98b	13.18 b	12.86 b	13.26 b	12.92 b
Sweet sorghum (Giza 1)	14.71a	13.98a	14.56 a	13.85 a	14.64 a	13.92 a
Inter species Hybrid sorghum (S x 17)	12.61c	11.52c	12.46 c	11.40 c	12.53 c	11.46 c
F. test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	13.92a	13.26a	13.77 a	13.11 a	13.85 a	13.19 a
105000 plants/ fad.	13.69b	12.97b	13.52 b	12.81 b	13.60 b	12.89 b
140000 plants/ fad.	13.46c	12.63c	13.29 c	12.51 c	13.38 c	12.57 c
210000 plants/ fad.	13.15b	12.46d	13.01 d	12.38 d	13.08 d	12.42 d
F. test	**	**	**	**	**	**
Nitrogen fertilizer level (N)						
15 kg N/ fad. / cut	13.24c	12.36c	13.09 c	12.22 c	13.17 c	12.29 c
30 kg N/ fad. / cut	13.55b	12.86b	13.42 b	12.73 b	13.49 b	12.80 b
45 kg N/ fad. / cut	13.87a	13.26a	13.68 a	13.16 a	13.78 a	13.21 a
F. test	**	**	**	**	**	**
Interactions						
G x D	NS	**	NS	**	NS	**
G x N	*	**	NS	NS	NS	**
D x N	NS	NS	NS	NS	NS	**

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 4. Crude protein content (CP%) in stems of sorghum as affected by forage sorghum genotypes, planting density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotypes (G)						
Sudan grass (Giza2)	12.75 b	12.19a	12.57 b	12.08 a	12.66 b	12.14 a
Sweet sorghum (Giza1)	13.59a	12.17a	13.41 a	12.07 a	13.50 a	12.12 a
Inter species Hybrid sorghum (Sx17)	11.06c	9.88b	10.90 c	9.82 b	10.98 c	9.85 b
F. test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	12.92a	12.20a	12.72 a	11.89 a	12.82 a	12.04 a
105000 plants/ fad.	12.66b	11.68b	12.46 b	11.63 b	12.56 b	11.65 b
140000 plants/ fad.	12.36c	11.25c	12.19 c	11.22 c	12.27 c	11.23 c
210000 plants/ fad.	11.94b	10.53d	11.79 d	10.57 d	11.87 d	10.55 d
F. test	**	**	**	**	**	**
Nitrogen fertilizer level (N)						
15 kg N/ fad. / cut	11.96c	10.97c	11.76 c	10.97 c	11.86 c	10.97 c
30 kg N/ fad. / cut	12.48b	11.39b	12.33 b	11.24 b	12.40 b	11.32 b
45 kg N/ fad. / cut	12.96a	11.88a	12.79 a	11.76 a	12.87 a	11.82 a
F. test	**	**	**	**	**	**
Interactions						
G x D	**	**	NS	NS	**	**
G x N	**	NS	*	NS	**	NS
D x N	NS	**	NS	NS	**	*

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 5. Crude fiber content (CF%) in leaves of sorghum as affected by forage sorghum genotypes, planting density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotypes (G)						
Sudan grass (Giza 2)	28.76 b	28.65 b	28.58 b	28.52 b	28.67 b	28.59 b
Sweet sorghum (Giza 1)	31.80 a	32.35 a	31.33 a	32.15 a	31.56a	32.25 a
Inter species Hybrid sorghum (S x 17)	27.77 c	28.24 c	27.56 c	28.08 c	27.66 c	18.16 c
F. test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	30.34 a	30.16 a	29.77 a	29.97 a	30.06 a	30.07 b
105000 plants/fad.	29.82 b	30.26 a	29.53 a	30.12 a	29.67 b	30.19 a
140000 plants/fad.	29.24 c	29.74 b	28.90 b	29.60 b	29.07 c	29.67 c
210000 plants/fad.	28.37 d	28.83 c	28.41 b	28.64 c	28.39 d	28.74 d
F. test	**	**	**	**	**	**
Nitrogen fertilizer level (N):						
15 kg N/ fad./cut	30.08 a	30.61 a	29.48 a	30.45 a	29.78 a	30.53 a
30 kg N/ fad./cut	29.52 b	29.42 b	29.20 a b	29.24 b	29.36 b	29.33 b
45 kg N/ fad./cut	28.72 c	29.22 c	28.78 b	29.05 c	28.75 c	29.13 c
F. test	**	**	*	**	**	**
Interactions						
G x D	**	**	NS	**	**	**
G x N	**	**	NS	**	**	**
D x N	**	**	NS	**	*	**

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 6. Crude fiber content (CF%) in stems of sorghum as affected by forage sorghum genotypes, planting density and nitrogen fertilizer levels in the two seasons (2013 and 2014) and their combined

Main effects and interactions	First season		Second season		Combined	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Forage sorghum genotypes (G)						
Sudan grass(Giza2)	28.37 b	28.78 b	28.16 a	28.33 a	28.26 a	28.55 b
Sweet sorghum(Giza1)	28.48 a	28.93 a	28.17 a	28.70 a	28.33 a	28.81 a
Inter species Hybrid sorghum (S x 17)	26.44 c	26.98 c	26.22 b	26.98 a	26.33 b	26.98 c
F. test	**	**	**	**	**	**
Planting density (D)						
70000 plants/ fad.	28.31 a	28.71 a	28.05 a	28.14 ab	28.18 a	28.42 a
105000 plants/ fad.	28.02 b	28.43 b	27.73 b	28.23 a	27.87 b	28.33 a
140000 plants/ fad.	27.50 c	28.12 c	27.22 c	27.97 b	27.36 c	28.05 b
210000 plants/ fad.	27.23 d	27.64 d	27.06 c	27.68 c	27.14 d	27.66 c
F. test	**	**	**	**	**	**
Nitrogen fertilizer level (N)						
15 kg N/ fad. / cut	28.21 a	28.75 a	28.02 a	28.44 a	28.12 a	28.60 a
30 kg N/ fad. / cut	27.71 b	28.26 b	27.36 b	27.94 b	27.54 b	28.10 b
45 kg N/ fad. / cut	27.36 c	27.66 c	27.17 c	27.63 b	27.27 c	27.65 c
F. test	**	**	**	**	**	**
Interactions						
G x D	NS	**	NS	**	NS	**
G x N	**	NS	NS	NS	NS	NS
D x N	**	NS	NS	NS	**	NS

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Forage sorghum genotypes effect

Crude protein and fiber percentage variations among the forage sorghum genotypes seemed to be significant at 1st and 2nd cuttings in both seasons and the combined analysis. These differences play a major role in determining not only a plant's ability to survive in the ecosystem, but also its potential productivity. Sweet sorghum gave higher value of crude protein and fiber contents in leaves and stems, sudan grass ranked the second and followed by interspecies hybrid sorghum at 1st and 2nd cut in the 1st and 2nd seasons as well as in the combined analysis. El-Naggar (1983), Almodares *et al.* (2009), Ayub *et al.* (2010), Mahmood *et al.* (2013) and Soleymani and Shahrajabian (2013) came to similar results on Sudanese sorghum.

Planting density effect

Data presented in Tables 3, 4, 5 and 6 show that crude protein content (CP%) and crude fiber content (CF%) in leaves and stems significantly decreased by increasing planting density from 70000 to 210000 plants/fad. The highest planting density gave the minimum protein and fiber percentages in leaves and stems at 1st and 2nd cuts in first, second seasons and their combined. Similar results were obtained by Geweifel (1990) in his investigation on fodder maize. Also, El-Naggar (1983), Abd-Alla (1994), Mahmoud (1997) and Bahrani and Deghani (2004) reported that increasing planting density decreased the percentage of protein and fiber in leaves, stalks and whole sorghum plant. While, Mahmood *et al.* (2013) found that planting density had no clear influence on most of the quality parameters, while Sanderson *et al.* (1995) found that increasing plant density increased fiber content in forage corn plants.

Nitrogen fertilizer levels effect

Results presented in Tables 3, 4, 5 and 6 show that crude protein content (CP%) and crude fiber content (CF%) in leaves and stems were significantly influenced by N- application . Where, raising nitrogen fertilizer level from 15 to 30 and up to 45 kg N/fad./cut led to a gradual increase in CP, while CF% showed a gradual decrease in 1st and 2nd cuttings in both seasons and their combined. These results are in harmony with those reported by Almodares *et al*. (2009), Mahmood *et al.* (2013), Soleymani and Shahrajabian (2013) and Abou-Amer and Kewan (2014).

Interaction effect

The interaction effect between forage sorghum genotypes (G) and planting density (D) was highly significant on crude protein and fiber contents, in the combined data. Data in Tables 3-a, 4-a and 5-a at the 2nd cut show that, the maximum CP% and CF% (14.05, 13.91 and 32.27%) in leaves and stems, respectively were recorded by planting sweet sorghum at plant population density 70000 plants/fad.

The interaction effect between forage sorghum genotypes (G) and nitrogen fertilizer levels (N) was highly significant on CP% in leaves at 2nd cut, in the combined data. Data in Table 3-b show that, the maximum CP% (14.33%) was produced by planting of sweet sorghum plants and adding 45 kg N/fad./ cut. while, the minimum value of CP (11.00%) was recorded by planting interspecies hybrid sorghum plants under 15 kg N/fad./cut.

Conclusion

Results of this experiments revealed that increasing planting density up to 140000 plants/ fad. led to increase fresh and dry forage yield /fad., but fresh and dry weight /plant, CP % and CF % in leaves and stems were decreased. Application of N fertilizer up to 45 kg N/fad., significantly increased fresh weight /plant, fresh forage yield /fad., and CP %, while CF % was significantly decreased.

Table 3-a. Crude protein (CP%) in leaves of sorghum plants as influenced by the interaction between forage sorghum genotypes (G) and planting density (D) at 2nd cut (combined data)

Forage sorghum genotype (G)	Planting density (plant/fad.)			
	70000	**105000**	**140000**	**210000**
	A	B	B	C
Sudan grass	13.40b	12.83	12.81b	12.64b
	A	A	B	B
Sweet sorghum	14.05a	14.10a	13.78a	13.73
	A	B	C	D
Interspecies hybrid sorghum	12.11c	11.74c	11.11c	10.89c

Table 3-b. Crude protein (CP%) in leaves of sorghum plants as influenced by the interaction between forage sorghum genotypes (G) and nitrogen fertilizer levels at 2nd cut (combined data)

Forage sorghum genotype (G)	Nitrogen fertilizer level (kg N/fad./cut)		
	15	**30**	**45**
	C	B	A
Sudan grass	12.53b	12.93b	13.30b
	C	B	A
Sweet sorghum	13.34a	14.08a	14.33a
	C	B	A
Interspecies hybrid sorghum	11.00c	11.38c	12.01c

Table 4-a. Crude protein (CP%) in stems of sorghum plants as influenced by the interaction between forage sorghum genotypes (G) and planting density (D) at 1st cut (combined data)

Forage sorghum genotype (G)	Planting density (plant/fad.)			
	70000	**105000**	**140000**	**210000**
	A	A	B	C
Sudan grass	12.97b	12.85b	12.64b	12.18b
	A	B	B	C
Sweet sorghum	13.91a	13.65a	13.52a	12.92a
	A	B	C	C
Interspecies hybrid sorghum	11.58c	11.18c	10.66c	10.50c

Table 5-a. Crude fiber content (CF%) in leaves of sorghum plants as influenced by the interaction between forage sorghum genotypes (G) and planting density (D) at 1st cut (combined data)

Forage sorghum genotype (G)	Planting density (plant/fad.)			
	70000	**105000**	**140000**	**210000**
	A	B	B	B
Sudan grass	29.34b	28.84b	28.46b	28.04b
	A	A	B	C
Sweet sorghum	32.37a	32.24a	31.52a	30.11a
	A	B	C	C
Interspecies hybrid sorghum	28.47c	27.93c	27.24c	27.01c

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تأثير كثافة الزراعة ومستويات السماد النيتروجينى على كمية محصول العلف الأخضر وصفات الجودة لبعض طرز سورجم العلف

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اقيمت تجربتان حقليتان خلال موسمى٢٠١٣ و٢٠١٤ بالحقل الارشادى بقرية ميت جابر- مركز بلبيس - بمحافظة الشرقية لدراسة تأثير الكثافات النباتية (٧٠٠٠٠ ، ١٠٥٠٠٠ ، ١٤٠٠٠٠ و ٢١٠٠٠٠ نبات/ فدان) ومستويات السماد النيتروجينى (١٥ و ٣٠ و ٤٥ كجم ن /فدان/حشة) على كمية محصول العلف الأخضر وصفات الجودة لبعض طرز سورجم العلف (حشيشة السودان والذرة السكرية والهجين الناتج من حشيشة السودان والذرة السكرية)، ويمكن تلخيص أهم النتائج التى تم التحصل عليهاعلى النحو التالي: أدى استخدام حشيشة السودان لحدوث زيادة معنوية لصفات الوزن الغض (جم/نبات) والمحصول الغض (طن/فدان) مقارنة بالذرة السكرية والهجين، أما الذرة السكرية فقد أدى استخدامها لحدوث زيادة معنوية في نسبة البروتين والألياف مقارنة بباقي الطرز وذلك في كل من الحشتين الأولى والثانية خلال موسمي الزراعة و التحليل المشترك، أدى استخدام الكثافة النباتية ٧٠٠٠٠ نبات للفدان إلى زيادة معنوية في الوزن الغض (جم/النبات) ونسبة البروتين والألياف فى كل من الأوراق والسيقان، بينما زادت كمية محصول العلف الغض (طن للفدان) بزيادة الكثافة النباتية حتى ١٤٠٠٠٠ أو ٢١٠٠٠٠ نبات/الفدان في الحشتين الأولى والثانية خلال موسمي الدراسة والتحليل المشترك، أدت زيادة السماد النيتروجيني من ١٥ إلى ٣٠ وحتى ٤٥ كجم ن /فدان إلى حدوث زيادة معنوية لجميع الصفات سابقة الذكر فيما عدا نسبة الألياف فى الأوراق والسيقان فقد انخفضت، وذلك في الحشتين الأولى والثانية خلال موسمي الزراعة والتحليل المشترك، أوضحت نتائج التحليل التجميعي للموسمين التأثير المعنوي لتداخل الفعل بين جميع العوامل تحت الدراسة على صفات الوزن الغض (جم/النبات) والمحصول الغض (طن/فدان) ونسبة البروتين والألياف وتبين أن استخدام حشيشة السودان بكثافة نباتية ١٤٠٠٠٠ نبات/فدان وإضافة ٤٥ كجم ن/ الفدان/حشة هي أفضل معاملة تم التوصل إليها ويمكن اعتبارها توصية للمزارعين تحت ظروف الأراضي الصفراء الثقيلة فى الدلتا.

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