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Grain sorghum as influenced by foliar fertilizer stimufol amino

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Two field trials were conducted in the new land at Wadi El- Rayyan, Fayoum governorate, Egypt during two successive seasons of 2014 and 2015 to study the response of two sorghum cultivars plants to foliar fertilizer stimufol amino. The results could be summarized as follows: Sorghum cultivar (Shandaweel-6 and Giza-15) significantly differed in growth characters at 70 and 85 days from sowing except CGR at 70 days from sowing, also yield, its components, protein and carbohydrate percentages content in grains. Giza–15 cultivar surpassed Shandaweel-6 cultivars in growth characters under study in addition yield, yield components, carbohydrate and protein percentages. Increasing stimufol foliar fertilizer from 250 g/ fed., till 350 g/ fed., and 450 g/fed., increased all growth characters under this study at 70 and 85 days from sowing compared with the control. Also there were significant differences between levels of stimufol foliar fertilizer in yield, its components, protein and carbohydrate percentages in grains in both seasons. The interaction effect between sorghum cultivars and stimufol foliar fertilizer level were significant in all growth characters except total dry weight/plant, LA, LAI at 70 days from sowing and SLA at 85 days from sowing. In addition the interaction in yield and yield components were significant except dry weight/ panicle (g).

Keywords: Sorghum, cultivars, stimufol foliar fertilizer, growth, yield, its components, chemical composition

INTRODUCTION

Grain sorghum (*Sorghum bicolor* L.) is one of the most important crops in the world. It is considered as the fourth cereal crops after maize, wheat and rice. It is grown in different part of tropical and subtropical regions in the world. Sorghum can yield reasonably well under adverse conditions of low soil moisture and high temperature, although it responses well to irrigation. It is grown as animal feed, for poultry and for some industrial products (Gomaa, 1996). Increasing sorghum yield per unit area can be achieved by breeding high yielding cultivars. To evaluate the yield of sorghum cultivars, it is useful to estimate the ability of sorghum plants to accumulate dry matter. Significant differences in sorghum cultivars have been shown by many investigators (El-Gazzar, 2003, Ahmed et al. 2007, Hassanein et al. 2010, Kumar et al. 2011 and Ahmed et al. 2014). Sorghum as one of grain crop belonging to grasses, is highly responding to nutrient fertilization especially nitrogen which is considered as limiting factor for sorghum production. Sorghum grown in the newly reclaimed sandy soils which characterized with low fertility, high pH value and low organic matter content. High demand of N-fertilizer requirement which led to high leaching of nitrogen and other fertilizers (P, K) through its high filtration rates. Application of NPK fertilizer as a foliar spray may decrease such losses. El-Fouly and Fawzi (1996) told that N-losses in summer crops are very high and efficiency of N-fertilizers used is very low. Thus foliar application of fertilizers as a

supplement was positive response (Zeidan, 2002, El-Karamany and Gobarah, 2005 and Hassanein et al. 2015).The objective of this study was to investigate response of two sorghum cultivars to foliar fertilizer stimufol amino

MATERIALS AND METHODS

Two field experiments were conducted during the two successive seasons of 2014 and 2015 seasons in Wadi El-Rayyan region, El-Fayoum governorate, Egypt, in summer seasons to study the effect of stimufol foliar spray fertilizer on growth at different stages, yield and chemical components of sorghum plant. The experimental design was a spilt-plot design with four replications. Sub-plot size was 21 m^2 = 1/200 fed., (6m in width and 3.5 in length), the distance between each row was 60 cm a part. Each sub-plot consisted of ten rows, five rows were devoted for plant growth sampling, while the other rows were left for yield and its components determinations, the main plots were occupied by cultivars treatments, while stimufol foliar fertilizer levels were assigned in sub-plot. Sorghum grains cultivars Shandaweel-6 and Giza-15 were sown in16thand18th June in2014and 2015 seasons. After three weeks, plants were thinned to two plants per hill. Phosphorus was added in the form of super phosphate (15.5 % P_2O_5) at the rate of 150 kg / fed., and nitrogen was added at the rate of 80 kg N/fed., in the form of ammonium nitrate (33.5% N),in two equal split applications before 1st and 2nd irrigation. To study the effect of stimufol foliar spray fertilizer amino the plants were sprayed two times during the elongation stage (30 and 50 days from sowing). Each experimental included 8 treatments which were the combination of two sorghum cultivars (i.e. Shandaweel-6 and Giza-15) and three concentrations of stimufol Amino fertilizer beside the control (250, 350 and 450 g/fed.), with 200 L water/fed. The chemical composition of foliar fertilizer were : N 25%, P 16%, K 12%, Amino acids 2%, Boron 0.044%, Fe 0.17%, Molybdenum 0.001%, Zink 0.03%, Copper 0.085, Cobalt 0.01%, Mg 0.02%, Manga 0.085% and EDTA. Pest control and other cultural practices were carried out as recommended. Soil samples was taken at depth of 30 cm for mechanical and chemical analysis as described by Chapman and Pratt (1978) and presented in Table (1). At 70 and 85 days after sowing the following growth attributes were recorded: **1-** Plant height (cm). **2-** Total dry weight/plant (g). **3-** Leaf area/ plant (LA dm^2) was calculated according to Bremner and Taha (1966). **4-** Leaf area index (LAI) was determined according to Watson (1952). **5-** Specific leaf area (SLA), (Blade leaf area in dm^2 /leaf dry weight in gram) was determined according to Abdel-Gawad et al. (1980).

At harvest time in October, ten individual guarded plants were taken randomly from each sub-plot of the other rows for determination of the following variables: **1-** Plant height (cm).. **2-** Weight of the panicle (g). **3-** Grain weight/panicle (g). **4-** Grain index. 5- Grain yield (ton/fed.). **6-** Straw yield (ton/fed.). **7-** Biological yield (ton/fed.). **8-** Protein percentage. **9-** Carbohydrate percentage. Grain, straw, biological yields were estimated from the whole plot. Crude protein was determined to the methods described in A.O.A.C. (1988), total carbohydrate was also determined according to Dubios et al. (1956).Statistical analysis was performed according to Gomez and Gomez (1984). Treatment means were compared by L.S.D. test. Combined analysis was made for the two growing seasons as results followed similar trend.

RESULTS AND DISCUSSION

1- Growth characters of sorghum plants as affected by cultivars and stimufol foliar fertilizer levels at various growth stages.

A- Cultivars differences:

The results in Table (2) showed that there were significant differences between the two sorghum cultivars (shandaweel-6 and giza-15) in growth characters i.e. plant height (cm), total dry weight/plant (g), LA(dm^2), LAI and SLA (dm^2/g) at 70 and 85 days after sowing. Giza-15 cultivar significantly surpassed the other cultivar shandaweel-6 in plant height (cm) and total dry weight/plant (g) at 70 and 85 days from sowing. On the same time shandaweel-6 cultivar significantly exceeded giza-15 cultivar in LA (dm^2), LAI and SLA (dm^2/g) at 70 and 85 days after sowing. The varietal differences between sorghum cultivars may be due to genetically differences between cultivars and differences between genotypes concerning partition of dry matter. These results which obtained from this study are in a harmony with obtained by El-Gazzar (2003); Ahmed et al. (2007); Ahmed et al. (2010); Hassanein et al. (2010) and Ahmed et al. (2014).

Table (1): Mechanical and chemical analysis of soil at experimental sites (Average of 2014 and 2015 seasons)

Sand%	Silt%	Clay%	Texture	pH	Organic matter O.M.%	Available N ppm	Available K ppm	Available P ppm
73.59	22.47	3.45	Sandy	8	0.49	84.00	134.00	12.5

Table 2: Effect of cultivars and stimufol foliar fertilizer on growth characters of Sorghum at 70 and 85 days after sowing. (Average of 2014 and 2015 seasons).

Characters / Treatments	Plant height(cm)		Total dry weight/plant (g)		LA (dm^2)		LAI		SLA (dm^2/g)	
	70	85	70	85	70	85	70	85	70	85
Cultivars										
Shandaweel 6	190.16	208.25	159.25	180.09	29.13	32.02	2.427	2.668	3.589	3.708
Giza 15	247.83	264.83	188.59	201.73	25.16	29.00	2.135	2.416	3.482	3.576
L.S.D at 5%	1.95	3.13	2.21	1.84	0.31	0.41	0.025	0.027	0.016	0.013
Stimufol Foliar Ferilizer										
Control	203.59	222.50	165.50	184.46	24.77	28.26	2.062	2.355	3.477	3.572
250 g/feddan	215.61	229.83	169.01	187.71	26.16	29.86	2.180	2.488	3.515	3.618
350 g/feddan	224.78	241.67	177.45	192.91	28.25	31.15	2.355	2.595	3.553	3.663
450 g/feddan	232.00	252.17	183.71	198.57	30.30	32.76	2.527	2.730	3.597	3.713
L.S.D at 5%	2.20	1.37	1.53	1.49	0.36	0.44	0.034	0.038	0.009	0.015

Table 3: Effect of interaction between cultivars x stimufol foliar fertilizer on growth characters of sorghum at 70 and 85 days after sowing. (Average of 2014 and 2015 seasons)

Characters / Treatments		Plant height(cm)		Total dry weight/ plant (g)		LA (dm^2)		LAI		SLA(dm^2 /g)	
		70	85	70	85	70	85	70	85	70	85
Cultivars x Stimufol Foliar Ferilizer											
Shandaweel 6	Control	181.18	200.33	151.89	176.01	26.40	30.40	2.193	2.533	3.523	3.640
	250 g/feddan	186.22	204.00	153.34	176.65	27.92	31.33	2.327	2.610	3.560	3.687
	350 g/feddan	194.23	211.67	162.57	182.50	30.12	32.14	2.510	2.680	3.610	3.717
	450 g/feddan	199,00	217.00	169.19	185.21	32.09	34.19	2.677	2.850	3.663	3.787
Giza 15	Control	226.00	244.67	179.12	192.90	23.14	26.12	1.930	2.177	3.430	3.503
	250 g/feddan	245.00	255.67	184.67	198.77	24.40	28.39	2.033	2.367	3.470	3.550
	350 g/feddan	255.33	271.67	192.33	203.31	26.39	30.15	2.200	2.510	3.497	3.610
	450 g/feddan	265.00	287.33	198.23	211.93	28.51	31.33	2.377	2.610	3.530	3.640
L.S.D at 5%		3.11	1.94	n.s	2.10	n.s	0.63	n.s	0.054	0.012	n.s

Table 4: Effect of cultivars and stimufol foliar fertilizer on yield and its components of sorghum (Average of 2014 and 2015 seasons).

Characters Treatments	Plant height (cm)	Dry Weight /panicle (g)	Grain weight/ panicle (g)	Grain index (g)	Grain yield (ton/fe)	Straw yield (ton/fed)	Biological yield (ton/fed)	Protein %	Carbohydrate %
Cultivars									
Shandaweel 6	207.67	83.16	58.94	39.78	3.420	12.078	15.498	12.673	80.386
Giza 15	268.58	87.46	61.17	46.72	4.650	13.473	18.123	12.387	80.468
L.S.D at 5%	0.34	1.06	0.96	0.35	0.079	0.160	0.196	0.020	0.027
Stimufol Foliar Ferilizer									
Control	228.33	79.86	54.76	41.15	3.353	11.867	15.220	12.393	80.285
250 g/feddan	232.42	83.68	58.12	42.57	4.000	12.680	16.680	12.518	80.387
350 g/feddan	240.63	87.23	62.33	43.68	4.290	13.130	17.420	12.573	80.492
450 g/feddan	251.13	90.46	65.00	45.59	4.497	13.427	17.924	12.635	80.545
L.S.D. at 5%	0.97	0.90	0.91	0.27	0.067	0.068	0.131	0.010	0.012

B- Effect of foliar fertilizer:

Data in Table (2) revealed that increasing concentration of foliar fertilizer from zero to 450 g/fed., significantly increased all growth characters under this study. It is clear from data that 450 g/ fed., foliar fertilizer gave the best value of growth characters at 70 and 85 days from sowing i.e. plant height, total dry weight/plant, LA, LAI and SLA followed by 350 g/ fed. El-Fouly and Fawzi (1996) and Afifi *et al* (2011) told that N and other nutrient losses in summer crops such as sorghum are very high and efficiency of N-fertilizer used is very low. It is worthy to mentioned that foliar feeding as a supplement or a substation to soil fertilizer application was studied by Ahmed (1989) and El-Karamany et al. (2003). Similar finding was reported by Hassanein et al. (2015).

C- Effect of interaction:

Data in Table (3) showed the interaction between sorghum cultivars and foliar fertilizer (stimufol amino). It is clear from data that interaction was significant in plant height at 70 and 85 days after sowing, while the interaction at total dry weight/ plant and LA at70 days from sowing and SLA at 85 days from sowing was not significant. The best treatment for all growth characters was giza-15 cultivar + 450g/ fed., foliar fertilizer.

2-Yield, its components and chemical composition of grains:

A- Cultivars differences:

Data in Table (4) indicated that sorghum cultivars shandaweel-6 and giza-15 significantly differed in yield, its components and chemical composition of grains. It is clear from data that giza-15 cultivar significantly surpassed shandaweel-6 cultivar in plant height (cm), weight of panicle (g), grain weight/panicle (g), grain

Table 5: Effect of interaction between cultivars x stimufol foliar fertilizer on yield and its components

Characters / Treatments		Plant height (cm)	Dry weight/ panicle (g)	Grain weight/ panicle (g)	Grain index (g)	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Protein %	Carbohydrate %
Cultivars x Stimufol Foliar Ferilizer										
Shandaweel 6	Control	203.00	77.16	53.51	37.18	3.053	11.447	14.500	12.470	80.220
	250 g/feddan	206.17	81.44	57.91	39.14	3.320	11.900	15.220	12.677	80.353
	350 g/feddan	208.25	85.17	60.67	40.12	3.563	12.313	15.876	12.737	80.460
	450 g/feddan	213.25	88.88	63.67	42.67	3.743	12.653	16.396	12.810	80.510
Giza 15	Control	253.67	82.56	56.00	45.12	3.653	12.287	15.940	12.317	80.350
	250 g/feddan	258.67	85.93	58.33	46.00	4.680	13.460	18.140	12.360	80.420
	350 g/feddan	273.00	89.29	64.00	47.24	5.017	13.947	18.964	12.410	80.523
	450 g/feddan	289.00	92.04	66.33	48.51	5.250	14.200	19.450	12.460	80.580
L.S.D. at 5%		1.38	n.s	1.28	0.39	0.095	0.096	0.185	0.014	0.017

index, grain yield (ton/fed.), straw yield (ton/fed.), biological yield (ton/fed.) and carbohydrate percentage, while shandaweel-6 cultivar significantly exceeded giza-15 cultivar in protein percentage. This differences between cultivars may be due to the variation in translocation rate of a photosynthesis from leaves to the storing organs i.e. the grains. Also we can mention that these results may be due to the differences in genetic structure between cultivars and to the cultivars differences in photosynthates partitioning. Also may be due to the increase in growth and yield which in turn reflected positively on chemical of sorghum grains. These results are in harmony with those reported by El-Gazzar (2003); Ahmed et al. (2007); Ahmed et al. 2010, Hassanein et al. (2010) and Ahmed et al. (2014).

B- Effect of foliar fertilizer:

Data in Table (4) revealed that increasing foliar fertilizer concentration from zero to 450 g/fed., increased significantly all yield attributes. There are significant marked stimulatory effect on plant height (cm), weight of panicle (g), grain weight/panicle (g), grain index, grain yield (ton/fed.), straw yield (ton/fed.), biological yield (ton/fed.), protein percentage and carbohydrate percentage .The increase in yield attributes may be due to increased rate of assimilate transport from the source to the developing organs and decrease aborting of reproductive organs (Afifi et al. 2011). The increase in yield may be due to more grains and increased assimilate partitioning from leaves to grains as suggested by the 1000-grain weight. Similar finding were reported by Hassanein et al. (2015) in maize**.**

C-Effect of interaction:

Data in Table (5) revealed that all yield attributes and chemical composition were significantly affected by the interaction between sorghum cultivars and foliar fertilizer (stimufol amino) concentration except dry weight/ panicle (g). It is clear that the best treatment for plant height (cm), grain weight/panicle (g), grain index, grain yield (ton/fed.), straw yield (ton/fed.), biological yield (ton/fed.), protein percentage and carbohydrate percentage was giza-15 cultivar + 450g/ fed., foliar fertilizer (stimufol amino).

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

Hassanein, M.S., design of the work, Data analysis and interpretation, Amal, G. Ahmed, Data collection, Nabila, M. Zaki, Final approval of the version to be published.

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