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Grain sorghum as influenced by organic and microcat mix fertilizer

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ABSTRACT

Two field experiments were carried out in the new land at Wadi El-Rayan, Fayoum governorate, Egypt during two successive seasons of 2015 and 2016 to study the response of two sorghum cultivars plants to organic and microcat mix fertilizer.

Sorghum cultivars (Shandaweel-1 and Pioneer-840) significantly differed in growth characters at 70 and 85 days from sowing except leaf area and leaf area index at 70 and 85 days from sowing and specific leaf area and leaf area ratio at 85 days from sowing, as well as yield and its components except harvest index percentage. Addition chicken manure at rate of 6 ton/ feddan + 300 cm microcat mix fertilizer significantly enhanced all growth characters, also increased significantly plant height (cm), total dry weight / plant(g), dry weight / panicle (g), grain weight/panicle (g), grain index, grain yield (ton/fed.), straw yield (ton/fed.) and biological yield (ton/fed.) compared with control. The interaction between sorghum cultivars x organic and microcat mix fertilizer observed that Pioneer-840 cultivar + 6 ton/ feddan chicken manure and 300 cm microcat mix fertilizer lead to the more significant values of growth, yield and its components.

***Keywords*:** Sorghum, cultivars, chicken manure, microcat mix fertilizer, growth, yield, its components.

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 the tropical and subtropical regions in the world. In Egypt its acreage is concentrated in the middle and upper parts. The newly reclaimed sandy soils of Egypt have low- yielding capacity for most cultivars. Such soils require proper fertilization policy, using organic fertilizer and microelements in addition to the usually used mineral fertilizer. The addition of organic material to the soil has been one of the most common rehabilitation practices to improve soil physical properties such as aggregation, water holding capacity, hydraulic conductivity bulk density, the degree of compaction, fertility and resistance to water and wind erosion (Fronzluebbers 2002 and Mohamed *et al*. 2011).Further-more, it is generally accepted that the application of organic fertilizers stimulates soil microbial activities (Bell *et al.* 2006) found that organic fertilizers can improve soil- water plant relations through modifying bulk density, total porosity, soil water relation and consequently, increasing plant growth and its productivity. Evanylo *et al* (2008) pointed out that the addition of organic manure to sandy soils enhances microbial activity thereby increasing their fertility and their fertilizers use efficiency. Bodawy (2008) found that applying organic manure to sandy soils plays an important role for improving soil media through modifying the pore size distribution and consequently, the majority of soli physical properties, namely the bulk density, moisture constants, hydraulic conductivity, water consumptive use and water use efficiency. Further comparisons are needed among sorghum cultivars from adverse conditions. Increasing sorghum yield per unit area can be achieved by breeding high yielding cultivars. Significant differences in sorghum cultivars have been shown by many workers (Ahmed *et al.* 2007, Hassanein *et al.* 2010, Kumar *et al.* 2011 and Ahmed *et al.* 2014).Foliar feeding is an effective practice for the application of some micronutrients, since it uses low rates and the micronutrient does not directly contact the soil, avoiding losses through fixation. The foliar application of microcat mix fertilizer micronutrient as a supplement was positive response (El-Karamany and Gobarah, 2005 and Hassanein *et al.* 2015).

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The objective of this study was to investigate response of two sorghum cultivars to organic fertilizer and microcat mix foliar fertilizer.

Materials and Methods

Two field experiments were carried out in the new land at Wadi El-Rayan, Fayoum Governorate, Egypt during the two successive seasons of 2015 and 2016 to study the response of two sorghum cultivars plants to organic and microcat mix fertilizer. The physical and chemical characters of soil (30 cm depth) in the experimental site were as follows; sand 52.5%, silt 20%, clay 27.5%, PH 8.02, organic matter 0.84%, $CaCo_3$ 20.9%,Ec 2.9 m mhos/cm^3, soluble N 74 ppm according to as described by Chapman and Pratt 1961.

The experimental design was a spilt-plot design with four replications. Sorghum cultivars i.e. (Shandaweel-1 and Pioneer-840) were allocated in the main plots, while fertilizer i.e. (organic and microcat mix) rates (1)control, (2)2 ton/fed., chicken manure, (3)4 ton/fed., chicken manure, (4) 6 ton/fed., chicken manure, (5)2 ton/fed., chicken manure+ 300 cm Microcat mix, (6) 4 ton/fed., chicken manure+300 cm Microcat mix, (7) 6 ton/fed., chicken manure+300 cm Microcat mix occupied the subplots. The plot size was 21 m^2 (1/200 fed.) the distance between each row was 60 cm. Each plot consisted of ten rows, five rows were devoted for plant growth sampling, while the other five rows were devoted for yield and its components. Sorghum grains cultivars Shandaweel-1 and Pioneer-840 were sown in 20th and 24th June in 2015 and 2016 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., also organic fertilizer was added before sowing. The half of recommended dose of nitrogen fertilizer was added in the form of ammonium nitrate (33.5% N), in two equal split applications before 1st and 2nd irrigation. Then Microcat Mix was sprayed at 21 days after sowing. The normal agronomic practices of growing sorghum were practiced till harvest as recommended by sorghum Research Dep. A.R.C. Giza, Egypt.

The following growth characters were recorded after 70 and 85 days after sowing:

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).
6- Specific leaf weight (g/cm^2), calculated according to Pearce *et al.* (1969).
7- Leaf area ratio (LAR), (Blade leaf area in dm^2 /whole plant dry weight in gram).
8- Crop growth rate (CGR) (mg / cm2 / day) was calculated using the formula suggested by Radford (1967), CGR = NAR X LAI.
9- Relative growth rate (RGR) (g/g/day): Relative growth rate (g/g/day) was calculated according to the following formula suggested by Radford (1967),

$RGR = Loge\ W_2 - Loge\ W_1 / T_2 - T_1$

Where: Loge = Nobarian Log.

Random samples of ten guarded plants from each plot were taken at harvest to estimate the following characters:

1- Plant height (cm).
2- Total dry weight/plant (g).
3- Dry weight / panicle (g).
4- Grain weight/panicle (g).
5- Grain index (g).
6- Grain yield (ton/fed.).
7- Straw yield (ton/fed.).
8- Biological yield (ton/fed.).
10- Harvest index %.

Statistical analysis was performed according to Gomez and Gomez (1984). Treatments mean were compared by L.S.D. test. Combined analysis were made from the two growing seasons hence the results of two seasons followed similar trend.

Results and Discussion

1- Growth characters.

A- Cultivars differences:

The results in Table (1) indicate that there were significant differences between the two sorghum cultivars (Shandaweel-1 and Pioneer-840) in growth characters except leaf area (dm^2) and leaf area index at 70 and 85 days from sowing, while specific leaf area and leaf area ratio at 85 days from sowing only. The differences between sorghum cultivars were significant i.e. plant height (cm), total dry weight/plant (g), specific leaf weight (g/cm^2), crop growth rate (CGR) (mg / cm^2 / day) and relative growth rate (RGR) (g/g/day) at 70 and 85 days from sowing, while specific leaf area (SLA) (dm^2/ g) and leaf area ratio (dm^2/ g) at 70 days from sowing. Pioneer-840 cultivar significantly surpassed Shandaweel-1 cultivar in plant height (cm), total dry weight/plant (g), specific leaf weight (g/cm^2), crop growth rate (CGR) (mg / cm^2 / day) and relative growth rate (RGR) (g/g/day) at 70 and 85 days from sowing and specific leaf area at 70 days from sowing. On the other hand Shandaweel-1 cultivar surpassed Pioneer-840 cultivar in leaf area ratio (dm^2/ g) at 70 days from sowing. It could be concluded that varietal differences between sorghum cultivars may be due to genetically differences between cultivars and differences between genotypes concerning partition of dry matter. These obtained results of varietal differences in growth characters in this study are in a harmony with those obtained by Ahmed *et al.* (2007), Ahmed *et al.* (2010) and Ahmed *et al.* (2014).

B- Effect of organic and microcat mix fertilizer:

Regarding the influence of organic fertilizer and microcat mix fertilizer levels on growth characters. Data in Table (1) indicated that all growth characters at 70 and 85 days from sowing were significantly affected by adding organic fertilizer and foliar spraying with microcat mix fertilizer. Increasing organic fertilizer (chicken manure) from 2 ton/ fed., till 6 ton/ fed., increased growth characters significantly compared with control also spraying microcat mix fertilizer with chicken manure increased all growth characters under this study at 70 and 85 days from sowing. The best treatment for all growth characters i.e. (plant height (cm), total dry weight/plant (g), leaf area (dm^2), leaf area index, specific leaf area (dm^2/ g),specific leaf weight (g/cm^2),leaf area ratio, crop growth rate (CGR) (mg / cm^2 / day)) and relative growth rate (RGR) (g/g/day) was adding 6 ton/ fed., chicken manure + 300 cm microcat mix fertilizer. Organic fertilizer positively affected growth parameters, this may be due to the stimulation of microbial activity present in the organic fertilizers around the root system (Ahmed *et al.*, 2010). Also the stimulation of microbial and enzyme activities in the soil is greater when using organic fertilizers than control (Mohamed *et al.*, 2011).This increment in vegetative growth of sorghum plants may be due to the role of organic fertilizer in improving the physical properties of soil and it content of high level of nutrients elements, which are essential for plant growth (Rizwan *et al.*, 2008).

In this regard Bell *et al.* (2006) stated that organic fertilizers improve soil porosity, drainage and aeration, reduce compaction and improve the water holding capacity of the soil, increase soil microorganism populations which in turn increases the uptake of nutrients from soil to plants, thereby helping plants to produce better growth. Similar results were obtained by Abusuwar and Elzilal (2006) and Mia *et al.* (2010). The organic nutrients not only supply the essential nutrients but also show some positive interaction with chemical fertilizers through increasing their efficiency and thereby reducing the environmental hazards (Ahmad *et al.,* 1996).

C- Effect of interaction:

Data listed in Table (2) indicated that significant interaction between sorghum cultivars and organic manure + microcat mix fertilizers in growth characters i.e. (total dry weight/plant (g), leaf area (dm^2) and specific leaf weight (g/cm^2) at 70 and 85 days from sowing, while specific leaf area (dm^2/ g) at 70 days from sowing, plant height (cm), leaf area index and relative growth rate (RGR) (g/g/day) at 85 days from sowing. Pioneer-840 cultivar fertilized with 6 ton/ fed., chicken manure + 300 cm microcat mix gave the highest values of plant height (cm), total dry weight / plant (g), leaf area (dm^2), specific leaf area (dm^2/g) and relative growth rate (RGR) (g/g/day), also Shandaweel-1 cultivar gave the highest value of leaf area index.

2-Yield, its components:

A- Cultivars differences:

Data illustrated in Table (3) showed that sorghum cultivars in this study significantly differed in yield and its components i.e. plant height (cm),total dry weight (g), dry weight/ panicle (g), grain weight/panicle (g), grain index(g), grain yield (ton/fed.), straw yield (ton/fed.) and biological yield (ton/fed.). Pioneer-840 cultivar surpassed Shandaweel-1cultivar in yield and its components except grain index (g), where Shandaweel-1 cultivar gave the highest value of grain index. The differences between sorghum cultivars might be attributes to the variation in translocation rate of a photosynthesis from leaves to the storing organs i.e. the grains. It is noteworthy to mention the results of cultivars differences in yield and its components may be due to the differences in genetic structure between sorghum cultivars in this study, and also, the cultivars differences in photosynthates partitioning. These results may be due to increase of growth and yield which in turn reflected positively on chemical of sorghum grains.

These results are in harmony with those obtained by El-Gazzar (2003), Ahmed *et al.* (2007), Ahmed *et al.* (2010), Hassanein *et al.* (2010) and Ahmed *et al.* (2014).

B-Effect of organic and microcat mix fertilizer:

The modification of soil medium and the prevailing favorable conditions of vegetative growth affect in a positive way the sorghum grain yield. A considerably greater increase was recorded in all the fertilization treatments, compared with the control as shown in Table (3). Data showed that increased organic fertilizer from 2 ton/ fed., chicken manure to6 ton/ fed., chicken manure + 300 cm microcat mix increased yield and its components significantly compared with the control except harvest index percentage. The treatment 6 ton/ fed., chicken manure + 300 cm microcat mix gave the highest value of yield and its components. These increase might be due to treatments stimulation effect on number or weight of the grain. Such beneficial effects were actually reflected in the increase of sorghum grain yield due to the applied organic fertilizer, which decrease the loss of soil moisture, enhanced soil water retention, as well as increased the ability rate of leaves for photosynthetic process, increased the grain filling intensity, and consequently increased the grain weight. The addition of organic manure to sandy soils enhanced microbial activity and increased their ability to conserve fertigation and consequently increasing their fertility and fertilizers use efficiency as a final goal (Singh *et al.,* 1999, Rizwan *et al.,* 2008, Ahmed *et al.*, 2010, Amin, 2010, Russo *et al.,* 2010 and Mohamed *et al.,* 2011).

C-Effect of interaction:

The effect of interaction between sorghum cultivars x organic manure + microcat mix fertilizers on yield and its components Table (4) were significant except dry weight/ panicle and grain index.Pioneer-840 cultivar fertilized with 6 ton/ fed., chicken manure + 300 cm microcat mix gave the highest values of plant height (cm),total dry weight (g), grain weight/panicle (g), grain yield (ton/fed.) and harvest index%, also Shandaweel-1 cultivar gave the highest values of straw yield (ton/fed.) and biological yield (ton/fed.).

Table 1: Effect of cultivars and organic + microcat mix fertilizer on growth characters of sorghum at 70 and 85 days after sowing. (Average of 2015 and 2016 seasons).

Characters	Plant height (cm)		Total dry weight/plant (g)		LA (dm^2)		LAI		SLA (dm^2/g)		SLW (g/cm^2)		LAR		CGR		RGR	
Treatments	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**
Cultivars																		
Shandaweel 1	162.81	168.36	199.35	218.67	31.19	32.68	2.60	2.73	3.54	3.71	2.49	2.54	8.83	8.32	24.82	22.04	193.49	171.69
Pioneer 840	172.20	178.56	208.68	237.51	31.48	33.05	2.63	2.74	3.62	3.77	2.66	2.79	8.73	8.37	29.52	25.69	198.27	174.89
L.S.D at 5%	3.83	1.09	0.85	1.72	n.s	n.s	n.s	n.s	0.02	n.s	0.06	0.05	0.06	n.s	1.61	0.26	1.76	1.37
Organic fertilizer																		
T1	159.57	166.74	189.31	213.02	28.14	29.57	2.35	2.46	3.33	3.53	2.44	2.53	8.63	8.14	22.16	18.77	185.87	156.69
T2	162.88	169.17	194.95	220.00	29.62	30.92	2.45	2.58	3.43	3.63	2.58	2.56	8.71	8.42	24.86	21.25	190.26	162.63
T3	166.96	171.47	201.91	226.54	31.83	33.48	2.66	2.79	3.52	3.74	2.52	2.67	8.76	8.39	26.09	21.75	194.77	170.28
T4	169.94	175.03	209.89	235.95	32.83	34.64	2.74	2.89	3.66	3.78	2.58	2.67	8.82	8.36	29.46	26.21	200.15	178.27
T5	166.52	173.39	201.42	225.19	30.09	31.70	2.56	2.64	3.68	3.79	2.55	2.67	8.79	8.31	26.28	22.99	194.78	172.54
T6	171.59	177.16	210.32	232.09	32.63	33.65	2.72	2.81	3.73	3.83	2.64	2.77	8.84	8.37	29.89	27.22	200.67	183.62
T7	175.07	181.26	220.34	243.82	34.23	36.11	2.85	2.95	3.71	3.88	2.70	2.80	8.92	8.44	31.45	28.87	204.67	192.50
L.S.D at 5%	1.49	1.09	0.61	1.37	0.68	0.57	0.08	0.07	0.09	0.08	0.06	0.06	o.o5	0.17	1.49	1.43	1.37	1.35

Table 2: Effect of interaction between cultivars x organic and microcat mix fertilizer on growth characters of sorghum at 70 and 85 days after sowing. (Average of 2015 and 2016 seasons).

Characters		Plant height (cm)		Total dry weight/ plant (g)		LA (dm^2)		LAI		SLA (dm2 /g)		SLW (g/cm^2)		LAR		CGR		RGR	
Treatments		**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**	**70**	**85**
Cultivars x Organic fertilizer																			
Shandaweel1	**T1**	154.90	161.78	184.74	204.26	27.29	29.28	2.28	2.44	3.26	3.47	2.34	2.36	8.67	8.10	20.16	16.86	182.69	154.38
	T2	158.34	164.04	191.97	212.38	29.38	30.42	2.44	2.53	3.35	3.55	2.57	2.46	8.75	8.32	22.19	19.32	188.40	160.94
	T3	161.51	166.91	199.30	217.75	31.61	33.44	2.64	2.79	3.44	3.69	2.42	2.52	8.82	8.49	23.28	19.34	192.24	168.47
	T4	165.67	168.18	203.36	226.18	32.39	34.46	2.70	2.87	3.57	3.73	2.48	2.58	8.91	8.35	26.94	24.27	197.81	173.59
	T5	161.45	169.01	198.38	218.34	30.55	31.20	2.55	2.66	3.78	3.82	2.42	2.51	8.82	8.24	25.41	22.08	193.27	171.59
	T6	166.73	172.52	203.41	220.55	32.72	33.42	2.73	2.79	3.75	3.81	2.53	2.63	8.89	8.33	27.34	26.20	198.61	181.18
	T7	171.06	176.10	214.30	231.20	34.41	36.55	2.87	3.05	3.64	3.89	2.63	2.76	8.96	8.42	28.39	26.22	201.40	191.69
Pioneer 840	**T1**	164.23	171.69	193.88	221.77	28.98	29.86	2.42	2.49	3.39	3.59	2.54	2.70	8.59	8.19	24.16	20.68	189.05	159.00
	T2	167.41	174.30	197.93	227.62	29.85	31.42	2.46	2.62	3.51	3.72	2.59	2.66	8.66	8.52	27.52	23.18	192.11	164.31
	T3	172.41	176.03	204.52	235.34	32.05	33.52	2.67	2.79	3.61	3.79	2.62	2.81	8.70	8.29	28.90	24.15	197.29	172.08
	T4	174.20	181.89	216.42	245.71	33.26	34.83	2.77	2.90	3.74	3.83	2.67	2.75	8.73	8.36	31.97	28.15	202.49	182.95
	T5	171.60	177.77	204.45	232.04	29.62	32.19	2.57	2.83	3.58	3.76	2.68	2.82	8.75	8.39	27.15	23.89	196.29	173.48
	T6	176.44	181.81	217.22	243.62	32.55	33.89	2.71	2.83	3.71	3.84	2.75	2.91	8.79	8.41	32.44	28.24	202.72	186.06
	T7	179.08	186.41	226.38	256.45	34.05	35.67	2.84	2.84	3.77	3.86	2.76	2.84	8.87	8.46	34.51	31.51	207.93	193.31
L.S.D at 5%		n.s	1.55	0.86	1.93	0.96	0.81	n.s	0.10	0.13	n.s	0.09	0.09	n.s	n.s	n.s	n.s	n.s	1.91

T1: Control, T2: 2 ton/fed. Chicken manure, T3:4 ton/fed. Chicken manure, T4: 6 ton/fed. Chicken manure , T5:2 ton/fed. Chicken manure + 300 cm Microcat mix, T6: 4 ton/fed. Chicken manure + 300 cm Microcat mix, T7: 6 ton/fed. Chicken manure+300 cm Microcat mix

Table 3: Effect of cultivars and organic + microcat mix fertilizer on yield and its components of sorghum. (Average of 2015 and 2016 seasons).

Characters / Treatments	Plant height (cm)	Total dry weight/plant (g)	Dry weight /panicle (g)	Grain weight/ panicle (g)	Grain index (g)	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index %
Cultivars									
Shandaweel 1	169.76	241.07	89.06	67.00	28.41	10.588	13.504	24.091	43.99
Pioneer 840	180.83	253.48	91.82	72.03	26.21	10.993	13.582	24.613	44.49
L.S.D at 5%	0.36	0.98	0.16	1.07	1.44	0.047	0.064	0.087	n.s
Organic fertilizer									
T1	168.02	230.80	82.41	57.62	23.81	10.135	12,650	22.785	44.48
T2	170.36	237.54	87.69	62.85	25.31	10.435	13.252	23.820	44.06
T3	173.42	244.97	90.27	69.50	27.59	10.753	13.512	24.265	44.32
T4	178.12	251.92	92.70	73.10	29.04	10.932	13.772	24.703	43.58
T5	174.55	246.85	90.08	69.45	26.08	10.867	13.585	24.452	44.43
T6	179.15	255.13	93.13	75.33	28.51	11.062	13.900	24.962	44.28
T7	183.43	263.69	96.81	78.75	30.86	11.348	14.130	25.478	44.55
L.S.D. at 5%	0.52	1.10	0.66	1.25	0.68	0.047	0.101	0.209	n.s

Table 4: Effect of interaction between cultivars x organic and microcat mix fertilizer on yield and its components of sorghum. (Average of 2015and 2016 seasons).

Treatments / Characters		Plant height (cm)	Total dry weight/ Plant (g)	Dry weight/ panicle (g)	Grain weight/ panicle (g)	Grain index (g)	Grain yield (ton/Fed.)	Straw yield (ton/Fed.)	Biological yield (ton/fed)	Harvest Index (%)
Cultivars x Organic fertilizer										
Shandaweel1	T1	163.81	226.99	80.49	56.31	25.48	9.973	12.437	22.410	44.50
	T2	165.25	234.23	86.49	62.18	26.21	10.297	13.007	23.303	44.18
	T3	167.40	240.17	89.40	65.24	28.55	10.547	13.390	23.937	44.06
	T4	170.42	247.04	91.61	69.49	30.55	10.837	13.887	24.723	43.83
	T5	169.80	239.19	89.64	66.64	27.19	10.503	13.440	23.943	43.87
	T6	173.95	245.51	91.05	72.94	29.37	10.780	13.977	24.757	43.54
	T7	177.66	254.33	94.76	76.19	31.55	11.177	14.390	25.567	43.72
Pioneer 840	T1	172.23	234.61	84.33	58.93	22.13	10.297	12.863	23.160	44.46
	T2	175.46	240.85	88.89	63.51	24.41	10.573	13.497	24.337	43.93
	T3	179.44	249.76	91.15	73.75	26.64	10.960	13.633	24.593	44.57
	T4	185.83	256.80	93.78	76.72	27.53	11.027	13.657	24.683	43.32
	T5	179.29	254.51	90.51	72.26	24.97	11.230	13.730	24.960	44.99
	T6	184.34	264.76	95.21	77.72	27.66	11.343	13.823	25.167	45.02
	T7	189.20	273.06	98.85	81.31	30.16	11.520	13.870	25.390	45.37
L.S.D. at 5%		0.74	1.56	n.s	1.76	n.s	0.067	0.142	0.295	1.07

T1: Control, T2: 2 ton/fed. Chicken manure, T3:4 ton/fed. Chicken manure, T4: 6 ton/fed. Chicken manure, T5:2 ton/fed. Chicken manure + 300 cm Microcat mix, T6: 4 ton/fed. Chicken manure + 300 cm Microcat mix, T7: 6 ton/fed. Chicken manure+300 cm Microcat mix

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