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EFFECT OF BIOFERTILIZATION AND COMPOST LEVELS ON PRODUCTIVITY OF SOME SUMMER FODDER CROPS UNDER SALINE STRESS

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ABSTRACT

This study was carried out to develop a technique for improving the productivity of some summer fodder crops under salinity stress condition. Field analysis and estimations were done for two progressive seasons (2016 and 2017) at South Sinai Reaserch Station, Ras Sudr, Desert Research Center, to consider the impact of biofertilizer application and compost rates in enhancing some summer fodder crops. The utilized biofertilizers were *A. chroococcum* and *Azospirillum brasilense* single and mixed treatments with two compost rates(10 and 20 m^3/Fed.).

Analysis of the manure, the soil microbiological properties and physicochemical analysis of compost showed a highly efficient compost productivity was obtained with narrow C/N ratio and rich microbial counts. Soil microbial properties and production of some fodder crops (Maruit 1 , Black suddan grass and Pearl millet) irrigated with saline water were measured. Obtained results showed that, there was a superiority of mixed biofertilization treatments over all individual with 20m^3 followed by mixed with 10 m^3 compost when compared with all individual treatments. Increase in compost rate increased significantly all the studied parameters. *A. chroococcum* and *Azospirillum brasilense* played an energizing role especially with application of compost. Also, results indicated that, the three studied Sorghum varieties differed significantly in their responses to biofertilization treatments and organic matter (compost levels). Highest obtained values of all parameters were recorded with Maruit-1 followd by pearl millet. Also, mixed treatments with *Azotobacter chroococcum and Azospirillum brasilence* recorded the highest activity to alleviate salt stress compared with single and control. It can concluded that, organic matter application at 20 m^3/fed with mixed biofertilization treatments improve yield, its components and stimulate microbial and enzymatic activity in rhizosphere of the studied fodder crops under salinity stress compared with all the other treatments.

INTRODUCTION

Biofertilizer is a wide term, which includes a diverse category of bioinoculants such as nitrogen fixers, phosphate solubilizers, phosphate mobilizers and plant growth promoting rhizobacteria. Numerous bacterial species have found as PGPR mainly *Azotobactor, Azosprillium, Bacillus, Pseudomonas* etc. The application of these bacterial species as biofertilizers could be the alternate source of synthetic fertilizers because these bacterial species have great potential to fix atmospheric nitrogen as well as to solubilize the phosphorus in the soil. *Azotobacter* and *Azospirillum* genera are free-living bacteria and fix atmospheric nitrogen in cereal crops without any symbiosis. They fix 20-40 kg ha^{-1}. *Azotobacter* sp. also has ability to produce antifungal compounds against many plant pathogens. Thus, biofertilizers containing beneficial organisms that are cost effective, pollution free and a perennially renewable source of plant nutrients, making them ideal partners and essential supplements to chemical fertilizers **(EI-Latief, 2016).** Biofertilizers like *Azospirillum* may release phytohormones like auxin which enhance root branching and also root elongation. This would be a clear advantage for plants in dry areas **(Steenhoudt and Vandereyden, 2000).** Furthermore, biofertilizers are able to produce other plant hormones like gibberellins and cytokinins in the case of *Azotobacter* **(Bhardwai *et al*., 2014).**

Inoculation of PGPR can increase plant uptake from several nutrients such as Ca, K, Fe, Cu, Mn and Zn. This uptake usually occurs during acidification of the soil rhizosphere via organic acid production or via stimulation of proton pump ATP ase **(Mantelin and Touraine, 2004).**

Soil salinity is an increasing problem in the world and main obstacle to agricultural productivity especially in areas where irrigation is necessary. It adversely affects plant growth and development. Adoption of salt tolerant variety is more important here and so screening of salt tolerant germplasms is essential **(Roy et al., 2018).** Salinity is one of the major abiotic stresses in agriculture worldwide, limiting crop productivity **(Munns and Tester, 2008).** Globally, a total land area of 831 million hectares is affected by salinity **(Turkan and Demiral, 2009; Munns, 2005).** Salt accumulation is mainly related to a dry climate, salt rich parent materials of soil formation, insufficient drainage and irrigation with saline ground water **(Almodares, et al., 2008).**

The adverse physiological effects may be attributed to unavailability to water, reduction in photosynthesis through loss of turgidity, impeded nutrient uptake causing deficiency and ion toxicity to plants **(Niu, et al.,2012 ;Munns and Tester, 2008; Netondo et al., 2004a، 2004b).** Salt stress may also impair synthesis of biochemical substances such as enzymes, sugars and protein **(Singh** and Chatrath**., 2001).** During salinity stress decrease in K^+ and Ca^{2+} and accumulation of Na^+ and Mg^{2+} ions in both roots and shoots occurs in plant body **(Farooq et al., 2015; Yasmeen et al., 2013)**. Also, causing reduction in dry matter accumulation and grain yield **(Flowers and Flowers 2005).**

Sorghum (*Sorghum bicolor* L.) is the fourth most important cereal crop grown in the world. Sorghum is grown on approximately 44 million hectares in 99 countries. **(FAOSTAT, 2013).**Sorghum has potential uses such as: food (grain), feed)grain and biomass), fuel (ethanol production), fiber paper, fermentation (methane production) and fertilizer utilization of organic byproducts. Sorghum is a principal source of energy, protein, vitamins and minerals for millions of the poorest people in the semi arid regions **(Khaton *et al*., 2016).** The protein content of sorghum (11.3%) is nearly equal and is comparable to that of wheat and maize. Average starch content of the seeds range from 56to 73% and is relatively rich in iron, phosphorous and vitamin B-complex **(**Reddy **et al.,2010)**. From the microbiological point of view، green manure has two main positive effects, i.e. it provides nutrient rich in organic carbon for the microbial biomass, which converts unavailable nutrients in plant residues to ones available for crops at it enhances biodiversity of soil microorganisms**(Abd El Gawad,2008). Azim, *et al.*, (2018)** reported that the role of compost in salt-affected soils is very vital because the organic source is ultimate opportunity to improve the physical properties of soils, which have been deteriorated to the extent that water and air passage become extremely difficult in such soils .

The main objective of the present study was to examine the effect of biofertilization and compost levels on the productivity of some fodder crops under saline stress

MATERIALS AND METHODS

A field experiments were conducted during two successive seasons at Ras Sudr Research Station, South Sinai Governorate to study the effect of different rates of compost and different biofertilization treatments, i.e. *Azotobacter chroococcum, Azospirillum brasilensce* and the mixture of them on the productivity of some summer forage crops namely

Maruit-1, black Sudan grass and pearl millet under soil and water saline conditions.

Physical properties and chemical analysis of soil and irrigation water are presented in Table 1 and Table 2.

Table (1). Some physical and chemical properties of the experimental soil.

Depth Cm	pH	EC soil paste dS/m	OM	$CaCO_3$	Sand	Silt	Clay	CEC Cmole/ kg soil	Texture
			%						
0-30	7.73	8.56	2.28	26.9	75.5	12.57	11.93	5.81	LS
30-60	7.96	7.35	1.73	27.4	73.4	15.31	11.29	6.65	LS
Cations and anions in soluble soil (meq/L)									
Depth	Na^+	K^+	Ca^{+2}	Mg^{+2}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
0-30	65.2	1.3	23.9	9.5	0	19.4	58.7	21.8	
30-60	62.94	3.9	22.57	10.23	0	16.55	56.5	23.5	
		Available nutrients in soil (ppm)							
Depth	N	P	K	Fe	Mn	Zn	Cu	B	
0-30	36.8	5.19	48.5	4.26	2.18	1.25	0.57	0.18	
30-60	21.5	3.84	52.3	4.64	2.23	1.31	0.66	0.12	

Table (2). Some chemical properties of the irrigation water at Ras Sudr Research Station.

pH	EC dS/m	Na^+	K^+	Ca^{+2}	Mg^{+2}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
		meq/L							
7.94	7.85	46.9	2.62	20.5	8.48	0.00	6.3	47.5	24.7

Preparation of Compost:

Preparation of substrate:

Substrates such as plant residues, weeds and grasses should be chopped. Chopping helps speed up decomposition by increasing the surface area available for microbial action and providing better aeration. The harder or wooden the tissues, the smaller they need to be decomposed rapidly. Woody material should be passed through a grinder. All existed agricultural wastes were subjected to analysis before composting for C/N ratio which was as follow:

Sheep manure used as an initiative material had values: O.C: 19.46 %, T.N: 1.4 %, C/N:13.9, O.M ،%33.5:moisture 28.7 and PH 7.6

Composting Method:

This method involves digging a pit (360 cm long × 180 cm wide ×90 cm deep) in a shaded area (length can vary according to the volume of waste materials available). Farm wastes such as vegetable refuse, weeds, leaves and grasses are spread to a thickness of 15-20 cm. fresh liquid culture of cellulose decomposing bacteria were activated with molass (2 liter bacteria 10^8 cfu/ml+ 1 liter molass and 97 litre water for each ton of wastes) and added to facilitate and activate decomposing

process. Wet animal dung is spread over this layer to a thickness of 5 cm. Water is sprinkled to moisten the material (50-60 percent of mass). This procedure is repeated until the whole mass reaches a height of 60 cm above ground. It is then covered with plastic sheet. In four weeks, the mass becomes reduced and the heap flattens. The cover plastic is removed and the entire mass is turned Aerobic decomposition commences at this stage, Beneficial soil microorganisms was added to enrich bio-compost with nutrients and other important secretion. Water is sprinkled to keep the material moist. The compost is ready for use after four months **Russel,1991.**

Compost Enrichment:

Farm compost is poor in P content (0.4- 0.8 %).Addition of P makes the compost more balanced, and supplies nutrient to microorganisms for their multiplication and faster decomposition. The addition of P also reduces N losses.

Compost can be enriched by application of calcium ammonium nitrate (33.3%N) and calcium super phosphate (15.5 % P_2 O_5) were added in concentrations of 20 Kg / ton and 5 Kg / ton as sources of nitrogen and phosphorous, respectively.Calcium carbonate was added in concentration of 20 Kg / ton to neutralize the pH of compost.

Microbial Preparation:

Fresh liquid culture strains of highly efficient for nitrogen fixation, i.e. *Azotobacter chrococcum* and *Azospirillum brasilense* that previously isolated and identified and were used for seed inoculation, liquid cultures of *Azotobacter chrococcum* and *Azospirillum brasilense* 10^8 cfu /ml were applied. The experiment was conducted in split-split plot design, with three replicates.

Compost was added at two rates (10 and 20 m^3/fed), biofertilization treatments added to soil after germination throughout two weeks after each cut

Grains were planted at four rows with 20 cm apart. All plots received 31kg P_2O_5/fed, as calcium super phosphate, 70 kg N/fed. as ammonium nitrate (33.5 % N). Samples of ten plants were taken after 55, 110 and 160 days from planting for the 1^{st}, 2^{nd} and 3^{rd}cuts, respectively, to assessment plant height and fresh yield.

Chemical analysis of soil was carried out to determine total nitrogen in soil was determined according to **Page et al.,(1982)**,Nitrogen in leaves was determined according to **Bremner and Mulvaney, (1982),** protein by multiplying nitrogen 6.25

Microbiological analysis: Nutrient modified Bunt and Rovira media, Ashbys and Doberiner media were used for total microbial, phosphate solubilizing bacteria (PSB) counts, *Azotobacter* and *Azospirillum* densities, respectively. Dehydrogenase activity according to method

described by **(Casida *et al*.,1964).** Nitrogenase activity was determined according to **(Haahtela et al., 1981).**

Statistical analysis: Analysis of variance was calculated according to the method of Duncan's, multiple range tests at 0.05 level, using MSTAT computer statistical software according to **Russel, (1991).**

RESULTS AND DISCUSSION

1.Physicochemical and microbiological analysis of the obtained Compost:

The rapid decomposition can be detected by a pleasant odour, by the heat produced , by the growth of white fungi on the decomposing organic material, by a reduction of volume, and by the materials changing colour to dark brown. As near completion, the temperature drops and finally little or no heat is produced. The compost is then ready to use. Table (3) showed the physicochemical and microbiological analysis of resulted compost. It is clear that all macro and micronutrients, are in the accepted ranges. Both N content and C/N ratio are very close to the reported values by **El-Sersawy et al.(1995).** Microbial examination of the obtained compost revealed the increase in numbers of beneficial microorganisms like azotobacters, phosphate dissolving fungi, aerobic cellulose decomposers and total microbial counts, despite absence of pathogenic microorganisms and nematodes. These results are in compatible with **Indira, and Singh(2014).**

The quality of compost can be further improved by secondary inoculation of Azotobacter chroococcum, and Phosphate dissolving fungi. These microorganisms, can be sprinkled when the decomposing material is turned after one month. As a result of this inoculation, the N content of compost can be increased by up to 2%. In addition to improving N content and the availability of other plant nutrients, these additions help to reduce the composting time considerably **(Abd ElGawad,2008).**

Table (3).Physico-chemical and microbiological analysis of the used compost:

Sample	pH	C%	Total nutrients						C/N ratio
			N	P	K	Fe	Mn	Zn	
			%			Ppm			
Compost	7.6	28.1	0.83	0.17	0.35	749	71.5	13.1	29.2
Microbiological analysis									
Microbiological determinations (C.F.U/g dry matter)									
Total microbial counts $\times10^5$			230						
Azotobacter densities $\times10^3$			51						
Phosphate dissolving fungi (PDB)$\times10^2$			23						
Cellulose decomposers $\times10^4$			54						
CO_2 evolution			28 (mg CO_2/100 g dry soil/24 hr)						

2.Effect of Organic Matter Rates, Biofertilization on plant height,fresh and dry yield of the studied forage crops.

The effect of compost rates (10 and 20m^3) application with the studied three biofertilization treatments on plant height, fresh and dry yield among the three studied forage crops was presented in Table (4). Results reported

that, bacterial inoculation recorded significant increases for all the measured parameters. Maximum stimulatory effect of the biofertilizers was existed in plant treated with mixture of both ***A. chroococcum*** and ***A. brasilensce*** at $20m^3$ rate of compost. Significant differences were obtained between the three used fodder crops in all studied traits and were observed by applied treatments. It would be concluded that the genotypes difference between the three fodder crops may be due to genetically difference between genotypes and the difference between genotypes concerning partition of dry matter. These obtained results of genotypes differences on the studied traits are in agreement with those obtained by **Muchow, (1989), Zerbini, and Thomas, (2003).**

Table (4). Effect of Compost Rates and Biofertilization on plant height and fresh yield for of the studied fodder crops under salt stress

Genotypes	OM	Biofertilization Treatments	Plant height (cm)			Fresh weight (Ton/fed.)			Dry weight (Ton/fed.)		
			Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3
Black Sudan grass	10	Control	109	98	94	2.29	2.1	1.84	0.31	0.39	0.32
		Azotobacter	135	130	126	2.89	2.92	2.73	0.39	0.47	0.43
		Azospirillm	131	128	122	2.75	2.58	2.46	0.42	0.52	0.48
		Mixture	148	139	137	3.76	4.19	3.95	0.75	0.91	0.79
	20	Control	127	128	123	2.53	2.46	2.39	0.38	0.46	0.42
		Azotobacter	209	194	186	5.27	5.14	5.03	0.51	0.64	0.61
		Azospirillm	183	182	174	4.91	4.89	4.61	0.53	0.67	0.63
		Mixture	219	212	209	5.81	5.59	5.48	0.89	0.96	0.87
Pearl millet	10	Control	103	101	99	1.32	1.26	1.12	0.33	0.45	0.41
		Azotobacter	127	125	112	2.05	2.81	2.64	0.48	0.55	0.49
		Azospirillm	120	116	104	1.95	2.63	2.37	0.49	0.58	0.56
		Mixture	136	133	127	2.24	3.69	3.41	0.88	0.94	0.91
	20	Control	118	112	110	1.89	1.83	1.68	0.41	0.49	0.43
		Azotobacter	139	135	129	3.59	4.28	4.11	0.69	0.78	0.71
		Azospirillm	131	127	121	3.37	3.98	3.80	0.73	0.85	0.77
		Mixture	150	141	129	4.52	5.41	5.15	1.02	0.99	0.94
Maruit-1	10	Control	107	103	98	1.7	1.62	1.54	0.33	0.47	0.45
		Azotobacter	130	130	123	2.44	2.89	2.6	0.54	0.62	0.59
		Azospirillm	129	127	124	2.25	2.64	2.42	0.59	0.65	0.63
		Mixture	140	135	125	3.31	3.92	3.57	0.93	1.08	0.92
	20	Control	124	119	113	1.79	1.72	1.63	0.45	0.51	0.47
		Azotobacter	169	161	157	3.91	5.64	5.22	0.66	0.79	0.75
		Azospirillm	161	156	142	3.87	5.61	5.39	0.68	0.84	0.81
		Mixture	188	186	170	4.68	6.22	5.91	1.16	1.23	1.08
L.S.D at 0.05% interaction			2.063			0.129			0.0551		

3.Effect of compost rate and biofertilization treatments on yield of some fodder crops under salt stress

Data in Table (5) clearly showed that the biofertilization treatments have resulted in increase of grain/panicle and grain yield Ton/fed. It was clear that there is a gradual increase in yield with the different biofertilization treatments from single to the mixed treatment. Mixed biofertilization treatment resulted to the highest significant increase in

grain yield of Maruit-1 which recorded 112.8% followed by pearl millet 94.3% and Black Sudan grass 84.7% of increase in grain yield over control in descending order at compost level $20m^3$. Synergistic effect between biofertilizers in mixed treatment positively affected grain yield. These results may be attributed to the differences among the studied forage crops in yield and its components as the differences in genetically contents of the three forage crops. Maruit-1 may be more adapted to salinity and drought conditions. So, it is considered a favorable forage crops under Ras Sudr conditions. These results are in agreement with those reported by **El-Sherbiny, and Abed El- Lateef, (2009).** High yield obtained with compost level $20m^3$was applied and with Maruit-1 and the other tested forage crops. There was a significant effect among biofertilization , compost levels and forage crops on the studied traits obviously with the mixed biofertilization treatments which gave the maximum effect on yield of the studied forage crops. The same trend was obtained by **Kim, et. al. (2000),**

Table (5). Effect of Compost Rates and Biofertilization on plant height and fresh yield for of some fodder crops under salt stress

Genotypes	OM	Biofertilization Treatments	Grain weight (g/plant)	Grain yield (Ton/fed.)
Black Sudan grass	10	Control	29.7	1.31
		Azotobacter	40.2	1.86
		Azospirillm	44.9	1.91
		Mixture	49.5	1.97
	20	Control	34.1	1.45
		Azotobacter	45.3	2.08
		Azospirillm	47.5	2.17
		Mixture	54.2	2.42
Pearl millet	10	Control	30.1	1.41
		Azotobacter	45.8	2.15
		Azospirillm	48.1	2.29
		Mixture	56.2	2.41
	20	Control	37.3	1.82
		Azotobacter	50.8	2.51
		Azospirillm	53.2	2.58
		Mixture	59.1	2.74
Maruit-1	10	Control	31.1	1.64
		Azotobacter	51.6	2.78
		Azospirillm	54.7	2.85
		Mixture	56	3.06
	20	Control	39	2.19
		Azotobacter	53.9	3.11
		Azospirillm	58	3.25
		Mixture	62.1	3.49
L.S.D at 0.05% interaction			1.294	0.269

4.Effect of compost rate and biofertilization treatments on total nitrogen in soil, nitrogen and protein in leaves for some fodder crops under salt stress

Data presented in Table (6) showed that nitrogen contents in soil at three cuts, indicated that nitrogen content in soil was significantly affected by the applied treatments and the three fodder crops. **Maruit-1** which gave highest concentration **(174ppm),** followed by 173 and 170 for **pearl millet and Black Sudan grass respectively**. These forage crops may be adapted to drought and salinity conditions. So, it is considered as a favorable forage crop under Ras Sudr conditions. These results are in agreement with those represented by **Ague and Palmer (2007).**

For biofertilizer applications treatments, data indicated that inoculation process increased N and protein content in leaves. Inoculation with ***A. chroococcum*** and ***Azospirillum brasilensce*** singly or mixed cause highest N_2 fixation compared with control. Thus, ***Azotobacter*** and ***Azospirillum*** enriched the soil by nitrogen fixation and other different activities which increased soil fertility.

Table (6): Effect of organic mtter rate and biofertilization treatments and micronutrients on total nitrogen in soil, nitrogen and protein in leaves of the fodder crops. (Average of two seasons2016 and 2017)

Genotypes	OM	Biofertilization treatments	N in soil(ppm)			N in leaves (%)			Protein (%)		
			Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3
Black Sudan grass	10	Control	115	128	121	0.91	0.96	0.94	5.7	6.0	5.9
		Azotobacter	122	132	127	0.98	1.12	1.05	6.1	7.0	6.6
		Azospirillm	123	139	129	0.94	1.06	0.93	5.9	6.6	5.8
		Mixture	130	149	141	1.12	1.18	1.11	7.0	7.4	6.9
	20	Control	126	138	130	1.071	1.113	1.052	6.7	7.0	6.6
		Azotobacter	147	151	146	1.281	1.307	1.3755	8.0	8.2	8.6
		Azospirillm	148	153	147	1.239	1.386	1.3335	7.7	8.7	8.3
		Mixture	152	170	161	1.3545	1.449	1.3965	8.5	9.1	8.7
Pearl millet	10	Control	117	129	123	0.94	1.02	0.97	5.9	6.4	6.1
		Azotobacter	125	144	139	1.02	1.28	1.25	6.4	8.0	7.8
		Azospirillm	127	148	140	0.94	1.25	1.18	5.9	7.8	7.4
		Mixture	134	152	147	1.16	1.36	1.32	7.3	8.5	8.3
	20	Control	126.4	140.8	137	1.078	1.167	1.096	6.7	7.3	6.9
		Azotobacter	148.3	156.5	152.9	1.353	1.454	1.399	8.5	9.1	8.7
		Azospirillm	149.1	155.1	147.4	1.265	1.221	1.155	7.9	7.6	7.2
		Mixture	152.9	173.8	166.1	1.408	1.508	1.464	8.8	9.425	9.15
Maruit-1	10	Control	120	129	125	0.94	1.08	0.98	5.9	6.8	6.1
		Azotobacter	127	145	134	1.05	1.32	1.26	6.6	8.3	7.9
		Azospirillm	128	151	148	0.97	1.28	1.21	6.1	8.0	7.6
		Mixture	138	156	149	1.17	1.39	1.3	7.3	8.7	8.1
	20	Control	130	142.6	139.5	1.12	1.29	1.24	7.0	8.1	7.75
		Azotobacter	149.7	158.3	155.2	1.37	1.49	1.44	8.6	9.3	9
		Azospirillm	150.6	159.1	154.8	1.29	1.35	1.29	8.1	8.4	8.1
		Mixture	157	174.3	169.9	1.41	1.52	1.48	8.8	9.5	9.3
L.S.D at 0.05%			0.988			1.03			0.711		

In the present investigation a mixed inoculation of different forage crops with ***A. chroococcum*** and ***Azospirillum*** enhanced the growth of three forage crops and increased the soil fertility as reflected by soil mineral contents. This result is in compatible with the findings of **Ahmed and El-Shazly (2018).**

5-Effect of compost rate and biofertilization treatments on Na^+ and K^+ in the studied fodder crops.

Organic matter rates with biofertilization treatments showed a significant effect on the concentration of Na^+ in roots for the studied different forage crops. Data in (Table 7) indicated that the content of Na^+ was strongly affected by the different biofertilization treatments and two organic matter rates. The effect of biofertilization with ***Azotobacter, Azospirillum*** and mixed treatment decreased significantly the accumulation of Na^+. While K concentration took the opposite trend. Generally, concentration of K^+ decreased at third cut. Inoculation with ***Azotobacter*** and ***Azospirillum*** allowed a better accumulation of Na^+. The effect of salt stress increased the absorption of Na^+, whereas the absorption of K^+ decreased in the roots for three forage crops tested. **Bhivare and Nimbalkar (1984)** found that reducing the amount of K^+ and increased the content of Na^+ could be attributed to the effect of competition between Na^+ and K^+ on the sites of absorption in the plant.

6-Effect of compost rate and biofertilization treatments on proline content in three fodder crops under salt stress

Proline is an important biochemical indicator, which is considered as a major osmoregulator in plants under various stresses and very much sought after compatible osmolyte, which help plants to counteract and recovery from salt stress **(Kumar *et. al.*, 2010)**. There was a steep increase in proline content in the different genotypes with different biofertilization treatments as shown in Table (7). Maximum proline content recorded with biofertilizer application especially ***Azospirllum brasilence***. Although ***Azospirillum*** was directly related to its ability to fix N_2, it also evidenced the multiple capabilities these bacteria have. As well as having the potential to fix N_2, they can produce siderophores, bacteriocins, and plant growth hormones **(Bashan & de Bashan, (2010) and Jain *et. al.*, (2010).** They can also increase ion absorption (e.g., K^+ and NO_3^-) to avoid plant hydric stress, and modify soil redox potential (**Bagheri, (2011); Bashan, *et. al.*, (2004); Hungria *et. al.*, (2010) and Pidello, (2011).**

Table (7). Effect of compost rate and biofertilization treatments on Na^+ , K^+ and proline content in the leaves of the studied fodder crops.

Genotypes	OM	Biofertilization treatments	Na(mg/g dw)			K(mg/g dw)			Proline (mg/g fw)		
			Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3
Black Sudan grass	10	Control	36.6	40.1	42.6	3.1	3.7	3.4	3.1	3.3	3.2
		Azotobacter	35.6	38.3	40	4.6	4.7	4.5	4.3	4.4	4.2
		Azospirillm	33.0	37.4	39.1	4.6	4.7	4.6	4.3	4.33	4.3
		Mixture	32.1	36.5	37.4	4.7	4.8	4.6	4.4	4.4	4.3
	20	Control	43.5	46.6	51.94	3.4	3.8	3.6	3.8	3.7	3.5
		Azotobacter	42.4	44.5	48.8	5.0	5.0	4.8	4.9	5.0	4.8
		Azospirillm	39.2	43.5	47.7	5.0	5.3	4.9	5.0	4.9	4.9
		Mixture	38.2	42.4	45.6	5.1	5.3	4.9	5.1	5.3	4.9
Pearl millet	10	Control	39	52.7	57.0	3.3	3.8	3.7	3.5	3.3	3.3
		Azotobacter	42.1	48.2	53.0	4.7	4.9	4.6	4.8	5.0	5.3
		Azospirillm	45.6	53.2	49.4	4.6	4.8	4.5	4.95	5.1	5.4
		Mixture	39.8	45.6	46.5	4.9	5.0	4.6	5.04	5.3	5.6
	20	Control	40.0	54.2	58.71	3.6	4.2	3.9	4.3	4.1	4.1
		Azotobacter	43.4	49.7	54.59	4.8	5.0	4.7	5.8	5.6	5.5
		Azospirillm	47.5	55.4	51.5	4.6	4.8	4.7	6.04	5.72	5.6
		Mixture	41.4	47.5	48.41	5.0	5.4	4.9	6.1	5.9	5.8
Maruit-1	10	Control	39.7	40.7	42.6	4.0	3.9	3.9	3.6	3.4	3.4
		Azotobacter	37	38.8	41.6	5.2	5.1	5.0	4.9	5.2	5.5
		Azospirillm	34.7	39.8	40.6	5.3	5.3	5.3	5.1	5.3	5.6
		Mixture	34.7	36.9	38.7	5.7	5.4	5.4	5.2	5.5	5.8
	20	Control	36.4	38.3	41.4	4.3	4.2	4.2	4.4	4.2	4.2
		Azotobacter	32.3	35.3	41.4	5.6	5.5	5.4	6.0	5.8	5.7
		Azospirillm	35.1	37.2	40.4	5.7	5.7	5.7	6.2	5.9	5.8
		Mixture	31.1	33.2	38.3	6.1	5.8	5.8	6.3	6.1	6.02
L.S.D at 0.05%			0.059			0.182			0.0175		

7. Effect of compost levelsand biofertilization on soil microbial activity in rhizosphere of the studied forage crops.

7.1. Total microbial counts: Data presented in Table (8) showed that, the microbial counts in rhizosphere for the studied forage crops varied greatly with different treatments. The initial total microbial counts in soil before cultivation were 47×10^5 cfu/g dry soil. Counts were tended to increase with different biofertilization treatments either in single or mixed application. The highest mean counts were associated with the organic matter $20m^3$ and mixed biofertilizer application being 157.5×10^5 cfu. /g dry soil. However, slight differences in total microbial counts with different forage crops. Maruit 1 exhibited the highest figure for total microbial counts which indicated that, Maruit 1 is well adapted to different environmental stress and highly response to biofertilization treatments application. The enhancement in microbial activity is good parameter for soil improvement indices. Plant growth promoting rhizobacteria (PGPR) like ***Azotobacter*** and ***Azospirillum*** produce growth promoting substance which enhance plant growth proliferation, lateral roots and root hairs which increase nutrient absorbing surface **(Metin *et. al*.,2014).**

Table (8).Effect of organic matter rates, biofertilization treatments on microbial determinations at rhizosphere area of the studied forage crops. (Average of two seasons 2016 and 2017)

Genotypes	OM (m^3)	Biofertilization treatments	Total microbial counts ($\times10^5$cfu/g dry soil)			*Azotobacter* densities ($\times10^3$cells/g dry soil)			*Azospirillum* counts ($\times10^3$cellsdry soil)		
			Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3	Cut_1	Cut_2	Cut_3
Black Sudan grass	10	Control	55	77	70	40	49	46	28	31	29
		Azotobacter	69	96	84	49	62	55	31	34	34
		Azospirillm	62	91	82	45	55	49	39	47	45
		Mixture	71	115	97	55	63	58	43	49	44
	20	Control	68	82.6	74.5	45.9	59.2	53	31.6	36.7	34.7
		Azotobacter	84	120.4	109.1	60.2	72.4	66.3	35.7	39.8	42.8
		Azospirillm	75.6	114.2	107.1	51	64.3	62.2	43.9	57.1	49
		Mixture	96.9	131.6	114.2	63.2	74.5	65.3	51	60.2	52
Pearl Millet	10	Control	67	78	71	53	62	54	39	44	39
		Azotobacter	76	103	94	65	74	75	48	56	41
		Azospirillm	69	98	91	62	68	66	57	64	59
		Mixture	88	116	98	73	79	81	61	69	63
	20	Control	68.6	91.14	78.4	59.8	82.3	78.4	46.2	52.5	50.4
		Azotobacter	86.3	146	134.3	74.2	108.2	102.9	51.5	59.9	55.7
		Azospirillm	79.4	140.1	139.2	71.5	100.3	92.6	65.1	74.6	70.4
		Mixture	100	154.8	146	90.3	118.7	110.3	68.3	79.8	75.6
Maruit-1	10	Control	68	78	71	53	66	59	41	49	45
		Azotobacter	89	107	98	68	74	79	48	57	55
		Azospirillm	80	99	93	65	69	73	59	70	64
		Mixture	114	129	121	75	89	86	62	75	71
	20	Control	81.9	98.7	94.5	62	82.9	78.6	45.1	52.9	50
		Azotobacter	121.8	153.3	136.5	75.6	105.8	96.1	51.9	59.8	57.8
		Azospirillm	107.1	144.8	128.1	73.5	101.9	88.2	62.7	74.5	71.5
		Mixture	146	157.5	151.2	91.2	123.5	110.7	65.7	80.4	78.4
L.S.D.at 0.05%			1.539			0.184			0.342		

7.2. ***Azotobacter*** **densities:** Inoculation with heavy suspension of ***Azotobacter*** led to a rather pronounced increase in densities recorded at the 1^{st} and 2^{nd} cuts. The effect diminished with the prolongation of plant growth period. The lowest densities of ***Azotobacter*** (Table 8) were recorded at rate $10m^3$ organic matter without biofertilization treatments(Control) . Slight difference in ***Azotobacter*** densities recorded with different forage crops; while Maruit 1 exhibited the highest value of ***Azotobacter*** densities. The promoting effect due to application of ***A. chroococcum*** not only due to the nitrogen fixation but also to the production of plant growth promoting substances, production of amino acids, organic acids, vitamins and antimicrobial substances as well which increase soil fertility, microbial community and plant growth (**Singh *et. al.* 2013).**

7.3. ***Azospirillum*** **densities:** data in Table (8) showed the estimation of ***Azospirillum*** densities in rhizosphere area of the studied forage crops, ***Azospirillum*** densities tended to increase at the 1^{st} and 2^{nd} cuts, and then declined toward the third cut. Also for the organic matter addition $20m^3$ and mixed biofertilization treatments recorded better values . Biofertilization with ***Azospirillum*** increased its densities in single and mixed treatment compared with the control treatment. These results agreed with that obtained by **Abd El Gawad and Omar, (2014).**

7.4. Enzymatic activities: Measurements of enzymatic activities in soil samples are critical index of soil fertility because enzymes play an important role in nutrient cycles (Anwesha et. al., 2012), data in Table (9) showed that the determination of enzymatic activity in rhizosphere area of the studied forage crops plants epresented the followings:

Dehydrogenase enzyme: Dehydrogenase activity (DHA) represents the energy transfer, therefore, it is considered as an index of overall microbial activity in the soil. Represented data in table 9 recorded that organic matter rates wihout biofertilizer application recorded lower values of DHA activity compared with biofertilization treatments and addition of $20m^3$organic matter. Interaction treatment of organic matter and biofertilization recorded the highest DHA activity. This may be due to that *A.chroococcum* and *A.brasilence* played an important role as plant growth promoting rhizobacteria via N_2 fixation (**Muthukumar and Udaiyan2006).** This might led to accumulate available nutrients and stimulate the microorganisms in soil rhizosphere.

Nitrogenase activity: Nitrogenase activity in soil samples increased with different biofertilization treatments. The highest mean values of

nitrogenase enzyme was recorded with the mixed biofertilization treatments with addition of $20m^3$organic matter. Many investigators demonstrated the positive effect of dual inoculation with N_2-fixer on N_2-ase activity **(El- Komy, 2005).**

Table (9): Effect of Organic Matter rates and Biofertilization treatments on Enzymatic activities at rhizosphere area for the studied forage crops. (Average of two seasons 2016 and 2017)

Genotypes	OM (m^3)	Biofertilization Treatments	Dehydrogenase µlDHA/g dry soil	Nitrogenase µMC2H4kg/h
Black Sudan grass	10	Control	0.55	0.25
		Azotobacter	0.91	0.58
		Azospirillm	0.75	0.66
		Mixture	0.98	0.89
	20	Control	0.69	0.27
		Azotobacter	1.38	0.88
		Azospirillm	1.22	0.94
		Mixture	1.53	1.02
Pearl Millet	10	Control	1.13	0.27
		Azotobacter	1.28	0.64
		Azospirillm	1.23	0.53
		Mixture	1.44	0.71
	20	Control	1.41	0.59
		Azotobacter	1.58	1.06
		Azospirillm	1.46	1.19
		Mixture	1.82	1.28
Maruit-1		Control	1.38	0.38
		Azotobacter	1.69	0.94
		Azospirillm	1.53	1.24
		Mixture	2.20	1.36
		Control	1.51	0.48
		Azotobacter	1.89	1.35
		Azospirillm	1.85	1.41
		Mixture	2.17	1.46
L.S.D at 0.05%			0.2883	0.016

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تأثير التسميد الحيوى ومعدلات من الكمبوست على انتاجية بعض محاصيل الاعلاف الصيفية تحت ظروف الاجهاد الملحي

امال السيد احمد و منى مرسى الشاذلى

قسم خصوبة وميكروبيولوجيا– الاراضى مركز بحوث الصحراء

أجريت تجربة حقلية خلال موسمى 2016، 2017 بمحطة التجارب الزراعية التابعة لمركز بحوث الصحراء بمدينة رأس سدر محافظة جنوب سيناء وذلك لدراسة تأثير مستويين من المادة العضوية(10 و 20 م3 للفدان) و معاملات التسميد الحيوى بكتريا الازوتوباكتر والازوسبيريللم (بكتريا مثبته للنيتروجين) كمعاملات منفردة وكذلك معاملة مشتركة لكل منهما

علـى نمـو وانتاجيـة لـبعض محاصـيل العلـف الصـيفية صـنف مريـوط–1، والصـنف حشيشـة السودان السوداء، والدخن تحت ظروف الأراضـى الجيرية و المتأثرة بالملوحة بمنطقة رأس سدر جنوب سيناء.

وقد اظهرت النتائج مايلى:

- تباينت الاصناف المختلفة تحت الدراسة معنويا فى سلوكها واستجابتها لتأثير المعاملات المختلفة من التسميد الحيوى ومعدلات المادة العضوية
- أظهرت المعاملات المختلطة من بكتريا الأزوتوباكتر والأزوسبيريللم أفضل النتائج مقارنة بمعاملة الكنترول والمعاملات المنفردة لكل منهما لجميع الصفات تحت الدراسة تحت ظروف الاجهاد المائى،
- كان الصنف مريوط –1 من افضل التراكيب الوراثية لصفات محصول العلف الغض
- أظهرت المعاملات المختلفة من التسميد الحيوى دورا ايجابيا فى تحسين انتاجية اصناف العلف المختلفة تحت الدراسة وكانت المعاملة المختلطة بمخلوط من بكتريا الأزوتوباكتر والأزوسبيريللم من أفضل المعاملات مقارنه بالمعاملات المنفردة والكنترول،
- أدت معاملات التسميد الحيوى الى زيادة النشاط الميكروبى والانزيمى فى التربة وزيادة نسبة محتوى النيتروجين مما يشير الى دورها الايجابى فى زيادة تحمل المحاصيل تحت ظروف الاجهادات البيئية المختلفة.

توصى الدراسة باستخدام المعاملة المختلطة لكل من بكتريا الأزوتوباكتر والأزوسبيريللم مع مستوى 20م^3 مادة عضوية وذلك لتحسين انتاجية العلف الغض من السورجم مريوط –1 المنتخب بمركز بحوث الصحراء تحت ظروف الاراضى المتأثرة بالملوحة والجفاف والرى بالمياه المالحة بمنطقة رأس سدر والمناطق المماثلة بجنوب سيناء والتركيز على زراعة هذه الاصناف نظرا لزيادة تحملها لظروف الإجهاد المائى والملوحة وإستجابتها للتسميد الحيوى.