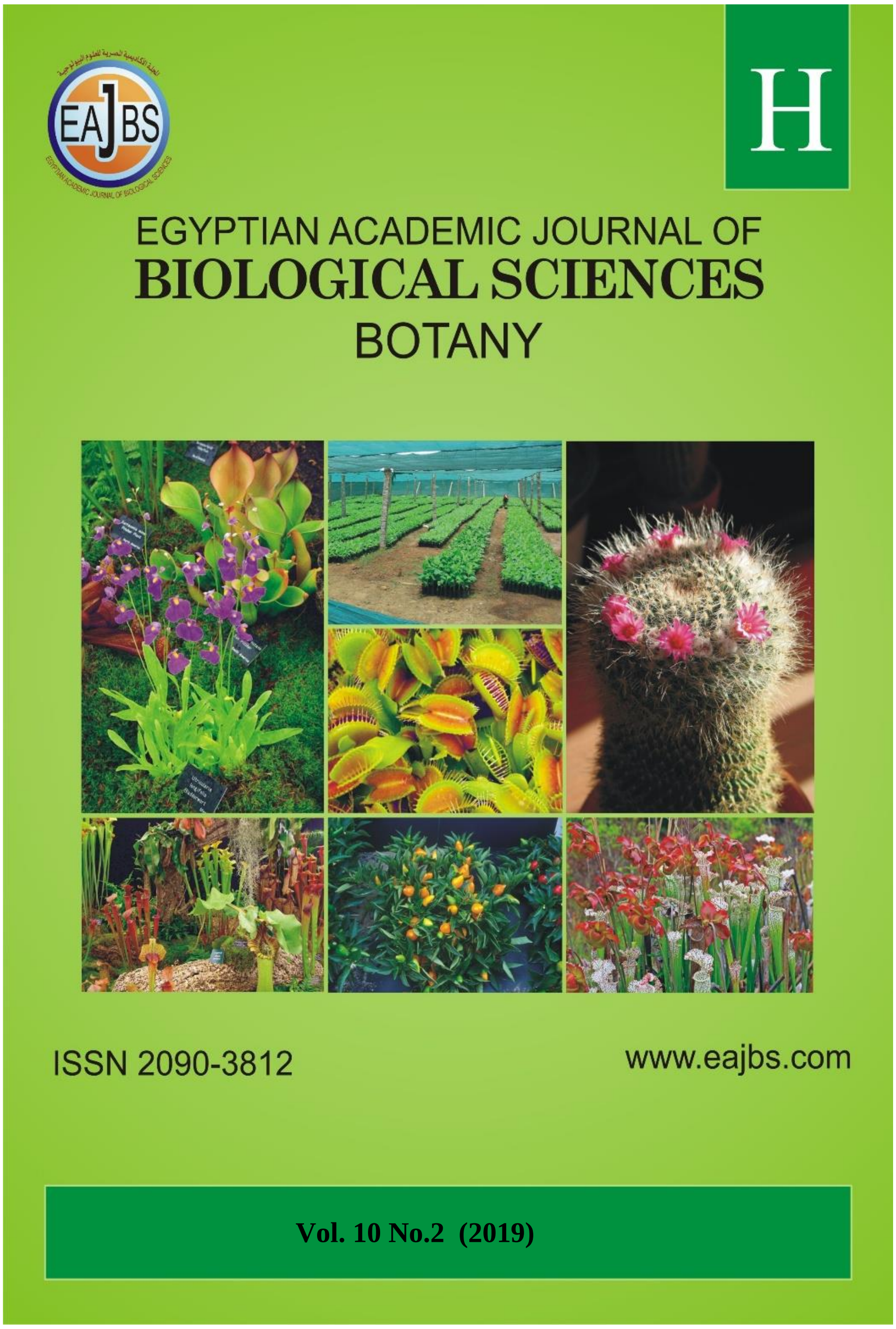

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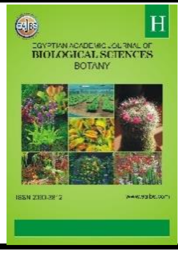

Potential of Some Forage Shrubs for Improving Degraded Rangelands Using Compost in Northwestern Coast of Egypt

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ABSTRACT

The northwestern coast of Egypt is one of the most important grazing areas in the country, with a natural rangelands area of about 2.3 million hectares. Rangelands in this area have been facing overgrazing and mismanagement for years, so rehabilitation and restoration approaches are urgently needed for the sustainable development of these rangelands. Hence, this research was conducted at Wadi El-Washka, El- Kaser Region, Northwestern Coast, Marsa Matrouh Governorate, Egypt, in 2017 and 2018 growing seasons to study the effect of compost manure rates on the growth parameters of three forages shrubs species. The experimental design of the experiment was split-plot design with four replications. The main plots included the three shrubs species (*Medicago arborea*, *Periploca angustipholia,* and *Atriplex nummularia*), while compost rates (0, 5, and 10 t/fed) in the subplot. The results concluded that the different shrubs significantly differed under increasing the rate of compost manure. In this respect fertilizing *Atriplex nummularia* by addition compost at the rate of 10 t/fed as organic manure increased all growth characters including, shrub height of 119.40 and 126.08 cm, number of branches/plants of 11.08 and 11.73 branches, crown coverage of 0.929 and 0.506 m^2 and crown volume of 0.363 and 0.260 m^3 in spring and autumn growing seasons of 2017 and 2018, respectively under study conditions at northwestern coast of Marsa Matrouh Governorate, Egypt. These findings would have management implications for the better use of untraditional water resources for the sustainable development of degraded desert rangelands.

INTRODUCTION

Continuous desertification of arable lands due to urbanization, global warming, and low rainfall mandates use of low quality/saline water for irrigation, especially in regions experiencing water shortage. Thus, there is an urgent need for finding salt/drought tolerant plant species to survive/sustain under such stressful conditions (Pessarakli, 2011). Deterioration in plant diversity in the North Western coastal zone is primarily observed in the cushion growth form acquired by under-shrubs and shrubs which are the main perennial elements of the natural plant cover. It is further indicated by the dominance of numerous unpalatable plants including spiny shrubs and under-shrubs (Khalifa, 2015). Most of those rangeland degradations resulted from overgrazing and land-use changes in the area which induced by climate variation and human activities.

Under rainfed conditions in Marsa Matrouh area, a cropping system that includes saltbush shrubs (*Atriplex nummularia*) intercropped with barley was introduced by (Moselhy and El-Hakeem, 2002). Their results showed that the increase of saltbush density had highly significant effects on fresh and dry forage yields and feed unit per Feddan. In this respect another experiment of planting *Medicago arborea* shrubs at different population densities with barley and vicia indicated that number of branches/shrub of *Medicago arborea* was significantly affected by the different interplanted herbaceous fodder crops. The number of branches of *Medicago arborea* shrubs was 12 branch/ shrub when the interplanted herbaceous crop was barley compared with 15 branches/shrub when it was vicia with significant increase of 25%. The crown volume of *Medicago arborea* was significantly increased as the population density of such interplanted shrubs increased from 100 up to 400 shrubs/fed (El-Hakeem, 1998).

The effects of using compost on soil conditions improvement and increasing plant growth were determined. The compost improved soil nutrient and organic matter rates and favored the expansion of a sustainable soil microbial biomass in addition to increasing *Atriplex halimus* biomass and ground cover (Clemente *et al*., 2012). Application of 3.0 t/ha of the compost produced the best of all the growth parameters of *Amaranthus cruentus* as compared to the other levels of compost (Babajide and Olayiwola, 2014). The soil was amended with compost manure at the rates of 0, 15 and 30 t/ha to evaluate its role on crop growth and nutrient uptake. Application of compost significantly improved biomass yield, protein (%) and ash content (%) of *Atriplex amnicola* (Eissa *et al*., 2016).

Further, compost is an excellent soil amendment that adds a balance of nutrients, while contributing valuable organic material to the soil. Compost is needed for the growth of soil microorganisms, to improve water holding capacity, soil structure, pH buffering, and the organic complexing of nutrients, making them more available for uptake by plants. It is well documented that the incorporation of organic manure into the soil is increasingly important whereas it improves soil fertility and increased crop yield (Singh, 2001). Compost may be defined as the stabilized and sanitized product of composting, which is compatible and beneficial to plant growth. The application of compost has a positive effect on basic soil properties (physical, chemical, and biological fertility). The composition of the input substrate has a significant effect on compost quality (Diaz *et al.*, 2007). Application of compost manure with A- mycorrhizal fungus, significantly, increased grain yield and components of maize than control treatment (Gomaa *et al*., 2015).

Recently, there has been an expansion of digging wells to pump subsurface water on the northwestern coast of Egypt. Water wells are used to irrigate some field crops and vegetable plants and to provide supplementary irrigation for fruit trees. High dissolved salts have been observed in most of these wells, making them often unfit for growing vegetable plants and crops. These wells can be a good way to rehabilitate rangelands and provide green forage during the summer season for livestock, especially if they are used in the cultivation of some local and introduced forage shrubs, which have a high ability to resist drought and salinity. Therefore, this investigation aimed to study the growth response of three forage shrubs to application of different compost manure levels under Northwestern Coast of Egypt condition.

MATERIALS AND METHODS

Description of the Study Area:

This research was conducted at Wadi El-Washka, El- Kaser area, Northwestern Coast, Marsa Matrouh Governorate, Egypt, during the growing seasons of 2017 and 2018 to study the effect of different rates of compost manure on the growth and the productivity of the three forages shrubs. The North-Western Mediterranean Coastal Belt, where this study was carried out, extends from Alexandria westward to El Sallum for about 500 km, and from the seashore inward for about 15 km, is considered the richest part of Egypt in flowering plants, owing to its relatively high rainfall. In addition, there are about 218 Wadis in the area running from south to north and represent suitable environment for cultivation fruit, vegetables, and growing native plants. There are 8 plant communities dominate the north-western coast area and these rangeland communities differ in the vegetation types and the plant productivity based on the soil type and the amount of rainfall in the specific location.

The climate of the study area belongs to the Mediterranean coastal region of Egypt which is warm coastal desert climate. The occasional short rainstorms occur in winter and most of the days are sunny with mild temperature. Generally, the rainy season occurs during the winter and is characterized by great fluctuation in distribution and intensity of rainfall from one year to another. The average annual precipitation ranges between 102 mm at El Sallum and 180 mm at Alexandria. Soil physical and chemical properties and soil fertility status analysis of the study were estimated according to the method described by Chapman and Pratt (1978), and are presented in Table (1).

Table1. Soil chemical and physical properties and soil fertility status of the study area at Wadi El-Washka, Northwestern, Egypt.

Some chemical properties												
Depth Cm	pH	EC dS/m	Cations (meq/ L)				Anions(meq/L)				SAR	SEP
			Na	K	Ca	Mg	Cl	CO3	HCO3	SO4		
0 – 30	7.7	0.94	4.48	0.16	3.10	1.67	4.16	0.25	3.96	1.04	2.90	2.92

Some physical properties					
0 – 30	CaCO3 %	Gravels %	Particle size distribution %			Texture class
			Sand	Silt	Clay	
	26.32	8.16	74.32	20.52	5.17	Sandy loam

Soil fertility status								
0 – 30	OM %	Available nutrients, mg/kg						
		N	P	K	Fe	Mn	Zn	Cu
	0.53	97.6	6.82	358.1	14.23	19.90	2.26	2.14

Experimental Design:

Split plot design with four replications was used in this experiment. Where, the main plots included the three shrubs species (*Medicago arborea*, *Periploca angustipholia*, and *Atriplex nummularia*), while compost rates (0, 5, and 10 t/fed) was located in the subplot. The experimental subplot area was 36 m^2 [3 ridges (6 m) of each shrub at 6 m along]. Seedlings of the three perennial shrubs species were planted by transplants on 4th of April 2017 in distance 2 x 2 m^2 and irrigated on the same day of planting. Compost as organic manure treatments at the rates of 0, 5 and 10 t/fed were distributed in the planting hills before transplanting of the seedling of three shrubs species. NPK fertilizer by the rate of 16/16/16 was applied one time in winter season after 9 months after planting of the seedlings at 15th of January 2018. Irrigation was mainly as supplemental irrigation during the summer season and dry periods. Analysis of well water used to irrigate the experiment was evaluated at the soil lab of the Sustainable Development Center of Matrouh Resources, Desert Research Center and is presented in Table (2).

Data Collection and Shrubs Measurements:

The collected data was recorded in the spring season (26 April 2018) and in autumn season (13th of October 2018). Where, shrub height (cm) and number of branches/shrub, crown cover (m^2), and crown volume (m^3) were recorded in spring and autumn seasons. Crown cover and crown volume were calculated using the following equation as described by Thalen (1978).

Crown cover = ¼ л x D1 x D2

Crown volume = 1/6 л x D1 x D2 x H

Where, л = 3.14, D1 and D2 are the shortest and the longest diameters of the shrub, respectively and H is the shrub height.

Table 2. Analysis of irrigation well water

Propriety	Value	Unit
PH	7.89	-
EC	6.68	ds/m
Soluble cations (meq/l)		
Na+	44.48	meq/l
K+	0.82	meq/l
Ca++	3.50	meq/l
Mg++	18.00	meq/l
Soluble Anions (meq/l)		
CO3−	0.00	meq/l
HCO3	3.00	meq/l
CL-	38.60	meq/l
SO4	25.20	meq/l
TDS	5344	Ppm

Statistical Analysis:

All collected data were subjected to analysis of variance according to the method described by Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique using CoStat computer software package (CoStat, Ver. 6.311., 2005). The least significant difference (LSD at 0.05 level of probability) was used to compare the treatment means

RESULTS AND DISCUSSION

The results presented in Tables (3 and 4) showed the response of the three shrubs species to different rates of compost manure and their interaction in the two growing seasons of 2017 and 2018. The obtained results indicated that there were significant differences in the response among the three shrubs species, where *Atriplex nummularia* shrub recorded the highest mean values of shrub height of 99.58 and 117.98 cm, number of branches/plants of 8.97 and 10.42 branches, crown coverage of 0.953 and 0.749 m^2, and crown volume of 0.464 and 0.359 m^3, respectively in spring and autumn seasons of 2017 and 2018, followed by *Periploca angustipholia* shrub in all studied characteristics under this study. Meanwhile, *Medicago arborea* achieved the lowest values of growth parameters. The different response of the three shrubs species may be due to genetics factors of these shrubs for adaptation to the study conditions and the difference in their ability to drought tolerance. These findings results are in agreement with those obtained by El-Hakeem (1998), Moselhy and El-Hakeem (2002) and Clemente *et al.* (2012).

Regarding the effect of compost manure rates, the results in Table (3 and 4) indicated that increasing compost manure level from 0 to 10 t/fed had increased shrub height of 85.67 and 91.93 cm, number of branches/plant of 10.31 and 9.67, crown coverage of 0.929 and 0.506 m^2, and crown volume of 0.363 and 0.260 m^3 during spring and autumn of the year 2017 and 2018, respectively as compared with the other treatments. While the control treatment (0 compost) recorded the lowest mean values in all studied characters of this study. The increase from these traits could be due to vital role of compost as organic manure for soil and crops. These results are in harmony with those obtained by Babajide and Olayiwola (2014), Gomaa *et al.* (2015) and Eissa *et al.* (2016)

Respecting the interaction effect between shrubs species and compost rates, the results in Tables (3 and 4) showed that there was significant interaction on all studied characters, where application of compost manure for *Atriplex nummularia* recorded the highest mean values of shrub height of 119.40 and 126.08 cm, number of branches/plants of 11.08 and 11.73 branches, crown coverage of 0.929 and 0.506 m^2 and crown volume of 0.363 and 0.260 m^3 in spring and autumn growing seasons of 2017 and 2018, respectively, followed by the same type of shrub (*Atriplex nummularia*) and 5 ton compost/fed in both growing seasons. While the lowest values obtained when fertilizing *Medicago arborea* with no application of compost manure in the two seasons. The response of shrubs under compost rates indicate that each factor acted dependently under different factor of application.

Table3. Shrub height (cm) and the number of branches/plants of the three forage shrubs as affected by compost manure under Northwestern Coast of Egypt in spring and autumn seasons.

Treatments		Shrub height (cm)		Number of branches/plant	
		Seasons			
		Spring	Autumn	Spring	Autumn
A) Forage types					
Medicago arborea		54.31	50.37	8.91	8.76
Periploca angustipholia		63.24	77.47	7.71	6.38
Atriplex nummularia		99.58	117.98	8.97	10.42
LSD at 0.05		12.24	6.31	0.95	0.94
B) Compost manure (t/fed)					
0 (control)		57.23	70.15	6.34	7.44
5 t/fed		74.24	83.73	8.93	8.45
10 t/fed		85.67	91.93	10.31	9.67
LSD at 0.05		5.44	6.93	0.75	1.08
Interaction					
A x B		*	*	*	*
Interaction					
Forage types	Compost (t/fed)				
Medicago arborea	0 (control)	43.93	41.65	6.75	7.15
	5 t/fed	57.40	55.40	9.40	8.83
	10 t/fed	61.60	54.05	10.58	10.30
Periploca angustipholia	0 (control)	47.58	64.55	5.28	5.38
	5 t/fed	66.15	72.18	8.58	6.80
	10 t/fed	76.00	95.68	8.83	6.98
Atriplex nummularia	0 (control)	80.18	104.25	7.00	9.73
	5 t/fed	99.18	123.60	9.28	9.80
	10 t/fed	119.40	126.08	11.08	11.73
LSD at 0.05		9.41	12.00	1.30	1.87

Table 4. Crown coverage and crown volume of the three forage shrubs as affected by compost manure under Northwestern Coast of Egypt in spring and autumn seasons

Treatments		Crown coverage		Crown volume	
		Seasons			
		Spring	Autumn	Spring	Autumn
A) Forage types					
Medicago arborea		0.341	0.151	0.103	0.036
Periploca angustipholia		0.483	0.226	0.145	0.069
Atriplex nummularia		0.953	0.749	0.464	0.359
LSD at 0.05		0.370	0.159	0.254	0.067
B) Compost manure (t/fed)					
0 (control)		0.256	0.240	0.118	0.036
5 t/fed		0.592	0.381	0.232	0.168
10 t/fed		0.929	0.506	0.363	0.260
LSD at 0.05		0.248	0.154	0.181	0.075
Interaction					
A x B		*	*	*	*
Interaction					
Forage types	Compost (t/fed)				
Medicago arborea	0 (control)	0.200	0.085	0.035	0.023
	5 t/fed	0.236	0.159	0.139	0.036
	10 t/fed	0.585	0.211	0.136	0.057
Periploca angustipholia	0 (control)	0.201	0.165	0.089	0.054
	5 t/fed	0.572	0.245	0.087	1.205
	10 t/fed	0.675	0.267	0.258	0.109
Atriplex nummularia	0 (control)	0.366	0.471	0.231	0.223
	5 t/fed	0.968	0.738	0.469	0.390
	10 t/fed	1.526	1.040	0.693	0.613
LSD at 0.05		0.430	0.266	0.314	0.129

Conclusion:

Our results have shown that native and well-adapted introduce forage species could be very valuable in rangelands restoration and rehabilitation programs particularly in desert rangelands with similar environmental conditions as the northwestern coast of Egypt. The three shrub species, *Atriplex nummularia, Medicago arborea, and Periploca angustipholia*, have shown high potential for improving the degraded desert rangelands and had high growth characteristics particularly with using compost as a soil amendment and organic fertilizer. The highest growth parameters were achieved by *Atriplex nummularia* under 10 t/fed of compost manure.

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ARABIC SUMMARY

قدرة بعض الشجيرات العلفية لتحسين المراعى المتدهورة باستخدام الكمبوست فى الساحل الشمالى الغربى لمصر

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تعتبر منطقة الساحل الشمالي الغربي لمصر من اهم مناطق الرعي في مصر حيث تبلغ مساحة المراعي الطبيعية بها حوالي 2,3 مليون هكتار. تعرضت المراعي في هذه المنطقة الي الرعي الجائر وسوء الإدارة لسنوات طويلة، لذا فإن منهجيات إعادة تأهليها وإستعادتها مطلوبة بشدة من أجل تحقيق التنمية المستدامة لهذه المراعي، ومن ثم أقيمت تجربتان بهدف تنمية المراعي وزيادة انتاجية وحدة المساحة عن طريق ادخال الشجيرات العلفية ضمن المراعي الطبيعية مع استخدام الكمبوست كسماد عضوي لتحسين نمو هذه الأنوع ولدراسة تأثير استخدام التسميد العضوي علي نمو وانتاجية بعض الشجيرات العلفية النامية تحت ظروف الساحل الشمالي الغربي لمصر التصميم التجريبي المستخدم في هذا الدراسة هو القطع المنشقة مرة واحدة split plot design فى أربعة مكررات علي ان توضع الثلاثة أنواع من النباتات الرعوية في القطع الرئيسية Main plots و معاملات التسميد العضوي في القطع فرعيةsub plots ووزعت المعاملات توزيع عشوائياً كالأتي:

1- القطع الرئيسية اشتملت علي الأنواع النباتية الرعوية (البرسيم الشجيري *Medicago arborea* ، الحلاب *Periploca angustipholia* ، القطف الاسترالي *Atriplex nummularia*

ب) القطع الشقيه اشتملت علي مستويات التسميد العضوى (الكمبوست) وهي بدون (كنترول) ، 5 طن كمبوست/ فدان ، 10 طن كمبوست فدان.

تم تسجيل قياسات النمو المختلفة (ارتفاع الشجيرة ، عدد الأفرع/شجيرة ، التغطية التاجية ، الحجم التاجي) علي الشجيرات العلفية (البرسيم الشجيري ، الحلاب ، القطف الاسترالي) في موسمي الجفاف والرطوبة تحت ظروف الامطار..

ولخصت النتائج فيما يلي:

- أختلفت الأنواع الثلاثة من الشجيرات أختلافاً معنوياً في جميع الصفات المدروسة مثل أرتفاع الشجيرة وعدد الأفرع للشجيرة ، الغطاء التاجي للشجيرة والحجم التاجي للشجيرة خلال موسم الربيع والخريف لعام 2018. حيث سجل القطف الأسترالي أعلي متوسطات قيم للصفات السابق ذكرها ، متبوعاً بعشب الحلاب في حين أن البرسيم الشجيري حقق اقل القيم في صفات النمو والمحصول.
- بالنسبة لتأثير سماد الكمبوست وجد أن زيادة معدل السماد العضوي الصناعي (الكمبوست) من صفر الى 10 طن/فدان حقق زيادة معنوية في كل الصفات المدروسة.
- كما سجل التداخل بين عاملي الدراسة (الثلاثة شجيرات و الثلاثة معدلات من الكمبوست) حيث أن التسميد بمعدل 10 طن للفدان للشجيرة القطف الأسترالي التى أعطت أعلى متوسطات قيم للصفات المدروسة.

من خلال النتائج المتحصل عليها وجد أن شجيرة القطف الأسترالي حققت أعلى إستجابة لمعدلات السماد العضوي (الكمبوست) حيث أن إضافة 10 طن من الكمبوست للفدان أثناء الزراعة حقق أعلي نمو وإنتاجية علفية لشجيرة القطف الأسترالي تحت ظروف وادي الوشكة – منطقة القصر – محافظة مرسى مطروح – الساحل الشمالي - مصر والمناطق المماثلة لها.

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