

Effect of Treatment by Mix of Raw Mineral Elements on Productivity and Quality of Jew's Mallow (*Corchorus olitorius*) Under Ras Sudr Conditions, South Sinai, Egypt

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Abstract: The experiment was carried out on Jew's mallow plant (Siwi and Balady cultivars) during two successful seasons 2017 and 2018 at the Experimental Farm of Desert Research Center Ras Sudr District, South Sinai Governorate, Egypt, to study the effect of mix of raw mineral elements on growth and productivity of some Jew's mallow cultivars. The field experiment was performed in the of split plot. The main plots were the Jew's mallow cultivars, while the sub-plots were mix of raw mineral elements which were used at rates (0, 50, 75, 100 and 125 kg /fed). Fertilizing Jew's mallow Siwi cultivar with mix of raw mineral elements at 125 kg /fed. gave the highest value of plant growth (plant height, fresh and dry weight, number of leaves) and total yield (gm/m²) and recorded the maximum content of K, P and Ca in plant leaves. Whereas the Balady cultivar without fertilization with mix of raw mineral elements recorded the highest concentration of chloride and sodium in plant leaves of Jew's mallow.

Key words: Jew's mallow *Corchorus olitorius* • Cultivars • Yield • Raw mineral elements

INTRODUCTION

Ras Sudr is one of the Egyptian cities located on the Gulf of the Suez Canal in the Red Sea Coast. It is located in the South Sinai Governorate. It's a model of saline-affected land, whether soil salinity or irrigation water as show in Tables B and C. Therefore, agricultural production facing many challenges in these areas, especially vegetable crops with salinity in the soil or in the irrigation water it is potentially classified as one of the most important soil reclamation problems in many parts of the world. Generally salinity is reducing the growth rate include shorter internodes, stature, reduce roots length and mass, also, salinity change some characters such as shoot to root ratio, leaves index area and burning of leaves. Huang *et al.* [1] reported that, the leaf relative water content was decreased as salinity increased. Chemically, salinity led to changing in leaf color due to the decrements of Mg⁺⁺, NO₃⁻ and NH₃⁻ concentrations in leaves which in turn change chlorophyll contents.

Jew's mallow (*Corchorus olitorius*) is one of the major leafy vegetables and it is one of the most popular vegetables in every home in Egypt, Jew's mallow is an important vegetable crops that have a large consumer

loyalty in the local market. In addition to its nutritional and medical value, we had to consider the problems of production in the new reclamation areas, especially in Sinai. The plan of the state guarantees stability of the homeland. Thus we must overcome the problems of development in South Sinai Governorate.

Mguis *et al.* [2] showed that the final germination percentage and germination rate significantly decreased with increasing salt. The high variation of these characters mainly related to geographical origin. Ahmed and Ahmed [3] mentioned that increasing the level of water salinity significantly decreased all the studied characters *viz.*, plant height, fresh shoot weight and number of branches and leaves. No significant genotypic differences were found among the cultivars.

The mix of raw mineral elements is one of the raw materials discovered in the Eastern Desert of Egypt (source Al-Ahram Mining Company) which was conducted on some experiments in research centers.

Natural raw materials considered slow release fertilizer for macro elements, which were make converting them in soluble forms of P, K, Ca and Mg in a long run [4]. In another study on Dill (*Anethum graveolens*, L.) plants Hassan [5] reported that, the highest values of

plant height, branch number, herb dry weight, umbels number, fruit yield/plant and per fed., N, P and K percentages, were generally increased as a result of applying mixed minerals ores at high rate of mixed minerals ores (800 kg /fed.). It has assumed great importance for sustainable production and to improve the soil physical, chemical and biological properties [6]. Application of 4 kg natural raw material mixture/tree which were gave the best leaf NPK contents, growth, high yield and improving fruit quality of Washington navel orange trees [7]. The application of natural P and K rocks fertilizers in combination with P and K solubilizing bacteria in sandy soil will increase soil available and plant uptake of nutrients, yield and quality of table beet plants [8].

Therefore the aim of this study is to try increase producing of Jew's mallow using a mixture of natural elements under saline conditions to reduce the harmful effect of salinity and environmental pollution. We hope that this study provides us with good information about the nature of this work under high salinity conditions.

MATERIALS AND METHODS

Two successive trials were conducted during summer seasons of 2017 and 2018 at Ras Sudr Experiment Station of Desert Research Center, South Sinai Governorate, Egypt. The aim of the experiments was to study the effect of mix of raw mineral elements (0, 50, 75, 100 and 125 Kg./fed.) on growth, productivity of two cultivars Jew's mallow (*Corchorus olitorius*), i.e. Balady (local cultivar in Qalubia Governorate) and local cultivar in Siwa (Siwi cultivar) under saline conditions.

The soil of the experimental field was classified as sandy loam with high calcium carbonate content. Random soil samples were taken at depth from 0-30 cm before planting for mechanical and chemical analysis according to Piper [9] and the obtained data were presented in Tables (A and B). Under ground irrigation

water was analyzed according to Jackson [10], its analysis is shown in Table (C) and the chemical analysis of mix mineral elements in Table (D).

The mix of neutral raw mineral elements was added before sowing with organic sheep manure (saved from Ras Sudr animals Farm Station) 20 m³/fed., at the soil preparation. Drip irrigation system was used in this experiment. Seeds of Jew's mallow cultivars (Siwi and Balady) were sown on 20th and 25th March in the first and second seasons respectively, using dry sowing method on two sides of the dripper line. The area for each plot was 10.5 m² (1 m.width10.5 m. long). NPK fertilizers were phosphoric acid at rate 20 kg/fed (85% P₂O₅), ammonium sulphate (20.5% N) at the rate of 100 kg /fed. and potassium sulphate (48% k₂o) at rate 50 kg/fed. The quantity NPK were divided and applied at five times after 25, 30, 35, 40 and 45 days from germination through fertigation.

Tables (A and B) presented the physical and chemical soil and irrigation water was carried out using the standard method analysis of the studied site were determined according to Page *et al.* [11] and Klute [12], respectively.

Data Recorded

Growth Parameters: After 55 days from germination, one kg. plants from each experimental unit were randomly taken for recording vegetative growth characteristics, i.e., plant height(cm), number of leaves/plant, fresh weight per plant(gm) and dry weight according to Brown and Lillil [13].

Mineral and Chlorophyll Contents in Leaves: Chlorophyll meter, SPAD-502, MINOLTA, was used to determine the total chlorophyll in leaves tissues. P was determined according to the method described by Frie *et al.* [15] while K, Na, Cl and Ca contents were determined by Huphries [14] respectively.

Table (A): Mechanical properties of the experimental soil at Ras Sudr station

Character	CaCO ₃ %	Coarse sand (0.5-1mm)	Fine sand (0.1-0.25 mm)	Silt (0.002-0.05mm)	Total sand (0.1-1mm)	Clay < (0.002mm)	Class texture
	57.99	38.98	42.51	9.77	81.53	8.70	Sandy loam

Table B: Chemical analyses of the experimental soil at Ras Sudr station

Depth	pH	E.C(dS/m)	Cations			Anions				Available nutrients (mg Kg. ⁻¹)			
			Ca ⁺⁺	Mg ⁺⁺	Na ⁺	CO ₃	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	N	P	K	Fe
30-60	7.8	8.82	25.2	5.7	57.8	0.0	6.2	61.9	26.4	26.2	5.2	51.5	4.3
30-60	7.9	7.50	17.3	4.2	42.9	0.0	3.8	50.2	23.7	18.6	3.6	35.4	3.6

Table C: Chemical analyses of average irrigation water at Ras Sudr Station

pH	EC (dS/m)	Total soluble salts (ppm)	Soluble Cations in mmol/L ⁻¹				Soluble Anions in mmol/L ⁻¹			
			K ⁺	Na ⁺	Mg ⁺⁺	Ca ⁺⁺	So ₄ ⁻	Cl ⁻	HCO ₃ ⁻	CO ₃ ⁻
8.10	7.03	4540	0.56	35.42	18.34	18.08	4.35	57.43	1.75	-

Table D: Chemical analysis of the natural mineral rocks

%										
K ₂ O	P ₂ O ₅	MgO	CaO	Na ₂ O	Al ₂ O ₃	Cl	SO ₃	Fe ₂ O ₃	MnO	L.O.I
4.37	8.14	0.72	13.45	1.92	7.8	0.56	5.38	4.88	0.72	9.01
ppm										
Zn	Cu	Ni	Co	Mo	Pb	Ba	Rb			
30.82	17.8	25.8	17.5	2.4	-	545	46			

Total Yield: During the entire season were counted and weighed for calculating total yield (Kg./m²).

Statistical Analysis: The experimental replicate included 10 treatments were arranged in split plot design with three replicates; the main plots were assigned for 2 cultivars, whereas 5 mix of raw mineral elements (0, 50, 75, 100 and 125 Kg./fed) were randomly arranged in the sub plots. Statistical analyses of the obtained data were analyzed according to Thomas and Hills [14].

RESULTS AND DISCUSSION

Growth Characters: Data in Table (1) show the influence of cultivar and mix of raw mineral elements on plant height, plant fresh (shoot) and dry weight/plant and leaf number of Jew's mallow plants during 2017 /2018 seasons. Siwi cultivar showed a significant increase in Plant height, plant fresh and dry weight/plant and leaf number as compared with the Balady cultivar in the two growing seasons. These results might be due the microclimate at Ras Sudr district was high adaptability of Siwi plants. These results coincide with those mentioned by Mgeis *et al.* [2] and Ahmed and Ahmed [3].

As for, fertilization treatments, the mix of raw mineral elements at 125 Kg./fed. showed significant highest values of plant height, plant fresh (shoot and leaves) and dry weight/plant and leaf number of Jew's mallow plants as compared with the other tested treatments in both seasons. The control treatment (without fertilization) showed the lowest value in both seasons. The enhancing effect of the mix of raw mineral elements at 125 Kg./fed. on growth characters of Jew's mallow plants have been reported by Hegazi *et al.* [4] and El-Sayed *et al.* [8].

Siwi cultivar with 125Kg./fed. of mix of raw mineral elements under Ras Sudr condition gave the highest

values of plant height, plant fresh and dry weight/plant and leaf number / plant when compared with the other treatments in the two studied seasons.

Total Yield: Data presented in Fig. 1 indicate the influence of two cultivars and mix of raw mineral elements on yield (gm/m²) in the two tested seasons. It is evident from Fig. 1, Siwi cultivar has a significant increases in total yield (gm/m²), while, the Balady cultivar recorded the lower yield in both growing seasons. These results may be due to Siwi cultivar attributed to the favorable climatic conditions and tolerant to salinity which was reflected on the stimulation of plant growth and total yield in both seasons. These results agree with those of Ahmed and Ahmed [3].

As regard, the effect of mix of raw mineral elements on total yield (gm/m²), data showed that fertilization with mix of raw mineral elements at 125 Kg./fed resulted in the highest yield when compared to any tested concentration in both tested seasons. Similar results were mentioned by Hassan [5] and El-Sayed *et al.* [8]. The stimulative effect of mix of raw mineral nutrients on yield/m² may be due to the mix of raw mineral elements contain high mineral elements, i.e. P, Mg, Ca, Fe, Zn and Cu Table (D)

As for, to the effect of interaction between cultivar and fertilizer with mix of mineral elements on total yield gm/m² of Jew's mallow, the results indicated that Siwi plants fertilizer with mix of mineral elements at rate 125 Kg./fed was the best treatment and gave the highest yield as compared with all treatments in the two tested seasons.

Mineral Content: Table 2 showed that the minerals content in plant tissue which were influence of by cultivar and fertilizing with raw mineral elements on P, K, chloride and Ca contents in the two growing seasons.

Table 1: Effect of treatment by mix of raw mineral elements on Plant height, plant fresh and dry weight leaves/plant and leaf number of Jew's mallow under Ras Sudr conditions at 55 days from sowing during 2017 and 2018 seasons

Fertilizer	Plant height						Plant fresh weight/plant					
	First season			Second season			First season			Second season		
	Balady	Siwi	Mean (A)	Balady	Siwa	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)
Without	36.13	51.63	43.88	32.53	41.47	37.00	20.87	25.93	23.40	18.53	21.67	20.10
50 Kg./fed.	38.43	55.60	47.02	35.57	42.80	39.18	25.40	30.20	27.80	21.30	25.33	23.32
75 Kg./fed.	40.70	58.50	49.60	38.13	45.53	41.83	29.43	33.73	31.58	24.80	29.73	27.27
100 Kg./fed.	43.67	61.63	52.65	41.60	48.53	45.07	32.47	37.70	35.08	27.60	32.90	30.25
125 Kg./fed.	47.87	66.80	57.33	44.30	51.83	48.07	34.77	42.17	38.47	30.73	36.50	33.62
Mean (B)	41.36	58.83		38.43	46.03		28.59	33.95		24.59	29.23	
L.S.D at 5%	A=0.29	B=0.21	Ax B=0.20	A=0.14	B=0.20	Ax B=0.19	A=0.17	B=0.22	Ax B=0.20	A=0.08	B=0.17	Ax B=0.16
Fertilizer	Leaf number/plant						Plant dry weight/plant					
	First season			Second season			First season			Second season		
	Balady	Siwi	Mean (A)	Balady	Siwa	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)
Without	16.47	21.43	18.95	14.13	17.37	15.75	4.30	5.43	4.87	3.80	4.47	4.13
50 Kg./fed.	19.57	25.47	22.52	17.67	19.90	18.78	5.23	6.23	5.73	4.40	5.23	4.82
75 Kg./fed.	23.63	28.43	26.03	19.83	22.67	21.25	6.13	7.04	6.59	5.13	6.20	5.67
100 Kg./fed.	27.30	31.50	29.40	24.83	26.90	25.87	6.77	7.80	7.28	5.70	6.60	6.15
125 Kg./fed.	31.10	36.80	33.95	29.37	31.60	30.48	7.23	8.73	7.98	6.37	7.57	6.97
Mean (B)	23.61	28.73		14.36	23.69		5.93	7.05		5.08	6.01	
L.S.D at 5%	A=0.20	B=0.17	Ax B=0.15	A=0.05	B=0.20	Ax B=0.19	A=0.04	B=0.05	Ax B=0.05	A=0.08	B=0.11	Ax B=0.10

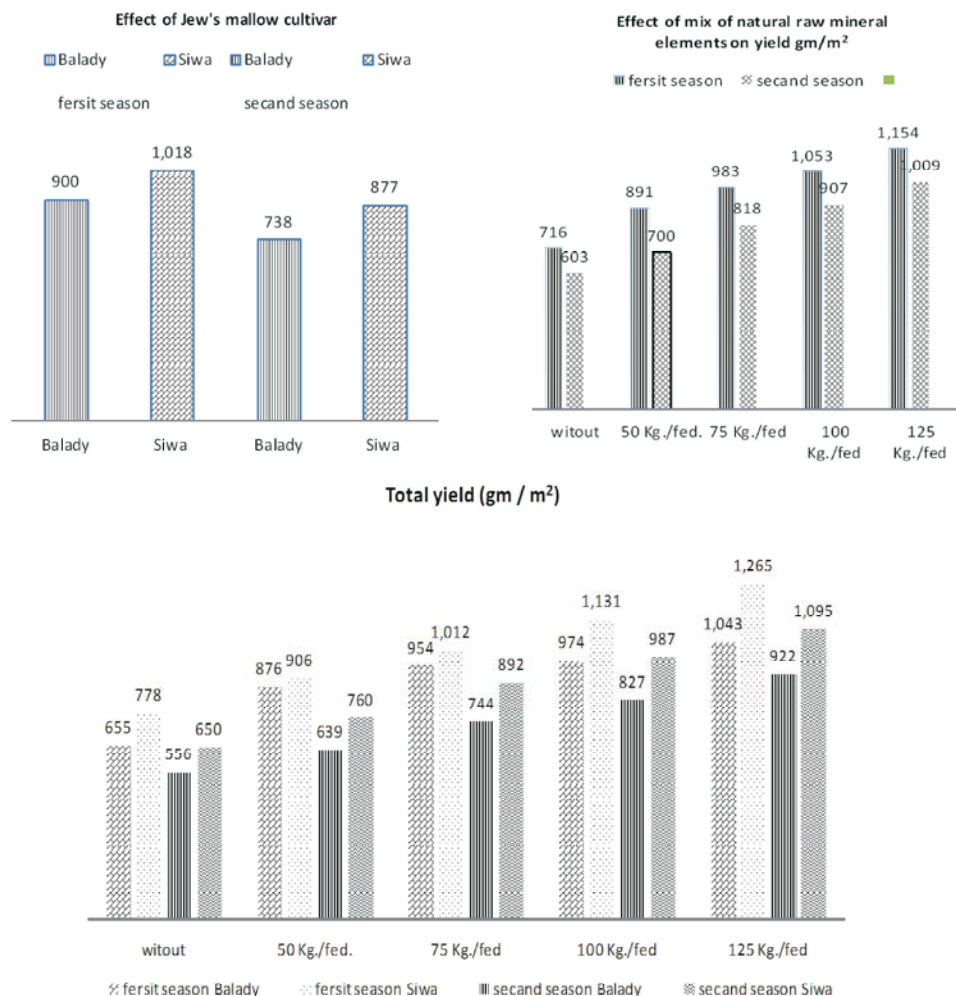


Fig. 1: Effect of treatment by mix of raw mineral elements on yield (gm/m²) of Jew's mallow under Ras Sudr conditions during 2017 and 2018 seasons

Table 2: Effect of treatment by mix of raw mineral elements on P, K, chloride and Ca in Jew's mallow leaves under Ras Sudr conditions during 2017 and 2018 seasons

	P %						K %					
	First season			Second season			First season			Second season		
	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)
without	1.29	1.14	1.22	0.85	1.20	1.03	1.23	1.16	1.19	1.10	1.10	1.10
50 Kg./fed.	1.51	1.47	1.49	1.45	1.22	1.33	1.53	1.38	1.46	1.40	1.50	1.45
75 Kg./fed	1.71	1.69	1.70	1.57	1.43	1.50	1.79	1.57	1.68	1.80	1.70	1.75
100 Kg./fed	1.91	1.82	1.87	1.83	1.73	1.78	2.16	1.89	2.03	2.43	2.30	2.37
125 Kg./fed	2.07	2.54	2.30	1.81	1.97	1.89	2.55	2.18	2.36	2.70	2.53	2.62
Mean (B)	1.70	1.73		1.50	1.51		1.85	1.63		1.89	1.83	
L.S.D at 5%	A=0.04	B=0.04	Ax B=0.04	A=0.08	B=0.06	Ax B=0.06	A=0.02	B=0.05	Ax B=0.05	A=0.10	B=0.08	Ax B=0.07
	Cl %						Ca %					
	First season			Second season			First season			Second season		
	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)
without	3.72	3.82	3.77	4.17	3.80	3.98	0.84	0.93	0.89	0.77	0.83	0.80
50 Kg./fed.	3.11	2.44	2.78	3.73	3.30	3.52	1.36	1.43	1.40	1.30	1.47	1.38
75 Kg./fed	2.16	1.73	1.95	2.60	2.33	2.47	2.15	2.36	2.26	1.80	1.80	1.80
100 Kg./fed	1.07	0.88	0.98	2.07	1.73	1.90	2.39	2.64	2.51	2.27	2.33	2.30
125 Kg./fed	0.63	0.32	0.47	1.60	1.27	1.43	3.18	3.65	3.42	2.73	3.23	2.98
Mean (B)	2.14	1.84		2.83	2.49		1.98	2.20		1.77	1.93	
L.S.D at 5%	A=0.14	B=0.11	Ax B=0.10	A=0.19	B=0.09	Ax B=0.08	A=0.02	B=0.03	Ax B=0.03	A=0.07	B=0.11	Ax B=0.11

Table 3: Effect of treatment by mix of raw mineral elements on Na and chlorophyll in Jew's mallow leaves under Ras Sudr conditions during 2017 and 2018 seasons

	Na %						Chlorophyll mg/ 100g					
	First season			Second season			First season			Second season		
	Balady	Siwi	Mean (A)	Balady	Siwi	Mean (A)	Balady	Siwa	Mean (A)	Balady	Siwi	Mean (A)
Without	5.35	5.16	5.26	5.70	5.27	5.48	66.65	60.38	63.52	71.10	65.57	68.33
50 Kg./fed.	4.65	4.52	4.59	4.93	4.70	4.82	63.91	58.55	61.23	67.17	59.20	63.18
75 Kg./fed	4.14	4.10	4.12	4.30	4.40	4.35	59.41	54.95	57.18	62.57	54.53	58.55
100 Kg./fed	3.91	3.44	3.68	3.90	4.00	3.95	54.69	52.54	53.62	59.23	49.37	54.30
125 Kg./fed	3.54	3.17	3.35	3.53	3.27	3.40	48.38	45.46	46.92	51.73	46.00	48.87
Mean (B)	4.32	4.08		4.47	4.33		58.61	54.38		62.36	54.93	
L.S.D at 5%	A=0.04	B=0.07	Ax B=0.06	A=0.03	B=0.14	Ax B=0.14	A=0.39	B=0.41	Ax B=0.39	A=0.39	B=0.41	Ax B=0.39

The obtained data indicated that, the highest content of P, K and Ca was detected in Siwi cultivar, while Cl was observed the highest content in Balady cultivar in both seasons. This result may be due to Siwi cultivar more tolerant to salinity which was reflected on increasing the minerals content as P, K, Ca and decreased chloride content in plant in both seasons. These results agree with those obtained by Ahmed and Ahmed [3].

Regarding, the effect of fertilizing with raw mineral elements on minerals content, data in Table 2 show that increasing the level raised to 125kg./fed of raw mineral elements significantly raised the percent of K, P and Ca and reduced chloride compared with control treatment in both growing seasons. These results may be due to the role of mix of mineral elements to improve absorption

of different minerals and consequently caused an increase in the amount of metabolites synthesized. These results agree with those obtained by Huang *et al.* [1]; Hegazi *et al.* [4] and Hassan [5].

Concerning, the interaction between mix of raw mineral elements and two cultivars of Jew's mallow plant, data indicated that the highest value from K, P and Ca content were noticed between Siwi cultivar with 125kg. /fed. On the other hand, chloride plant content gave increases values with control treatment in two tested seasons.

Data in Table (3) show that Balady cultivar gave the highest concentrations of Na and chlorophyll leaves content when compared to Siwi cultivar during the both growing seasons.

Whereas, the control (without fertilization) treatments gave the highest content of Na and chlorophyll as compared with investigated treatments in both seasons. These results may be attributed to that the mix of raw mineral elements. The ability of mix raw mineral elements of inhibiting Na absorption in plants promotes absorption of potassium anti-sodium absorption.

The interaction between Jew's mallow cultivars and mix of raw mineral elements had significant effect on Na and chlorophyll in plant and increased Balady cultivar without mix of raw mineral elements gave the highest values of Na and chlorophyll in leaf tissues during the two growing seasons.

CONCLUSION

The most important results obtained in this study can be summarized that the yield of Jew's mallow of leafy vegetables is very important especially in the new reclamation land. The use of mix of raw mineral elements considered the best way to preserve the environment. In general, the Siwi cultivar using a mix of raw mineral elements was more suitable than other varieties when using the same treatments to increase crop yield and reduce the percentage of chemical pollution resulting from the use of processed fertilizers, especially in saline condition.

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