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Effect of Rock Phosphate, Feldspar and Kaolin on Growth and Yield of Some Jew's Mallow (*Corchoru solitorius*) Cultivars under Siwa Oasis Conditions

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Abstract: A field experiment was conducted on Jew's mallow (Siwi, Balady and Saidi) throughout two successive in seasons of 2016 and 2017 in Khimisah experimental farm which is located at Siwa Research Station, Matrouh Governorate, Desert Research Center, Egypt. The field experiment was split plot design conducted in a randomized complete block. The main plots were for the Jew's mallow cultivars, while the sub plots were dedicated to the raw natural material fertilizers, *i.e*. rock phosphate at rate 50 Kg./fed., feldspar rate at rate 50 Kg./fed and kaolin at rate 50 Kg./fed. Results indicated that application of the three mixed rock phosphate, feldspar and kaolin with Siwi cultivar produced the highest significant values of growth characters *viz* plant length, fresh weight, leaf number, dry weight and total yield. This treatment also resulted in the highest percentage of K, P and Ca as well as the lowest percentage of Na and Cl in plant leaf. On the contrary, the interaction between check treatments with Balady cultivar recorded the highest leaf percent of chloride and Sodium with the lowest yield. Jew's mallow is one of the most important vegetable crops in the Siwa Oasis. This study showed that the cultivation of the Siwi cultivar using a mixture of natural raw materials (phosphate rock, potassium rock and kaolin) was the most appropriate than the other cultivars with the same treatments. Taking into consideration environmental pollution, it is better to use natural raw materials than to use processed chemical fertilizers in the production of leafy vegetable crops such as Jew's mallow.

Key words: Jew's mallow · Cultivars · Rock phosphate · Feldspar · Kaolin

INTRODUCTION

Siwa Oasis is a natural depression of about 23m below sea level. The main activity of Siwa oasis is agriculture which depends on the ground water that out flows from about 1435 wells. Agriculture represents the main source in Siwa economy, essentially focused on cultivation especially date palm, olive and vegetables.

Jew's mallow (*Corchorus olitorius* L.) is a leading leafy vegetable cultivated, traded and consumed in many countries., not only an essential green and leafy edible vegetable but also for its fiber product, jute and besides the leaves are highly nutritious, rich in proteins, vitamins A, C and E, beta-carotene, iron, calcium, thiamin, riboflavin, niacin, folate, indeed dietary fiber and essential amino acids [1-3]. Jew's mallow is one of the most important vegetables on which the farms in Siwa Oasis depend mainly; it is grown largely under olive and palms trees in many places in the oasis. It represents a large part of the agricultural economy of the Siwa farmer. We must suggest the studies to overcome the problems of development in the Siwa Oasis. Using raw natural materials may be a new trend to the farmers to increase food and productivity.

Feldspar considered as one source of potassium which plays an important role on the promotion of enzyme activity and enhancing the translocation of assimilated sugars, starch and protein synthesis. Moreover, it increases root growth, improve drought resistance, builds cellulose and reduce stress [4].Chemical potassium fertilizer became a high expensive fertilizer in Egypt, thus the most of farmers ignored using it and thus they use alternative resources such as feldspar to alleviate the dependence of imported or costly commercial fertilizers.

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Using natural raw materials and feldspar have numerous benefits, that it is considered as slow release fertilizer for macro elements, which make converting them in soluble forms of P, K, Ca and Mg in a long run, it has assumed great importance for sustainable production and to improve the soil physical, chemical and biological properties [5, 6]. El Sayed *et al.* [7] reported that the application of natural P and K rock fertilizers in combination with P and K bio-fertilizers in sandy soil will give high available and uptake nutrients, yield and quality close to those obtained by chemical phosphorus and potassium application, beside available P and K in soil and their content and uptake. Thus, replacing these chemical phosphorus and potassium fertilizers by natural one will help in reducing environmental pollution especially in Siwa Oasis. Feldspar is a good alternative to reduce uses of chemical fertilizers [8, 9].

The use of potassium feldspar gave a yield response, although no greater than for conventional fertilizers [10].On potato plants, nitrate content increased in tuber with increasing the dose of feldspar-K treatments [11].

Rock phosphate and feldspar may be attributed to their release of macro elements which make converting them in soluble forms of P, K, Ca and Mg in comparison with the compost without natural rocks [12, 13].

Yagodin [14] explained that phosphorus plays an important role in the most metabolic processes especially in biosynthesis and translocation of carbohydrates. It is very important for developing the fruit and the deficiency appeared in terms of decline on the yield and an adverse effect on fruits quality. Using rock phosphate and potassium with fertilizer on the Roselle plant produced the highest growth and yield when plants were treated with 200kg/fed rock phosphate plus phosphorus dissolving bacteria [15].

Kaolin applications have been used to mitigate the negative effects of water and heat stress on plant physiology and productivity with variable results, ranging from increased to decreased yields and photosynthetic rates. The mechanisms of action of kaolin applications are not clear, although the increased albedo reduces leaf temperature and the consequent heat stress, it also reduces the light available for photosynthesis, possibly offsetting benefits of lower temperature [16]. Moreshet *et al.* [17] studied the effect of kaolin reflectant sprays on the cotton plants. They reported that plant growth, characterized by the stand's height, leaf area index and dry weight, were not significantly affected. On ber (*Ziziphus mauritiana* L.) tree, Mukhaerjee *et al*. [18] studied the combinations of three water regimes, four mulches and two kaolin treatments, kaolin improved only the productivity regardless other growth characters.

The aim of this work was to study the effect of some commercial natural products as soil additions, cultivars of Jew's mallow and their interactions under Siwa Oasis conditions

MATERIALS AND METHODS

The field work was carried out at Siwa Research Station of the Desert Research Center (Khimisa farm), Marsa Matrouh Governorate Egypt, during the two consecutive seasons of 2016 and 2017.The experiments was conducted to study the effect of soil application with some raw natural materials, *i.e.*50 Kg./fed. rook phosphate, 50 Kg./fed. rook potassium, 50Kg./fed. kaolin and mixture of them, with 3 cultivars (Siwi, Balady and Saidi) of Jew's mallow. The sources of Siwi, Balady and Saidi cultivars were Siwa, Qalyubia and Qena respectively.

This experiment included 24 treatments, which were the combination between 3 cultivars and 8 treatments (Check, rock phosphate, feldspar and kaolin and their combination) these treatments were arranged in split plot design in three replicates, cultivars were randomly arranged in the main plots and treatments were randomly distributed in sub plots.

May be the raw of mineral elements is one of the raw materials discovered in the Eastern Desert of Egypt, which was conducted on some experiments in research centers and with the knowledge of the company producing and discovered for the ore (source Al-Ahram Mining Company) with the participation of some researchers and we hope that this study provides us with good information about the nature of this work under protected area at Siwa Oasis conditions

The raw natural materials doses were added before sowing date and mixed with compost at the rate of 4 ton/fed; during the land preparation. Drip irrigation system was practiced in this experiment. Other agricultural practices were performed as commonly followed such as Siwa farmer's application. Seeds of *C. olitorius* three cultivars were sown on 25th of March and 5th April in the first and second seasons, respectively, using dry sowing method on the two sides of the dripper line. The area for each experimental plot was 10.5 m^2 (1 m. width and10.5 m. long). The ammonium sulphate (20.6.5% N) at the rate 100Kg/fed., potassium sulphate (48% k_2o) at rate 50 kg/fed. and phosphorus (15.5. % P)at the rate 50Kg/fed;

Table 1: Some physical and chemical properties for the experimental soil and irrigation water during the two growing seasons

Soil properties	Coarse sand%	Fine sand%	Silt%	Clay %	Soil texture	1:2.5 (soil to water extraction) pH	EC (dSm^{-1})	Organic matter (g/kg)	$CaCO_3$ (g/kg)	Total N (g/kg)	Available (ppm) P	K
$Season_1$	45.70	29.76	20.14	4.4	Sandy soil	7.28	1.42	6.1	22.4	2.3	13.25	96
$Season_2$	46.02	28.88	19.92	5.18	Sandy soil	7.18	1.58	6.7	22.8	2.8	14.05	106

Irrigation water chemical analysis	EC (dSm^{-1})	pH	SAR	Soluble Cations in $mmoLcL^{-1}$ Na^+	K^+	Ca^{++}	Mg^{++}	Soluble Anions in $mmoLcL^{-1}$ CO_3^-	HCO^-_3	Cl^-	SO^{--}_4
	3.60	7.45	12.92	27.40	0.60	3.30	5.70	Nd	3.50	22.00	11.50

were added the quantity NPK were divided and applied at four times after 20, 30, 40 and 50 days from germination through fertigation.

The chemical analysis of the applied vegetarian compost showed the flowing values: pH 6.76, EC 2.85 dSm-1, total N 1.22%, total P 0.24 %, total K 0.64%, C/N 17.33.

The chemical formula for kaolinite as used in mineralogy is $Al_2Si_2O_5(OH)_4$ however, in ceramics applications the formula is typically written in terms of oxides, thus the formula for kaolinite is $Al_2O_3.2SiO_2•2H_2O$

Rock phosphate (RP) contained 10.5 % P_2O_5, 0.31 % K_2O, 7.9 %SiO_2, 41.22 %CaO, 0.41% Al_2O_3), while feldspar contained (10.1%K_2O, 0.10%P_2O_5, 66.12 %SiO_2, 0.2%CaO, 17.59% Al_2O_3).

Table (1) presents the physical and chemical properties of the soil and irrigation water of the studied site which were determined according to Page *et al*. [19] and Klute [20], respectively.

Data Recorded

Growth Parameters: After 55 days from germination, one kg. plants from each experimental plot were randomly taken for recording vegetative growth characteristics, *i.e*. plant length, number of leaf/plant, fresh and dry weight per plant, dry weight according to Brown and Lillil [21].

Mineral and Chlorophyll Contents in Leaves: Chlorophyll meter, SPAD-502, MINOLTA, was used to determine the total chlorophyll in leaf tissues. P was determined according to the method described by Frie *et al*. [22] while K, Na, Cl and Ca percentages were determined by Huphries [23] respectively.

Total Yield: During the entire season plants were counted and weighed for calculating total yield.

Statistical Analysis: The experimental treatments were arranged in split plot design with three replicates; the main plots were assigned for 3 cultivars, whereas raw natural materials were randomly arranged in the sub plots. Statistical analyses of the obtained data were analyzed according to Thomas and Hills [24].

RESULTS AND DISCUSSION

Plant Growth Characters: It is clear from data presented in Table (2) that Siwi Jew's mallow cultivar showed significantly the highest values of growth characters, *i.e.* plant length, fresh weight and leaf number compared with Balady and Saidi cultivars in the two growing seasons. The superiority of Siwi Local cultivar may be due to that such cultivar is more adapted with environmental conditions under the studied area. These results are in agreement with those obtained by Edmonds [25].

Regarding the effect of raw natural materials, the mixture of rook phosphate, feldspar and Kaolin gave the highest values of plant growth characters compared with the single or bilateral materials in both tested seasons. The single treatments of feldspar, rook phosphate or Kaolin showed no significant differences among them in the growth character values. While, the bilateral mixed raw materials gave higher value on plant length, fresh weight and leaf number compared with the single treatments. On the other hand, the check treatment gave the lowest values in both tested seasons. These results agree with mentioned by El-Sayed *et al*. [7].

As regard to the interaction between raw material fertilizers and cultivars the Siwi cultivar which was treated with mixed treatment (rook phosphate, feldspar and Kaolin) gave the maximum plant growth in both tested seasons. The enhancing effective may be due to the role of mixed raw materials to improve plant growth and Siwi cultivar is more adapted to environmental condition in this region.

Dry Weight and Yield: As presented in Table (3), the Siwi cultivar of Jew's mallow produced significantly the highest plant dry weight and total yield compared with Balady and Saidi cultivars in both tested seasons.

Table 2: Effect of some raw natural materials and cultivars on plant length, fresh weight and leaf number of Jew's mallow (*Corchorus olitorius*) during 2016 – 2017 seasons

	First season				Second season			
	Cultivars							
Raw natural materials	Siwi	Balady	Saidi	Mean (A)	Siwi	Balady	Saidi	Mean (A)
	Plant length (cm)							
50 kg. R.Ph.	101.33	88.53	54.40	81.42	105.73	91.37	58.63	85.24
50 kg. Feldspar	101.57	88.57	54.43	81.52	105.50	91.47	59.03	85.33
50 kg. Kaolin	101.73	88.40	54.43	81.52	105.50	91.63	58.63	85.26
50 kg. R.Ph+ 50 kg. Feldspar	107.33	90.70	56.70	84.91	109.27	93.57	62.10	88.31
50 kg. R.Ph+ 50 kg. Kaolin	107.50	90.50	56.27	84.76	109.10	93.30	62.50	88.30
50 kg. Feldspar + 50 kg. Kaolin	107.47	90.57	56.17	84.73	109.40	93.40	62.43	88.41
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	115.03	93.77	57.53	88.78	112.40	96.13	63.57	90.70
Check	92.50	82.20	43.43	72.71	99.10	91.57	54.27	81.64
Mean (B)	104.31	89.15	54.17	----	107.00	92.80	60.15	----
L.S.D. at 5%	A= 0.44	B=0.39	AXB=0.36		A=0.33	B=0.46	AXB=0.42	
	Fresh weight/ (gm)							
50 kg. R.Ph.	155.90	130.27	45.33	110.50	175.27	155.27	65.03	131.86
50 kg. Feldspar	155.47	130.70	45.30	110.49	175.30	155.47	65.47	132.08
50 kg. Kaolin	155.27	130.40	45.57	110.41	175.33	155.43	65.07	131.94
50 kg. R.Ph+ 50 kg. Feldspar	166.27	135.40	51.37	117.68	178.13	160.20	70.17	136.17
50 kg. R.Ph+ 50 kg. Kaolin	166.43	135.60	51.40	117.81	178.27	160.20	70.37	136.28
50 kg. Feldspar + 50 kg. Kaolin	166.77	135.40	51.47	117.88	178.57	160.57	70.17	136.43
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	187.40	145.47	59.73	130.87	185.50	165.23	75.53	142.09
Check	145.27	78.77	35.50	86.51	166.13	135.40	53.33	118.29
Mean (B)	162.35	127.75	48.21	----	176.56	155.97	66.89	----
L.S.D. at 5%	A=9.33	B=13.20	AXB=11.97		A=0.12	B=0.69	AXB=0.62	
	Leaf number/plant							
50 kg. R.Ph.	84.90	77.77	38.60	67.09	86.57	81.60	42.50	70.22
50 kg. Feldspar	84.70	77.43	38.47	66.87	86.43	81.50	42.43	70.12
50 kg. Kaolin	84.33	76.70	38.33	66.46	86.70	81.47	42.57	70.24
50 kg. R.Ph+ 50 kg. Feldspar	86.30	80.37	39.53	68.73	89.33	83.70	44.60	72.54
50 kg. R.Ph+ 50 kg. Kaolin	86.50	81.47	39.50	69.16	89.30	84.33	44.50	72.71
50 kg. Feldspar + 50 kg. Kaolin	86.63	81.27	39.53	69.14	89.53	84.03	44.57	72.71
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	90.17	83.70	40.63	71.50	92.30	86.67	46.33	75.10
Check	81.97	80.53	36.50	66.33	84.43	81.23	40.47	68.71
Mean (B)	85.69	79.90	38.89	----	88.08	83.07	43.50	----
L.S.D.at 5%	A=0.28	B=0.35	AXB=0.32		A=0.20	B=0.30	AXB=0.27	

Rock phosphate = R. Ph

These results may be due to the Siwa cultivar is the most tolerant to the environmental condition in local area followed by Balady and Saidi cultivars. Similar results have been mentioned by Edmonds [25] and Oladiran [26].

Respecting the effect of raw natural materials, the most effective treatment was the application of the mixture of 50 kg. rock phosphate, 50 kg feldspar and 50 kg. Kaolin followed by the dual soil applications, followed by the single treatments from feldspar, rock phosphate and Kaolin in both tested seasons. The single element may not be able to supply the plant with the nutritional requirements of growth and production. On the other hand, the supply of plants with more than one element may be useful for the necessary plant physiological processes. Similar results were mentioned by Rosati *et al*. [16], Ali and Taalab [4], Hegazi *et al*. [5], Abdel-Kader and Saleh [15] and El Sayed *et al.* [7].

As for the interaction, the addition of the three natural materials to Siwi cultivar resulted in the highest dry weight and yield compared to the other tested treatments, followed, in decreasing order, by the bilateral then the single additions for the same cultivar. The lowest interaction percentages were noticed when Saidi cultivar received the check treatment.

Table 3: Effect of some raw natural materials and cultivars on plant dry weight, total yield Ton/fed and Total yield gm/m^{2}of Jew's mallow (*Corchorus olitorius*) during 2016 – 2017 seasons

	First season				Second season			
	Cultivars							
Raw natural materials	Siwi	Balady	Saidi	Mean (A)	Siwi	Balady	Saidi	Mean (A)
	Plant dry weight (g)							
50 kg. R.Ph.	28.60	24.08	8.37	20.35	31.53	28.27	11.50	23.77
50 kg. Feldspar	28.47	24.20	8.37	20.34	31.80	28.23	11.90	23.98
50 kg. Kaolin	28.67	24.13	8.37	20.39	32.40	28.47	12.53	24.47
50 kg. R.Ph+ 50 kg. Feldspar	30.73	25.04	9.50	21.76	32.97	29.53	12.87	25.12
50 kg. R.Ph+ 50 kg. Kaolin	30.77	25.07	9.47	21.77	32.93	29.23	12.93	25.03
50 kg. Feldspar + 50 kg. Kaolin	30.87	25.07	9.50	21.81	33.08	29.40	12.93	25.14
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	34.67	26.90	11.04	24.20	34.20	30.53	13.93	26.22
Check	26.87	20.80	6.53	18.07	30.30	25.00	9.50	21.60
Mean (B)	29.95	24.41	8.89	----	32.40	28.58	12.26	----
L.S.D. at 5%	A=0.13	B=0.15	AXB=0.14		A=0.25	B=0.46	AXB=0.42	
	Total yield (Ton/fed)							
50 kg. R.Ph.	11.53	8.37	3.33	7.74	11.80	8.80	3.70	8.10
50 kg. Feldspar	11.53	8.40	3.60	7.84	12.20	8.70	3.60	8.17
50 kg. Kaolin	11.43	8.53	3.53	7.83	12.27	8.80	3.87	8.31
50 kg. R.Ph+ 50 kg. Feldspar	12.30	9.23	3.70	8.41	12.60	9.70	4.20	8.83
50 kg. R.Ph+ 50 kg. Kaolin	12.37	9.40	3.73	8.50	12.40	9.47	4.40	8.76
50 kg. Feldspar + 50 kg. Kaolin	12.30	9.30	3.70	8.43	12.80	9.70	4.57	9.02
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	13.33	10.20	4.43	9.32	13.67	10.70	4.87	9.74
Check	10.73	8.07	3.10	7.30	11.23	8.27	3.20	7.57
Mean (B)	11.94	8.94	3.64	----	12.37	9.27	4.05	----
L.S.D. at 5%.	A=0.27	B=0.25	AXB=0.23		A=0.04	B=0.24	AXB=0.21	
	Total yield (gm/m^2)							
50 kg. R.Ph.	2883.33	2091.67	833.33	1936.11	2950.00	2200.00	925.00	2025.00
50 kg. Feldspar	2925.00	2100.00	900.00	1975.00	3035.00	2175.00	900.00	2036.67
50 kg. Kaolin	2825.00	2133.33	883.33	1947.22	3066.67	2200.00	966.67	2077.78
50 kg. R.Ph+ 50 kg. Feldspar	3075.00	2308.33	925.00	2102.78	3150.00	2425.00	1050.00	2208.33
50 kg. R.Ph+ 50 kg. Kaolin	3091.67	2350.00	933.33	2125.00	3100.00	2366.67	1100.00	2188.89
50 kg. Feldspar + 50 kg. Kaolin	3075.00	2325.00	925.00	2108.33	3200.00	2425.00	1141.67	2255.56
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	3333.33	2550.00	1108.33	2330.56	3416.67	2675.00	1216.67	2436.11
Check	2683.33	2016.67	805.00	1835.00	2808.33	2066.67	800.00	1891.67
Mean (B)	2986.46	2234.38	914.17	----	3090.83	2316.67	1012.50	----
L.S.D. at 5%	A=66.58	B=56.83	AXB=51.53		A=7.53	B=59.44	AXB=53.90	

Rock phosphate = R. Ph

Chlorophyll and Mineral Composition: Data presented in Tables (4 and 5) indicated that Balady cultivar gave the highest values in total chlorophyll, Na and Cl as compared with those of Siwi cultivar and Saidi in both growing seasons. On the other hand, the Siwi cultivar recorded the highest percentage of K, P and Ca and the lowest percentage of Na and Cl in leaf. The satisfactory mineral composition of cv Siwi may be due to this cultivar is the most adapted to Siwa environmental conditions and the most tolerant to different stresses. These results agree with those reported by Hegazi *et al*. [5] and El Sayed *et al.* [7].

Check treatment gave the highest values of total chlorophyll, Na and Cl in Jew's mallow leaf plant, while the soil application of the three mixed natural raw materials resulted in the lowest value of these characters and the highest value of K, P and Ca. This was true in both seasons compared to the other single or bilateral tested treatments. Our results are in conformity with those obtained by El Haggar *et al*. [12] and Mohamed [13].

Concerning, the interaction between the cultivars of Jew's mallow and natural raw materials plants of Siwi cultivar which received the three mixed natural raw materials (50 kg. rock phosphate + 50 kg feldspar + 50 kg.

Table 4: Effect of some raw natural materials and cultivars on chlorophyll, Na and K of Jew's mallow (*Corchorus olitorius*) during 2016 – 2017 seasons

	First season				Second season			
	Cultivars							
Raw natural materials	Siwi	Balady	Saidi	Mean (A)	Siwi	Balady	Saidi	Mean (A)
	Chlorophyll (mg/ 100g)							
50 kg. R.Ph.	49.33	52.83	51.57	51.24	49.10	55.07	54.47	52.88
50 kg. Feldspar	49.67	52.27	51.33	51.09	48.97	54.87	54.30	52.71
50 kg. Kaolin	49.27	51.77	51.77	50.94	49.47	54.93	54.40	52.93
50 kg. R.Ph+ 50 kg. Feldspa	42.73	48.37	46.63	45.91	43.50	50.93	49.33	47.92
50 kg. R.Ph+ 50 kg. Kaolin	42.37	48.57	46.60	45.84	43.67	50.77	49.60	48.01
50 kg. Feldspar + 50 kg. Kaolin	42.13	48.20	46.73	45.69	43.27	50.20	49.23	47.57
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	32.13	37.57	35.23	34.98	34.67	39.93	38.40	37.67
Check	58.27	56.93	57.30	57.50	60.50	59.37	59.87	59.91
Mean (B)	45.74	49.56	48.40	----	46.64	52.01	51.20	----
L.S.D. at 5%	A=0.50	B=0.51	AXB=0.47		A=0.23	B=0.32	AXB=0.29	
	Na %							
50 kg. R.Ph.	2.47	2.87	2.70	2.68	2.73	3.27	2.93	2.98
50 kg. Feldspar	2.37	2.70	2.67	2.58	2.77	3.23	3.00	3.00
50 kg. Kaolin	2.33	2.93	2.60	2.62	2.73	3.23	3.03	3.00
50 kg. R.Ph+ 50 kg. Feldspa	1.70	2.40	2.20	2.10	2.20	2.70	2.50	2.47
50 kg. R.Ph+ 50 kg. Kaolin	1.70	2.47	2.10	2.09	2.17	2.67	2.50	2.44
50 kg. Feldspar + 50 kg. Kaolin	1.60	2.30	2.17	2.02	2.17	2.73	2.53	2.48
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	1.07	2.00	1.70	1.59	1.33	2.37	2.00	1.90
Check	2.93	3.60	3.53	3.36	3.40	4.07	3.93	3.80
Mean (B)	2.02	2.66	2.46	----	2.44	3.03	2.80	----
L.S.D. at 5%	A=0.19	B=0.15	AXB= 0.14		A=0.12	B=0.17	AXB=0.16	
	K %							
50 kg. R.Ph.	4.17	3.80	3.53	3.83	5.07	4.17	4.40	4.54
50 kg. Feldspar	4.43	3.70	3.60	3.91	5.30	4.23	4.37	4.63
50 kg. Kaolin	4.50	3.77	3.70	3.99	5.40	4.47	4.40	4.76
50 kg. R.Ph+ 50 kg. Feldspa	5.40	4.53	4.43	4.79	5.80	5.27	5.53	5.53
50 kg. R.Ph+ 50 kg. Kaolin	5.33	4.37	4.60	4.77	5.77	5.03	5.37	5.39
50 kg. Feldspar + 50 kg. Kaolin	5.30	4.60	4.50	4.80	5.87	5.23	5.60	5.57
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	6.43	5.87	5.77	6.02	6.90	6.30	6.43	6.54
Check	2.40	2.47	2.57	2.48	2.27	2.73	2.50	2.50
Mean (B)	4.75	4.14	4.09	----	5.30	4.68	4.83	----
L.S.D. at 5%	A=0.18	B=0.19	AXB=0.17		A=0.10	B=0.18	AXB=0.17	

Rock phosphate = R. Ph

Kaolin) contained the highest percent of K, P and Ca but had the values of Na and Cl in both tested seasons, compared to the other studied interactions. Our findings are in agreement with Edmonds [25] and Oladiran [26] who reported that mineral content depends on variation of cultivars. In addition, Jew's mallow plants which received the check treatment of the Siwa Jew's mallow farmers, contained the highest chlorophyll, Na and Cl values and the lowest K, P and Ca percent, irrespective of the tested cultivar, in both tested seasons. In other words, the addition of the three raw natural materials improved the yield and mineral composition of the local Siwi cultivar; these results were true in both test seasons.

Table 5: Effect of some raw natural materials and cultivars on chloride %, P and Ca of Jew's mallow (*Corchorus olitorius*) during 2016 – 2017 seasons.

	First season				Second season			
	Cultivars							
Raw natural materials	Siwi	Balady	Saidi	Mean (A)	Siwi	Balady	Saidi	Mean (A)
				Cl %				
50 kg. R.Ph.	1.87	2.10	1.90	1.96	1.73	2.20	2.27	2.07
50 kg. Feldspar	1.70	2.20	1.87	1.92	1.80	2.00	2.03	1.94
50 kg. Kaolin	1.73	2.17	1.93	1.94	1.77	2.10	2.20	2.02
50 kg. R.Ph+ 50 kg. Feldspa	1.40	1.80	1.60	1.60	1.60	1.97	1.70	1.76
50 kg. R.Ph+ 50 kg. Kaolin	1.47	1.73	1.63	1.61	1.70	1.80	1.80	1.77
50 kg. Feldspar + 50 kg. Kaolin	1.37	1.70	1.67	1.58	1.63	1.73	1.70	1.69
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	0.80	1.30	1.20	1.10	1.10	1.30	1.37	1.26
Check	2.30	2.67	2.57	2.51	2.30	2.50	2.37	2.39
Mean (B)	1.58	1.96	1.80	----	1.70	1.95	1.93	----
L.S.D. at 5%	A=0.07	B=0.13	AXB=0.12		A=0.18	B=0.17	AXB=0.16	
				P %				
50 kg. R.Ph.	0.73	0.60	0.63	0.66	0.90	0.57	0.67	0.71
50 kg. Feldspar	0.77	0.57	0.67	0.67	0.90	0.60	0.63	0.71
50 kg. Kaolin	0.80	0.60	0.63	0.68	0.93	0.60	0.67	0.73
50 kg. R.Ph+ 50 kg. Feldspa	1.70	0.83	1.47	1.33	1.20	0.80	0.87	0.96
50 kg. R.Ph+ 50 kg. Kaolin	1.77	0.87	1.47	1.37	1.07	0.83	0.80	0.90
50 kg. Feldspar + 50 kg. Kaolin	1.77	0.90	1.53	1.40	1.13	0.90	0.87	0.97
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	2.17	1.50	1.93	1.87	1.77	1.60	1.30	1.56
Check	0.50	0.40	0.37	0.42	0.43	0.50	0.40	0.44
Mean (B)	1.28	0.78	1.09	----	1.04	0.80	0.78	----
L.S.D. at 5%	A=0.04	B= 0.13	AXB=0.12		A=0.11	B=0.15	AXB=0.13	
				Ca %				
50 kg. R.Ph.	0.80	0.60	0.63	0.68	0.70	0.60	0.67	0.66
50 kg. Feldspar	0.83	0.63	0.67	0.71	0.70	0.63	0.60	0.64
50 kg. Kaolin	0.87	0.67	0.80	0.78	0.73	0.60	0.60	0.64
50 kg. R.Ph+ 50 kg. Feldspa	1.63	1.20	1.30	1.38	1.17	0.97	0.90	1.01
50 kg. R.Ph+ 50 kg. Kaolin	1.70	1.13	1.33	1.39	1.30	1.03	1.07	1.13
50 kg. Feldspar + 50 kg. Kaolin	1.77	1.30	1.47	1.51	1.40	1.20	1.03	1.21
50 kg. R.Ph+ 50 kg. Feldspar+ 50 kg. Kaolin	2.30	1.93	1.90	2.04	2.70	1.90	1.87	2.16
Check	0.40	0.30	0.40	0.37	0.47	0.50	0.40	0.46
Mean (B)	1.29	0.97	1.06	----	1.15	0.93	0.89	----
L.S.D. at 5%	A=0.09	B=0.13	AXB=0.12		A=0.07	B=0.16	AXB=0.14	

Rock phosphate = R. Ph

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