Estimation of soil Fertility and Yield Productivity of Three Alfalfa (*Medicago sativa* L.) Cultivars Under Sahl El-Tina Saline Soils Conditions

Abd El-Naby, Zeinab, M.[1], Nabila, A. Mohamed[1] and Kh. A. Shaban[2]

[1]Forage Res. Dept., Field Crop Res. Inst., Agric. Res. Center, Giza, Egypt
[2]Soil, Water and Environment Res. Inst. Agric. Res. Center, Giza, Egypt
zeina_bree@yahoo.com

Abstract: Salt stress is a serious environmental problem throughout the world which may be partially relieved by breeding cultivars that can tolerate salt stress. Three alfalfa cultivars, i.e., Ismaelia, New Valley and Siwa, were sown under three levels of salinity (8.73, 10.63 and 15.31dSm^{-1})**.** A field experiment was carried out in sandy clay loam soil at North Sinai Governorate during two successive seasons from mid-spring 2011 to late-Autumn 2012. The results of this study indicated that long growing duration of alfalfa cultivars under different soil salinity levels led to a slight decrease in soil pH and soil EC. The available macronutrients (N, P and K) and micronutrient (Fe, Mn and Zn) contents accumulated in soil recorded positive increasing effects, depending on the length of alfalfa cultivation period. Evaluation at the germination stage is absolutely critical in developing cultivars that can establish a good stand. Natural selection through frequent cutting and salinity stress is an excellent means to screen large sets of salt tolerant genotypes and get an idea for regrowth potential under high salinity levels. Siwa cultivar was the highest yielding across all seasons and salinity levels; it also recorded the highest mean of total fresh and dry forage yield (53.06 and 12.60 t fed^{-1}, respectively), while New Valley cultivar recorded the lowest means (40.66 and 10.12 t fed^{-1}, respectively) across all salinity levels. Siwa cultivar was superior over Ismaelia and New Valley in most of the agronomical characters under study. The high level of salinity (EC= 15.31dSm^{-1}) depressed the number of tillers plant^{-1}, fresh and dry forage weight (g) plant^{-1}. New developed alfalfa population (Sinai-1) was the most tolerant and adaptable to saline soils in Sahl El-Tina conditions.

[Zeinab, M. Abd El-Naby, Nabila, A. Mohamed and Kh. A. Shaban. **Estimation of soil Fertility and Yield Productivity of Three Alfalfa (*Medicago sativa* L.) Cultivars Under Sahl El-Tina Saline Soils Conditions.** *Life Sci J* 2013;10(1):2082-2095] (ISSN:1097-8135). http://www.lifesciencesite.com. 296

Key words: *Alfalfa, Midicago sativa, soil Salinity, Macronutrients, Micronutrients, Forage, Fresh, Dry yield.*

Introduction

In Egypt the total cultivated area is approximately 3.15 million hectare (hectare =2.385 Feddan); comprised of 2.35 million hectare of old fertile and 0.8 million hectare of new reclaimed land. The country has a rapid population growth rate; the population is expected to reach about 110 million inhabitants by the year 2025. Sinai represents 6% of the total area of Egypt (Hafez 2005). Sahl El-Tina plain is situated in the North Western part of Sinai Peninsula. Jing *et al*. (2012) reported that the EC in the soil profile is gradually decreased with increasing the duration of alfalfa cultivation. The effect of successive alfalfa planting for an improvement of soil fertility across the years is considerably significant in salt-affected soils. In comparison with the control, EC in the 0–20 cm soil layer decreased significantly, after 1 and 2 years, respectively (*Zhang et al.* 2007). Fan *et al*. (2002) showed that a greater effect on the soil physico-chemical properties was found with increasing the duration of alfalfa cultivation. Morever, Tang *et al*. (1999) found that the pH in the soil layer of 0–20 cm was decreased by 0.15 units as compared to that before alfalfa planting. Alfalfa species relying on symbiotic N_2 fixation acidified their rhizosphere, causing a considerable H^+ extrusion in the rhizosphere to decrease soil pH. Qadir *et al*. (2008) indicated that the effect of successive alfalfa planting for soil fertility improvement across the years is considerably significant in salt-affected soil.

Alfalfa (*Medicago sativa* L.), is a perennial warm-season legume, that is grown on 30 million hectares worldwide. It has been characterized as moderately sensitive to salts (Maas and Hoffman, 1977). In contrast, alfalfa has also been characterized as tolerant to salts with a range of EC values from 6.0 to 8.0 (3840 to 5120 ppm) at which some reduction in growth and yield can be expected (Longenecker and Lyerly, 1974). Alfalfa yields can be expected 7% decrease with each dSm^{-1} unit increase in saturation extract (Rawlins, 1979). Alfalfa was as tolerant as barley (*Hordeum vulgare*) and cotton (*Gossypium spp*.), however the growth of alfalfa was still retarded in saline conditions (Munns, 2005). Alfalfa can be successfully grown on most soils, and can tolerate some level of salinity during the germination stage, but once established it will tolerate higher levels of salinity up to 8 dSm^{-1}, (Sheard, 2007) and 10.3 dSm^{-1} (Shaban and El-Sherief, 2007). In addition, alfalfa fixes its own nitrogen with the help of *Rhizobium meliloti* bacteria on its roots (Bauder, 2007).

Local alfalfa cultivars (Siwa and Ismaelia), are characterized with a higher level of tolerance to salinity, as been recognized in Argentina (El-Nahrawy *et al*., 1995), which has resulted in increasing the demand for seed export. Argentina asked Egyptian authorities for importing about 2500 tons of alfalfa seed annually of the two mentioned cultivars, if available. There is a high tendency to expand in alfalfa cultivation in the reclaimed lands of the Egyptian desert. Now its cultivated area is about 63.000 ha (El-Nahrawy *et al*., 1995).

Sahl El-Tina is situated in the North Western part of Sinai Peninsula, covers about 50.000 fed lying between longitudes 30^o 51 South and 31^o 15 North. Experiments of this study were located at the southern part of Sahl El-Tina, which composed of silty clay soil intercalated with salts and evaporates in the western part. Our breeding efforts have been directed at creating salt-tolerant populations capable of surviving high salinity levels and producing high yields in the same time.

This research was conducted to: a) evaluate alfalfa productivity under different salinity levels, b) study the effect of alfalfa long term stand on soil fertility (the main physical and chemical properties of the cultivated soils and also their content of some macro and micro-nutrients).and c) select new alfalfa composite population of more adaptability to salinity stress

Materials and Methods

A field experiment was carried out in sandy clay loam soil of a private farm at Gelbana, east Suez Canal at North Sinai Governorate during two successive seasons from mid-spring 2011 to late-autumn 2012. Three salinity levels were measured 8.73 dSm^{-1}, 10.63 dSm^{-1} and 15.31 dSm^{-1}. The three Egyptian alfalfa studied cultivars, i.e., Ismaelia, New Valley and Siwa were obtained from Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Cultivars had sown in a split block design in randomized complete blocks arrangement with three replications. Salinity levels were considered the main plots, while the cultivars were distributed in the sub- plots. The plot size was 50 m^2 (5 mX10 m). Seeds were sown with the rate of 20 Kg fed^{-1}. Super phosphate (15.5 % P_2O_5) was applied at a rate of 200 kg fed^{-1} during tillage then 100 kg super-phosphate was added every four months. Urea (46% N) was applied as N fertilizer at a rate of 30 kg N fed^{-1} on three equal doses after 21, 42 and 62 days from planting. Potassium sulphate (48% K_2O) was applied at a rate of 100 kg fed^{-1} with two doses, after 21and 42 days, and then 50 kg fed^{-1} were added every four months. The first irrigation was applied after eight days from sowing. The following irrigations were applied each eight days during summer and fifteen days during winter seasons. Irrigation water was applied from Salam Canal.

Soil studies

Soil samples from the surface (0-30 cm) were collected from each treatment before and after alfalfa harvesting, ground and subjected to determination of available nutrients N, P and K as outlined by Page *et al*. (1982). Soil pH was determined using a 1 :2.5 soil water suspension

Electrical conductivity and soluble cations and anions of soil saturation paste extract were determined (Page *et al*., 1982**)**. The soil samples were air dried, crushed and finely ground, then sieved through a 2mm sieve and kept for analysis. Available micronutrients were extracted from soil samples by Diethyline tetra amin penta Acitic acid (DTPA) according to Lindsay and Norvell (1978) and determined by Atomic Absorption Spectrophotometer model GBC 932.

The obtained data were statistically analysed using COSTAT program and L.S.D. value at the probability levels of 5% was calculated according to Gomez and Gomez (1984).

Table 1. Physical and chemical properties in soil before planting.

	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Texture		O.M* (%)		CaCO$_3$ (%)	
Mean	2.16	65.83	10.60	21.41	Sandy clay loam		0.45		5.92	
Salinity levels EC (dS/m)	pH (1:2.5)		Cations (meq^{-1})				Anions (meq^{-1})			
			Ca^{++}	Mg^{++}	Na^+	K^+	HCO^-_3	Cl^-	SO^{-}_4	
15.31 (S1)	8.12		10.49	22.69	119	0.92	10.20	98	44.90	
10.63 (S2)	8.07		12.68	14.67	78	0.95	5.63	52	48.67	
8.73 (S3)	8.05		10.36	8.97	62	0.97	4.82	44	40.09	
	Available nutrients ($mgkg^{-1}$ soil)									
	N	P	K		Fe		Mn		Zn	
15.31 (S1)	34	3.36	180		1.84		6.26		0.85	
10.63 (S2)	37	3.69	188		1.92		6.31		0.88	
8.73 (S3)	40	3.77	193		1.95		6.36		0.91	

*.= organic matter %.

Table 2. Mean Chemical composition of El-Salam Canal water.

pH	EC (dSm^{-1})	Soluble cations (meq/l)				Soluble anions (meq/l)				SAR*
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO^{-2}_3	HCO^{-}_3	CL^{-}	SO^{2-}_4	
8.20	1.93	3.57	5.30	10.10	0.16	0.00	2.83	8.40	8.10	5.22

Macronutrients (mg/l)		Micronutrients (mg/l)					
NO_3-N	NH_4 N	P	Fe	Mn	Zn	Ca	B
4.03	12.57	5.10	0.51	0.31	0.40	0.55	0.05

*= Sodium adsorption ratio.

Agronomical traits

Fifteen cuts were taken according to dates presented in Figure (1). Figure 1 shows cutting dates after sowing in March 2011 till July 2012, then plants were prevented from irrigation and left for flowering for four months to seed set.

Percentage of plant stand establishment recordings were made after the first cut (75 days from sowing). Cutting was done at 8-centimeter height at 28-30 day intervals. Fresh forage weight was recorded in the field immediately after cutting. Fresh forage plot^{-1} weighed and air dried to calculate dry matter %. Samples of ten plants from each plot were collected for agronomical observations plant^{-1} on height (cm), stem diameter (cm), number of tillers fresh (g) and dry weight (g), root length (cm), crown diameter (cm), and root weight (g) for fifteen cuts plot^{-1} for each cultivar and each salinity level. Also, seed characters were recorded for 1000 seed weight (g), number of seeds g^{-1}, number of default seeds g^{-1}, seed weight (g) m^{-2} and seed weight (kg) fed^{-1} after harvesting.

Laboratory analysis

Samples of ten plants were collected randomly from each plot before cutting and then oven dried at 70 ^{o}C. The plant samples were ground, 0.5 g of each sample was digested using H_2SO_4 and $HClO_4$ mixture according to the methods described by Black, (1965). The plant content of nitrogen was determined by Kjedahl method (Chapman and Partt,1961**).** P, K, Fe, Mn and Zn were determined in plant digestion by Inductively Coupled Plasma Spectrometer (ICP) plasma 400 according using the methods described by Cottenie *et al*. (1982) and Page *et al.* (1982).

Statistical methods.

Data were recorded and submitted to ANOVA using SAS 9.2 TS Level 2M3 (Der and Everitt, 2008). Fresh and dry forage weights plot^{-1} across the fifteen cuts were adjusted to t fed^{-1} for each cultivar and productivity was calculated. Statistical analysis used the general linear model (GLM) for repeated measures to account for the split block design (α = 0.05) under each salinity level and least significant differences were calculated according to Waller and Duncan (1969).

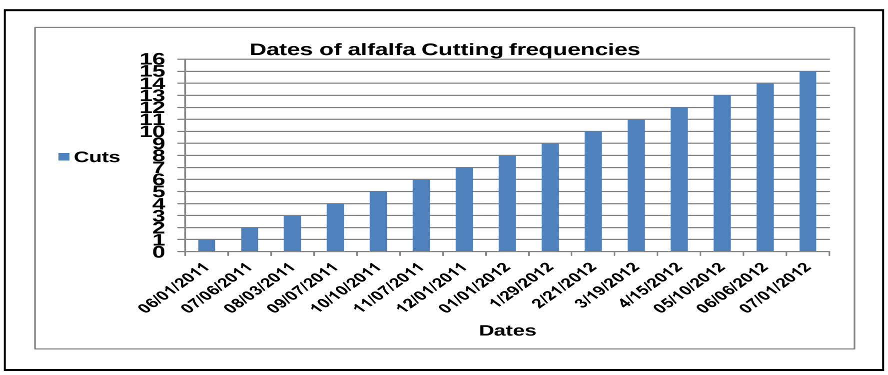


Figure 1. The dates of agronomical practices and cutting frequencies.

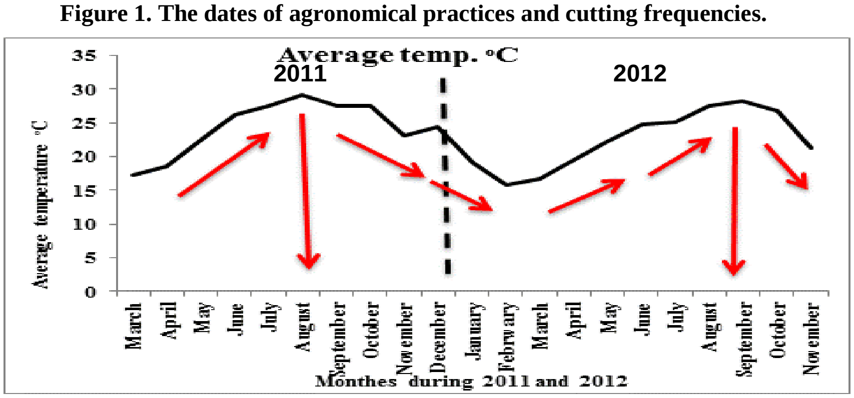


Figure 2. Average temperature °C during sowing, growing, cutting and blooming months.

Results and Discussion

Soil evaluation

Effect of growing alfalfa on soil EC (dSm^{-1}) and pH

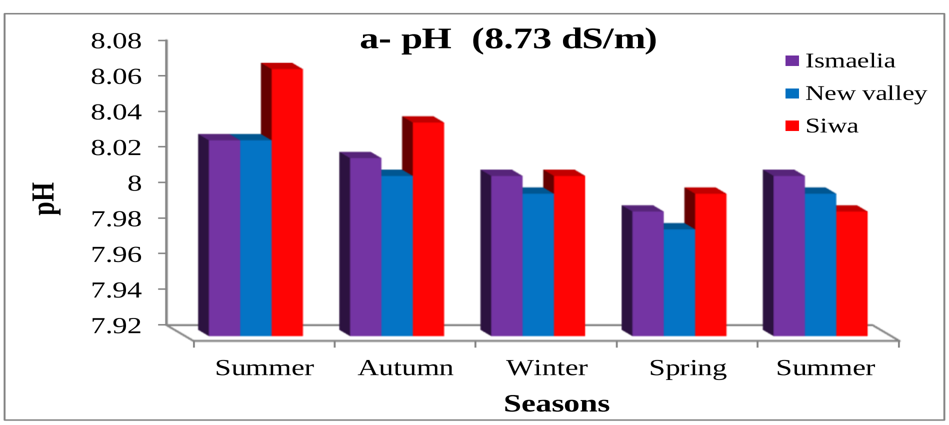
The effects of alfalfa cultivation for long duration period (from summer 2011 to summer 2012) on soil salinity are illustrated in Figure (3) and Table (3). The soil EC was decreased with increasing the growing periods. All cultivars were efficient in decreasing EC values after alfalfa cutting compared with the initial soil EC (Table-3). The highest mean value of EC was 9.84 dSm^{-1} for Ismaelia cultivar, while the lowest mean values of EC was 7.62 dSm^{-1} for Siwa cultivar after cutting. However, the greatest reduction in EC values was recorded in winter 2012, hence the mean values of soil EC were 6.97, 6.83 and 6.92 dSm^{-1} for Ismaelia, New Valley and Siwa cultivars, respectively. The relative decreases of mean values of soil EC as affected by Ismaelia, New Valley and Siwa cultivars were (35.73, 49.31 and 40.04 %) for S1, (25.50, 27.00 and 30.95 %) for S2 and (25.66, 26.28 and 27.49 %) for S3, compared with the initial soil EC. (Table-3) These results are in agreement with Jing *et al.* (2012) who indicated that planting alfalfa led to a significant decrease in salt content in upper soil layer. Morever, Zhang and Ming (2004) found that the effect of alfalfa on saline soil improvement was significant.

Table 3. Soil salinity levels EC (dSm^{-1}) after alfalfa cutting across different growing seasons.

Cultivars	Initial salinity levels Ec (dSm^{-1})	Soil EC (dSm^{-1}) across growing seasons					
		Summer	Autumn	Winter	Spring	Summer	Mean
Ismaelia	8.73 (S3)	7.94	6.88	5.73	5.88	6.01	6.49
	10.63 (S2)	9.41	8.33	6.97	7.05	7.82	7.92
	15.31 (S1)	12.59	10.98	8.20	8.45	8.96	9.84
Mean		9.98	8.75	6.97	7.13	7.60	8.08
New Valley	8.73 (S3)	7.56	6.71	5.84	6.00	6.14	6.45
	10.63 (S2)	9.14	8.17	6.55	6.96	7.96	7.76
	15.31 (S1)	12.20	10.22	8.10	8.20	8.75	9.49
Mean		9.63	8.37	6.83	7.05	7.62	7.90
Siwa	8.73 (S3)	7.31	6.49	5.80	5.98	6.09	6.33
	10.63 (S2)	8.55	7.99	6.52	6.68	6.97	7.34
	15.31 (S1)	11.85	9.79	7.95	8.10	8.22	9.18
Mean		9.24	8.09B	6.76	6.92	7.09	7.62
LSD (0.05)		0.57	0.85	2.92	2.06	0.10	n.s.

.n.s. : Insignificant differences at level of probability (0.05).

The changes in soil pH play a key role in the bioavailability of insoluble elements in soil. Data presented in Figure (3-a, b and c) show that the three alfalfa cultivars grown under different soil salinity levels led to decreasing slightly the soil pH values during the growing seasons. The highest value of soil pH was 8.10 in summer 2011 for Siwa cultivar. At the highest level of soil salinity, the lowest value of pH was 7.98 in Spring 2012 for New Valley cultivar. In other words the pH values ranged between 8.10 and 7.98. The relative reduction of soil pH after cutting of the three alfalfa cultivars were 1.11 %, 4.95 % and 1.24 % for Ismaelia, New Valley and Siwa cultivars compared with initial pH, respectively. These results agreed with those reported by Shaban and Omar (2006), who indicated that the high activity of dehydrogenase enzyme and the released carbon dioxide in the rhizosphere cause the formation of carbonic acids and thus the decrease of pH of the root zone.



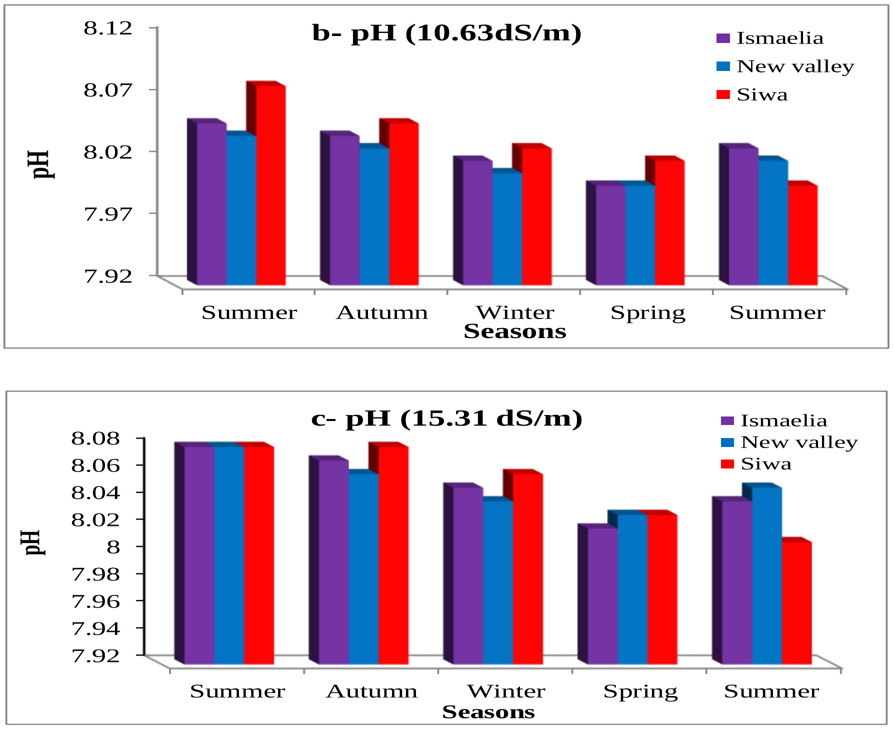


Figure 3. Soil pH after alfalfa cutting under different levels of salinity: a) Ec =8.73 dSm^{-1}, b) Ec =10.63 dSm^{-1} and c) Ec =15.31 dSm^{-1}.

Available macronutrients

a) In soil

Different alfalfa cultivars caused a positive increase in macronutrients (N, P and K available in soil under conditions of saline soil levels. Data presented in Table (4) indicated an increase in available N, P and K in soil by increasing growing duration of alfalfa. The highest mean value of N, P and K content in soil was 52.77, 3.97 and 205 mg kg^{-1}, respectively, after cutting of Siwa cultivar compared with the other cultivars. On the other hand the best mean value of N content in soil was 56.78 mg kg^{-1} recorded for Spring 2012 season, while the mean values of P and K contents in soil recorded (4.01 and 208 mg kg^{-1} soil) for winter 2012 season, respectively (Table 4).

Results indicated that highest relative increase of N content was in soil planted with New Valley compared other cultivars, while the soil planted with Ismaelia cultivar showed the highest increase of P and K content in soil compared to other cultivars. Therefore, the effect of long period of alfalfa planting for improving soil fertility is considerably significant in salt-affected soil. N content in the soil increased due to N_2 fixation by alfalfa roots. These results agreed to those of Xue *et al*. (2010) who noticed that the available N content in the soil decreased in the first year of cultivation. Such a result could be attributed to the uptake of nutrients from the soil in the early growth stages of alfalfa, as well as decrease of N fixation under the high level soil salinity. With the growth and development of alfalfa, its capacity for N fixation enhances; furthermore, due to decomposition and turnover of root residues, total N content in the soil increases with the extension of cultivation time. The effects of different periods of planting all alfalfa cultivars on available P content in saline soil indicated an increase in P content with decreasing soil pH and soil salinity. These results are in agreement with Jing *et al*. (2012) who reported that the effect of successive alfalfa planting for an improvement of soil fertility over the years is considerably significant in salt-affected soils. The general tendency was that EC and salt ions gradually declined yearly, and soil organic matter, N storage and P availability significantly increased with the extension of cultivating ages as compared to the non-planted soils.

b) Concentration of macronutrients in alfalfa plant tissues

Data presented in Table (4) show that the macronutrients (N, P and K) concentration in plants per alfalfa cultivars, after cutting under three soil salinity conditions, were significantly ($p< 0.05$) increased by increasing time periods of planting alfalfa. The N, P and K concentrations (%) on alfalfa plants tissues of the three studied cultivars were increased with the decreasing of soil salinity level. Such increase was found in long planting periods. The Mean values content of N concentration (3.81 %) in the winter 2012 for New Valley Cultivar was higher than other cultivars. The highest mean values of P concentration (0.48 %) of alfalfa for New Valley cultivar during spring 2012 period planting compared with other cultivars. On the other hand, the mean values of K concentration (2.77 %) of dry matter of alfalfa for New Valley cultivar during spring 2012 planting period compared with other cultivars. Also the mean values of N, P and K concentrations in New Valley cultivar were higher than that of all cultivars. These results may be attributed to improving soil properties and increasing available nutrients contents by growing alfalfa.

The relative increases of mean values of N, P and K contents in soil after alfalfa cutting for N in soil planting of Ismaelia, New Valley and Siwa cultivars were 43.44, 49.17, and 32.00 %, respectively, compared with N initial mean in soil (37 mg/kg). Also, the corresponding relative increases of mean values of available P content in soil were 15.77, 6.23 and 5.30 % for Ismaelia, New Valley and Siwa cultivars, respectively compared with the initial (4.61mg kg^{-1}) . The relative increases of mean values of K content in soil were 11.67, 8.00 and 6.22% for Ismaelia, New Valley and Siwa cultivars, respectively (Table 4).

Across salinity levels, N content in plant tissue recorded 19.35 % in New Valley and 9.35 % in Siwa cultivars compared with Ismaelia cultivar. While (P content was 41.37 % in Ismaelia and 48.27 % in New Valley cultivars compared with Siwa cultivar. K content recorded 1.2 % in Ismaelia and 4.8 % in New Valley cultivars compared with Siwa cultivar (Table 4).

These results are in agreement with those of Jing *et al*. (2012) who reported that alfalfa caused a variable degree of soil nutrients, which was influenced by the development stage and physiology change of the root system as well as the degree of P utilization by the root system at different soil layers. Khorshidi *et al*. (2009) found that increasing salinity led to decreasing Ca^{2+}, K^{+} and N concentration but increased significantly Mg^{2+}, P, Na^{+} and Cl^{-}. Tolerant alfalfa cultivars can absorb more K^{+} and Ca^{2+} ions under saline conditions and prevent Na^{+} absorption and then increase K^{+}/Na^{+} and Ca^{2+}/Na^{+} ratios.

Table 4. Macronutrient contents in soil just before alfalfa cutting ($mgkg^{-1}$) and its concentration (%) in alfalfa tissues after cutting

Cultivars	Initial salinity levels Ec (dSm^{-1})	In soil						In plant tissues					
		Summer	Autumn	Winter	Spring	Summer	Mean	Summer	Autumn	Winter	Spring	Summer	Mean
		N ($mgkg^{-1}$)						N %					
Ismaelia	8.73	46.16	50.13	53.03	55.33	52.12	51.35	2.88	3.25	2.95	3.31	2.70	3.02
	10.63	45.29	49.07	51.20	53.41	51.20	50.03	2.81	3.10	2.89	3.25	2.65	2.94
	15.31	38.14	42.95	46.77	48.86	47.86	44.92	3.13	3.57	3.21	4.02	2.85	3.36
	Mean	43.20	47.38	50.33	52.53	50.39	48.77	2.94	3.31	3.02	3.53	2.73	3.10
New Valley	8.73	40.09	45.28	48.18	51.91	48.77	46.85	3.68	3.62	3.75	3.60	3.56	3.64
	10.63	46.28	51.53	53.02	55.34	52.27	51.69	3.72	3.69	3.81	3.68	3.66	3.71
	15.31	49.10	53.17	55.31	57.22	53.32	53.62	3.77	3.72	3.86	3.73	3.70	3.76
	Mean	45.16	49.99	52.17	54.82	51.45	50.72	3.72	3.68	3.81	3.67	3.64	3.70
Siwa	8.73	52.47	54.74	57.30	59.30	53.41	55.44	3.42	3.55	3.64	3.51	3.39	3.50
	10.63	48.29	52.34	54.46	56.35	50.34	52.36	3.35	3.41	3.49	3.42	3.26	3.39
	15.31	44.46	48.70	52.81	54.70	51.85	50.50	3.28	3.32	3.36	3.30	3.22	3.30
	Mean	48.41	51.93	54.86	56.78	51.87	52.77	3.35	3.43	3.50	3.41	3.29	3.39
LSD. (0.05)		n.s.	1.153	1.151	n.s.	0.33	-	0.91	0.85	0.83	0.48	1.03	-
		P ($mgkg^{-1}$)						P %					
Ismaelia	8.73	3.94	3.95	3.98	3.91	3.87	3.93	0.41	0.45	0.48	0.45	0.40	0.44
	10.63	3.89	3.91	3.97	3.87	3.85	3.90	0.38	0.43	0.45	0.42	0.39	0.41
	15.31	3.79	3.85	3.94	3.82	3.81	3.84	0.35	0.41	0.42	0.40	0.36	0.39
	Mean	3.87	3.90	3.96	3.87	3.84	3.89	0.38	0.43	0.45	0.42	0.38	0.41
New Valley	8.73	3.96	3.98	4.00	3.94	3.91	3.96	0.38	0.49	0.43	0.51	0.43	0.45
	10.63	3.93	3.96	3.97	3.92	3.89	3.93	0.36	0.39	0.47	0.48	0.35	0.41
	15.31	3.82	3.87	3.93	3.88	3.86	3.87	0.39	0.44	0.42	0.46	0.38	0.42
	Mean	3.90	3.94	3.97	3.91	3.89	3.92	0.38	0.44	0.44	0.48	0.39	0.43
Siwa	8.73	3.99	4.02	4.05	4.01	3.97	4.01	0.28	0.26	0.28	0.32	0.27	0.28
	10.63	3.97	3.99	4.02	3.99	3.95	3.98	0.26	0.30	0.30	0.33	0.23	0.28
	15.31	3.89	3.92	3.96	3.95	3.90	3.92	0.24	0.28	0.32	0.36	0.25	0.29
	Mean	3.95	3.98	4.01	3.98	3.94	3.97	0.26	0.28	0.30	0.34	0.25	0.29
LSD. (0.05)		0.570	1.153	1.150	n.s.	n.s.	-	0.079	0.082	0.120	0.082	0.068	-
		K ($mgkg^{-1}$)						K %					
Ismaelia	8.73	198	205	209	205	202	204	2.50	2.63	2.39	2.60	2.36	2.50
	10.63	195	201	206	203	201	201	2.44	2.65	2.40	2.69	2.41	2.52
	15.31	189	197	203	201	199	198	2.56	2.74	2.52	2.72	2.31	2.57
	Mean	194	201	206	203	201	201	2.50	2.67	2.44	2.67	2.36	2.53
New Valley	8.73	205	207	209	207	206	207	2.45	2.65	2.43	2.73	2.51	2.55
	10.63	202	203	206	204	202	203	2.63	2.72	2.51	2.74	2.49	2.62
	15.31	195	199	204	202	201	200	2.59	2.81	2.63	2.83	2.43	2.66
	Mean	201	203	206	204	203	203	2.56	2.73	2.52	2.77	2.48	2.61
Siwa	8.73	208	209	210	206	205	208	2.50	2.52	2.56	2.58	2.51	2.53
	10.63	206	207	209	205	203	206	2.48	2.46	2.53	2.56	2.48	2.50
	15.31	200	203	205	202	200	202	2.43	2.45	2.52	2.54	2.43	2.47
	Mean	205	206	208	204	203	205	2.47	2.48	2.54	2.58	2.47	2.50
LSD. (0.05)		n.s.	6.50	5.00	1.22	2.59	-	0.83	0.87	0.72	0.85	n.s.	-

Micronutrients content

a) In soil

Available micronutrient contents (Fe, Mn and Zn mg kg^{-1}) in affected soil under alfalfa growing are presented in Table (5). Results from the three levels of soil salinity grown with three alfalfa cultivars after two growing seasons, indicated low changes in micronutrient contents were obtained. Micronutrients (Fe, Mn and Zn) contents in soil under three levels of salinity were significantly increased with increase in duration period. The highest mean values of Fe Mn and Zn contents in soil were 2.07, 6.50 and 0.98 mg kg^{-1}, respectively. The increase of micronutrients content in soil depended on the decrease of soil pH and EC (dSm^{-1}) and increase of growing duration of alfalfa. These results are in agreement with this obtained by Johan *et al*. (2012). Availability of soil nutrients is determined by the form and chemical properties of the element, the soil pH, and interactions with soil colloids, microbial activity and soil physical conditions such as aeration, compaction, temperature, and moisture. On the other hand, the increase of microelements in soils depends on long duration of growing period. The distribution pattern of available Fe, Mn and Zn in soil may be due to the increase of soil organic matter in the surface layer. These results are in agreement with those obtained by Shaban (2005), who found that increasing in upper soil layer microelements were depending on long time of leached periods after rice and wheat. The distribution pattern of available Fe, Mn, Zn, B and Pb in soil may be due to the increase of soil organic matter in the surface layers.

Also, the relative increases of Fe content in soil as affected by different alfalfa cultivars under three levels of soil salinity were 8.69, 7.81 and 3.59% for Ismaelia, New Valley and Siwa cultivars, compared with initial soil salinity, respectively. Moreover, the relative increases of Mn content in soil compared with initial soil salinity were 3.35, 3.01 and 2.20 % for planting Ismaelia, New Valley and Siwa cultivars, respectively. On the other hand, the relative increases of Zn content in soil were 9.41 %, 7.95 % and 8.90 % for Ismaelia, New Valley and Siwa cultivars compared with initial soil salinity, respectively (Table 5). It is worthy to mention that in this study contents of available microelements, in general, lay within the sufficient limits of Fe, Mn and Zn (FAO, 1992).

b) Concentration of micronutrients in alfalfa tissues.

Micronutrients concentrations in plant tissues of different alfalfa cultivars under levels of soil salinity are presented in Table (5). Data showed that the amounts of Fe, Mn and Zn in tissues were increased over all alfalfa cultivars by increasing alfalfa growing duration. The highest mean values of Fe concentration was in Ismaelia cultivar tissues (82.69 mg kg^{-1}) for spring season compared with other treatments. However, Mn content was maximum (61.51mg kg^{-1}) in New Valley cultivar during winter season. On the other hand, the best mean values of Zn concentration was 38.24 mg kg^{-1} for Siwa cultivar in winter season, compared with other cultivars. Concentrations of Fe, and Mn in alfalfa tissues across cultivars were maximum in winter and spring seasons, while the Zn concentration in plant tissues was insignificant in summer 2012. Also, data showed that increasing of Fe, Mn and Zn concentrations in alfalfa tissues across all cultivars by decreasing soil salinity. These results are in agreement with those of Wang and Han (2007), who reported that, salinity reduced Cu uptake and concentrations in alfalfa tissues but significantly increased the Zn content in the roots, shoots and leaves. Moreover, soil salinity significantly increased uptake and concentration of Mn in the shoots and leaves of alfalfa plants. Murat *et al*. (2011) found that the salinity treatment caused significant increases in the Fe content of the leaves, shoots and roots across all cultivars.

From the previous results, it could be concluded that planting alfalfa under saline soil conditions in the newly reclaimed areas is very important to improve soil fertility. Also, the results showed that New Valley and Siwa cultivars had a significant positive effect on soil fertility.

Plant evaluation

1-Plant establishment

Seed germination is highly affected by salinity levels, seedling growth and plant recovery after cutting. Figure (5) show that the percentages of plants establishing gradually decreased by increasing in salinity level. Although tolerance at the germination and seedling development stages is highly desirable at high salinity levels, tolerance of the resultant adult plants is of equivalent importance. Siwa cultivar showed the best stand plants across all salinity levels followed by Ismaelia cultivar. The New Valley cultivar was the most sensitive with high salinity levels. Natural selection plays an important role in our study.

The stand of residual plants was amazing and incredible vigorous after the fourth cut; they were getting more tillers, branches and sub branches. Soil salinity may affect the germination of seeds either by creating low osmotic potential to the seeds preventing water uptake or through the toxic effects of Na+ and Cl- ions on germinating seed (Khaje-Hosseini *et al.*, 2003; Atak *et al*., 2006; Kaya *et al*., 2006 and Golbashy *et al.*, 2010).

Table 5. Micronutrient contents (mgkg^{-1}) in soil and in plant tissues after cutting.

Cultivars	Initial salinity levels Ec (dSm^{-1})	In plant tissuesl						In soil					
		Summer	Autumn	Winter	Spring	Summer	Mean	Summer	Autumn	Winter	Spring	Summer	Mean
		Fe (mgkg^{-1})											
Ismaelia	8.73	57.19	62.11	74.10	81.00	70.14	68.91	2.03	2.05	2.08	2.12	1.99	2.05
	10.63	64.24	69.10	75.37	83.02	72.29	72.80	1.97	1.96	2.02	2.04	1.97	1.99
	15.31	62.33	63.25	77.21	84.05	66.34	70.64	1.91	1.94	1.98	1.99	1.95	1.95
	Mean	61.25	64.82	75.56	82.69	69.59	70.78	1.97	1.98	2.03	2.05	1.97	2.00
New Valley	8.73	74.29	75.00	75.07	77.22	62.08	72.73	2.01	2.07	2.09	2.08	1.98	2.23
	10.63	65.17	63.06	70.36	74.26	58.14	66.20	1.99	2.06	2.08	1.96	1.95	2.01
	15.31	60.08	68.22	66.20	72.11	63.32	65.99	1.94	2.03	2.06	1.95	1.93	1.98
	Mean	66.51	68.76	70.54	74.53	61.18	68.31	1.98	2.05	2.08	1.99	1.95	2.07
Siwa	8.73	64.19	68.04	77.22	79.10	63.33	70.38	2.03	2.04	2.07	2.07	2.01	2.04
	10.63	59.42	63.41	72.18	76.43	66.20	67.53	1.98	1.99	2.05	2.06	1.99	2.01
	15.31	62.31	67.63	66.15	71.11	62.38	65.92	1.96	1.98	2.02	2.03	1.98	1.99
	Mean	61.97	66.36	71.85	75.55	63.97	67.94	1.99	2.00	2.05	2.05	1.99	2.02
LSD. (0.05)		8.34	n.s.	6.01	n.s.	5.38	-	n.s.	0.011	1.15	n.s.	0.015	-
		Mn (mgkg^{-1})											
Ismaelia	8.73	44.36	48.41	52.25	47.38	46.22	47.72	6.50	6.51	6.54	6.57	6.47	6.52
	10.63	40.20	46.18	49.00	45.43	43.01	44.76	6.46	6.48	6.52	6.56	6.43	6.49
	15.31	43.19	44.22	47.06	44.50	38.23	43.44	6.35	6.39	6.44	6.47	6.40	6.47
Mean		42.58	46.27	49.44	45.77	42.49	45.31	6.44	6.46	6.50	6.53	6.43	6.47
New Valley	8.73	52.00	54.23	64.18	59.06	42.17	54.33	6.47	6.51	6.56	6.56	6.57	6.53
	10.63	49.19	52.28	62.13	57.41	38.26	51.85	6.44	6.48	6.53	6.53	6.54	6.50
	15.31	46.15	49.30	58.22	56.23	36.11	49.20	6.39	6.43	6.48	6.51	6.49	6.46
	Mean	49.11	51.94	61.51	57.57	38.85	51.79	6.43	6.47	6.52	6.53	6.53	6.50
Siwa	8.73	49.33	53.22	58.36	55.09	45.27	52.25	6.48	6.53	6.57	6.58	6.49	6.53
	10.63	46.52	47.35	56.25	52.00	43.36	49.10	6.46	6.51	6.55	6.55	6.47	6.51
	15.31	43.05	42.39	50.10	47.26	41.24	44.81	6.41	6.45	6.52	6.50	6.45	6.47
	Mean	46.30	47.65	54.90	51.45	43.29	48.72	6.45	6.50	6.55	6.54	6.47	6.50
LSD.(0.05)		-	8.15	n.s.	5.23	7.95	8.11	0.57	0.86	0.91	0.75	n.s.	1.88
		Zn (mgkg^{-1})											
Ismaelia	8.73	21.71	23.69	26.59	28.81	23.38	24.84	0.93	0.95	0.99	0.96	0.93	0.95
	10.63	22.96	21.45	23.70	24.46	19.17	22.35	0.90	0.93	0.98	0.94	0.92	0.93
	15.31	18.68	19.20	20.24	22.20	17.09	19.48	0.89	0.92	0.94	0.92	0.90	0.91
	Mean	21.12	21.45	23.51	25.16	19.88	22.22	0.91	0.93	0.97	0.94	0.92	0.93
New Valley	8.73	33.29	35.18	37.66	39.59	35.28	36.20	0.93	0.97	0.99	0.98	0.95	0.96
	10.63	28.60	34.41	35.54	37.14	29.34	33.01	0.92	0.96	0.98	0.96	0.94	0.95
	15.31	24.52	31.33	33.18	32.56	27.55	29.83	0.88	0.94	0.96	0.95	0.91	0.93
	Mean	28.80	33.64	35.46	36.43	30.72	33.01	0.91	0.96	0.98	0.96	0.93	0.95
Siwa	8.73	35.38	37.65	40.25	38.10	37.83	37.84	0.97	0.99	1.04	1.03	0.98	1.00
	10.63	30.52	33.28	38.77	35.09	31.75	33.88	0.95	0.97	1.02	1.00	0.97	0.98
	15.31	27.33	32.67	35.69	34.02	28.71	31.68	0.93	0.96	0.98	0.99	0.94	0.96
	Mean	31.08	34.53	38.24	35.74	32.76	34.47	0.95	0.97	1.01	1.01	0.96	0.98
LSD. (0.05)		2.41	7.15	8.43	3.48	n.s.	-	n.s.	0.021	0.026	0.022	0.031	-

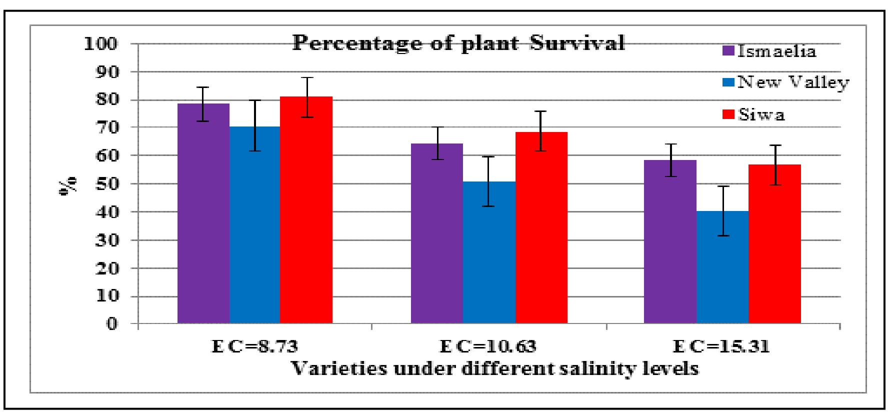


Figure 5. Percentages of plant survival (percentages±SE) of three alfalfa cultivars sown under three levels of salinity after 65-day from sowing.

2-Forage and dry yield

The analysis of variances of fresh and dry forage yield with three local cultivars, under three salinity levels and their interaction. The focus of fresh and dry forage yield were significantly ($P<0.01$) affected by salinity levels, cultivars and their interaction except for spring 2011 season, where differences between cultivars were significant. Salinity levels recorded highly significant differences in fresh and dry yield across all seasons, whereas insignificant affected of fresh forage yield in spring and summer 2011. Fresh and dry forage yield analysis indicated highly significant differences ($P<0.01$) for all seasons except for spring 2011 season across cultivars. Which reversed any difference in dry yield interaction effects in spring 2011 season and for fresh forage yield in summer 2011season.

Table (6) shows forage fresh and dry yield means (t.fed^{-1}) at different growing seasons. Summer (2012) season recorded the best means of forage fresh and dry yield for all studied seasons. Siwa cultivar was superior yielding cultivar over all seasons and salinity levels. Also, it recorded the best average of total fresh forage yield (55.91, 53.17 and 50.09 t fed^{-1}) and total dry forage yield (13.57, 12.45 and 11.77 t fed^{-1}) for the three starting levels of salinity (EC's = 8.73, 10,63 and 15.31 dSm^{-1}), respectively (Table 6 and Figure 6). Ismaelia cultivar followed Siwa cultivar in total forage fresh and dry yield with an average fresh yield of 52.07, 47.03 and 42.38t fed^{-1} and dry yield of 12.93, 11.23 and 9.38 t fed^{-1}, respectively. New Valley cultivar was the lowest yielding among cultivars, and thus it was the most sensitive cultivar in this study to higher salinity levels. Summer (2012) season recorded the highest mean of fresh and dry forage yield (t fed^{-1}), this may be due to temperature effects.

High phenotypic variation between genotypes was found in the second and third starting levels of salinity (10.73 and 15.31 dSm^{-1}). Monirifar *et al*. (2004) reported the presence of phenotypic variation between some alfalfa cultivars at different salinity levels expressed in forage yield. Epstein *et al*. (1980) and Shannon (1984) reported that the development of salt tolerance in crops depends on the availability of genetic variation by screening and selection of those plants with superior performance. Our results were in agreement with the phenotypic variation of alfalfa cultivars for salt tolerance reported by Al-Khatib *et al*. (1993) and Noble *et al*. (1984).

Dry yield was increased according to the decrease of salinity levels across the three studied cultivars of alfalfa. Such increase was found in long duration period of plant standing. Ismaelia cultivar recorded high dry forage yield (t fed^{-1}) in summer 2012 season under 8.73 and 10.63 dSm^{-1} initial salinity levels. New Valley cultivar showed the best forage dry yield (t fed^{-1}) in winter (2011-2012) under 8.73 dSm^{-1} starting level of salinity and in summer 2012 season under 10.63 dSm^{-1} initial level of salinity (2.636 and 2.576 t fed^{-1} respectively). Siwa cultivar had the best forage yield performances for all growing seasons and salinity levels (Figure 6 and Table 6).

Table 6. Means of fresh and dry forage yield (t fed^{-1}) for natural selected alfalfa population through different seasons.

Populations	Initial salinity levels Ec (dSm^{-1})	Spring (2011) - 1 cut		Summer (2011) -3 Cuts		Autumn (2011) - 3 Cuts		Winter (2011/12) - 3 Cuts		Spring (2012) - 3 Cuts		Summer (2012) - 2 Cuts		Total	
		Fresh Yield	Dry Yield	Fresh Yield	Dry Yield	Fresh Yield	Dry Yield	Fresh Yield	Dry Yield	Fresh Yield	Dry Yield	Fresh Yield	Dry Yield	Fresh Yield	Dry Yield
Ismaelia	8.73	4.467	0.853	7.689	2.304	8.044	2.131	9.333	2.524	9.644	2.286	10.889	2.737	52.07	12.93
	10.63	3.233	0.580	6.089	1.973	7.178	1.840	8.100	2.150	8.933	2.062	10.000	2.291	47.03	11.23
	15.31	3.133	0.478	5.711	1.371	5.533	1.167	6.533	2.045	7.867	1.936	9.200	2.085	42.38	9.38
	Mean	3.611	0.637	6.496	1.883	6.918	1.713	7.989	2.240	8.815	2.095	10.030	2.371	47.160	11.180
New Valley	8.73	3.933	0.680	7.689	2.203	5.956	1.748	7.917	2.636	9.467	2.340	9.822	2.377	46.92	12.20
	10.63	2.433	0.387	6.867	2.005	5.244	1.507	6.750	1.850	7.022	1.362	8.978	2.576	42.19	10.09
	15.31	2.000	0.312	4.400	1.712	5.178	1.289	6.000	1.708	5.711	1.148	6.844	1.938	32.87	8.070
	Mean	2.789	0.460	6.319	1.973	5.459	1.515	6.889	2.065	7.400	1.617	8.548	2.297	40.660	10.120
Siwa	8.73	5.233	0.921	8.978	2.866	8.733	1.716	9.550	2.836	11.156	2.468	10.889	2.671	55.91	13.57
	10.63	3.560	0.606	8.578	2.546	8.667	1.927	9.033	2.557	9.378	2.382	10.044	2.119	53.17	12.45
	15.31	3.200	0.433	7.711	2.412	7.511	1.852	8.533	2.622	9.089	2.018	10.044	2.104	50.09	11.77
	Mean	4.031	0.653	8.422	2.608	8.304	1.832	9.039	2.672	9.874	2.289	10.326	2.298	53.057	12.597
Grand mean		3.478	0.573	7.035	2.155	6.894	1.686	7.972	2.325	9.052	2.111	9.635	2.322	45.19	11.39
LSD (0.05)	Salinity	1.789	0.290	2.780	1.138	1.890	0.433	2.059	0.631	1.98	0.650	2.97	1.140	1.801	0.290
	Cultivars	0.449	0.049	1.350	0.679	0.499	0.111	0.981	0.220	1.00	0.260	0.822	0.240	0.450	0.049
	Interaction	0.770	0.185	2.340	0.389	0.861	0. 201	1.360	0.390	1.731	0. 442	1.420	0.411	0.771	0.098

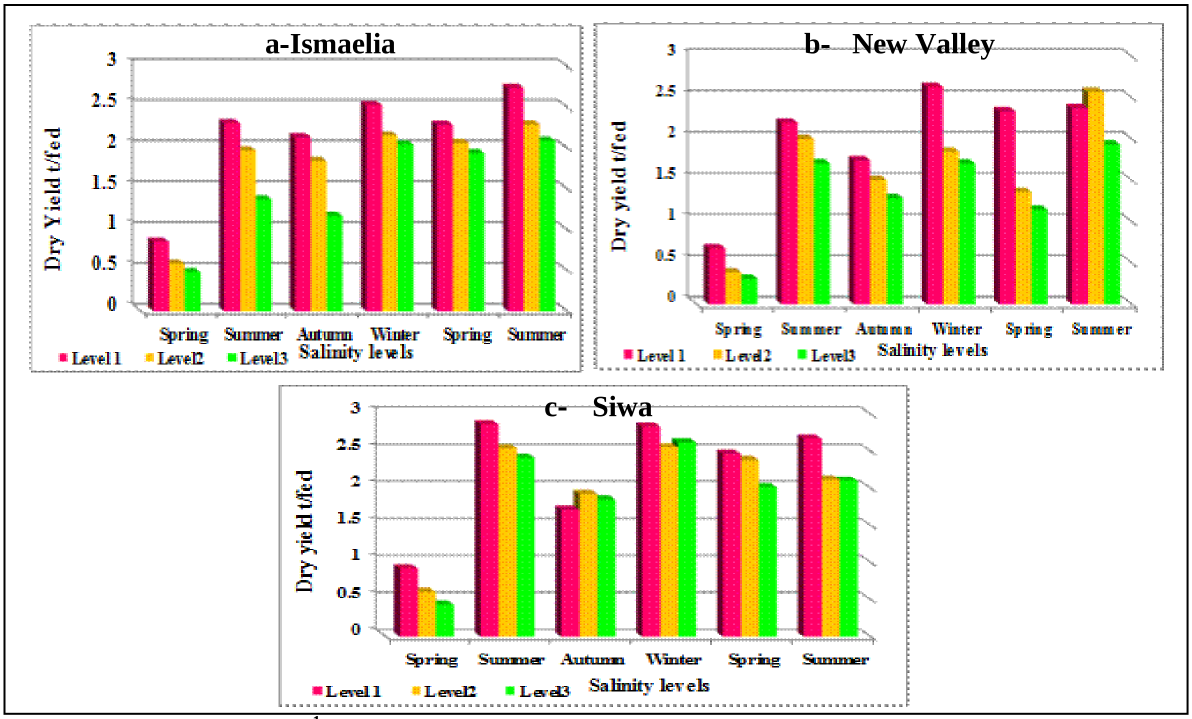


Figure 6. Mean dry yield (t fed^{-1}) of three alfalfa cultivars under different starting levels of soil salinity at different growing seasons.

3-Seed Characters:

Data showed that the studied seed characters significant differences ($P<0.05$) among salinity stress levels. Cultivars had significant differences for all studied characters except for thousand seed weight g^{-1}. Variance due the interaction between salinity and cultivar was significant for No. of seed g^{-1}, No. of default seeds $g^{-1}$and seed weight kg fed^{-1}.

The highest weight of of thousand seed weight was recorded with EC= 8.73 dSm^{-1} (2.31, 2.21` and 2.28) for Ismaelia, Siwa and New Valley cultivars, respectively (Table 7). Siwa cultivar had the greatest weight of thousand seed (1.86 g) at (EC= 15.31) initial level of salinity, therefore it had the highest seed number g^{-1} (491.3, 358.3 and 370.0 in initial salinity levels (EC= 8.73, 10.63 and 15.31 dSm^{-1}, respectively). New Valley cultivar recorded the highest number of default seeds g^{-1} at the three starting levels of salinity (97.3, 112. 7 and 124.0, respectively). Siwa cultivar had superior in both of weight seeds (g) m^{-2} and (kg) fed^{-1} over all starting levels of salinity (74.13 g and 281.7 kg) in EC= 8.73 dSm^{-1}, (58.57g and 222.5 kg) in EC= 10.63 dSm^{-1} and (55.37g and 210.4 kg at EC=15.31 dSm^{-1}), respectively. Ismaelia cultivar behaved similar to Siwa cultivar for the three starting salinity levels. However, New Valley cultivar recorded the lowest means of seed characters and was superior in weight of seeds (g) m^{-2} and (kg) fed^{-1} at the high initial level of salinity EC= 15.31 dSm^{-1} (Table 7).

Table 7. Means of seed characters of three alfalfa cultivars across three salinity levels.

Cultivars	Initial salinity levels Ec (dSm^{-1})	1000 seed weight (g^{-1})	No. seed (g^{-1})	No. default seeds (g^{-1})	Seed weight (g m^{-2})	Seed weight (kg fed^{-1})
Ismaelia	**8.73**	2.31	473.30	77.33	70.50	267.90
	10.63	2.11	351.30	94.00	49.80	189.20
	15.31	1.64	351.70	94.00	37.87	143. 90
	Mean	**2.02**	**392.10**	**88.44**	**52.72**	**200. 40**
New Valley	**8.73**	2.21	373.00	97.33	60.00	228.80
	10.63	1.67	348.30	112.67	45.50	172.90
	15.31	1.06	292. 70	124.00	40.60	154.30
	Mean	**1.64**	**338.00**	**111.33**	**48.70**	**185.30**
Siwa	**8.73**	2.28	491.30	50.67	74.13	281.70
	10.63	2.28	358.30	63.33	58.57	222.50
	15.31	1.86	370.00	98.67	55.37	210.40
	Mean	**2.14**	**406.50**	**70.89**	**62.69**	**238.20**
Grand mean		**1.93**	**378. 90**	**90.22**	**54.72**	**208.00**
L.S.D (0.05)	**Salinity**	**0.28**	**95.00**	**62.38**	**20.72**	**78.74**
	Cultivars	**n.s.**	**32.99**	**19.79**	**4.14**	**15.73**
	Interactions	**n.s.**	**57.14**	**34.29**	**n.s.**	**27.25**

n.s.= insignificant

Table 8. Means of individual plant shoot and root characters as affected by cultivars and salinity across growing seasons.

Cultivar	Initial salinity levels Ec (dSm^{-1})	Shoot characters $plant^{-1}$				Root characters $plant^{-1}$		
		Plant height (cm)	Stem diameter (cm)	No. tillers	Fresh weight (g)	Length (cm)	Diameter (cm)	Weight (g)
Ismaelia	8.73	52.31	0.43	16.29	75.40	27.97	2.91	28.10
	10.63	55.95	0.33	14.49	75.01	29.81	2.45	30.49
	15.31	53.85	0.32	11.75	58.07	27.48	1.97	23.49
	Mean	54.04	0.36	14.18	69.49	28.42	2.81	27.36
New Valley	8.73	55.00	0.37	16.79	71.45	30.28	2.77	27.53
	10.63	57.11	0.34	14.11	70.97	28.92	2.48	26.00
	15.31	52.80	0.32	11.33	54.99	28.98	1.35	19.03
	Mean	54.96	0.342	14.08	65.80	29.39	1.83	24.19
Siwa	8.73	55.25	0.36	18.19	83.35	30.71	2.72	34.64
	10.63	57.76	0.35	13.24	66.98	29.36	2.49	25.37
	15.31	56.61	0.34	12.53	63.61	29.35	2.33	24.14
	Mean	56.54	0.44	14.35	71.31	29.81	2.53	28.05
Grand mean		**55.18**	**0.38**	**13.97**	**68.87**	**29.21**	**2.72**	**26.53**
L.S.D (0.05)	Cultivars	5.11	0.13	1.67	12.28	n.s.	n.s.	n.s.
	Salinity	n.s.	n.s.	0.53	19.30	n.s.	n.s.	n.s.
	Interactions	n.s.	n.s.	1.64	21.14	n.s.	n.s.	6.09

n.s.= insignificant differences

Selection of highly salinity tolerant genotypes among and within open pollinated cultivars could be expected to provide useful material for further breeding, and for experimental comparisons (Al-Khatib *et al*., 1993). Selected seeds were blend after harvesting to contain new developed alfalfa population (Sinai-1) which had extra tolerance and adaptablity to saline soils in Sahl El-Tina conditions. Now developed population (Sinai-1) under evaluation with their parents by the same initial levels of salinity in Sahl El-Tina conditions.

Plant shoot and root characters

Although high salinity levels reduced shoot growth of all cultivats, the magnitude of the reduction varied among them. Data recorded significant differences ($p<0.01$) for plant height, No. tillers, plant fresh weight of all cultivars and ($p< 0.05$) for stem diameter. Root characters recorded insignificant differences over cultivars, salinity levels and their interactions among growing seasons except for root weight indicated significant differences ($p<0.01$) for the interaction among cultivar and salinity levels dSm^{-1}. Levels of salinity dSm^{-1} recorded significant differences ($p= 0.01$) for No. tillers and fresh weight $plant^{-1}$ across growing seasons.

Results presented in Table (8) indicated that Siwa cultivar was superior to Ismaelia and New Valley in most of studied shoot and root characters when estimated across the three initial salinity levels. However, root length and diameter insignificantly affected number of tillers. Plant fresh weight (g) was significantly affected by salinity levels. The high starting salinity (EC= $15.31 dSm^{-1}$) reduced tillers number $plant^{-1}$ and fresh weight (g) (11.75, 11.33, 12.53 tillers $plant^{-1}$ and 58.07, 54.99, 63.61g $plant^{-1}$ for Ismaelia, New Valley and Siwa cultivars, respectively (Table 8). Means of studied characters were significantly reduced as salinity levels were increased. The same trend was observed for root fresh weight (g). These results were in agreement with those reported by Monirifar and Barghi (2009).

Figure 7. Alfalfa plants growing under salt soils in: a) spring 2011 season after 45 from sowing, b-3*ed* cut in summer 2011 season , c) 8*th* cut in winter 2012 season , d) 12*th* cut in spring 2012 season and e) 15 *th* cut in summer 2012 season.

Conclusions:

Three alfalfa cultivars were evaluated through three levels of salinity. Comparison of screening is difficult due to the fact that field conditions are extremely difficult because of the high salinity concentration and the limited layer of growing soil (30-50 cm) in Sahl El-Tina soil conditions.

At different duration of planting, alfalfa caused a variable degree of soil salinity amelioration. The general tendency was that EC and salt ions gradually declined yearly, and soil organic matter, N storage and P availability significantly increased with the extension of growing periods as compared to these non-planted alfalfa. The schedule of 15 cuts of reclamation via alfalfa growing achieved and maintained a good soil quality with adequate structure and nutrient availability status, but the change of solute ion, pH, organic matter, total N and available P in the soil profile presented a spatial and temporal variability due to its being affected by the interaction between soil and plant.

Evaluation at the germination stage is absolutely critical in developing cultivars that can establish a good stand. This is the key starting point to the identification of salt tolerant genotypes. Natural selection through successive cutting with selection for high yield and vigour plants under salinity stress is an excellent method to screen large sets of salt tolerant genotypes and get an idea for regrowth potential under high salinity levels. This study has reaffirmed the difficulty in correlating different screening procedures for salt tolerance in alfalfa. The importance of researching, developing and marketing salt tolerant alfalfa cultivars is substantial, especially when we consider the economic advantages to growers in salt affected regions. Siwa cultivar had the top yielding ability, comparing to Ismaelia and New Valley under Sahl El-Tina conditions.

1- It was possible in this study to develop a high tolerant composite population may be considered as a new cultivar available to be grown in salt affected regions in Egypt.
2- This study raised the idea of role of sowing alfalfa in saline soils for increasing the chance to improvement of soil physical and chemical properties and thus soil fertility.
3- New developed alfalfa population (Sinai-1) resulted from this study; it is the most tolerant and adaptable to saline soils in Sahl El-Tina conditions.

Correrspondìng author
Zeinab M. Abd El-Naby
Forage Res. Dept., Field Crop Res. Inst., Agric. Res. Center, Giza, Egypt
zeina_bree@yahoo.com

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2/2/2013