

Effect of Cationic Surfactant on Some Growth Parameters and Nutrients Uptake of Barley Plant

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Abstract: This work was conducted to study the effect of ethanediyl-1,2-bis (dimethyldodecylammonium chloride; CS12) as cationic surfactant on germination percentage, dry matter, nitrogen, phosphorous and potassium contents and uptake of barley plant grown in sandy and calcareous soils collected from Cairo Alexandria desert road (Sadate city) and Amria region respectively. In a pot experiment 20 seed of barley plant were planted in two kg of used soils. The soil samples were treated by 0.0, 0.2, 0.5 and 1.0% rates of cationic surfactant CS12. The agricultural management processes were introduced as the general recommendations of the agronomists. The obtained results showed that all the investigated parameters were improved by increasing doses of cationic surfactant treatments over the control. This results may be due to the positive effect of CS12 on improving soil and plant conditions.

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1. Introduction

The concurrence of drought, water shortage and soil and water loss are the greatest limiting factors for socially and economically sustainable development in arid-semiarid regions of Egypt. Macromolecule polymers and other soil conditioners have been recognized resource in situations of drought and water shortage. Recently, surfactants were used as wetting agents for soil to improve water penetration and moisture retention. In general, surfactants are composed of organic molecules with hydrophobic tails and hydrophilic heads. Furthermore, surfactants render the soil wet table as the hydrophobic tail of the wetting agent chemically bonds to the hydrophobic coating on the soil particle, while the hydrophilic head attracts water molecules, allowing them to pass into the soil, **Cisar et al. (2000)**, **Kostka (2000)**. A few studies were reported the effect of surface active agent on plant growth but data are still lacking for making clear recommendations.

The previous studies in this concern reported that the application of soil surfactants to the soil improve most of their physical properties, **Feng et al. (2002)**, **Sepaskhah et al (2002)**, **Lentz (2003)**, **Ishiguro et al. (2008)**, **Urrestarazu et al. (2008)**, **Cooley et al. (2009)**, **Miokovics et al.(2011)** and **Mobbs (2012)**. The influence of nonionic surfactant (DLBA) on soil properties, growth parameter and nutrients content of wheat plant were discussed by **Mohamed (2004)** and **Mohamed & Magdi (2005)**. Their results stated that addition of soil surfactant to sandy and calcareous soils led to improve their physical properties, plant growth parameters, and nutrients content and uptake. Generally, this improvement was relatively correlated with the addition rates of surfactant used, **Micich & Linfield (1986)**, **Nawar (2002)** and **Abdullah (2004)**.

This study examines the effect of cationic surfactant CS12 on some growth parameter of barley plant and nutrient content and uptake.

2. Materials and Methods

Soil samples (0-30 cm depth) were collected from Amria region and Alexandria desert road (Sadate city), respectively and prepared for study purpose and analysis.

Soil portions from each sample were mixing with 0.0, 0.2, 0.5 and 1.0% of CS12 which synthesized according to the method reported elsewhere, **Zana (1997)** in Applied Organic Chemistry department, faculty of science, Al-Azhar University (girls branch). Analysis of soils used are shown in **Table 1**. Data stated that Sadate city soil was sandy texture have 2.40% CaCO₃ content while, Amria soil was sandy loam texture have 20.0% CaCO₃ content. Two kilograms portion from two treated soils used were packed in plastic pots (20cm inside diameter) with three replicates for each treatment. Twenty seed of barley (Giza123) were sowing in each pot and water content adjusted at 100% of its field capacity until end of the experiment. After ten days from sowing the germination percentage was recorded. Then, the pots were fertilized by recommended doses of N.P.K fertilizers. Barley shoots were harvested above the soil surface after sixty days from cultivation, washed, dried at 70°C, ground and kept for analysis. Portions from the plant dry matter were taken to determine their N.P.K contents according to **Chapman and Pratt (1961)**. Also, soil portions were taken from each treatment after end of the experiment and analyzed for their N, P, K, Fe, Zn, Mn and Cu contents according to general methods described by **Black (1965)**.

3. Results and Discussion

3.1. Effect of cationic surfactant; CS12 on soil chemical properties and nutrients content for tested soil samples:

Slightly increases were found in all estimated parameters of both soils under investigation by increasing CS12 addition rates; **Table 2**. Values of cation exchange capacity (CEC) were increased from 3.25 to 3.81 mol kg⁻¹ in sandy soil and from 14.80 to 15.98 mol kg⁻¹ in calcareous soil for control and 1.0% CS12 treatments, respectively.

Concerning organic matter percentage (O.M %), slightly increased for both soils used due to the treatments effect and the residual plant parts after the experimental duration.

Acidity values were slightly increased in both sandy and calcareous soils used. This result may be due to the chemical composition of surfactant used. Also, for the EC values, results revealed that in two soils used a slightly increase was observed due to cultivation processes. These increasing values for all parameters were relatively correlated to the increasing in addition rates of CS12.

3.2. Effect of cationic surfactant; CS12 on germination, dry matter and nutrients content and uptake of Barley plant:

Germination percentages in sandy and calcareous soils treated by CS12 are represented in **Table 3**. Data showed that CS12 used increase germination percentage after ten days from planting. These values were 55.00, 66.00, 75.00 and 81.00% for control, 0.2, 0.5 and 1.0% treatments, respectively for sandy soil. In calcareous soil, these values were 46.00, 55.00, 70.00 and 77.00% for the same treatments used. **Fig.1**, illustrated that rates of germination percentage in calcareous soil were higher than in sandy soil. Whereas in calcareous soil were 21.74, 52.17 and 67.39% over control and were 20.00, 36.36 and 47.27 % over control for sandy soil. These data indicated that the probable hard crust of calcium carbonate that

usually occur in calcareous soils was apparently softened by CS12 used, also, in the case of wet table soil which treated with this surfactant water films are present around the individual or aggregated soil particle and moisture percentage of the soil surface is suitable for germination. However, improvement of soil physical condition due to CS12 addition to these soils was enhanced germination and other requirement for plant growth. Also, these results are accordance to those obtained by **Mohamed (2004) and Mohamed & Magdi (2005)**.

Data in **table 3** showed that addition of CS12 led to increasing of plant dry matter to 7.7% over control at 1.0 % treatment in sandy soil and 16.5 % in calcareous soil.

N.P.K. contents and uptake values for barley plants were increased by increasing addition rate of CS12 in both soils used. These results are in good agreement with those obtained by previous studies used polymers and surfactants as soil improvements; **Wolkowski et al.(1985), Sunderman (1988), Nawar (2002), Abu-Zreig et al. (2003), Mohamed (2004), Lowors et al. (2005), Oneill et al (2005), Yangyuoru1 et al. (2006), Urrestarazu et al.(2008) and Mobbs et al. (2012)**. The results clearly showed that a significant increase was observed in N content and uptake values for both soils used. Whereas the N contents were increased in sandy soil from 0.60% for control treatment to 0.71, 0.80 and 0.89 % for application of CS12 at different doses; 0.2, 0.5 and 1.0 %, respectively. In calcareous soil, these values were increased from 0.55% for control treatment to 0.71, 0.79 and 0.83 % at the same rates of CS12, respectively.

The same trend was obtained for N uptake in sandy and calcareous soils. Also, data in **Table 3** showed that P and K contents and uptake were slightly increased than those for N.

Table 1: Chemical and physical characteristics of the studied soil samples:

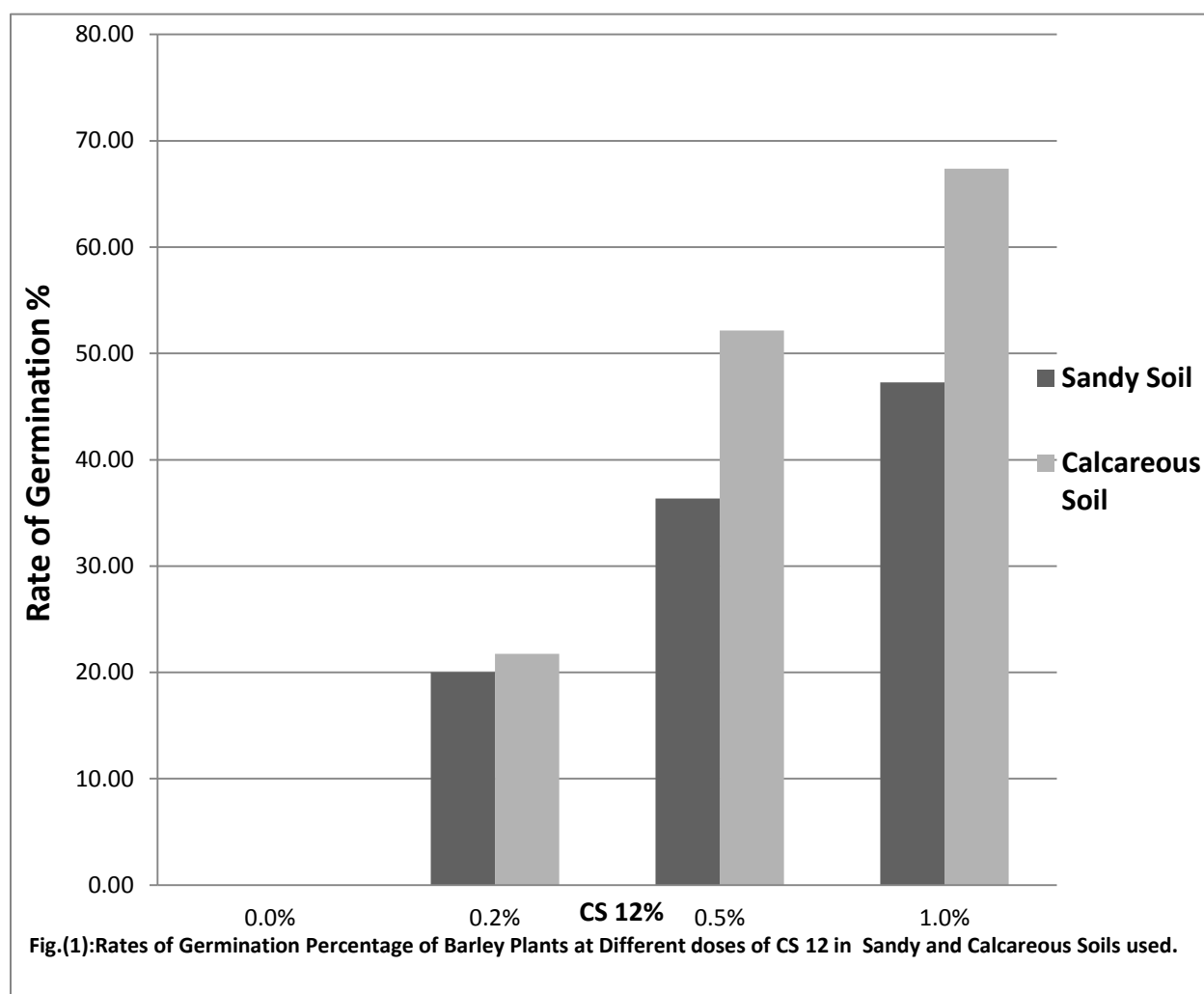
Soil location	Particle size distribution (%)				Textural class	O.M(%)	CaCO ₃ (%)	E.C dSm ⁻¹	pH	Soluble ions (meq l ⁻¹)							
	Course sand	Fine sand	Silt	Clay						Cations				Anions			
										Ca	Mg	Na	K	CO ₃	HCO ₃	Cl	SO ₄
Sadate	53.19	34.00	6.11	7.00	Sandy	0.55	2.40	0.44	7.3	1.8	1.5	2.3	0.43	--	0.5	3.1	2.30
Amria	35.33	38.00	9.95	16.91	Sandy loam	0.81	20.00	0.90	7.9	4.0	1.7	2.7	0.50	---	0.8	3.4	2.98

Table 2: Effect of cationic surface active agent on some soil chemical properties and nutrients for treated soils.

Soil treatment	pH	E.C dcm ⁻¹	C.E.C mol kg ⁻¹	O.M %	Macroelements (ppm)			Microelements (ppm)			
					Na	P	K	Fe	Mn	Zn	Ca
Sandy Soil											
Control	7.10	1.01	3.25	0.25	35.00	7.99	80.13	0.88	1.19	0.43	0.18
0.2%	7.09	1.30	3.39	0.30	40.00	8.11	80.66	1.00	1.22	0.94	0.22
0.5%	7.08	1.59	3.50	0.35	48.11	8.85	80.85	1.05	1.41	0.55	0.28
1.0%	7.07	1.88	3.81	0.38	50.19	9.08	82.11	1.11	1.43	0.59	0.31
Calcareous Soil											
Control	7.60	1.33	14.80	0.60	69.11	6.98	89.99	1.50	1.99	0.66	0.35
0.2%	7.59	1.45	15.20	0.68	77.12	7.11	90.12	1.60	2.01	0.71	0.40
0.5%	7.56	1.70	15.83	0.69	83.08	7.34	90.05	1.79	2.30	0.79	0.43
1.0%	7.54	1.98	15.98	0.71	90.00	7.80	91.09	1.80	2.40	0.84	0.49

Table 3: Effect of cationic surface active agent on growth parameters of Barley plant.

Soil treatment	Germination %	Dry matter g/ pot	Content %			Uptake mg/ pot		
			N	P	K	N	P	K
Sandy Soil								
Control	55.00	6.88	0.60	0.08	0.27	41.28	5.50	18.58
0.2%	66.00	7.19	0.71	0.11	0.30	51.15	7.91	21.57
0.5%	75.00	7.30	0.80	0.13	0.36	58.40	9.49	26.28
1.0%	81.00	7.41	0.89	0.15	0.39	65.95	11.12	28.90
Calcareous Soil								
Control	46.00	6.00	0.55	0.05	0.21	33.00	3.00	12.60
0.2%	55.00	6.22	0.71	0.09	0.23	44.16	5.60	14.31
0.5%	70.00	6.55	0.79	0.11	0.25	51.75	7.21	16.38
1.0%	77.00	6.99	0.83	0.13	0.29	58.02	9.09	20.27

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