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Zamzam Water Effect on Growth of *Sesamum indicum* (Local Varity) as a Field Crop

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Abstract: The effect of Zamzam water in different concentrations (100, 75, 50, 25, 10% and 0% as a control) on seedling growth parameters for *Sesamum indicum* (local Varity) family Pedaliceae which was planted in King Abdul-Aziz nursery in two seasons in 2012-2013 years was studied. Results clearly showed that highly significant effect in germination ratio for *S. indicum* (local Varity) seeds. The proportion of average daily germination increased with increasing Zamzam water level from 0-100% by 61.50% in zero concentration (control) to 85% at 100% Zamzam level. Also plants water content for shoots and roots, leaves numbers, leaf area, stem length and diameter, roots volume, photosynthetic pigments, protein content and ions content showed the same trend where fresh and dry weights were slightly affected with using Zamzam water in irrigation.

Key words: Zamzam Water · Irrigation · Growth · Productivity · *Sesamum Indicum*

INTRODUCTION

It is well known long ago that germination is a critical stage in plant life cycle and inhibition of plant seed germination leads to reduction in the yield, Al-Zahrani and Al-toukhy [1]. Extensive studies have been made concerning the effect of water stress on seed germination and seedling growth using different crop species and different osmotic substances, e.g. [2, 3].

Zamzam well situated inside the Holly mosque in Makkah city, Saudi Arabia. Zamzam water known to be slightly brackish water, contains multi-elements such as Ca, Mg, S, Fe, Mn and Cu [4]. Therefore, the need arises to utilize this huge amount of Zamzam water in agriculture, where some plants can be grown as food crops or garden trees especially at Holly places such as, Arafat, Mozdaliva and Mina areas. It was found that Zamzam water stimulate the growth of beans, wheat and *Sesamum indicum* (local Varity) [2, 5]. Positive results was also showed for carbohydrate content, dissolved and total content of amino and protein, fatty acids, lipids, some nutrients content and percentage of mineral content in these plant species. These results were attributed to two reasons, the first is due to the nutrients richness of Zamzam water, the second attribute to the special inter relations of elements content of Zamzam, which are together benefited plant. Bloom and Finazzo [6] in their study on the faba bean plant, stated that the processes of absorption, the transport and accumulation of elements within the plant and concentration of these elements add to the soil.

Hamed *et al*. [7] used Zamzam water to irrigate *Vicia faba* and *Triticum vulgaris* and found an increase in the productivity of these crops. Algandaby *et al*. [2] also used Zamzam water with different treatment i.e. Zamzam only in different levels (0, 10, 25, 50, 75 and 100%); magnic Zamzam water and holly Quran reading as a new technology for plant growth and found an increase in seed germination with all treatments comparing to control 0% Zamzam water. Also, Alsokari and Abdulatif, Baeshen [8, 9] reported a positive effect of Zamzam water on the germination and other growth parameters of some crop plants. The aim of this study was to evaluate impact of Zamzam water irrigation on growth of *S. indicum* (local Varity) as a field crop at KSA.

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MATERIALS AND METHODS

Germination Exp: The germination experiment of *Sesamum indicum* (local Varity) seeds was carried out similar to method described by [10] and continued for twenty days. Zero, 10, 25, 50, 75 and 100% Zamzam water concentrations were used. Zamzam concentrations were prepared by mixing it with fresh water at different ratios (v/v) under room temperature.

Twenty seeds from *S. indicum* were placed on absorbent pads in each Petri dish to which 30 ml of the experimental solution were added and seeds were considered to be germinated after radical emergence from the tests. The experiment was laid out in randomized complete design with 3 replicates.

Growth Experiment: seeds of *S. indicum* (local Varity) were sown in perforated plastic pots, each containing 15 Kg of sieved soil from nursery area of King Abdul-Aziz university at Jeddah province at KSA, mixed with pyrlit at 3:1 ratio. The pots were divided into six groups, four pots for each one concentration from Zamzam water. Five seedlings per pot were left grow in the King Abdul-Aziz University at about 30ºC at soil water potential near field capacity then, watered with half strength Hoagland nutrient solution. Plants were irrigated at two days intervals with Zamzam water at 6 levels (0, 10, 25, 50, 75 and 100%) and every ten days the plants were irrigated with fresh tap water, more than field capacity, in order to prevent accumulation of salt in soil at pots in root zoon.

At the end of the experiment, shoot, root fresh and dry weight (gram/pot), water content (%), leaves number, leaf area, stem length and diameter in (cm), root volume (cm^3) plant pigments (chlorophyll a and b, carotenoids) in (mg/g fresh leaves) proteins using method of Bradford [10] and minerals content were determined in dry shoots and roots samples which dried at aerated oven in 70°C according to Hamphries [11].

Statistical Analysis: Means, standard deviations (SD) and one way analysis of Variance (ANOVA) were calculated for the means of the respective plant analysis.

RESULTS AND DISCUSSION

Effect of Zamzam Water on Germination: Data concerning the effect of Zamzam concentration on daily seeds germination for *Sesamum indicum* (local Varity) are presented in Table (1&2), Fig (1). Results showed increased the period needed for germination to three days in all Zamzam concentrations. Also, the results in Table (1) cleared a reduction in germination ration (%) from 85% t0 61.5% when Zamzam water concentration decreased from 100, 75, 50, 25, 10% to 0%. The results are in agreement with [2, 8, 9] who reported a positive effect of Zamzam water on the germination and other growth parameters of some field crop plants.

Effect of Zamzam Water Levels on *Sesamum Indicum* (Local Varity) Growth: Data presented in Table (3) revealed that plant growth of *S. indicum* (local Varity), growth was increased with increasing Zamzam level compared to control. The highest fresh and dry weight of shoots, were 28.87 and 5.39 g/pot at 50% Zamzam water level compared to control which gave 22.08 and 4.70 g/pot for fresh and dry weight in shoot also lowest values for fresh and dry shoot weight noticed at 100% level Zamzam water 14.84 and 4.03 g/pot. The highest fresh and dry weight of root were 8.65 and 3.64 g/pot at levels 25 and 75% Zamzam water respectively compared with 7.69 and 3.48 g/pot in control.

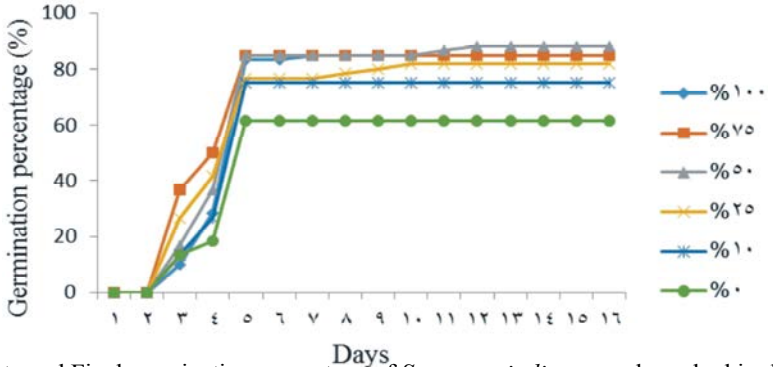

Fig. 1: Germination rate and Final germination percentage of *Sesamum indicum* seeds soaked in different Zamzam water dilutions (Zamzam water By mean and SD significantly influences germination final percentage but not the germination rate)

Table 1: Effect of Zazam water irrigation different levels (0,10, 25, 50, 75 and 100% with mean and SD) on seeds of *Sesamum indicum* (local Varity) germination (%)

Zamzam water level (%)		Days of germination 3	4	5	6	7	8	9	10	11	12	13	14	15	Gr.%
100	Mean	1.67	4.67	6.67	8.67	9.67	10.7	11.7	12.7	13.7	15	16	16	16	80
	SD	1.7	1.25	1.89	0.47	0.47	0.47	0.47	0.64	1.7	0.82	0	0	0	
75	Mean	0.33	2.67	5	7	9.33	10.7	12	13	13.7	15	1.75	15.7	15.7	78.5
	SD	0.47	1.7	1.63	1.41	1.25	0.47	0.82	0.82	1.25	1.41	0.47	0.47	0.47	
50	Mean	1.67	3.67	5.67	8.67	11	11.7	13.3	16.7	17.7	17.7	18	18	18	90
	SD	1.25	1.25	0.94	0.94	0.82	0.47	1.25	1.89	0.47	0.47	0.82	0.82	0.82	
25	Mean	1.33	4.67	6.67	8	9.67	11.7	13.3	15	16	16	16.7	16.7	16.7	83.5
	SD	0.94	1.25	1.7	2.16	1.25	1.25	2.05	1.63	0.82	0.82	0.47	0.47	0.47	
10	Mean	2	3.67	6.33	7	9.33	9.67	13.3	15	16.7	18	18.3	18.3	18.3	81.5
	SD	0	1.25	2.49	1.63	1.89	1.7	1.7	0.82	1.7	0.82	0.47	0.47	0.47	
0	Mean	4	5.33	7.33	7.67	10.3	10.7	12.7	13.7	14	15.7	16.3	16.3	16.3	81.5
	SD	2.16	2.87	1.7	2.05	0.47	0.47	1.25	0.47	0.82	0.94	1.25	1.25	1.25	

Gr = Germination ratio% SD = Standard deviation

Table 2: The mean differences of germination rate between each level of Zamzam concentration and its significance level using Least Significant Differences (LSD) at 95%

	Zamzam concentration (%) 100	75	50	25	10	0
100	0	0.06^{ns}	3.85^{ns}	4.48^{*}	2.14^{ns}	5.59^{*}
75		0	3.91^{ns}	4.54^{*}	$2.1p^{ns}$	5.65^{*}
50			0	0.62^{ns}	2.34^{ns}	1.12^{ns}
25				0	2.34^{ns}	1.12^{ns}
10					0	3.45^{ns}
0						0

Confidence Interval (ns = non significant, *P<0.05, **P<0.01, ***P<0,001, ****P<0,0001)

Table 3: Effect of Zamzam irrigation in different levels (0, 10, 25, 50, 75 and 100% with mean and SD) on *Sesamum indicum* (local Varity) growth

Zamzam water level (%)	Parameter: Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root	Water Content Shoot	Water Content Root	Morphological Parameters: Leaf No	Leaf area (Cm^2)	Stem length (Cm)	Stem diameter (Cm)	Root volume (Cm^3)
100	14.84±1.59	4.72±0.7	0.03±0.1	3.22±0.1	72.68±2.27	30.92±8.45	22.00±3.46	112.33±2.5	9.63±3.3	127.50±6.1	43.67±14.8
75	19.75±2.91	6.15±0.2	4.46±0.3	3.64±0.4	77.27±1.65	40.63±7.47	23.33±3.06	103.00±4.0	10.9±2.3	120.17±7.9	46.33±20.9
50	28.87±9.13	8.50±2.6	5.39±1.1	3.4±0.05	81.41±2.86	57.65±11.6	19.33±5.03	98.67±3.21	8.03±2.2	118.67±7.9	49.33±33.7
25	24.50±3.38	8.65±1.3	5.03±0.4	3.54±0.2	79.35±1.33	58.58±4.72	22.67±2.31	98.67±5.77	8.2±0.98	117.7±16.9	38.33±7.64
10	22.58±0.75	8.30±1.3	4.77±0.1	3.61±0.1	79.07±0.26	55.88±6.57	21.33±2.31	96.67±5.77	9.13±1.6	108.67±9.1	35.00±13.2
0	22.98±6.08	7.69±2.0	4.7±0.57	3.48±0.0	79.06±3.01	53.49±9.01	18.00±3.46	89.00±3.61	7.20±2.1	113.0±18.3	31.00±25.5

Data in Table (3) cleared that increasing Zamzam water level to 50% increased shoot and root fresh and dry weight in *S. indicum* (local Varity), but in high levels (75, 100%) from Zamzam water decreased fresh and dry weight, this may be related to the increase of osmotic pressure of soil solution which reduce water availability, interference of nutrient uptake or due to toxic effect of NaCl found in Zamzam water used in irrigation and finally unbalanced nutrient uptake by seedling. Similar trend was noticed in moisture content in shoot and root of *S. indicum* (local Varity).

Data in Table (3) presented growth of leaves in *S. indicum* (local Varity) which irrigated with different Zamzam water levels (0, 10, 25, 50, 75 and 100%). Results cleared that leaves numbers and leaf area (cm^2) were increased with increasing up to high level, the highest leaves number 23.33 cm^2 leaf, leaf area was 112 cm^2 obtained at 75% and 100% Zamzam water levels respectively compared to 18.00 and 89 cm^2 at 0% (control) or tap water. Standard deviations showed a highly significant for Zamzam water concentrations on leaves number and leaf area.

Stem Length Diameter and Root Volume: Data in Table (3) represented growth of stem length, diameter and root volume in *S. indicum* (local Varity) which irrigated with different Zamzam water levels (0, 10, 25, 50, 75 and 100%). Results showed that stem lengthens, diameters

Table 4: Effect of Zamzam irrigation in different levels (0, 10, 25, 50, 75 and 100% with mean and SD) on *Sesamum indicum* (local Varity) pigments

	Pigment Content			
Zamzam water level (%)	Ch.a (mg/g)	Chl.b (mg/g)	Caro. (mg/g)	Total Pigments (%)
100	0.24±0.54	0.23±1.27	1.24±0.16	0.50±3.40
75	0.14±0.65	0.36±3.47	0.08±1.02	0.33±4.90
50	0.14±0.49	0.97±2.64	0.03±0.49	1.00±3.61
25	2.28±0.15	0.87±2.93	0.17±1.83	1.00±7.07
10	1.07±4.18	0.19±3.66	1.34±2.47	2.73±10.03
0	0.59±3.87	0.18±2.75	0.36±1.14	0.27±7.76

Table 5: Effect of Zamzam water irrigation in different levels (0, 10, 25, 50, 75 and 100% with mean and SD) on *Sesamum indicum* (local Varity) protein content (mg/g)

	Proteins (mg/g)		
Zamzam water level (%)	Soluble	Insoluble	Total
100	0.04±0.50	0.42±0.57	0.78±0.46
75	0.50±0.27	0.60±0.50	1.09±0.24
50	0.93±0.95	0.24±0.17	1.17±0.77
25	0.64±0.38	0.07±0.04	0.71±0.36
10	1.46±0.06	5.00±0.28	6.46±0.21
General mean	0.73±0.34	1.31±0.30	2.04±0.41
0	0.63±0.20	0.29±0.12	0.81±0.10

and root volume increased with increasing Zamzam water irrigation up to high level, the highest values were (127.50, 10.90 cm^3 and 49.33 cm^3) respectively obtained with high level Zamzam level. These results agrees with Yakubu *et al*., [3] whom found that Zamzam water was a positive effect for many plant contents [2, 12, 13] such as carbohydrates and protein contents.

Plant Pigments: Total pigments (Chl. a, b and carotonoids in the fresh leaves of *S. indicum* (local Varity) irrigated with Zamzam water in different levels (0, 10, 25, 50, 75 and 100%) were affected (Table 4).

Results showed that in chl. a, b and carotenoids to 2.28, 0.97 and 1.34 mg/g fresh weight respectively in low level from Zamzam water (10%). Generally the total pigments content increased compared with control (0%) where values in control were 0.59, 0.18, 0.36 mg/g FW for chl. a,b and carotenoids respectively. These results are in agreement with Yakubu *et al*., [3] when he/they explained that the decrease in shoot pigments may be due to many reasons such as increase in osmotic pressure of soil solution which reduce water availability interference of nutrient uptake, or due to toxic effect of the NaCl used in the irrigation water and finally, un balanced nutrient uptake by seedlings.

Effect of Zamzam Water on Protein Content: Total, soluble and insoluble proteins in dry *S. indicum* (local Varity) were affected by irrigation with different Zamzam levels (Table 5). Regarding plant proteins content there were increase to 115.87, 451.72 and 251.85% soluble, insoluble and total proteins using Zamzam water respectively compared to plant plants irrigated with tap water (0%). These results are in agreement with findings of Alsokari and Abdulatif, Baeshen [8, 9] whom reported a positive effect of Zamzam water on germination and other parameters growth of some field crop plants.

Effect of Zamzam Water on Ion Concentration: Zamzam water had s significant effect on the ion concentrations in *S. indicum* (local Varity) plant parts (shoot and root), the results are shown in Tables (6, 7 and 8). Regarding plant shoot ion concentrations there were increase in K^+ to (137.72 and 114.55%) Mg^+ (107-119%) Na^+ (94.02 – 147.7%) Ca^{++} (14.65 and 129.0%) at 25 and 50% Zamzam water levels respectively, compared to plants irrigated with tap water (0%), on the other hand all ions (K^+, Ca^{++}, Mg^+ and Na^+) concentration were decreased at 75 and 100% Zamzam water. The reduction ratios were 2.31, 25.41, 27.12 and 21.47 for K^+, Ca^{++}, Mg^+ and Na^+ ions respectively. Micro-ions Pb, Fe, Zn and Cu taked the same trend of macro-elements (Table 7). Ions plant root concentrations were take the same trend. These results in agreement with findings of Al-Zahrani and Al-toukhy [1] who found the same trend in prose millet plant parts (shoot and root) irrigated with seawater.

Relation between ions accumulated in shoot and root of *Sesamum indicum* (local Varity) in Table (8) cleared that all ion ratios are very small and most of ratios less than one which give indication that *Sesamum indicum* (local Varity) has ability to prevent Na^+ to accumulate at plant shoot and root.

Table 6: Effect of Zamzam water concentrations on shoot and root macro-elements (mg/g DW) of *Sesamum indicum* (local Varity) as a field crop with mean and SD

		K		Ca		Mg		Na	
Zamzam water level%		Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	Mean	44.67	122.3	9.84	60.31	3.76	17.89	6.52	1.37
	SD	7.94	12.00	1.00	12.32	0.46	4.13	0.68	0.76
10	Mean	41.04	79.37	14.42	47.35	4.13	13.8	7.33	1.67
	SD	10.56	13.58	8.14	6.01	1.42	1.36	6.29	0.70
25	Mean	51.17	99.38	11.81	44.52	4.05	16.38	6.13	1.22
	SD	17.62	28.46	2.09	10.88	0.58	4.26	0.37	1.5
50	Mean	61.52	138.40	12.82	34.67	4.50	18.95	9.63	1.86
	SD	10.84	7.92	1.26	25.83	0.69	2.51	1.97	0.00
75	Mean	41.55	60.1	10.12	27.7	3.92	7.79	7.17	2.57
	SD	6.62	48.96	2.26	22.99	0.84	6.7	0.74	0.60
100	Mean	43.64	90.72	7.34	51.54	2.74	14.5	5.12	3.63
	SD	4.46	43.93	2.55	6.86	0.45	6.8	2.26	0.52

Table 7: Effect of Zamzam level% on some micro-elements (mg/g DW) of shoot and root of *Sesamum indicum* (local Varity) as a field crop with mean and SD

		Pb		Fe		Zn		Cu	
Zamzam water level%		Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	Mean	0.002	0.68	2.33	2.60	0.30	0.82	0.017	0.04
	SD	0.001	0.68	0.70	0.47	0.19	0.23	0.001	0.02
10	Mean	0.019	0.32	3.47	3.36	13.95	0.72	0.026	0.26
	SD	0.021	0.43	2.69	0.55	7.66	0.07	0.020	0.05
25	Mean	0.015	0.04	18.13	1.64	24.36	0.75	0.020	0.02
	SD	0.007	0.06	11.52	1.24	6.52	0.30	0.00	0.00
50	Mean	0.003	0.04	4.43	3.77	0.76	2.27	0.002	0.04
	SD	0.003	0.04	1.22	1.28	0.48	2.02	0.003	0.014
75	Mean	0.020	0.13	2.94	1.86	0.12	4.08	0.020	0.44
	SD	0.021	0.134	0.67	1.62	0.04	3.12	0.016	0.04
100	Mean	0.006	0.04	0.01	2.97	0.08	1.57	0.30	0.06
	SD	0.005	16.25	0.002	1.34	0.07	18.70	0.18	0.01

Table 8: Effect of Zamzam water level on ion rations accumulated in shoots and roots (mg/g DW) in *Sesamum indicum* (local Varity) as a field crop with mean and SD

Zamzam water level%	Plant tissue	Na/K	Na/Ca	Na/Mg
0	Shoot	0.14	0.66	1.73
	Root			
10	Shoot	0.18	0.51	1.77
	Root			
25	Shoot	0.12	0.52	1.51
	Root			
50	Shoot	0.16	0.75	2.14
	Root			
75	Shoot	0.17	0.71	1.83
	Root			
100	Shoot	0.12	0.70	1.87
	Root			

Increasing in some elements and decreasing in others in *Sesamum indicum* (local Varity) tissues may be due to the effect of salinity on physiological phenomena, where increasing of Na^+ and Cl^- ions in the protoplasm at cells leads to disturbances in ionic balance (K^+ and Ca^{++} to Na^+) as ion effects on enzyme proteins and membrane as a result to little energy produced by photophosphorylation and phosphorylation in the respiratory chain [14]. Therefore the above discussion permits to some extent to the relatively low and moderate Zamzam water levels.

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