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Effect of organic coats with superabsorbent polymers on improving the germination and early vigor Milk thistle (*Silybum marianum L.)* seeds under salinity stress

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Abstract

Salinity is a major environmental stress negatively influencing germination and seedling establishment in a wide variety of crops. The objective of this study was to use the organic materials with superabsorbents to improve the emergence rate and seedling traits of Milk thistle (*Silybum marianum* L.) under salinity stress. A factorial experiment in a completely randomized design with three replications was conducted in outdoor pots. Treatments included: organic coats at two levels (C_1= peat moss and C_2= vermicompost), superabsorbent polymers at seven levels (A_1= without superabsorbent, A_2-A_4= coats with 2, 4, and 6 g superabsorbent of A200 per kg organic material, and A_5-A_7= coats with 2, 4, and 6 g superabsorbent of F1 per kg organic material), and salinity (S) stress at five levels (0, -2, -4, -6, and -8 bar). Results showed that organic material and the type and amount of superabsorbent significantly ($p \leq 0.05$) affected emergence, emergence rate, plant vigor index, shoot dry weight, leaf area, specific leaf area, relative water content, and total chlorophyll. Application of superabsorbent polymers with organic material reduced salinity stress in the primary growth stage of Milk thistle. Generally superabsorbent A200 is more effective than superabsorbent F1 and vermicompost coats better are than peat moss coats.

Keywords: Early vigor; Organic coats; Salinity stress; *Silybum marianum* L.; Superabsorbent polymer

1. Introduction

The beginning of the 21st century is marked by the global scarcity of water resources, environmental pollution and increased salinization of soil and water. Increased human population and reduction in cultivation land are major two threats to agricultural sustainability (Shahbaz and Ashraf, 2013). Various environmental stresses such as high winds, extreme temperatures, soil salinity, drought and flood affect the production and cultivation of agricultural crops. Among such environmental stresses, soil salinity is one of the most devastating causing, major reductions in cultivated land area and crop, productivity and quality (Yamaguchi and Blumwald, 2005; Shahbaz and Ashraf, 2013). Saline soil is generally defined as one in which the electrical conductivity (EC) of the saturation extract (EC_e) in the root zone exceeds 4 dS m^{-1} (approximately 40 mM NaCl) at 25̊C and has an exchangeable sodium of 15%. The yield of most crop plants is reduced at this EC_e while, many crops exhibit yield reduction at lower EC_{es} (Munns, 2005; Jamil *et al*., 2011). Among the strategies for coping with salinity stress, we can increase the tolerance of crops to salinity and the use of salinized plants (Nabati *et al*., 2011). Germination is one of the sensitive stage to environmental stresses, particularly salinity stress; even plants tolerant during germination and seedling establishment are sensitive to salinity stress. Milk thistle (*Silybum marianum* [L.] Gaertn.) is a medicinal plant cultivated in agricultural areas (Haban *et al*., 2009(. Its seeds

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contain flavonolignans, silybin, silychristin, and silydianin, together called silymarin (Morazzoni and Bombardelli, 1995). Silymarin is a biologically active component conducive to treating liver and biliary diseases and preventing liver cancer (Eskandari Nasrabadi *et al*., 2014). Marjoram S. marianum L. is sensitive to salinity in germination stages. Ahmadian *et al*. (2012) compared solute-specific effects on seed germination characteristics of SM seed (*S. marianum*) at the same osmotic potential under salinity and drought stress conditions. Their results showed that increased concentration in salt and dry environments, caused germination reduction. Masouvi Zavariyan *et al.* (2015) investigated effect the of seed priming by potassium nitrate on germination and biochemical indices in *S. marianum* under salinity stress. They reported that salinity stress reduced the germination indices and the amount of seedling protein and also increase the peroxidase activity.

Increasing the water level around the seed is an approach to reducing the effect of osmotic pressure due to drought and salinity in the germination stage. To keep water around the seeds, organic materials can be utilized as water absorbent materials next to the seed in the soil. Dolat Kordestani *et al*. (2013) used organic materials as seed dressing to increase water content and reduce osmotic pressure under drought stress conditions around the seed during the germination stage. Another method for maintaining water around the seeds is to use polymer materials as absorbent materials next to the seed. Bhat *et al*. (2009) showed that absorbent polyacrylamide under saline conditions was able to increase the amount of available water. Enjavi *et al*. (2011) observed that with the increase in superabsorbent material in soil, the effect of drought stress on seed germination stage could be reduced. However, some researchers have proposed blending superabsorbents with organic materials. Rosta *et al*. (2013) investigated the effect of super absorbent polymer and organic materials on maintaining soil moisture. Soil salinity absorbs water in a difficult manner. Some materials can increase moisture along the seed, reduce osmotic stress, and establish the plant in saline land. The present study aimed to use superabsorbent materials mixed with organic materials as organic coatings under salt stress in order to increase Milk thistle early vigor and establish plant in saline land. Superabsorbent polymer and organic material can keep water around the seeds and gradually provide water to plant.

2. Materials and Methods

During 10 weeks (from 2015.06.23 to 2015.09.06), a factorial experiment was carried out based on completely randomized design with three replications (the number of replicates was selected based on the tests performed under the same conditions) was conducted in outdoor pots at the College of Agriculture, Shiraz University, Shiraz, Iran (29°36′ N; 52°15′E; elevation 1810 m). Treatments included: organic covers at two levels (C1= peat moss and C2= vermicompost), superabsorbent polymers at seven levels (A1= without superabsorbent, A2-A4= coats with 2, 4 and 6 g superabsorbent of A200 per kg organic material and A5-A7= coats with 2, 4, and 6 g superabsorbent of F1 per kg organic material), and salinity (S) stress at five levels (0, 5.5, 12, 16.6 and 22 dS/m). To produce the organic coatings, we dried and ground peat moss and vermicompost (at 70 ºC for 24 hours), Afterwards, different ratios of super absorbent powder 0, 2, 4 and 6 gram per kilogram of organic material (vermicompost and peat) was prepared and balls hub (almost half the size of ping-pong balls) and molding were dried at room temperature. Salt (NaCl) was used to apply salinity. The soluble salt of van't Hoff (Equations (1) and (2)) was calculated (Massarat *et al*., 2013; Puppala *et al*., 1999; Redmann *et al*., 1994). To ensure the preparation of the solution, salt concentration was measured by electrical conductivity. Watering pots with a field capacity of 200 ml were designed to prevent the accumulation of salt. Leaching requirement was calculated according to Equation (3).

$$W = \mathrm{m.i.r.t} \qquad (1)$$

where W= osmotic potential, m= molar concentration, r= constant factor equal to 0.0831, t= kelvins, and i= resolved constant ionization matter.

$$W = EC \times 0.36 \qquad (2)$$

W= osmotic potential (bar), EC= electrical conductivity (dS/m)

$$LR = D_{dw}/D_{iw} = EC_i/EC_d \qquad (3)$$

where D_{dw} is equivalent depth of drainage water, Diw is depth of irrigation water, ECi Is Irrigation salt concentration and ECd is salt drainage water concentration irrigation drainage = D_{iw} = EC_i = EC_d salt concentration of irrigation water salinity drainage water (Rhoades *et al*., 1999). Seedling traits included: emergence,

emergence rate, plant vigor index, shoot dry weight, leaf area (Siosemardeh *et al*., 1999), specific leaf area (Arias *et al*., 1999), relative water content and total chlorophyll.

$$EP\ \% = (ES/TS) \times 100 \quad (4)$$

Because EP is emergence percentage, ES is the number of emerged seeds and TS is the total number of seeds
(Nicols and Heydecker, 1968).

$$ER = \Sigma\, N_i/T_i \quad (5)$$

As ER is the emergence rate, N_i is the number of seeds emerged at time T_i, and T_i is the time after emergence
(Ellis and Roberts, 1981).

$$\text{Vigor Index (VI)} = \text{Plant Length (mm)} \times EP \quad (6)$$

(Agrawal, 2003)

$$RWC = (FW\text{-}DW/TW\text{-}DW) \times 100 \quad (7)$$

FW=wet weight, DW=dry weight, TW = turgescence weight RWC = relative water content

The samples were immersed in distilled water for one hour to weigh the leaves in saturated or turgeous weight. To measure the dry weight, samples were transferred to oven for 24 hours at 70 °C (Ritchi *et al*., 1999) and accurately weighed with a precision of 0.01 g. Mean comparison was done at Duncan's 1 and 5% level using SAS software.

3. Results and Discussion

Results showed that the organic material, type, and amount of superabsorbent had a significant ($p \leq 0.05$) effect on emergence, emergence rate, plant vigor index, shoot dry weight, leaf area, specific leaf area, relative water content, and total chlorophyll.

Table 1. Analysis of variance (Mean square) for seedling traits

S. O. V.	d.f.	Emergence (%)	Emergence rate rate	Plant vigor index	Shoot dry weight	Leaf area	Relative water content	Specific leaf area	Chlorophyll SPAD
(A) Organic material	1	4098*	0.0008*	1550445*	0.20*	32778*	5009*	4924^{ns}	4447*
(B) Superabsorbent	6	2539*	0.00004^{ns}	694287*	0.01*	3068*	2501*	15628*	31*
(C) Salinity	4	28487*	0.056*	6925019*	0.12*	68605*	17412*	468707*	3492*
A×B	6	3703*	0.0001*	1091959*	0.02*	11813*	4024*	21950*	144*
A×C	4	4144*	0.0002*	917410*	0.01*	3742*	2458*	52214*	569*
B×C	24	5284*	0.00002^{ns}	227247*	0.004*	2828*	959*	31967*	140*
A×B×C	24	1186*	0.00007*	207646*	0.003*	2512*	883*	3202*	117*
Error	140	239.77	0.000034	17592	0.00038	248.77	21.97	1194.11	7.10
C.V.		37.33	14.74	21.47	22.18	24.1	14.5	27.9	13

^{ns} ** , and *: not-significant and significant at 1 and 5 percent level of probability, respectively

Table 2. Effect of superabsorbent, salinity, and organic material on different seedling traits

Organic material	Superabsorbent	Salinity	Emergence%	Emergence rate (seed/day)	Plant vigor index	Shoot dry weight (g)	Leaf area (cm^2)	Specific leaf area ($cm^2\ g^{-1}$)	Relative water content	Chlorophyll (SPAD)
		S_1	50 bc	0.063 bc	625.0 r-v	0.035 uv	72.2mno	672.8ab	65.2c-f	24.8h-q
		S_2	50 bc	0.052 cd	568.3s-v	0.040 uv	33.9pq	161.0opq	60.9ef	27.8c-l
	A_1	S_3	50 bc	0.067 abc	545.0s-v	0.100 o-s	52.9op	161.0opq	60.7f	27.5c-m
		S_4	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	100 a	0.067 abc	1473.0 b-f	0.135 k-p	144.8a-f	286.0f-n	65.0c-f	26.5e-n
		S_2	100 a	0.059bc	839.0m-s	0.165 g-m	106.9g-m	100.0qr	61.1ef	25.0h-q
	A_2	S_3	75 ab	0.075ab	964.5 j-p	0.110 o-s	107.8f-m	499.2cd	67.4a-f	21.0o-r
		S_4	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	67ab	0.063 bc	1060.0 i-n	0.130 l-q	147.8a-e	269.0h-o	60.8f	25.7f-o
		S_2	83 ab	0.067 abc	1341.0 c-i	0.137 k-p	128.6c-i	382.0e-h	64.2def	22.8l-q
	A_3	S_3	75 ab	0.063 bc	966.5 j-p	0.110 o-s	112.2e-l	588.3bc	67.4a-f	25.2g-q
		S_4	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	100 a	0.067 abc	1475.0 b-f	0.110 o-s	147.5a-e	184.3m-q	65.4c-f	24.9h-q
		S_2	100 a	0.067 abc	1650.0 ab	0.140 k-p	136.0c-h	274.9g-o	66.6b-f	21.2n-r

Continued Table 2. Effect of superabsorbent, salinity, and organic material on different seedling traits

Organic material	Superabsorbent	Salinity	Emergence%	Emergence rate (seed/day)	Plant vigor index	Shoot dry weight (g)	Leaf area (cm^2)	Specific leaf area ($cm^2 g^{-1}$)	Relative water content	Chlorophyll (SPAD)
	A_4	S_3	83 ab	0.059bc	1141.0 g-l	0.120 m-q	173.7ab	726.7a	78.2ab	23.5j-q
		S_4	50 bc	0.067 abc	675.0 p-v	0.180 f-k	66.3nop	368.2e-j	67.8a-f	26.5e-n
		S_5	0 d	0.000 e	0x	0.000v	0.0q	0.0r	0.0g	0.0s
C_1		S_1	100 a	0.067 abc	1407.0 b-g	0.170 g-l	150.2a-d	244.6k-p	71.6a-f	23.0l-q
		S_2	50 bc	0.056 cd	660.0 q-v	0.065 stu	88.2k-o	588.3bc	71.2a-f	20.4p-r
	A_5	S_3	50 bc	0.056 cd	839.0m-s	0.110 o-s	112.2e-l	161.0opq	65.2c-f	23.4j-q
		S_4	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	83 ab	0.067 abc	1340.0 c-i	0.157 i-m	148.9a-e	213.7l-q	68.1a-f	24.6i-q
		S_2	100 a	0.067 abc	1540.0 a-e	0.160 h-m	94.3i-n	471.3de	72.3a-f	27.7c-l
	A_6	S_3	50 bc	0.063 bc	475.0 t-w	0.060 stu	52.9op	311.1f-l	79.1a	23.2k-q
		S_4	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	75 ab	0.067 abc	1410.0 b-g	0.160 h-m	147.5a-e	308.0f-l	66.4c-f	22.2m-r
		S_2	67ab	0.067 abc	1110.0 h-m	0.170 g-l	112.2e-l	303.4f-l	65.0c-f	24.3i-q
	A_7	S_3	75 ab	0.067 abc	1075.0 i-n	0.140 k-p	106.0g-m	305.5f-l	72.7a-e	19.8qr
		S_4	50 bc	0.059bc	545.0 s-v	0.100 o-s	34.7pq	394.1ef	65.1c-f	22.6l-q
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	83 ab	0.083 a	1321.0d-i	0.177 f-l	178.6a	301.0f-m	63.9def	28.9b-j
		S_2	67ab	0.083 a	1313.0d-i	0.320 a	147.0a-e	199.4l-q	61.1ef	28.6b-k
	A_1	S_3	50 bc	0.067 abc	790.0n-s	0.255 bc	102.5g-n	236.0k-p	61.1ef	30.1a-h
		S_4	50 bc	0.067 abc	545.0 s-v	0.120 m-q	77.5 l-o	236.7k-p	60.7f	25.3g-p
		S_5	0 d	0.000e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	100 a	0.067 abc	1775.0 a	0.205 e-h	179.7a	346.0f-k	67.7a-f	24.7h-q
		S_2	75ab	0.083 a	1324.0d-i	0.230 b-e	145.8a-e	210.0l-q	63.0def	31.3a-e
	A_2	S_3	50 bc	0.075 ab	892.0 l-r	0.170 g-l	100.9h-n	135.0pq	64.2def	24.5i-q
		S_4	75ab	0.067 abc	1235.0 f-k	0.165 g-m	106.9g-m	268.2h-o	74.7a-d	27.3c-m
		S_5	0 d	0.000e	0.0x	0.000v	0 q	0.0r	0.0g	0.0s
		S_1	100 a	0.067 abc	1770.0 a	0.230 b-e	160.1abc	289.0f-n	68.9a-f	26.3e-o
		S_2	83 ab	0.067 abc	1556.0 a-d	0.260 bc	139.3b-g	196.2l-q	69.9a-f	26.9d-m
	A_3	S_3	50 bc	0.075 ab	900.0 l-r	0.230 b-e	117.4d-k	194.0l-q	73.3a-d	27.5c-m
		S_4	50 bc	0.067 abc	758.3 o-t	0.120 m-q	93.7i-n	258.2i-o	71.9a-f	26.9d-m
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	100 a	0.067 abc	1406.0 b-g	0.220 c-f	178.5a	175.1n-q	71.9a-f	25.4f-p
		S_2	100 a	0.067 abc	1623.0 abc	0.265 b	140.0b-g	220.6l-p	67.1b-f	29.0b-i
	A_4	S_3	50 bc	0.067 abc	970.0 j-p	0.230 b-e	112.2e-l	192.7l-q	68.7a-f	23.2j-q
		S_4	67ab	0.067 abc	993.3 j-o	0.250 bcd	88.3ko	272.0g-o	67.4a-f	30.8a-f
		S_5	0 d	0.000e	0.0 x	0.000v	0.0q	0.0r	0.0g	0.0s
C_2		S_1	50 bc	0.067 abc	712.0 o-u	0.147 j-n	144.8a-f	279.0g-o	69.5a-f	30.4a-g
		S_2	67ab	0.067 abc	944.0 k-q	0.210 d-j	127.5c-g	255.0j-o	71.6a-f	28.7b-k
	A_5	S_3	75ab	0.067 abc	1010.0 j-o	0.160 h-m	103.9g-n	206.7l-q	76.7abc	29.2b-i
		S_4	50 bc	0.067 abc	562.5 s-v	0.100 o-s	68.4nop	371.7e-j	70.6a-f	29.7a-i
		S_5	0 d	0.000e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	50 bc	0.067 abc	675.0 p-v	0.147 j-n	160.1abc	212.6l-q	65.1c-f	27.1d-m
		S_2	50 bc	0.067 abc	800.0 n-s	0.190 e-j	74.1mno	164.6opq	67.6a-f	32.3a-d
	A_6	S_3	50 bc	0.067 abc	568.3 s-v	0.110 o-s	106.9g-m	183.0m-q	63.9def	33.6ab
		S_4	50 bc	0.067 abc	545.0s-v	0.075 r-u	71.3mno	198.1l-q	67.6a-f	28.6b-k
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s
		S_1	50 bc	0.067 abc	715.0 o-u	0.160 h-m	173.7ab	385.2efg	63.9def	28.6b-k
		S_2	50 bc	0.067 abc	945.0 k-q	0.145 j-o	95.2i-n	178.1n-q	65.2c-f	34.7a
	A_7	S_3	67ab	0.067 abc	1011.0 j-o	0.120 m-q	93.2i-n	261.0i-o	65.3c-f	29.2b-i
		S_4	50 bc	0.067 abc	562.5 s-v	0.110 o-s	52.9op	194.6l-q	65.1c-f	26.8b-k
		S_5	0 d	0.000 e	0.0x	0.000v	0.0q	0.0r	0.0g	0.0s

Means followed by similar letters in the same column don't significant difference based Duncan multiple range test ($p \leq 0.05$). C_1= peat moss, C_2= vermicompost, A_1= without superabsorbent, A_2-A_4= coats with 2, 4 and 6 g superabsorbent of A200 per kg organic material, A_5-A_7= coats with 2, 4 and 6 g superabsorbent of F1 per kg organic material, S_1= 0 bar, S_2= -2 bar, S_3= -4 bar, S_4= -6 bar and S_5= -8 bar

3.1. Effect of superabsorbent, salinity, and organic material on different seedling traits

3.1.1. Emergence percentage:

Mean comparison of the effects of superabsorbent, organic material (vermicompost, and peat moss), and salinity on seedling emergence percentage showed that the largest percentage was 100% (Table 2). Emergence percentage was 50% under 0 bar salinity, peat moss, and level 1 superabsorbent, however, under the same salinity, organic material, and level 3 super absorbent A200 and F1, it was 100% and 75%, respectively. Emergence percentage was 83.33% under 0 bar salinity, vermicompost, and level 1 superabsorbent. Nonetheless, under the same salinity, organic material, and level 3 super absorbent A200 and F1, it was 100% and 50%, respectively. Emergence percentage was not observed under -6 bar salinity, peat moss, and level 1 superabsorbent. However, it was 50% under -6 salinity, peat moss, and level 3 superabsorbent A200 and F1. Under -6 bar salinity, vermicompost and level 1 superabsorbent, the emergence percentage was 50%. Furthermore, it was respectively 66.67% and 50% under -6 salinity, vermicompost, and level 3 super absorbent A200 and F1 (Table 2). Emergence percentage was 83.33% under 0 bar salinity, vermicompost, and level 1 superabsorbent. Nonetheless, under the same salinity, peat moss, and level 1 super absorbent, it was 50% (Table 2). Superabsorbents reduced salinity stress and vermicompost coats better than peat moss coats (Table 2). In the study of Masouvi Zavariyan *et al.* (2015) salinity stress reduced the germination indices.

3.1.2. Emergence rate

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), and salinity on seedling emergence rate showed that the largest emergence rate was 0.083 (seed.day^{-1}) under -2 bar salinity, vermicompost and level 1 superabsorbent A200 (Table 2 and Fig. 1).

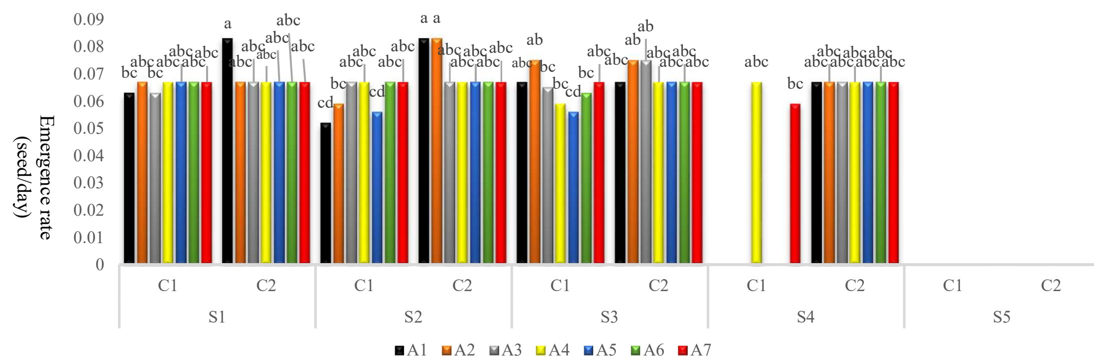

Fig. 1. Effect of superabsorbent, salinity and organic material (vermicompost, and peat moss) on emergence rate (Means followed by similar letters don't significant difference based Duncan multiple range test ($p \leq 0.05$). C_1= peat moss, C_2= vermicompost, A_1= without superabsorbent, A_2-A_4= coats with 2, 4 and 6 g superabsorbent of A200 per kg organic material, A_5-A_7= coats with 2, 4 and 6 g superabsorbent of F1 per kg organic material, S_1= 0 bar, S_2= -2 bar, S_3= -4 bar, S_4= -6 bar and S_5= -8 bar)

The emergence rate was 0.063 (seed.day^{-1}) under 0 bar salinity, peat moss, and level 1 superabsorbent. On the other hand, with the same salinity, organic material, and level 3 super absorbent A200 and F1, it was 0.067 and 0.066 (seed.day^{-1}) respectively, under 0 bar salinity, vermicompost and level 1 superabsorbent, the emergence rate was 0.083 (seed.day^{-1}). Nevertheless, with the same salinity, organic material, and level 3 super absorbent A200 and F1, it was 0.067 (seed.day^{-1}). Emergence was detected under -6 bar salinity, peat moss and level 1 superabsorbent. This rate was 0.067 and 0.059 (seed.day^{-1}) under -6 salinity, peat moss and level 3 super absorbent A200 and F1, respectively. Emergence rate was 0.067 (seed.day^{-1}) under -6 bar salinity, vermicompost and level 1 superabsorbent while it rate was 0.067 (seed.day^{-1}) under -6 salinity, vermicompost and level 3 super absorbent A200 and F1 (Table 2 and Fig. 1). This factor was 0.083 (seed.day^{-1}) under 0 bar salinity, vermicompost and level 1 superabsorbent while it rate was 0.063 (seed.day-1) under same salinity, super absorbent, and peat moss (Table 2 and Fig. 1). Vermicompost coats functioned better than peat moss coats and superabsorbent A200 was more effective than superabsorbent F1. Ahmadian *et al.* (2012) compared solute-specific effects on seed germination characteristics of SM seed (S. marianum) at the same osmotic potential under salinity and drought stress conditions. Their findings showed that high concentrations of drought and salinity treatments reduced the germination rate among 40 and 50%.

3.1.3. Plant early vigor

Mean comparison of the effects of superabsorbent, organic material (vermicompost, and peat moss), and salinity on plant early vigor showed that the largest plant vigor index was 1775 under 0 bar salinity, vermicompost, and level 1 superabsorbent A200 (Table 2). Plant early vigor was 625 under 0 bar salinity, peatmoss, and level 1 superabsorbent; however, with the same salinity, organic material, and level 3 superabsorbent A200 and F1, it was 1475 and 1410, respectively. Plant early vigor was 1326 under -6 bar salinity, vermicompost, and level 1 superabsorbent. Moreover, it was 993.3 and 562.5 under -6 salinity, vermicompost, and level 3 super absorbent A200 and F1, respectively (Table 2). Under -6 bar salinity, peat moss, and level 1 superabsorbent, the plant vigor index was 0. Plant early vigor was 675 and 545 under -6 salinity, peatmoss, and level 3 superabsorbent A200 and F1, respectively (Table 2). This index was 545 under -6 bar salinity, vermicompost, and level 1 superabsorbent. It was 933.2 and 562.5 under -6 salinity, vermicompost, and level 3 super absorbent A200 and F1, respectively (Table 2). Plant vigor index was 1321 under 0 bar salinity, vermicompost and level 1 superabsorbent while it was 625 under same salinity, superabsorbent, and peat moss (Table 2). Superabsorbent A200 was more effective than superabsorbent F1 and vermicompost coats better than peat moss coats. Dolat Kordestani *et al.*)2013) investigated effect of organic coating on plant vigor. Results showed that all traits affected by type of organic coating, with the most effect obsevered on plant vigor index.

3.1.4. Shoot dry weight

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), and salinity on shoot dry weight showed that the largest shoot dry weight was 0.32 g under -2 bar salinity, vermicompost, and level 1superabsorbent A200 (Table 2 and Fig. 2).

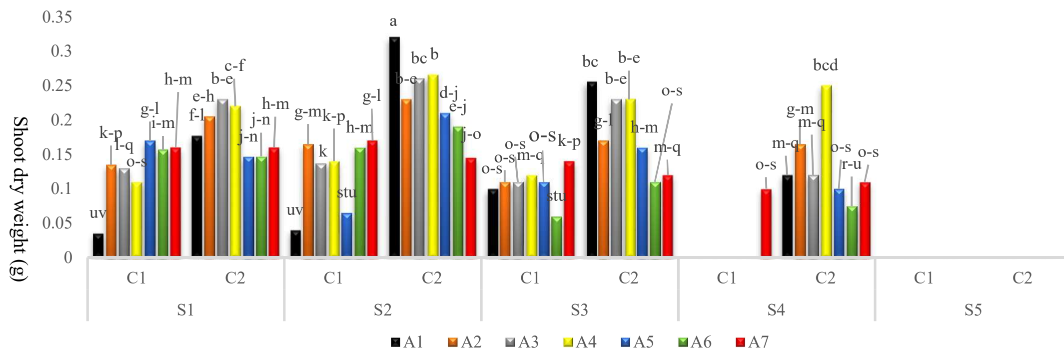

Fig. 2. Effect of superabsorbent, salinity and organic material (vermicompost, and peat moss) on shoot dry weight (Means followed by similar letters don't significant difference based Duncan multiple range test ($p \leq 0.05$). C_1= peat moss, C_2= vermicompost, A_1= without superabsorbent, A_2-A_4= coats with 2, 4 and 6 g superabsorbent of A200 per kg organic material, A_5-A_7= coats with 2, 4 and 6 g superabsorbent of F1 per kg organic material, S_1= 0 bar, S_2= -2 bar, S_3= -4 bar, S_4= -6 bar and S_5= -8 bar)

Shoot dry weight was 0.035 g under 0 bar salinity, peat moss, and level 1 superabsorbent; nonetheless, with the same salinity, organic material and level 3 super absorbent A200 and F1, this factor was 0.11 g and 0.16 g, respectively. Shoot dry weight was 0.177 g under 0 bar salinity, vermicompost, and level 1 superabsorbent but 0.22 g and 0.16 g with the same salinity, organic material, and level 3 superabsorbent A200 and F1, respectively. It was 0 under -6 bar salinity, peat moss, and level 1 superabsorbent. Shoot dry weight was 0.18 and 0.10 g under -6 salinity, peat moss, and level 3 superabsorbent A200 and F1, respectively (Table 2 and Fig. 2). This was 0.12 g under -6 bar salinity, vermicompost, and level 1 superabsorbent and 0.25 and 0.11 under -6 salinity, vermicompost, and level 3 superabsorbent A200 and F1, respectively (Table 2 and Fig. 2). This factor was 0.177 g under 0 bar salinity, vermicompost and level 1 superabsorbent while it was 0.035g under same salinity, superabsorbent, and peat moss (Table 2 and Fig. 2). Vermicompost coats functioned better than peat moss coats and superabsorbent A200 was more effective than superabsorbent F1. Abuzar and Charm (2014) showed that superabsorbent and salinity significantly affected the shoot dry weight ($p \leq 0.01$).

3.1.5. Leaf area

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), and salinity showed that the largest leaf area was 179.7 cm^2 under 0 bar salinity, vermicompost, and level 1 superabsorbent A200 (Table 2). This factor was 72.2 cm^2 under 0 bar salinity, peat moss and level 1 superabsorbent but 147.5 cm^2 with the same salinity, organic material, and level 3 super absorbent A200 and F1. Leaf area was 178.6 cm^2 under 0 bar salinity, vermicompost, and level 1 superabsorbent but 178.6 cm^2 and 173.7 cm^2 with the same salinity, organic material, and level 3 super absorbent A200 and F1, respectively (Table 2). Under -6 bar salinity, peat moss, and level 1 superabsorbent, the leaf area was 0. It was 66.3 cm^2 and 34.7 cm^2 under -6 salinity, peat moss, and level 3 superabsorbent A200 and F1, respectively and 0.42 under -6 bar salinity, vermicompost, and level 1 superabsorbent. This component was 0.68 and 0.58 under -6 salinity, vermicompost, and level 3 superabsorbent A200 and F1, respectively (Table 2). Leaf area was 178.6 cm^2 under 0 bar salinity, vermicompost and level 1 superabsorbent while it was 72.2 cm^2 under same salinity, superabsorbent, and peat moss (Table 2). Superabsorbent A200 is more effective than superabsorbent F1 and vermicompost coats better are than peat moss coats. Enjavi *et al*. (2011) reported that leaf area was increased by superabsorbent material.

3.1.6. Specific leaf area

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), and salinity revelaed the largest specific leaf area was 726.7 $cm^2\ g^{-1}$ under -4 bar salinity, peat moss, and level 1 superabsorbent A200 (Table 2).

Specific leaf area was 672.8 $cm^2\ g^{-1}$ under 0 bar salinity, peat moss, and level 1 superabsorbent but 184.3 and 308.00 $cm^2\ g^{-1}$ with the same salinity, organic material, and level 3 superabsorbent A200 and F1 (Table 2). This feature was 301 $cm^2\ g^{-1}$ under 0 bar salinity, vermicompost, and level 1 superabsorbent but 175.1 $cm^2\ g^{-1}$ and 375.2 $cm^2\ g^{-1}$ with the same salinity, organic material, and level 3 superabsorbent A200 and F1, respectively. Specific leaf area was 0 under -6 bar salinity, peat moss and level 1 superabsorbent and 368.20 $cm^2\ g^{-1}$ and 394.2 $cm^2\ g^{-1}$ under -6 salinity, peat moss, and level 3 super absorbent A200 and F1, respectively (Table 2).

Specific leaf area was 236.7 $cm^2\ g^{-1}$ under -6 bar salinity, vermicompost, and level 1 superabsorbent and 272.7 $cm^2\ g^{-1}$ and 194.67 $cm^2\ g^{-1}$ in -6 salinity, vermicompost, and level 3 super absorbent A200 and F1, respectively (Table 2). Masouvi Zavariyan *et al.* (2015) investigated the effect of seed priming by potassium nitrate on germination and biochemical indices in *S. marianum* under salinity stress. Their results showed that salinity stress had a negative impact on germination and seedling establishment.

3.1.7. Relative water content

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), and salinity showed that the largest relative water content was 79.1 under -4 bar salinity, vermicompost, and level 2 superabsorbent F1 (Table 2). This property was 65.2 under 0 bar salinity, peat moss, and level 1 superabsorbent but 65.4 and 66.4 with the same salinity, organic material, and level 3 super absorbent A200 and F1 (Table 2). Relative water content was 63.9 under 0 bar salinity, vermicompost, and level 1 superabsorbent but 71.9 and 63.9 with the same salinity, organic material and level 3 super absorbent A200 and F1, respectively (Table 2). It was 0 under -6 bar salinity, peat moss, and level 1 superabsorbent and 67.8 and 65.1 under -6 salinity, peatmoss, and level 3 superabsorbent A200 and F1, respectively (Table 2). This content was 60.7 in -6 bar salinity, vermicompost, and level 1 superabsorbent and 67.4 and 65.1 under -6 salinity, vermicompost, and level 3 superabsorbent A200 and F1, respectively (Table 2). Bhat *et al.* (2009) showed that the use of absorbent polyacrylamide under saline conditions could increase the amount of available water.

3.1.8. Chlorophyll (SPAD)

Mean comparison of the effects of super absorbent, organic material (vermicompost, and peat moss), salinity showed that the highest chlorophy ll (SPAD) was 33.6 under -4 bar salinity, vermicompost, and level 2 superabsorbent F1 (Table 2). Chlorophyll (SPAD) was 24.8 under 0 bar salinity, peat moss and level 1 superabsorbent yet 24.9 and 22.2 with the same salinity, organic material, and level 3 super absorbent A200 and F1 (Table 2). Chlorophyll (SPAD) was 24.8 under 0 bar salinity, peat moss and level 1 superabsorbent but

24.9 and 22.2 with the same salinity, organic material, and level 3 superabsorbent A200 and F1 (Table 2). It was 0 under -6 bar salinity, peat moss, and level 1 superabsorbent, 26.5 and 22.5 under -6 salinity, peat moss, and level 3 superabsorbent A200 and F1, respectively (Table 2), 25.3 under -6 bar salinity, vermicompost and level 1 superabsorbent, and 30.8 and 28.6 under -6 salinity, vermicompost, and level 3 superabsorbent A200 and F1, respectively (Table 2). Chlorophy ll (SPAD) was 28.9 under 0 bar salinity, vermicompost and level 1 superabsorbent while it was 24.8 under same salinity, superabsorbent, and peat moss (Table 2). Generally, superabsorbent A200 is more effective than superabsorbent F1 and vermicompost coats function better than peat moss coats. Akhzari and Ghasemi Aghbash (2014) investigated the effect of salinity and drought stress on the seedling growth and physiological traits of Vetiver grass (Vetiveria zizanioides stapf.). Their findings showed that chlorophyll concentration was lowest under 4 dS m^{-1} and FC salinity-aridity treatments.

4. Conclusion

The use of adsorbent materials were able to 1) increase the amount of water absorption and the duration of water storage, 2) reduce the salinity of the seeds around the seed, and 3) increase the percentage of germination and initial strain. Organic polymers and their derivatives were generated to absorb water and place it on the seed before and after germination and plant deposition; these compounds were able to absorb and store excess water in the soil and provide seed. Generally superabsorbent A200 is more effective than superabsorbent F1 also vermicompostcoats better than peat mass coats. As a result, to improve the germination and emergence in the soil, a vermicompost with a superabsorbent A200 can be used to prepare organic coatings. Organic coatings with superabsorbent polymers are conducive to collecting rainwater in arid and semi-arid areas of the early rainy seasons, which can absorb rainwater to a multiple of its weight and reduce the amount of salinity in the germination stage.

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