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Alleviation of Salinity Stress During Seed Germination and Early Growth Stage in Sweet Pepper by Seed Priming with Acetyl Salicylic Acid

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ABSTRACT

To investigate the interaction between salinity stress and seed priming with acetyl salicylic acid on sweet pepper seed germination and early growth, two factorial experiments were carried out during the two seasons 2014 and 2015. A lab experiment involved seed priming in four different concentrations 0.0, 0.1, 0.3 and 0.5 mM of acetyl salicylic acid, the performance of primed seeds was assessed under 4 different salinity levels 0, 30, 60, and 90 mM NaCl. The second experiment was carried out in foam transplanting trays under greenhouse conditions. Primed seeds were irrigated with 0, 30, 60, and 90 mM NaCl solutions. The obtained results showed that salinity reduced germination percentage, delayed germination, and reduced seedling and transplant growth parameters. Nutrients uptake was reduced by salinity increasing. Different concentrations acetyl salicylic acid had relieving effect. Among all concentration 0.3 mM acetyl salicylic acid was the best concentration in most cases.

Keywords: salinity, abiotic, stress, vigor, transplant, pepper, emergence, germination

INTRODUCTION

Salinization is one of the major crop productivity limiting factors particularly in arid and semi-arid characterized with limited water resources (Munns and Tester, 2008). In Egypt, as most of arable lands are irrigated, 33% of cultivated lands are salt-effected (Mohamed *et al*., 2007). Sweet pepper is considered one of the most important vegetable crops in arid and semi-arid regions suffering from salinity problems, it is considered sensitive to salinity (Kurunc *et al*., 2011; Pinero *et al*., 2014). Although pepper genotypes vary in their tolerance to salinity(Aktas *et al*., 2006), salinity resistance threshold found to be 1.5 dS m^{-1}, below which no negative effect on growth and a 14% reduction in biomass production for each additional 1 dS m^{-1} were observed (Maas and Hoffman, 1977; Rhoades *et al*., 1992). Seed germination and early seedling growth are considered as the most sensitive two stages to salinity stress (Ashraf and Foolad, 2005). Also, seed germination and seedling emergence of pepper is slow and non-uniform under normal as well as adverse conditions (Demir and Okcu, 2004). Low NaCl concentrations did not affect pepper seed germination percentage, however with salinity level increasing; the ability of seeds to germinate was significantly reduced. Negative effect was more pronounced on radicale length and seedling leaf area (Chartzoulakis and Klapaki, 2000) . Among Various techniques employed to improve seed germination, emergence and stand establishment under salt conditions, seed priming is one of the most effective and frequently utilized techniques. It enhances the speed and uniformity of germination, that results in faster and better germination in different crops (Cantliffe, 2003). It helps in seedling development in a wide range of conditions and decreases sensitivity to external factors (Ashraf and Foolad, 2005; Ibrahim, 2016). Inclusion of plant growth regulators and hormones during priming and other pre-sowing treatments can be improve Seed performance of different crops (Lee *et al*., 1998). Hormone like salicylic acid and its derivative acetyl salicylic acid have also proved alleviating cold stress on germination and emergence of sweet pepper (Korkmaz, 2005), acetyl salicylic acid has protected muskmelon seedlings against drought stress (Korkmaz *et al*., 2007). Also, salicylic acid and acetyl salicylic acid have been showed to decrease the harmful effects of abiotic stress on tomato and bean plants (Senaratna *et al*., 2000). In hot pepper, seed priming with both salicylic acid and acetyl salicylic acid could improve uniformity and seedling establishment under non-saline and saline conditions (Khan *et al*., 2009). Exogenous SA improved wheat seed germination, seedling growth, fresh weight, and dry weight of seedlings; enhanced cell division and extension of root; improved yield; and ameliorated drought and salt stress (Shakirova and Sakhabutdinova, 2003). Therefore, the purpose of the current study is to study the response of sweet pepper during seed germination and early growth stages to various salinity levels, Moreover, to figure out the most appropriate concentration of acetyl salicylic acid, as a priming agents, to alleviate salinity adverse effects on sweet pepper.

MATERIALS AND METHODS

In this study, two experiments were carried out. The first was a laboratory experiment. It was carried out in the lab of seed technology, Department of Vegetable Crops Seed Science and Technology, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt to study the germination characteristics. The second was a seedling trays experiment done under greenhouse conditions at a private nursery, Baramon, Mansoura, Egypt to study emergence behavior and transplant characteristics.

Seeds of pepper cv Orlando were surface sterilized by dipping in sodium hypochlorite (5 %) solution for 5 minutes, washed three times with tap water then rinsed with distilled water, and dried by blotting in filter paper. These surface sterilized seeds

were divided to four portions. Three portions were primed in aerated solution of acetyl salicylic acid at concentration of 0.1, 0.3, 0.5 mM, while the fourth portion was primed in distilled water (0.0 mM ASA) to serve as control. Seeds were primed for 36 h at 25 ± 2°C under dark conditions. After priming, seeds were washed with distilled water. Then the seeds were dried at room temperature between filter paper, after that packed in polythene bags and kept in a refrigerator at 5 °C for further use.

laboratory experiment was repeated twice, during February 2014 and February 2015: Primed seeds were sown in 90 mm diameter Petri dishes top of two layers of Whatman No. 1 filter paper, moistened with 5 ml of one of 0.0, 30.0, 60.0 and 90.0 mM NaCl solutions respectively, at 25±2°C and kept under 16 hours photoperiod, treatments were replicated 4 times, 50 seeds per each. Data on germination were recorded daily for 14 days; seed with 2 mm radicle protrusion was considered as germinated. Seven days old seedlings were used to measure radicle and plumule lengths, fresh and dry weights of seedlings.

Germination percentage was computed following the (ISTA, 2011)

$$GP = \frac{\text{Germinated Seeds No.}}{\text{Total Number of Seeds}} \text{ X } 100$$

Mean germination time (MGT) was calculated according to the equation of Ellis and Roberts (1981):

$$MGT = \sum Dn / \sum n$$

Where 'n' is the number of seeds germinated on day D, where D is number of days counted from the beginning of germination.

Germination performance index (GPI) was calculated according to formula: GPI= GP/MGT

Where GP is final germination percentage and MGT is mean germination time in days, Pill and Fieldhouse (1982).

The time taken to 50% germination (T50) was calculated according to the formula modified by (Farooq *et al*., 2005)

$$T_{50} = t_i + [(N/2) - n_i](t_j - t_i) / n_j - n_i$$

Where N is the final number of germinated seeds and n_i and n_j are the cumulative number of seeds germinated by adjacent seed count at times t_i and t_j respectively, when $n_i < N/2 < n_j$.

Coefficient of Velocity (CoV) was calculated according to the formula: CoV= 1/MGT X 100

Where MGT is mean germination time in days (Edwards and Sundstorm, 1987).

Vigor index was calculated in two ways by the following formulae:

Vigor Index 1= Final Germination (%) × Total Seedling Length (cm)

Vigor Index 2 = Final Germination (%) × Seedling dry weight (mg)

(Abdul-Baki and Anderson, 1973)

The transplant experiment was repeated twice through March and April 2014 and 2015, primed seed were sown in 209 cell foam trays filled with fertilized potting media constitutes of 1: 1 peat moss/ vermiculite (v:v), irrigated with the abovementioned salt water and incubated until seedling emergence initiated. The final emergence percentage was calculated, it was used in correlation and regression purpose. Transplant Height (cm) and transplant dry weight (g) were evaluated on 40 days old transplants. Chemical composition of leaves were analyzed; proline content was estimated following (Bates *et al*., 1973) . Nitrogen and phosphorus were calorimetrically determined according the methods described in (A.O.A.C., 1992). Potassium was measured using the flame photometer according to (Chapman and Pratt, 1961). Data were expressed as % of dry matter.

The experimental design followed was factorial in completely randomized design with four replicates. The recorded data were statistically analyzed using general linear model of Statistix 8.0 and treatments means were separated using DMR test ($p < 0.05$).

RESULTS AND DISCUSSION

Sweet pepper is considered either sensitive or moderately sensitive to salinity (Cornillon and Palloix, 1995 and Rhoades *et al*.,, 1992). During plant life, Seed germination and seedling growth are of the stages most sensitive to salinity. It delays or prevents the seed germination through various aspects, such as a reduction in water availability, ion toxicity, induction of oxidative stress, distribution in the mobilization of stored reserves and affecting the structural organization of proteins (Ibrahim, 2016). Data of laboratory experiment shown in table 1 reveal no significant difference between non-saline and low salinity on germination percentage in both seasons. With the increase of salinity level, a significant reduction was observed in GP. This maximized when seeds were germinated under 90 mM NaCl hereafter called high salinity conditions, as germinated seeds were reduced from 80.32% under non-stress conditions to 58.16 % under the high salinity stress. These findings are in agree with those of (Chartzoulakis and Klapaki, 2000; Yildirim and Güvenç, 2006). Regardless salinity level, seed priming in various concentrations of acetyl salicylic acid (ASA) offered a potential role in alleviating the negative effect of salinity on germination percentage , all treatments surpassed 0.0 mM ASA (control) and 0.3 mM ASA was the superior treatment recording an increase by 26.13 and 26.14 % over control in the first and second season respectively, similar to (Khan *et al*., 2009). The interaction between two factors varied due to the salinity level and priming treatment, it was in favor of 30 mM NaCl and 0.3 mM ASA as GP reached 88.88% and the least GP was observed when water primed seeds were germinated under high salinity to reach 47.81%. There was no significant difference between water primed seeds germinated under 60 mM NaCl, hereafter, moderate salinity and 0.3 mM ASA primed seeds under high salinity. This is remarkable, primed seed can be germinated under high salinity without significant loss in GP. and these agree with results of (Gain *et al*., 2004; Iroka *et al*., 2016).

Table 1. Effect of salinity, acetyl salicylic acid seed priming and their interaction on germination parameters during two seasons 2014 and 2015.

Treatments		Germination percentage (%)		MGT (days)		GPI		T50 (days)		Coefficient of velocity	
Salinity level	Seed priming	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Salinity level (mM NaCl)											
0 mM		80.32 a	78.71 a	5.00 d	4.75 d	17.26 a	17.80 a	4.97 d	4.77 d	21.07 a	22.18 a
30 mM		81.74 a	80.11 a	5.81 c	5.52 c	15.48 b	15.97 b	5.15 c	4.94 c	18.65 b	19.63 b
60 mM		73.34 b	71.86 b	7.05 b	6.70 b	11.15 c	11.50 c	5.81 b	5.57 b	14.99 c	15.78 c
90 mM		58.16 c	57.00 c	9.08 a	8.63 a	6.90 d	7.11 d	6.61 a	6.34 a	11.60 d	12.21 d
Seed priming (mM Acetyl Salicylic Acid)											
	0.0 mM	63.73 c	62.45 c	9.77 a	9.28 a	7.06 c	7.28 c	8.73 a	8.38 a	10.77 c	11.33 c
	0.1 mM	75.29 b	73.78 b	6.05 b	5.74 b	13.49 b	13.92 b	5.71 b	5.48 b	17.50 b	18.42 b
	0.3 mM	80.38 a	78.77 a	5.23 d	4.97 d	16.94 a	17.47 a	3.56 d	3.42 c	20.42 a	21.50 a
	0.5 mM	74.15 b	72.67 b	5.90 c	5.60 c	13.30 b	13.72 b	4.53 c	4.35 d	17.62 b	18.55 b
Interaction (salinity * seed priming)											
0 mM	0.0 mM	70.33 f	68.93 f	6.99 g	6.64 g	10.07 g	10.39 g	6.99 c	6.71c	14.32 fg	15.07 fg
	0.1 mM	80.27 bc	78.66 bc	4.65 l	4.42 l	17.27 c	17.81 c	5.62 e	5.39 e	21.50 c	22.63 c
	0.3 mM	92.24 a	90.40 a	3.75 n	3.56 n	24.62 a	25.40 a	3.10 j	2.97 i	26.70 a	28.10 a
	0.5 mM	78.42 cd	76.85 cd	4.59 lm	4.36 lm	17.08 cd	17.62 cd	4.17 h	4.00 h	21.78 c	22.92 c
30 mM	0.0 mM	73.75 ef	72.27 ef	8.93 c	8.49 c	8.25 h	8.52 h	7.19 c	6.91 c	11.19 j	11.79 j
	0.1 mM	81.52 bc	79.88 bc	4.75 l	4.51 l	17.17 c	17.71 c	5.85 e	5.61 e	21.06 c	22.17 c
	0.3 mM	88.88 a	87.10 a	4.36 m	4.15 m	20.53 b	21.18 b	3.34 i	3.21 i	23.09 b	24.31 b
	0.5 mM	82.83 b	81.17 b	5.19 k	4.93 k	15.96 d	16.46 d	4.22 gh	4.05 gh	19.26 d	20.27 d
60 mM	0.0 mM	63.03 g	61.77 g	10.13 b	9.63 b	6.22 j	6.42 j	9.14 b	8.77 b	9.87 k	10.39 k
	0.1 mM	81.82 bc	80.18 bc	6.53 h	6.21 h	12.54 ef	12.93 ef	6.22 d	5.97 d	15.31 f	16.12 f
	0.3 mM	74.75 de	73.25 de	5.50 j	5.22 j	13.59 e	14.02 e	3.44 i	3.30 i	18.18 d	19.14 d
	0.5 mM	73.74 ef	72.26 ef	6.03 i	5.73 i	12.24 f	12.63 f	4.43 g	4.25 g	16.60 e	17.47 e
90 mM	0.0 mM	47.81 i	46.85 I i	13.01 a	12.36 a	3.68 k	3.79 k	11.62 a	11.15 a	7.69 l	8.09 l
	0.1 mM	57.57 h	56.41 h	8.24 d	7.83 d	6.99 ij	7.21 ij	5.14 f	4.93 f	12.13 ij	12.77 ij
	0.3 mM	65.66 g	64.34 g	7.30 f	6.94 f	9.00 gh	9.28 gh	4.37 gh	4.20 gh	13.71 gh	14.43 gh
	0.5 mM	61.62 gh	60.38 gh	7.78 e	7.39 e	7.92 hi	8.17 hi	5.29 f	5.08 f	12.86 hi	13.54 hi

MGT: mean germination time, GPI: germination performance index, T_{50} : time required for 50% of germination

Mean germination time (MGT) and T_{50} as temporal parameters responded positively to salinity, the higher the salinity the longer the time required, in both seasons. This means delayed germination and these findings agree with (Khan *et al.*, 2009). Regardless, salinity level, ASA could diminish both of MGT and T_{50} to 54 % and 41% respectively, of the time required for control treatments which means faster germination. The interaction between two factors revealed that the most favorable results obtained when 0.3 mM ASA primed seeds were germinated under control conditions. Furthermore, priming seeds in 0.3 mM ASA could minimize the T_{50} regardless salinity level, which means that ASA seed priming is a potential technique to speed up germination process these findings agree with (Khan *et al.*,, 2009). Germination performance index GPI and coefficient of velocity CoV as two characteristics of germination quality had the same trend, they were reduced with the increase in salinity level. The lowest values recorded in both parameters were gotten under high salinity in the two seasons. Similarly they were responded positively to ASA priming treatments (Cantliffe, 2003).

Table 2 shows the results of seedling parameters and vigor index values estimated in 2 ways. All estimated values insure the negative impact of salinity on the abovementioned parameters. For instance, mean seedling length decreased from 9.59 to 8.66 and from 9.23 to 8.34 cm under control and high salinity in two seasons respectively and similarly were values of seedling fresh and dry weight, and vigor index 1 and 2. Regardless salinity effect, seed priming in ASA recorded improvements over control in all parameters and the highest values were in favor 0.3 mM ASA priming treatment these results agree with those published by (Chartzoulakis and Klapaki, 2000; Khan *et al.*, 2009). The interaction between seed priming and salinity revealed lowest values were recorded in the two seasons when water primed seeds were germinated under high salinity. Moreover, all of priming treatments improved seedling and vigor indices over control; this confirms that ASA seed priming can be potentially employed in enhancement of seedling characteristics and vigor indices under salinity stress conditions.

Table 2. Effect of salinity, acetyl salicylic acid seed priming and their interaction on seedling characteristics and vigor indices during two seasons 2014 and 2015.

Treatments		Seedling length (cm)		Seedling FW(mg)		Seedling DW(mg)		Vigor Index 1		Vigor Index2	
Salinity level	Seed priming	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Salinity level (mM NaCl)											
0 mM		9.59 a	9.23 a	33.824 b	32.471b	2.411 b	2.267b	729.00 a	772.86 a	178.93 b	194.24 b
30 mM		9.59 a	9.23 a	34.457 a	33.077 a	2.494 a	2.343 a	741.21 a	785.76 a	188.45 a	204.57 a
60 mM		9.10 b	8.77 b	33.614 c	32.270 c	2.537 a	2.385 a	630.93 b	668.82 b	171.83 c	186.53 c
90 mM		8.66 c	8.34 c	30.703 d	29.474 d	2.366 b	2.223 b	477.35 c	505.98 c	128.16 d	139.13 d
Seed priming (mM Acetyl Salicylic Acid)											
	0.0 mM	8.73 d	8.40 d	30.363 d	29.148 d	2.211 c	2.078 c	527.98 c	559.70 c	130.57 d	141.73 d
	0.1 mM	9.16 c	8.82 c	32.572 c	31.268 c	2.424 b	2.278 b	653.88 b	693.16 b	169.09 c	183.55 c
	0.3 mM	9.69 a	9.33 a	35.898 a	34.462 a	2.594 a	2.438 a	738.52 a	782.90 a	191.48 a	207.86 a
	0.5 mM	9.37 b	9.02 b	33.764 b	32.413 b	2.578 a	2.423 a	658.11 b	697.65 b	176.23 b	191.31b
Interaction (salinity * seed priming)											
0 mM	0.0 mM	9.06 h	8.72 h	31.230 i	29.980 i	2.230 f	2.097 f	600.91 fg	637.06 fg	144.52 ef	156.88 ef
	0.1 mM	9.51 e	9.15 e	33.967 ef	32.607 ef	2.440 de	2.293 de	720.10 bc	763.42 bc	180.53 c	195.97 c
	0.3 mM	10.05 a	9.68 a	35.800 b	34.370 b	2.467 de	2.320 cde	874.78 a	927.41 a	209.63 a	227.57 a
	0.5 mM	9.74 b	9.37 b	34.300 de	32.927 de	2.507 bcde	2.357bcde	720.21 bc	763.54 bc	181.04 c	196.53 c
30 mM	0.0 mM	9.070 gh	8.73 gh	31.880 h	30.603 h	2.250 f	2.113 f	630.80 ef	668.72 ef	152.82 ef	165.89 ef
	0.1 mM	9.52 e	9.16 e	33.617 fg	32.270 fg	2.470cde	2.320 cde	732.10 bc	776.11 bc	185.48 bc	201.35 bc
	0.3 mM	10.07 a	9.69 a	37.130 a	35.643 a	2.600abcd	2.443abcd	843.85 a	894.57 a	212.83 a	231.03 a
	0.5 mM	9.70 c	9.34 c	35.200 c	33.790 c	2.657ab	2.497 ab	758.07 b	803.63 b	202.66 ab	220.00 ab
60 mM	0.0 mM	8.60 k	8.28 k	31.200 i	29.953 i	2.347 ef	2.207 ef	511.19 hi	541.89 hi	136.24 fg	147.89 fg
	0.1 mM	9.03 i	8.69 i	33.070 g	31.747 g	2.537abcd	2.387abcd	696.75 bcd	738.59 bcd	191.13 bc	207.47 bc
	0.3 mM	9.54 d	9.19 d	35.930 b	34.493 b	2.677 a	2.517 a	672.91cde	713.32 cde	184.26 bc	200.02 bc
	0.5 mM	9.24 f	8.90 f	34.257 de	32.887 de	2.587abcd	2.430abcd	642.88 def	681.49 def	175.71 cd	190.74 cd
90 mM	0.0 mM	8.18 l	7.88 l	27.143 k	26.057 k	2.017 g	1.897 g	369.02 j	391.15 j	88.69 h	96.27 h
	0.1 mM	8.59 k	8.27 k	29.633 j	28.450 j	2.250 f	2.113 f	466.56 i	494.54 i	119.22 g	129.42 g
	0.3 mM	9.08 g	8.74 g	34.733 cd	33.343 cd	2.633 abc	2.473 abc	562.56 gh	596.29 gh	159.22 de	172.84 de
	0.5 mM	8.79 j	8.47 j	31.300 i	30.047 i	2.563 abcd	2.410 abcd	511.28 hi	541.94 hi	145.52 ef	157.97 ef

Data of the trays experiment are demonstrated in table 3; the harmful effect of salinity on emergence percentage is evident. It decreased gradually with the augment in salinity level. Despite the salinity level, ASA seed priming contributed positively to emergence percentage. Concerning interaction between two factors, the lowest values recorded were for water primed seeds sown under high salinity conditions. Priming in 0.3 mM ASA was the best treatment, it enhanced emergence under all salinity levels. It increased emergence by 34% and 33% under control and high salinity conditions respectively, these findings agree with (Khan *et al.*,, 2009). Data for emergence percentage were employed in development of regression relationship to figure out the best between 2 vigor indices (Fig: 1**).** As it can be noticed, vigor index 1 is much more reliable to predict emergence %. This is may be due to the involvement of seedling length in calculation of vigor index 1. Therefore, the longer the seedling the more capable to emerge out of planting media it is. Values for transplant height significantly decrease as a result of increase in salinity level. While plant height ranged between 15.37 and 15.83 cm under control conditions, it was reduced to 4.83 and 4.97 cm under high salinity for the two seasons respectively. On the other hand, ASA seed priming improved plant height, the highest values were obtained from seeds primed with 0.3 mM ASA, contributed positively to mean transplant height; it was 11.79 and 12.14 cm for the first and second season in that order. The same trend was found in transplant dry weight data. Concerning the interaction between seed priming and salinity level, it can be found that priming with 0.3 mM ASA was the most efficient dose. It mitigated the harmful impact of salinity on both of the two parameters. These results are in agreement with Cicek and Cakirlar (2002) studies on maize seedlings and (Khan *et al.*,, 2009) on hot pepper. The inhibition of plant growth is caused by cellular response to decreased water availability and high osmotic stress of external salts furthermore later on by toxic effects of excessive salt accumulation within the plant cells (Munns *et al.*, 1995). Proline accumulation is an adopted mechanism for plants to combat salinity. It is obvious form data in table 3 that proline accumulation increased with the higher salinities. On the other hand, ASA contributed to keep these values down. The highest values recorded for proline content were 7.113 and 6.987 mg g^{-1} for control seeds irrigated with high salinity solution. The effect of salinity on nutrient uptake was negative. N, P and K uptake was negatively responding to salinity. The uptake of the 3 nutrients decreased with the increase in the salinity levels. The lowest value for the nutrients uptake recorded when transplants were irrigated with high salinity solution. While all of ASA priming treatment promoted nutrients uptake, 0.3 mM ASA treatment surpassed. It increased N uptake about 87%, P 61% and K 15% over control. This was definitely translated in height increase and biomass accumulation in transplants. These results are in line with (Gammoudi *et*

al., 2016; Sakr *et al*., 2007). Finally, the harmful effects of salinity can be alleviated by seed priming in acetyl salicylic acid. This process involves many changes that promote seed vigor during germination and emergence under salinity stress (Ibrahim, 2016). Salicylic acid and it derivatives are well know agents with their role in abiotic stress alleviation. The results obtained in the current study stated that seed priming with acetyl salicylic acid, as one of salicylic acid derivatives, not only capable of improving seed germination and seedling establishment of pepper under favorable conditions, but also alleviated the deleterious effects of salinity stress during these stages. Many studies had similar results on various crop, (Khan *et al*.,, 2009) on hot pepper, (Osman and Salim, 2016) on snap bean, (Tari *et al*., 2002) on tomato. These positive effects may be referred to induction of enzymatic antioxidation system (Azooz, 2009) or due to antioxidation role and proline accumulation (Tari et al.,, 2002; Tari *et al*., 2004) or it may be due to its role in prevention of the decrease in growth promoters (IAA and cytokinin) levels (Shakirova et al., 2003) this is beside it stated role in enhancement of the photosynthetic rate and also maintenance of the Membranes stability (El Tayeb, 2005).

Table 3. Effect of salinity, acetyl salicylic acid seed priming and their interaction on physicochemical parameters of transplants during two seasons 2014 and 2015.

Treatments		Emergence %		Transplant Height (cm)		Transplant Dry Weight (g)		Leaf chemical characteristics							
								Proline (mg g^{-1})		N (%)		P (%)		K (%)	
Salinity level	Seed priming	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Salinity level (mM NaCl)															
0 mM		75.45 a	78.47 a	15.37 a	15.83 a	0.244 c	0.300 c	1.997 d	1.961 d	3.511a	3.602 a	0.702 a	0.719 a	1.822 a	2.000 a
30 mM		76.21 a	79.25 a	13.40 b	13.80 b	0.262 a	0.322 a	2.622 c	2.574 c	3.152 b	3.235 b	0.630 b	0.648 b	1.578 b	1.735 b
60 mM		67.15 b	69.84 b	9.80 c	10.10 c	0.250 b	0.307 b	3.867 b	3.798 b	2.900 c	2.975 c	0.551 c	0.568 c	1.394 c	1.533 c
90 mM		51.31 c	53.36 c	4.83 d	4.97 d	0.236 d	0.291 d	5.210 a	5.115 a	2.580 d	2.648 d	0.493 d	0.505 d	1.243 d	1.364 d
Seed priming (mM Acetyl Salicylic Acid)															
	0.0 mM	58.47 d	60.81 d	10.00 d	10.30 d	0.209 d	0.257 d	4.743 a	4.658 a	1.894 d	1.947 d	0.439 d	0.450 d	1.407 d	1.546 d
	0.1 mM	68.92 b	71.67 b	10.67 c	10.99 c	0.238 c	0.293 c	3.274 b	3.214 b	3.453 b	3.542 b	0.603 c	0.621 c	1.493 c	1.639 c
	0.3 mM	78.16 a	81.29 a	11.79 a	12.14 a	0.292 a	0.359 a	3.078 c	3.022 c	3.547 a	3.638 a	0.703 a	0.723 a	1.618 a	1.778 a
	0.5 mM	64.57 c	67.15 c	10.94 b	11.27 b	0.253 b	0.311 b	2.600 d	2.554 d	3.249 c	3.333 c	0.629 b	0.647 b	1.520 b	1.669 b
Interaction (salinity * seed priming)															
zero	zero	65.33 ef	67.95 ef	14.85 b	15.29 b	0.204 h	0.251 h	2.867 f	2.817 f	2.200 h	2.260 h	0.530 h	0.540 g	1.703 d	1.870 d
	0.1 mM	77.00 b	80.08 b	15.43 a	15.90 a	0.231 fg	0.285 fg	1.930 i	1.897 i	3.947 a	4.050 a	0.690 c	0.707 c	1.786 c	1.960 c
	0.3 mM	87.33 a	90.83 a	15.65 a	16.12 a	0.291 b	0.358 b	1.473 j	1.443 j	3.967 a	4.067 a	0.850 a	0.873 a	1.963 a	2.157 a
	0.5 mM	72.14cd	75.02 d	15.55 a	16.02 a	0.250 e	0.307 e	1.717 i	1.687 i	3.930 a	4.030 a	0.737 b	0.757 b	1.833 b	2.013 b
30 mM	zero	65.99 ef	68.63 ef	12.25 d	12.62d	0.222 g	0.273 g	3.750 d	3.680 de	2.050 i	2.110 i	0.463 j	0.477 i	1.476 g	1.623 g
	0.1 mM	77.77 b	80.88 b	13.37 c	13.77 c	0.251 de	0.309 de	2.553 g	2.507 g	3.787 b	3.883 b	0.657 e	0.676 d	1.550 f	1.706 f
	0.3 mM	88.21 a	91.73 a	14.63 b	15.07 b	0.312 a	0.384 a	2.230 h	2.190 h	3.827 b	3.924 b	0.727 b	0.747 b	1.690 d	1.857 d
	0.5 mM	72.86 c	75.77 c	13.33 c	13.74 c	0.261 cd	0.321cd	1.953 i	1.920 i	2.943f	3.020 f	0.673 d	0.693 c	1.597 e	1.753 e
60 mM	zero	58.15 g	60.47 g	8.96 g	9.23 g	0.210 h	0.258 h	5.243 b	5.150 b	1.760 j	1.810 j	0.403 k	0.413 j	1.293 j	1.423 j
	0.1 mM	68.53de	71.27de	9.78 f	10.07f	0.241 ef	0.296 ef	3.770 d	3.700 d	3.216 d	3.297 d	0.563 g	0.583 f	1.393 h	1.530 h
	0.3 mM	77.73 b	80.84 b	10.71e	11.03 e	0.299 b	0.367 b	3.507 e	3.447 e	3.383 c	3.470 c	0.653 e	0.673 d	1.490 g	1.640 g
	0.5 mM	64.20 f	66.77 f	9.76 f	10.05 f	0.251 e	0.308 de	2.947 f	2.897 f	3.240 cd	3.323 d	0.583 f	0.603 e	1.400 h	1.540 h
90 mM	zero	44.43 i	46.20 i	3.94 j	4.06 j	0.200 h	0.246 h	7.113 a	6.987 a	1.567 k	1.607 k	0.360 l	0.370 k	1.153 l	1.267 l
	0.1 mM	52.36 h	54.45 h	4.10 j	4.22 j	0.230 fg	0.283 fg	4.843 c	4.753 c	2.860 g	2.937 g	0.503 i	0.517 h	1.240 k	1.360 k
	0.3 mM	59.39 g	61.76 g	6.15 h	6.33 h	0.264 c	0.325 c	5.100 b	5.007 b	3.010 e	3.090 e	0.583 f	0.600 e	1.330 i	1.460 i
	0.5 mM	49.06 h	51.02 h	5.13i	5.28 i	0.251 de	0.309 de	3.783 d	3.713 d	2.883 g	2.957 g	0.523 h	0.533 g	1.250 k	1.370 k

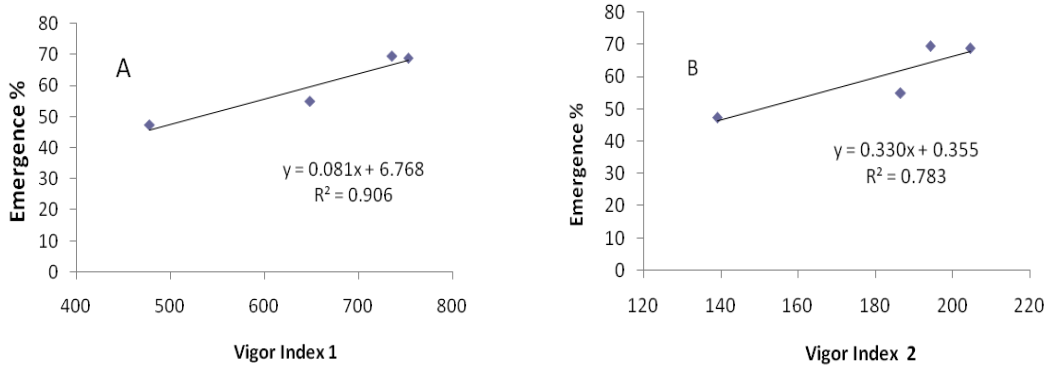

Fig. 1. regression relationship between seedling vigor indices and emergence percentage, average of two seasons 2014 and 2015 were employed.

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الحد من الأثار الضارة للملوحة على انبات و نمو شتلات الفلفل الحلو عن طريق التهيئة في محلول الاستيل سالسليك أسد

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أجريت تجربة معملية و تجربة صوب لدراسة تأثير الملوحة على الانبات و نمو الشتلات فى الفلفل الحلو و ذلك خلال الموسم ٢٠١٤ و الموسم ٢٠١٥ على التوالي. و كانت كلا التجربتين عاملية في تصميم تام العشوائية. حيث تم دراسة تأثير المستويات المتدرجة من الملوحة صفر (كنترول) و ٣٠ و ٦٠و ٩٠ مليمول من ملح كلوريد الصوديوم كعامل اول (الملوحة) . و بالنسبة للعامل الثانى في الدراسة فكان عبارة عن نقع بذور الفلفل في محاليل متدرجة صفر (كنترول) و ٠,١ و ٠,٣ و٠,٥ مليمول من الاستيل سالسليك أسد. حيث تم نقع البذور في المحاليل المشار اليها لمدة ٣٦ ساعة . بعدها جففت البذور و حفظت في الثلاجة على درجة ٥° م لحين استعمالها. ثم تم استنبات البذور في المحاليل الملحية المشار اليها و اخذت التقديرات التالية: نسبة الانبات و متوسط الوقت المطلوب للانبات و طول و وزن البادرات و دليل قوة الانبات . حيث لوحظ ان زيادة الملوحة أدت الى تخفيض نسبة الانبات و كفائة الانبات كما أدت اللى زيادة الوقت اللازم للانبات . في حين ان استعمال الاستيل سالسليك أسد كمادة نقع أدت الى الحد من الاثار الضارة للملوحة على كل من نسبة الانبات و طول البادرات و الوزن الطازج و الجاف للبادرات و زادت أيضا من كفائة الانبات و قيم دليل قوة الانبات . كما انها زادت من سرعة الانبات و قلل الفترة اللازمة لاتمامه. كما اشارت النتائج الى انه يمكن استعمال الاستيل سالسليك أسد كمحفز لانبات البذور تحت مستويات الملوحة المرتفعة دون و جود فروق معنية مقارنة بالكنترول. و بالنسبة لتجربة الصوب فإن الرى بالماء المالح أدى الى انخفاض نسبة التكشف و الارتفاع و الوزن الجاف للشتلات. كما أدى الى تراكم البرولين في النبات. و كذلك أدى الرى بالماء المالح الى الحد من امتصاص الشتلات لعناصر النتروجين و الفوسفور و البوتاسيوم . اما البذور المنقوعة مسبقا في محاليل الاستيل سالسليك أسد فقد أبدت تفوقا على الكنترول في كل من نسبة التكشف و ارتفاع و الوزن الجاف للشتلات و حدت من تراكم البرولين. بالإضافة الى انها زادت من تراكم العناصر الغذائية في النباتات. و عليه فانه يراعى استعمال مصادر جيدة للمياة منخفضة الملوحة عند استنبات و انتاج شتلات الفلفل . و في حالة تعذر ذلك و الاضطرار لاستعمال مياة منخفضة الجودة فان نقع البذور في محلول الاستيل سالسليك أسد (يفضل ٠,٣ مليمول) لمدة ٣٦ ساعة يعد اختيارا مناسبا لتحسين الانبات و جودة الشتلات الناتجة.