American Journal of Plant Sciences, 2016, 7, 937-948
Published Online April 2016 in SciRes. http://www.scirp.org/journal/ajps
http://dx.doi.org/10.4236/ajps.2016.76089

The Potential Role of Osmotic Pressure to Exogenous Application of Phytohormones on Crop Plants Grown under Different Osmotic Stress

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Received 17 February 2016; accepted 24 April 2016; published 27 April 2016

Abstract

The osmotic pressure represented as a sign of plant tolerance or sensitive to salinity stress. In the following plants, the increase in OP seems to be a manner of defense mechanism to survive. OP increased in shoots of maize, shoot and root of wheat and cotton plants was concomitant with shoot soluble sugar, root soluble protein and shoot and root amino acids of maize plants. However, in wheat the increase in OP was related with increase of root soluble sugar and protein of shoots and roots. In cotton plants, the elevation of OP was run parallel with increase soluble sugar of shoots and roots, shoot soluble protein and root amino acids. The increase in OP was related with a marked and significant reduction in the water content of these plants. However, the decrease in OP of shoot and root of broad bean was related with the reduction of shoots and roots soluble sugar, protein and root amino acids of broad bean. While the OP becomes more or less unchanged in shoots and tended to decrease in root of parsley plants, this concomitant with unchanged trend in the shoots amino acids and reduction in root soluble sugar and root amino acids. Run with previous trend values of OP and metabolites of parsley plants were related with stable values in shoot water content and reduction in root water content. With GA_3 and kinetin treatments mostly increase the values OP which parallel with increase and soluble sugar, soluble protein and amino acids contents of shoots and roots of maize, wheat, cotton, broad bean and parsley plants with NaCl increasing. This related with increase water uptake by roots in these plants. The results indicated that kinetin had a more effective to shoot maize, both organs of wheat, broad bean and parsley plants in response to salinity stress while GA_3 was more effective on cotton plants especially at higher levels of salinity. Thus plants strategy differed in their tolerance to salinity stress according to their species and differed also according to the different organs of the same plants and kinetin treatment induced highly positively affect than GA_3 treatments.

How to cite this paper: Abd El-Samad, H.M. (2016) The Potential Role of Osmotic Pressure to Exogenous Application of Phytohormones on Crop Plants Grown under Different Osmotic Stress. *American Journal of Plant Sciences*, **7**, 937-948.
http://dx.doi.org/10.4236/ajps.2016.76089

Keywords

Osmotic Pressure, GA_3 and Kinetin, NaCl

1. Introduction

Several environmental factors adversely affect plant growth development, hindering and seed germination such as water deficit, freezing, heat and salt stress. Biotic stress may be caused by numerous factors such as drought, salinity, cold, high temperature, alkalinity, heavy metal, air pollution and radiation [1]-[4]. Also, salinity has a deleterious effect on enzyme activity [5], nucleic acids, protein synthesis [6] and cell division [7]. However, plant species differ in their sensitivity or tolerance to salt stress [8]. There have been numerous studies of the effects of salinity on plants [9]. At the latest years, investigations have focused more on salt tolerance mechanisms in plants [10]. Some researchers have used exogenous application of biofertlizers as PGRs for reducing or eradicating the saline injury in plants [11]. Phytohormones are natural products and playing important roles in stress responses and adaptation [12]. It is thought that the repressive effect of salinity on seed germination and plant growth could be related to a lowering of endogenous concentrations of plant growth hormones [13]. Wang *et al.* (2001) [14] clearly defined that ABA and JA would be elevated in response to salinity, whereas other hormones as indole-3-acetic acid (IAA) and salicylic acid (SA) were lowered. For example, the exogenous application of PGRs, auxins [15], gibberellins [16], cytokinins [17] produces improves plant seed germination, growth, development and seed yields and yield quality under salinity stress [18]-[22].

In this investigation, the role of phytohormones (GA_3 or kinetin) in alleviating salinity stress in crop plants (maize, wheat, broad bean, cotton and parsley plants has been discussed.

2. Material and Methods

2.1. Experimental Sites

Five plant species Maize (*Zea mays*), Wheat (*Triticum aestivum*), Broad bean (*Vicia faba*), Cotton (*Gossypium herbaceum*) and Parsley plants (*Petroselinum crispum*) were grown in plastic pots in the soil without NaCl (control) and under salinization levels corresponding to osmotic potential of NaCl solution −0.3, −0.6, −0.9, and −1.2 MPa. Saline solutions were added to the soil in such a way that the soil solution acquired the assigned salinization levels at field capacity.

2.2. Salinity and Phytohormonal Treatments

Treatments of plants with saline solutions began when seedlings were two weeks old. The salinized and non-salinized plants were irrigated every other day with 1/10 Pfeffer's nutrient solution for two weeks. Then GA_3 and kinetin (100 ppm) solutions were sprayed three times (5 intervals) by spraying the shoot system of the growing plants (each pot with 10 cm^3 of GA_3 or kinetin solutions). The control plants were sprayed with distilled water. A week after the plants was used for analysis.

2.3. Laboratory Analysis for Metabolities

Dry matter was determined after drying plants in an aerated oven at 70 C to constant mass. Saccharides were determined by the anthrone-sulfuric acids method [23]. Free amino acids, proline and a soluble protein contents were measured according to [24] and [25] respectively. The osmotic potential of tissue sap was measured by advanced wide-range Osmometer 3W2.

3. Statistical Analysis

The data of all experiments were subjected to one way analysis variance and means were compared using the least significant difference test (L.S.D.) using statistical program (Sta. Base. Exe.) on computer [26].

4. Results

The data represented in **Table 1** explain that soluble sugar remained more or less unchanged up to the level −0.6 MPa, after that it was considerably increased in shoot of maize plant. In root a reduction was observed with rise of osmotic of osmotic stress (**Table 1**), the percent of reduction was 48.1% than control plants. In wheat plants soluble sugar content was markedly decrease in shoots while this content slightly increased up to −0.9 MPa in roots, after that a reduction was observed at −1.2 MPa (**Table 2**). The percent of reduction was 16.1%, 14.1% at −1.2 MPa NaCl levels in shoots and roots respectively than the control plants. The production of soluble sugars was significantly increased with increasing osmotic stress in shoots and roots of cotton plants (**Table 3**). Except of this trend the production of soluble sugar at −1.2 MPa in roots of cotton plants which was markedly decreased than control plants. It was observed that soluble sugar was significantly decreased starting from −0.3 MPa to −1.2 MPa in shoots and roots of broad bean plants (**Table 4**). The percent of reduction was 62.7% and 2.7%, in shoots and roots of broad bean respectively, this indicate that reduction was more in shoots than in roots. In parsley plants the contents of soluble sugar were decreased in roots while it exhibited a pronounced accumulation in shoot of plants grown at the level—0.3 MPa, 0.6 MPa and −0.9 MPa osmotic stress levels. Wheras a reduction was observed at −1.2 MPa NaCl levels. The percent of reduction was 6.2%, 35.2% in shoots and roots of parsley plants *i.e.* root was more effect with osmotic stress in opposite to broad bean plants (**Table 5**). The osmotic stress stimulated the accumulation of soluble protein in shoots of maize plants while in roots these contents remain more or less unchanged up to −0.6 MPa osmotic stresses, after that they were considerably decreased (**Table 1**). The percent of reduction was 18.8% and 39.8% at 0.9 and −1.2 MPa NaCl levels in maize roots. Increasing osmotic stress resulted in a considerable accumulation in soluble protein in shoots and roots of wheat plants (**Table 2**). Except, in roots of plants grown in −1.2 MPa, these contents were significantly reduced compared with control plants. There was a significant accumulation of soluble protein in both organs of cotton plants (**Table 3**). Whereas this content was markedly decreased at −1.2 MPa NaCl levels as compared with control plants. Soluble protein content decreased in shoots and in roots, this reduction was run slightly up to −0.9 MPa, after that it lower progressively at −1.2 MPa of broad bean plants, (**Table 4**). Increasing osmotic stress

Table 1. Analysis for soluble sugar soluble and amino acids contents of shoot and root of maize plants.

Treat.	NaCl	Soluble sugar (mg g^{-1} d.m.)		Soluble protein (mg g^{-1} d.m.)		Amino acids (mg g^{-1} d.m.)		Water content	
	−MPa	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	0.0	45.6	20.8	97.5	55.3	6.2	2.3	24.9	3.6
	0.3	43.1	17.4	107.9	56.1	5.3	3.4	24.3	2.5
	0.6	42.1	18.9	118.5	56.0	10.2	3.5	20.	3.1
	0.9	51.9	12.5	111.4	44.9	14.4	4.6	17.5	3.0
	1.2	50.4	10.8	115.1	34.9	9.4	4.5	18.7	1.7
GA_3	0.0	50.9	20.8	105.0	56.2	6.5	2.3	30.4	3.7
	0.3	52.1	18.2	141.3	56.4	7.9	1.7	27.1	4.8
	0.6	56.2	18.0	126.6	55.4	7.9	1.1	22.9	6.3
	0.9	56.2	16.2	129.2	54.2	12.0	0.979	25.1	4.3
	1.2	58.5	15.9	104.1	58.2	8.3	0.839	21.1	2.9
Kin.	0.0	88.9	21.1	180.4	67.6	6.2	1.1	31.3	3.9
	0.3	104.3	21.4	197.7	67.1	7.8	1.2	28.8	4.3
	0.6	105	27.1	247.0	68.9	7.7	1.3	28.9	4.2
	0.9	111	27.4	257.9	55.7	7.6	1.1	28.9	3.8
	1.2	108	27.4	265.3	40.9	2.9	1.1	23.3	2.8
L.S.D. 5%		4.7	2.3	1.6	1.5	1.4	0.80	1.3	1.0

Table 2. Analysis for soluble sugar soluble and amino acids contents of shoot and root of wheat plants.

Treat.	NaCl	Soluble sugar (mg g^{-1} d.m.)		Soluble protein (mg g^{-1} d.m.)		Amino acids (mg g^{-1} d.m.)		Water content	
	−MPa	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	0.0	43.6	25.2	104.3	25.8	9.5	2.9	6.5	1.9
	0.3	41.2	28.3	125.3	53.4	7.8	1.6	7.7	1.4
	0.6	38.8	27.9	111.4	36.6	8.0	1.2	7.3	1.4
	0.9	36.7	26.5	120.2	26.3	4..8	1.4	4.4	1.2
	1.2	36.6	21.9	129.2	22.4	4.9	1.3	5.1	1.4
GA_3	0.0	60.8	28.9	134.9	25.5	9.5	3.1	12.1	2.3
	0.3	43.9	28.5	134.2	25.7	7.5	4.5	10.6	1.7
	0.6	39.8	29.7	136.0	25.2	8.0	3.2	8.4	1.5
	0.9	38.5	27.9	120.1	24.2	5.0	3.6	8.5	2.6
	1.2	50.6	26.1	127.0	32.6	5.1	3.0	9.4	2.2
Kin.	0.0	67.3	24.9	105.0	30.9	3.2	2.9	9.2	2.5
	0.3	67.1	28.8	104.2	40.0	2.6	1.8	9.8	2.3
	0.6	59.7	28.7	103.8	37.8	6.1	1.6	9.4	1.7
	0.9	68.5	26.4	116.6	35.4	7.3	1.7	7.9	1.8
	1.2	68.5	26.2	134.2	30.6	4.9	1.8	7.1	1.8
L.S.D. 5%		0.96	0.679	1.7	0.998	1.0	0.368	1.1	0.85

Table 3. Analysis for soluble sugar soluble and amino acids contents of shoot and root of cotton wheat plants.

Treat.	NaCl	Soluble sugar (mg g^{-1} d.m.)		Soluble protein (mg g^{-1} d.m.)		Amino acids (mg g^{-1} d.m.)		Water content	
	−MPa	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	0.0	82.3	46.5	155.5	138.1	7.6	1.9	23.2	4.8
	0.3	92.9	63.2	165.1	157.5	6.6	2.3	24.3	3.9
	0.6	93.1	56.7	174.7	173.4	5.9	2.4	21.7	3.9
	0.9	94.0	183.5	176.5	138.8	5.1	2.9	20.2	2.0
	1.2	98.2	141.5	141.9	93.9	4.9	2.9	21.8	1.7
GA_3	0.0	56.9	54.1	206.1	36.2	7.7	3.9	25.2	5.4
	0.3	51.5	115.7	235.9	56.4	9.1	6.3	26.9	5.4
	0.6	72.5	109.7	242.0	55.4	8.7	5.9	29.6	4.8
	0.9	58.9	151.9	260.3	54.2	9.5	13.6	19.5	5.0
	1.2	49.6	109.3	220.0	48.2	6.3	18.6	17.5	5.0
Kin.	0.0	82.9	60.8	214.3	100.2	12.9	4.2	24.7	3.9
	0.3	97.1	113.2	198.0	160.5	8.9	4.7	25.2	4.7
	0.6	97.9	123.4	209.4	180.5	8.2	5.5	24.6	4.7
	0.9	98.7	125.9	220.9	180.4	8.2	7.0	23.5	4.8
	1.2	100.9	52.9	192.9	180.6	8.4	6.2	20.7	3.7
L.S.D. 5%		4.2	4.5	1.6	1.88	0.862	1.5	1.0	0.8

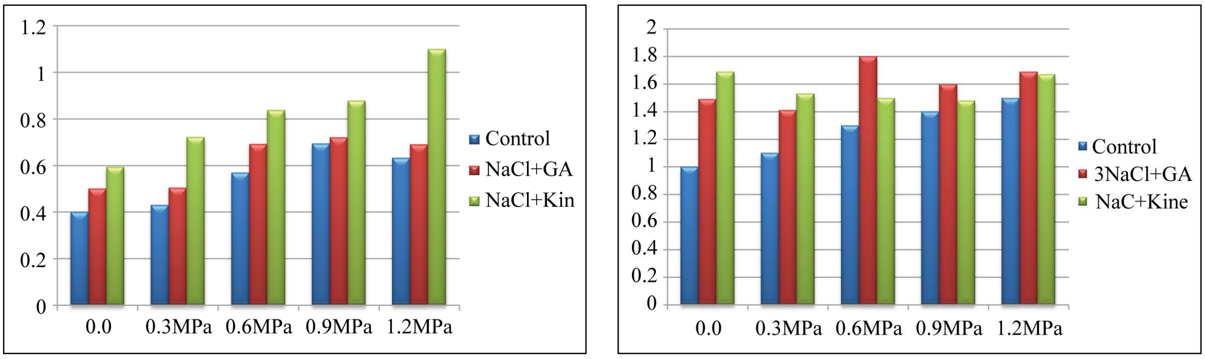
Table 4. Analysis for soluble sugar soluble and amino acids contents of shoot and root of broad bean plants plants.

Treat.	NaCl	Soluble sugar (mg g^{-1} d.m.)		Soluble protein (mg g^{-1} d.m.)		Amino acids (mg g^{-1} d.m.)		Water content	
	−MPa	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	0.0	28.4	33.9	303.0	78.0	12.3	11.3	25.6	3.2
	0.3	37.6	32.6	294.1	77.1	14.3	10.1	24.9	3.3
	0.6	41.0	32.5	225.1	74.0	18.9	9.8	24.5	2.8
	0.9	37.8	32.8	217.2	70.8	19.9	8.9	21.7	2.6
	1.2	33.8	33.0	210.0	32.4	25.4	9.8	22.7	1.6
GA_3	0.0	128.8	48.3	345.6	135.1	29.1	17.3	26.1	6.0
	0.3	126.5	66.1	340.7	12.5	21.2	17.0	25.7	6.1
	0.6	90.9	50.9	300.4	78.8	29.6	15.2	27.9	7.5
	0.9	90..2	50.6	300.6	79.4	25.8	15.5	25.1	8.0
	1.2	106.8	50.9	300.9	82.2	21.4	12.8	22.6	5.8
Kin.	0.0	93.5	38.1	313.5	91.3	32.6	16.3	26.9	6.1
	0.3	97.3	38.9	318.3	145.9	36.4	15.6	26.5	6.0
	0.6	109.9	55.9	318.9	160..1	26.9	16.7	25.3	6.1
	0.9	97.9	68.9	375.3	124.6	30.3	16.2	22.2	5.0
	1.2	98.1	66.2	349.7	120.9	24.6	12.5	22.2	5.3
L.S.D. 5%		5.9	5.3	1.8	1.7	1.6	1.6	2.1	1.1

Table 5. Analysis for soluble sugar soluble and amino acids contents of shoot and root of parsley plants plants.

Treat.	NaCl	Soluble sugar (mg g^{-1} d.m.)		Soluble protein (mg g^{-1} d.m.)		Amino acids (mg g^{-1} d.m.)		Water content	
	−MPa	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0	0.0	79.3	55.2	96.4	46.9	8.9	102.6	5.5	1.3
	0.3	68.6	60.2	97.4	55.9	8.3	6.7	5.3	1.3
	0.6	87.3	37.7	106.9	55.9	8.2	6.9	5.2	1.2
	0.9	87.6	34.3	108.9	49.9	8.8	6.4	5.9	1.2
	1.2	71.4	36.3	114.5	44.3	9.0	6.3	5.1	1.9
GA_3	0.0	132.2	83.3	109.8	47.1	8.9	12.7	26.1	6.0
	0.3	111.8	84.9	117.4	47.1	8.5	5.6	25.7	6.1
	0.6	126.1	78.3	129.9	46.0	9.8	5.6	27.9	7.5
	0.9	135.4	67.9	129.7	49.5	8.6	5.5	25.1	8.0
	1.2	178.4	89.2	129.1	46.7	5.5	5.9	25.6	5.8
Kin.	0.0	77.2	52.9	153.9	168.1	2.4	2.8	5.8	1.3
	0.3	77.1	77.6	137.8	142.9	2.3	1.8	5.8	2.1
	0.6	89.9	65.2	135.1	56.2	3.9	2.5	6.4	1.8
	0.9	85.4	44.4	113.8	55.5	4.1	2.8	6.7	1.4
	1.2	93.6	44.4	96.8	56.2	4.3	3.6	5.9	1.7
L.S.D. 5%		9.7	11.1	1.1	1.4	1.3	0.913	0.91	0.53

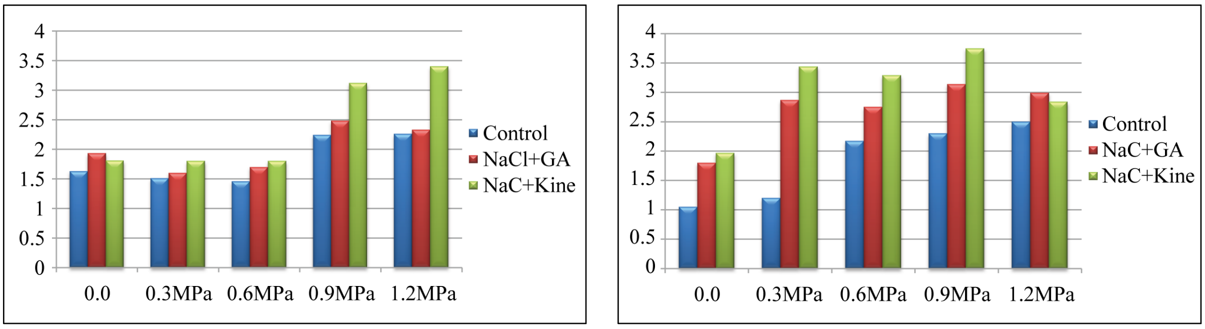
accumulated soluble protein of shoots and roots of parsley plants while a slightly decrease was observed at −1.2 MPa NaCl level (**Table 5**). The data represented in **Table 1** and **Table 2** showed that while osmotic stress accumulated the amino acids in shoots and roots of maize plants, induced in most cases a reduction in these accumulation in shoots and roots of wheat and parsley plants when compared with control plants (**Table 2**, **Table 5**). Except of this trend amino acid run in stable values in shoot of parsley plant. The accumulation of amino acids contents run in opposite directions of shoots and roots of cotton and broad bean plants. It was significantly increased in root cotton and shoots broad bean plants, while tended to decrease in shoot cotton and root broad bean plants (**Table 3**, **Table 4**). The values of OP were significantly elevated in shoots and roots of maize, wheat and cotton plants (**Figure 1(a)**, **Figure 1(b)**, **Figure 2(a)**, **Figure 2(b)** and **Figure 3(a)**, **Figure 3(b)**). The percent of increase at −1.2 MPa NaCl was 58.3%, 35% for shoot and root of maize plant, 34.9% and 13.3% of shoots and roots of wheat plants and 32.1% for cotton shoots plants. The OP values of root cotton reach 6.5-folds at −1.2 MPa NaCl level than the values of control plants (100%). In broad bean plants OP was markedly decreased in both shoots and roots (**Figure 4(a)**, **Figure 4(b)**). The percent of reduction was 24.8%, 21.9% of shoot and root of broad bean plants at −1.2 MPa NaCl levels compared with control plants. In parsley plant while OP remains unchanged in shoot, it was markedly decrease in root, the percent of reduction was 52.1% when compared with untreated plants (**Table 5**). Hormonal treatments (GA_3 or kinetin 200 ppm) stimulated the accumulation the soluble sugar of both organs of maize plants. Except of this trend GA_3 treatment in root organs, the soluble sugar showed no different changes (**Table 1**). However, phytohormonal application increased the contents of protein in shoots and roots as compared with the corresponding levels of salinity. It is worthy to mention that kinetin application induce a pronounced accumulation reach to 2-folds in shoot soluble sugar and shoot soluble protein of both organs of maize plants (**Table 1**). Phytohormonal treatments decreased the amino contents in shoots and roots maize plants compared with untreated plants (**Table 1**). GA_3 and kinetin induced in most cases, a pronounced increase in the production of soluble sugar, soluble protein on shoots and roots of



L. S. D. 5%: 0.5 (a)

L. S. D. 5%: 0.1 (b)

Figure 1. Analysis for plants on osmotic pressure (−MPa) of shoot (a) and root (b) maize plants.

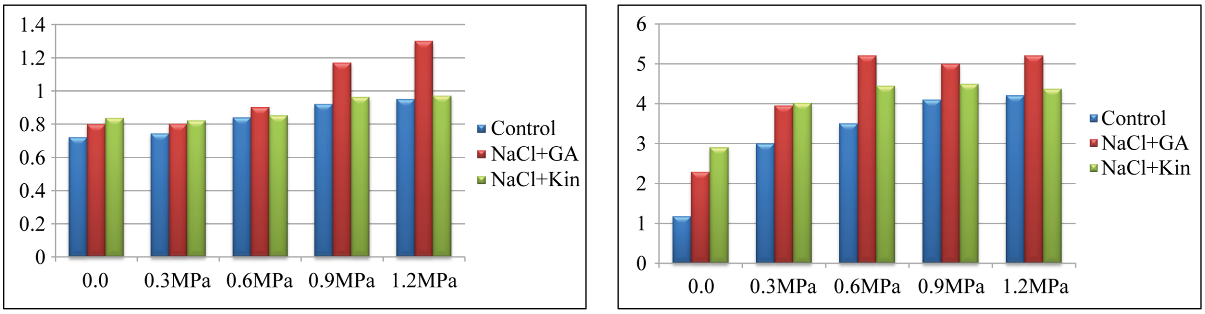


L. S. D. 5%: 0.3 (a)

L. S. D. 5%: 0.2 (b)

Figure 2. Analysis for plants on osmotic pressure (−MPa) of shoot (a) and root (b) wheat plants.

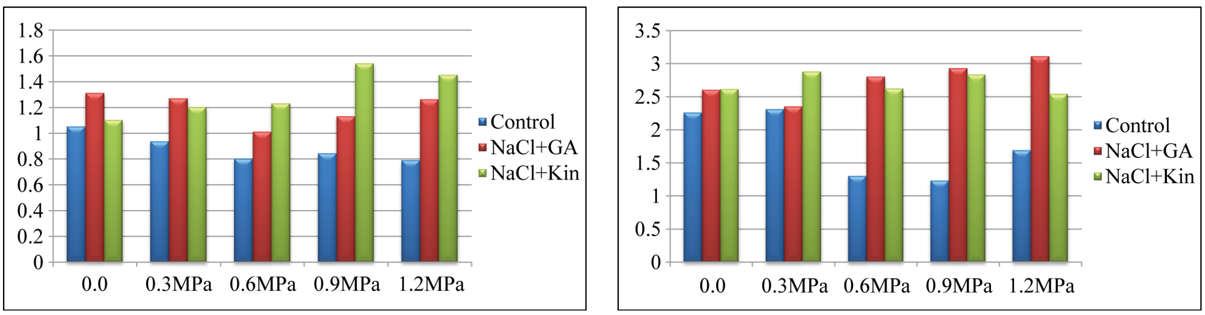
wheat plant (**Table 2**). Whereas amino acids content remain more or less unchanged of both organs except in root wheat plants treated with GA_3 they were increased when compared with untreated plants. A significant accumulation mostly was observed in the accumulation of soluble sugar, soluble protein and amino acids of shoots and roots of cotton plants, reach about 7-folds in root of plant treated with GA_3 than control plants (**Table 3**). Phytohormonal application induced in most cases an accumulation in soluble sugar, protein and amino acids of shoot and root of broad bean and parsley plants (**Table 4** & **Table 5**). Except of this trend amino acids in shoot and root of parsley plants tended to decrease with increasing osmotic stress compared with untreated plants (**Table 5**). Spraying vegetative parts with GA_3 or kinetin of 5 tested plants was elevated the OP in shoot cotton, root parsley, shoot and root broad bean, shoot maize compared with untreated plants (**Figure 1**, **Figure 5(a)**, **Figure 5(b)**).



L. S. D. 5%: 0.4 L. S. D. 5%: 0.2

(a) (b)

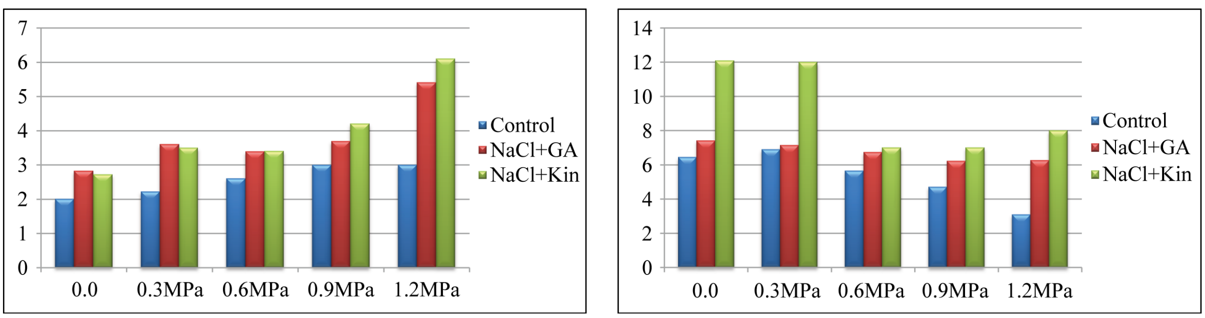
Figure 3. Analysis for plants on osmotic pressure (−MPa) of shoot (a) and root (b) cotton plants.



L. S. D. 5%: 0.25 L. S. D. 5%: 0.15

(a) (b)

Figure 4. Analysis for plants on osmotic pressure (−MPa) of shoot (a) and root (b) broad bean plants.



L. S. D. 5%: 0.16 L. S. D. 5%: 0.20

(a) (b)

Figure 5. Analysis for plants on osmotic pressure (−MPa) of shoot (a) and root (b) parsley plants.

5. Discussion

The high soil salinity affected the soil penetration, decreased the soil water potential and finally caused physiological drought The plants under salinity condition change their metabolism to overcome the changed environmental condition [27]. One mechanisms utilized by the plants for overcoming the salt stress effects might be via accumulation of compatible osmolytes, such as soluble sugar. Production and accumulation of free amino acids, especially proline by plant tissue during drought, salt and water stress is an adaptive response. The osmotic pressure represented as a sign of plant tolerance or sensitive to salinity stress [28]. In the following plants the increase in OP seems to be a manner of defense mechanism to survive. OP increased in shoots of maize, shoot and root of wheat and cotton plants was concomitant with shoot soluble sugar, root soluble protein and shoot and root amino acids of maize plants. However, in wheat the increase in OP was related with increase of root soluble sugar and protein of shoots and roots. In cotton plants the elevation of OP was run parallel with increase soluble sugar of shoots and roots, shoot soluble protein and root amino acids. The increase in OP was related with a marked and significant reduction in the water content of these plants. The percent of reduction in water content at 1.2 MPa NaCl level was 24.9%, 52.9%, 22.2%, 28.4%, 9.7%, 45.7% of shoots and roots of maize, wheat and cotton plants respectively. *i.e.* the root was more sensitive than shoots in the same plants because the root was the direct organ exposed to salinity injury [29] [30]. However, the decrease in OP of shoot and root of broad bean was related with the reduction of shoots and roots soluble sugar, protein and root amino acids of broad bean. While the OP become more or less unchanged in shoots and tended to decrease in root of parsley plants, this concomitant with unchanged trend in the shoots amino acids and reduction in root soluble sugar and root amino acids. Run with previous trend values of OP and metabolites of parsley plants were related with stable values in shoot water content and reduction in root water content. It is worthy to point that the increase of soluble sugar in shoot maize, root wheat, shoot and root cotton and shoot parsley plants may be related with salt tolerance of these plants. The increasing of photosynthesis carbohydrate is a signal for water deficiency tolerance. The high carbohydrate concentration with its role to reduce water potential helps to prevent oxidative losses and protein structure maintenance during water shortage. Also carbohydrates play a molecule role for sugar responsible genes that give different physiological response like defensive response and cellular expansion [31]-[34]. The increasing of the soluble sugar during salinity stress is effective on the balance against osmotic pressure. The plant cell for escaping from plasmolysis performance and creation during salt stress conditions should be changed and analyzed from macro molecule to micro molecule. Sucrose breaks down to glucose and fructose, and starch decomposition to glucose increases its osmotic pressure cell [35]. Put the light on the OP values, while tended to increase in shoot, it decrease in root of parsley plants indicated that root was more sensitive organ than shoot to salinity stress or the metabolites translocated to shoot organ. The reduction of OP values in shoot and increase in root of broad bean plants indicated that shoot was more effective organ than root in response to osmotic stress or an accumulation of metabolites in root was recorded *i.e.* the metabolites and OP not distributed similarity in both shoots and roots. In between ways, there is similarity position between the response of shoot and root of maize, wheat and cotton plants OP values increase in both organs toward the salinity stress. This open the field to say that the response of plants to salinity stress not only differ between different plants but between the different organs of the same plants as parsley and broad bean plants. Other plants as wheat shoot and root response at the same manner toward salinity stress as maize, wheat and cotton plants *i.e.* the metabolites and OP distributed at the same way between shoots and roots. This in accordance with Hamdia and Shaddad (2013) [36]. With GA_3 and kinetin treatments mostly increase the values OP which parallel with increase and soluble sugar, soluble protein and amino acids contents of shoots and roots of maize, wheat, cotton, broad bean and parsley plants with elevating NaCl increasing. This related with increase of water uptake by roots in these plants. The results obtained here indicated that kinetin has a more effective to shoot maize, both organs of wheat, broad bean and parsley plants in response to salinity stress while GA_3 was more effective on cotton plants especially at higher levels of salinity [37]. Plant growth regulators play key role in the defensive mechanism against biotic and a biotic stresses has been confirmed. Javid *et al.* (2011) [38] concluded that increasing salinity is associated with decreases in auxin, cytokinin, gibberellins and SA in the plant tissues and an increase in ABA and JA. Changes in hormone levels in plant tissue are thought to be an initial process controlling growth reduction due to salinity. Therefore, NaCl-induced reduction in the plant growth can be mitigated by application of plant growth regulators. Gibberellins (GAs) are generally involved in growth and development. They control seed germination, leaf expansion, stem elongation and flowering [39]-[42]. Exogenous application of kinetin overcame the effects of salinity stress on the growth of wheat seedlings [43] and treatment of potato plants with kinetin prior to salt stress diminished salt-related growth inhibition [44]. However, earlier studies reported that application of kinetin to bean plants during salinity stress exacerbated its effects [45]. Addition of benzyl adenin (BA) inhibited growth during stress of a salt-sensitive variety of barley, but overcame the decline in growth rate, shoot/root ratio and internal CK content in a salt-tolerant variety [6] [46]. Kinetin acts as a direct free radical scavenger or it may involve in antioxidative mechanism related to the protection of purine breakdown [47]. A possible involvement of genes in stress responses is often inferred from changes in the transcript abundance in response to a given stress trigger. An overview of the many changes in the transcript abundance of cytokinin genes in Arabidopsis in response to environmental factors was given elsewhere [48]. Shabala *et al.* (2010) [49] demonstrated that pants growth is impressed by biotic and abiotic stress inversely. There are many reports about proteins change level in salinity stress. Leaves fill up more soluble sugar of glucose, fructose and proline with treatment of salicylic acid**.** Thus plants strategy differed in their tolerance to salinity stress according to their species and differed also according to the different organs of the same plants and kinetin treatment induced highly positively affect than GA_3 treatments.

6. Conclusion

The osmotic pressure represented as a sign of plant tolerance or sensitive to salinity stress. In the following plants, the increase in OP seems to be a manner of defense mechanism to survive. OP increased in shoots of maize, shoot and root of wheat and cotton plants was concomitant with shoot soluble sugar, root soluble protein and shoot and root amino acids of maize plants. However, in wheat the increase in OP was related with increase of root soluble sugar and protein of shoots and roots. In cotton plants, the elevation of OP was run parallel with increase soluble sugar of shoots and roots shoot soluble protein and root amino acids. The increase in OP was related with a marked and significant reduction in the water content of these plants. The results indicated that kinetin had a more effective to shoot maize, both organs of wheat, broad bean and parsley plants in response to salinity stress while GA_3 was more effective on cotton plants especially at higher levels of salinity. Thus plants strategy differed in their tolerance to salinity stress according to their species and differed also according to the different organs of the same plants and kinetin treatment induced highly positively affect than GA_3 treatments.

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