

**RESEARCH ARTICLE**

**Effect both of Kinetin and NPKZn Fertilizer on Mitigating The Adverse effect of Sodium Chloride on sweet pepper plant *Capsicum annuum* L.**

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**ABSTRACT:**

The experiment was carried out in the green house of botanical garden belong to Department of Biology/College of Education for Pure Science- Ibn-al- Haitham/University of Baghdad, for the growth season 2015 using plastic pots. The experiment aimed to study the effect of two concentrations of sodium chloride (50, 100) mM.L<sup>-1</sup> in addition to the control and four concentrations of kinetin (25, 50, 75, 100) mg.L<sup>-1</sup> in addition to the control and the influence of application and non application of fertilizlizer NPKZn in the level 160 kg.h<sup>-1</sup> and their interactions on some growth parameters (fresh weight for both root and vegetative part, dry weight for leaves , value of secondary productivity, biomass duration for vegetative part and dry weight for fruits. Results showed that addition of sodium chloride minimized the growth parameters and spraying plant with Kinetin at the concentration 75 mg.L<sup>-1</sup>and fertilizing with NPKZn caused a significant increase in the averages of growth parameters studied and decline the negative effects of sodium chloride.

**KEYWORDS:** Kinetin, NPKZn, Sodium chloride, Sweet pepper.

**INTRODUCTION:**

Pepper is a saline sensitive plant [1]. Increasing sodium chloride concentrations in growth media causes reduction in plant height, root length, number of leaves, leaf surface area and chlorophyll content, as well as decrease in fresh and dry weight of the vegetative part[2]. Cytokines are important growth regulators used to increase plant's tolerance against salt stress, one of the most important is the Kinetin (N6-furfurylaminopurine) [3]. Cytokines control the aging of leaves, cell division and differentiation, development of flowers and organelles, such as green plastids, and contribute to the distribution of photosynthesis products [4]. Application of cytokinein affects the mitigation of the adverse effects of salt stress, leading to improved plant growth and increased yield [5].

The study of [6] confirmed that soaking seeds of spinach plant with different concentrations of kinetin (20, 40) mg. L<sup>-1</sup> gave positive effect in minimizing the adverse effect of salinity with high concentrations. Nutrients are very important in increasing vegetative and flowering growth of the plant, in a study on tomato plant subjected to salinity stress. results showed that application of NPK fertilizer caused increase in plant height, number of leaves and branches and fresh and dry weight of the plant [7]. A similar result was found in a study on sweet pepper, when adding the NPK fertilizer there was significant increase in the nitrogen, phosphorus, potassium, zinc and chlorophyll content and increasing in plant height and root length, dry weight of the vegetative and root part and the number and weight of fruits [8].

**MATERIALS AND METHODS:**

The experiment was carried out using plastic pots during the growth season of 2015 in the green house of botanical garden of Department of Biology/College of Education for Pure Sciences-Ibn al-Haitham/University of Baghdad. The soil was brought from the fields of the General Authority for Agricultural Research. Factorial

experiment was designed in completely randomized design with three replicates, the number of experimental units was 90 units. NPKZn fertilizer was applied before the seedlings were transferred based on 160 kg per hectare, in addition to control treatment. Three seedlings were planted in pot with equal quantity of soil (8 kg) on 4/2/2015, and irrigated with water up to 50% of the field capacity. During the growth season the pots were kept free from weeds. The seedling were slash to two seedlings after 19 days of planting. Irrigation with sodium chloride solutions started on 5/3/2015 using two concentrations (50, 100) Mm.L<sup>-1</sup>. Plants were sprayed with kinetin concentrations (25, 50, 75, 100) mg. L<sup>-1</sup> twice on 7/3/2015 and 31/3/2015 while control plant sprayed with distilled water. On 19/4/2015 plants were sampled for each unit experiment.

Plant growth parameters (fresh weight for root and vegetative part, dry weigh for leaves were measured, value of secondary productivity, and biomass duration of vegetative part were calculated after 74,84 days of seedling planting). Vegetative part and the leaves were dried in an electric dryer at 65-70 C° until the weight was confirmed for each treatment, dry weights were measured.

Value of secondary productivity was calculated by method [9] based on the number of plants in the experimental unit and the dry weight of the vegetative part at the age of the plant by applying the following formula:

$$\text{Value of secondary productivity (plant. gm)} = (W_2 - W_1) \times \frac{N_1 + N_2}{2}$$

N<sub>1</sub> = Number of plants taken on the first date.

N<sub>2</sub> = Number of plants taken on the second date.

W<sub>1</sub> = Dry weight of the vegetative part (g) at the first date.

W<sub>2</sub> = Dry weight of the vegetative part (g) at the second date.

Biomass duration was calculated using the dry weight of the vegetative part according to the following equation [10]:

$$\text{Biomass Duration (gm.day)} = \frac{(W_2 - W_1) (T_2 - T_1)}{2}$$

W<sub>1</sub> = Dry weight of the vegetative part (g) at the first date

W<sub>2</sub> = Dry weight of the vegetative part (g) at the second date

T<sub>1</sub> = Plant age (day) at the first date

T<sub>2</sub> = Plant life (day) at the second date

The fruits of each experimental unit were separated after 81 days from planting and dried in an electric dryer at 65-70C° until the weight was confirmed for each treatment. The dry weight for the fruit was measured.

The results were statistically analyzed according to the design followed, and least significant difference was used to compare the means at the probability level of 0.05 [11].

## RESULTS AND DISCUSSION:

The results of the tables (1,2,3,4,5,6) showed the adverse effect of sodium chloride in growth parameters (fresh weight for root and vegetative part, dry weight for leaves, the secondary productivity value, biomass duration for vegetative part and dry weight for fruits). Increasing sodium chloride concentration from zero to 100mM.L<sup>-1</sup> caused reduce the means of pepper plant parameters with reduction rate (57.86,59.57, 30.69, 88.42 ,87.27 and 45.64)%. The results of the tables also showed that there were a significant increase in the mean of the mentioned parameters as a result of the addition of NPKZn fertilizer compared to the non-additive, which increased from (17.41, 33.84, 1.75, 0.87, 4.39 and 4.05) to (20.23, 37.73, 1.91, 1.02, 4.70 and 4.54). The results also showed an increase in the mean of plant parameters by spraying the kinetin with superiority to the concentration 75 mg.L<sup>-1</sup> which gave the highest increase rate (42.65, 56.75, 29.37, 206.25,198.79, 31.72)% compared to zero concentration of kinetin. The addition of fertilizer has a positive effect in reducing the damage resulting from 100 mM.L<sup>-1</sup> sodium chloride and there was a significant increase in the means parameters from (11.23, 20.15, 1.43, 0.20, 1.01, 2.66) to (11.97, 22.16, 1.55, 0.25, 1.26, 3.47). The tables also showed the active role of the kinetin especially at the concentration 75mg.L<sup>-1</sup> that manged sodium chloride damage at concentration 100 mM.L<sup>-1</sup>, the increase rates were (22.87, 64.65, 60.52, 142.85, 140.84, 52.32)% Compared to zero concentration of kinetin and the same concentration of sodium chloride, the interaction was significantly between the level of fertilizer (160 kg.h<sup>-1</sup>) and all the concentrations of kinetin sprayed on the plant, the predominate concentration was to 75 mg.L<sup>-1</sup> and gave the best values for ( fresh weight for root and vegetative part, dry weight for leaves, the secondary productivity value, biomass duration for vegetative part and the dry weight for fruits) they were (24.08, 46.10, 2.13, 1.59, 8.04, 4.99) in comparative with (14.84, 26.46, 1.51, 0.45, 2.37 , 3.36) at the same concentration of kinetin and zero level of fertilizer. The results of the tables showed the positive effect of fertilizer 160 kg.h<sup>-1</sup> and kinetin 75 mg.L<sup>-1</sup> in reducing the harmful effect of sodium chloride 100 mM.L<sup>-1</sup> ,and show increase in growth parameters with increase rate (32.22, 89.36, 76.41, 192.30, 195.38, 145.16)% compared to non-fertilizer and zero concentration of kinetin and at the same concentration above sodium chloride. The highest values of parameters were at the level 160 kg.L<sup>-1</sup> fertilizer and concentration 75 mg.L<sup>-1</sup> kinetin with zero concentration of sodium chloride and gave (38.76, 72.16,

2.55, 3.53, 17.65 and 6.59), while the lowest values were (10.24, 14.10, 1.06, 0.13, 0.65, 1.55) at zero concentration of kinetin and non-fertilization under concentration 100 mL.L<sup>-1</sup> sodium chloride.

The addition of sodium chloride to growth media reduce plant growth due to its osmotic effect or disruption of the hormonal and enzymatic balance or the toxic effect of ions [12], or may be due to the oxidative stress caused by subjecting plant for a long time to high concentrations of sodium chloride [13]. The addition of kinetin stimulates increased cell length and width [14]. It plays vital role in activating absorption and transition processes for the materials produced in the leaves and increase the production of nuclear acids and the formation of proteins, which provides the raw materials needed by the cell to divide and increase its breadth [15]. It also affects synthesis of auxin in the root and leaf tissue as it mutates the genes responsible for the synthesis of auxin, so it is believed that biosynthesis of auxin is induced by cytokinin, as well as its important in the detection of organs. [16]. Kinetin affect the efficiency of photosynthesis by increasing the content of chlorophyll and increases the content of important elements in the plant [17]. It also delay the aging of leaves and increases plant growth and its dry weight [18]. The increase in

plant growth indices to the NPKZn fertilizer role in improving the various biological activities that lead to good vegetative and root growth as nitrogen affects the building of chlorophyll and increase the apical growth efficiency [19]. It also stimulates the plant to produce auxin (IAA), which promotes cellular division and elongation leading to increase in plant growth ,as well as the positive effect of phosphorus in most of vital processes, it helps to form and divide the cells, and formation of energy-rich compounds, and the accompaniment of enzymes which involved in synthesis of fatty acid and protein that leads to strong vegetative growth [15]. Potassium plays important role in activation of many enzymes, respiration, photosynthesis, development of chlorophyll, then improve the vegetative growth of the plant, zinc is important in the growth of plant due to its close relationship with auxin building, it is participative in the synthesis of tryptophan and enhance the production of cytochrom a and b, zinc is consider non enzymatic antioxidant [20].

We conclude from the experiment that the use of kinetin at the concentration of 75 mg.L<sup>-1</sup> and the level of fertilizer 160 kg. h<sup>-1</sup> contributed to increasing the rates of studied parameters and reduced the adverse effect of sodium chloride.

**Table 1: Effect of spraying with Kinetin and NPKZn fertilizer on fresh weight of root (gm) for pepper plant affected by sodium chloride stress**

sodium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	20.65	21.75	24.22	34.25	21.33	24.44
	160	26.09	27.53	34.25	38.76	26.43	30.61
50	0	13.64	16.36	18.23	18.53	16.12	16.58
	160	14.83	18.42	18.73	19.94	18.57	18.10
100	0	10.24	10.92	11.85	12.45	10.67	11.23
	160	10.92	11.51	12.85	13.54	11.60	11.97
Mean of kinetin		16.06	17.75	19.93	22.91	17.45	
		Kinetin concentration = 0.66					0.29
LSD (0.05)		Interaction of three factors = 1.63					
Mean of interaction sodium chloride x Kinetin							
sodium chloride concentrations (mM.L <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride
		0	25	50	75	100	
0		23.37	24.64	29.24	36.51	23.88	27.53
50		14.24	17.39	18.48	19.24	17.35	17.34
100		10.58	11.22	12.07	13.00	11.14	11.60
LSD (0.05)		2.31					0.51
Mean of interaction fertilizer level x kinetin							
Level of fertilizer (Kg.h <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of fertilizer Level
		0	25	50	75	100	
0		14.84	16.34	18.10	21.74	16.04	17.41
160		17.28	19.15	21.75	24.08	18.87	20.23
LSD (0.05)		5.93					0.42

**Table 2: Effect of spraying with Kinetin and NPKZn fertilizer on fresh weight of vegetative part (gm) for pepper plant affected by sodium chloride stress**

sodium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	37.06	43.56	54.40	63.45	46.07	48.91
	160	41.17	51.65	60.65	72.16	53.30	55.79

50	0	28.60	31.24	34.02	37.25	31.54	32.45
	160	30.60	33.70	37.35	39.44	35.08	35.23
100	0	14.10	18.72	22.47	26.11	19.31	20.15
	160	17.97	20.18	25.10	26.70	20.85	22.16
Mean of kinetin		28.19	33.18	39.00	44.19	34.36	
		Kinetin concentration =1.25					0.60
LSD (0.05)		Interaction of three factors =3.07					
Mean of Interaction sodium chloride x Kinetin							
Sodium chloride concentrations (mM.L <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride
		0	25	50	75	100	
0		39.12	47.61	57.53	67.81	49.69	52.35
50		29.41	32.47	35.69	38.35	33.31	33.84
100		16.04	19.48	23.79	26.41	20.08	21.16
LSD (0.05)		4.17					0.975
Mean of Interaction fertilizer level x Kinetin							
Level of fertilizer (Kg.h <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of fertilizer Level
		0	25	50	75	100	
0		26.46	31.19	36.96	42.27	32.31	33.84
160		29.91	35.18	41.03	46.10	36.41	37.73
LSD (0.05)		16.80					0.975

**Table 3: Effect of spraying with Kinetin and NPKZn fertilizer on dry weight of leaves (gm) for pepper plant affected by sodium chloride stress**

sodium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	1.83	1.95	2.07	2.31	1.98	2.03
	160	2.07	2.20	2.35	2.55	2.22	2.28
50	0	1.63	1.77	1.82	1.92	1.80	1.79
	160	1.80	1.89	1.94	1.96	1.92	1.90
100	0	1.06	1.28	1.70	1.79	1.30	1.43
	160	1.21	1.43	1.74	1.87	1.49	1.55
Mean of kinetin		1.60	1.75	1.94	2.07	1.79	
		Kinetin concentration =0.06					0.10
LSD (0.05)		Interaction of three factors =0.17					
Mean of Interaction sodium chloride x Kinetin							
sodium chloride concentrations (mM.L <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride
		0	25	50	75	100	
0		1.95	2.08	2.21	2.43	2.10	2.15
50		1.72	1.83	1.88	1.94	1.86	1.85
100		1.14	1.36	1.72	1.83	1.40	1.49
LSD (0.05)		0.16					0.04
Mean of Interaction fertilizer level x Kinetin							
Level of fertilizer (Kg.h <sup>-1</sup> )		Kinetin concentration(mg.L <sup>-1</sup> )					Mean of fertilizer level
		0	25	50	75	100	
0		1.51	1.67	1.86	2.01	1.69	1.75
160		1.69	1.84	2.01	2.13	1.88	1.91
LSD (0.05)		0.37					0.04

**Table 4: Effect of spraying with Kinetin and NPKZn fertilizer on value of secondary productivity (plant. gm) affected by sodium chloride stress**

sodium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	0.81	1.24	2.29	2.73	1.45	1.70
	160	0.91	1.71	2.57	3.53	1.71	2.09
50	0	0.42	0.66	0.79	1.03	0.65	0.71
	160	0.48	0.71	0.88	0.85	0.70	0.72
100	0	0.13	0.17	0.21	0.30	0.18	0.20
	160	0.15	0.18	0.31	0.38	0.23	0.25
Mean of kinetin		0.48	0.78	1.18	1.47	0.82	
		Kinetin concentration =0.063					0.014
LSD (0.05)		Interaction of three factors =0.156					
Mean of Interaction sodium chloride x Kinetin							
sodium chloride concentrations (mM.L <sup>-1</sup> )		Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride
		0	25	50	75	100	

0	0.86	1.48	2.43	3.13	1.58	1.90
50	0.45	0.69	0.84	0.94	0.68	0.72
100	0.14	0.18	0.26	0.34	0.21	0.22
LSD (0.05)	0.10					0.04
Mean of Interaction fertilizer level x Kinetin						
Level of fertilizer (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of fertilizer level
	0	25	50	75	100	
0	0.45	0.69	1.10	1.35	0.76	0.87
160	0.51	0.87	1.25	1.59	0.88	1.02
LSD (0.05)	0.22					0.04

**Table 5: Effect of spraying with Kinetin and NPKZn fertilizer on biomass duration (mg.day) for pepper plant affected by sodium chloride stress**

soium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	4.05	6.20	11.45	13.67	7.25	8.52
	160	4.57	5.55	12.85	17.65	5.55	9.23
50	0	2.42	3.32	3.98	5.18	3.35	3.65
	160	2.42	3.58	4.42	4.55	3.02	3.60
100	0	0.65	0.88	1.08	1.50	0.92	1.01
	160	0.77	0.92	1.55	1.92	1.15	1.26
Mean of kinetin		2.48	3.41	5.89	7.41	3.54	
LSD (0.05)		Kinetin concentration =0.99 Interaction of three factors =1.43					0.23
Mean of Interaction sodium chloride x Kinetin							
sodium chloride concentrations (mM.L <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride	
	0	25	50	75	100		
0	4.31	5.88	12.15	15.66	6.40	8.88	
50	2.42	3.45	4.20	4.87	3.19	3.62	
100	0.71	0.90	1.32	1.71	1.04	1.13	
LSD (0.05)		0.92					0.76
Mean of Interaction fertilizer level x Kinetin							
Level of fertilizer (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of fertilizer level	
	0	25	50	75	100		
0	2.37	3.47	5.50	6.78	3.84	4.39	
160	2.59	3.35	6.27	8.04	3.24	4.70	
LSD (0.05)		5.04					0.26

**Table 6: Effect of spraying with Kinetin and NPKZn fertilizer on dry weight of fruits (gm) for pepper plant affected by sodium chloride stress**

sodium chloride concentrations (mM.L <sup>-1</sup> )	fertilizer level (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of Interaction sodium chloride x fertilizer level
		0	25	50	75	100	
0	0	4.91	5.02	6.00	6.22	5.13	5.46
	160	5.16	5.27	6.58	6.59	5.44	5.81
50	0	3.61	3.66	4.30	4.80	3.75	4.04
	160	3.91	4.27	4.86	4.58	4.05	4.33
100	0	1.55	2.71	2.89	3.41	2.72	2.66
	160	3.19	3.24	3.63	3.80	3.47	3.47
Mean of kinetin		3.72	3.04	4.71	4.90	4.09	
LSD (0.05)		Kinetin concentration =0.19 Interaction of three factors =2.46					0.50
Mean of Interaction sodium chloride x Kinetin							
sodium chloride concentrations (mM.L <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of sodium chloride	
	0	25	50	75	100		
0	5.04	5.15	6.29	6.41	5.29	5.63	
50	3.76	3.97	4.58	4.69	2.90	4.18	
100	2.37	2.98	3.26	3.61	3.10	3.06	
LSD (0.05)		0.55					0.14
Mean of Interaction fertilizer level x Kinetin							
Level of fertilizer (Kg.h <sup>-1</sup> )	Kinetin concentrations(mg.L <sup>-1</sup> )					Mean of fertilizer level	
	0	25	50	75	100		
0	3.36	3.80	4.40	4.81	3.87	4.05	
160	4.09	4.26	5.02	4.99	4.32	4.54	
LSD (0.05)		1.37					0.11

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