

EFFECTS OF SEED PRIMING WITH SALICYLIC ACID ON ZEA MAYS SEEDLINGS GROWN UNDER SALT STRESS CONDITIONS

***IQBAL S, ALI Q, MALIK A**

Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore, Pakistan

*Corresponding author email: saratarar580@gmail.com

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Abstract: *Maize crop is cultivated as the 3rd most important cereal crop after wheat and rice in Pakistan. As an exhaustive crop maize required all essential nutrients at all crop growth stages. Among essential nutrients nitrogen involved with the greenish colors of the vegetative parts, leaves production, branching and end up with drier biomass. Hydro-priming and osmo-priming are the commonly used priming techniques. In both techniques the seeds were soaked in treatments for overnight followed by air drying before sowing. To overcome several a-biotic stresses of field crops seed priming techniques have been used globally. The current study was planned to evaluate effect of different salt treatments on the growth traits of maize. Two maize varieties Raka-Poshi and Pak-Afgoi were evaluated for the effect of salts stress on maize. Three salts ZnSO₄, MgSO₄ and NaCl were used @0.5 M and 0.25M solutions. Treatments used in the experiment were ZnSO₄ (0.5M), ZnSO₄ (0.25M), MgSO₄ (0.5M), MgSO₄ (0.25M), NaCl (0.5M), NaCl (0.25M), ZnSO₄ (0.5M) + MgSO₄ (0.5M), ZnSO₄ (0.25M) + MgSO₄ (0.5M), ZnSO₄ (0.5M) + MgSO₄ (0.25M), ZnSO₄ (0.25M) + MgSO₄ (0.25M), ZnSO₄ (0.5M) + NaCl (0.5M), ZnSO₄ 0.25M + NaCl (0.5M), ZnSO₄ (0.5M) + NaCl (0.25M), ZnSO₄ (0.25M) + NaCl (0.25M), ZnSO₄ (0.5M) + MgSO₄ (0.5M) + NaCl (0.5M), ZnSO₄ (0.25M) + MgSO₄ (0.25M) + NaCl (0.25M). Maximum growth was observed in the plants that were primed with ZnSO₄ used alone @ 0.5M and 0.25M or in combination with MgSO₄. However, NaCl retard the growth of plant used alone or in combination with other salts. Seed priming by 30 mg/l salicylic acid solution not only found vital to enhance the uniform seed germination and rate of seed germination but also are environment friendly, simple, low cost low risk techniques and easily adoptable.*

Keywords: *Zea mays*, salt stress, seed priming, seedling biomass, exhaustive crop

Introduction

Maize crop is cultivated as the 3rd most important cereal crop after wheat and rice in Pakistan. The total area under maize cultivation in Pakistan is around 1083 thousand hectares with the annual production of 4271 thousand tones and 15% increase in yield has been observed in comparison with the previous years (GOP, 2012). Among all provinces of the country about 98 percent maize crop is cultivated in Punjab and KPK (Anonymous, 2010). In developing countries like Pakistan maize is cultivated both for food and fodder. Maize grains not only confined to food and feed but also used in many commercial products. With the increase in human population and growing live stock industry the demand of maize also increased. With high yield potential and being short duration crop maize can be significant to boost the economy of developing countries like Pakistan. The average grains yield of maize crop in Pakistan is low

as compared to the developed countries. The biological potential of available maize cultivars has not been explored due to biotic and a-biotic factors. Timely and balanced dose of micro and macro nutrients are very important to maximize the maize crop yield (Aaliya et al., 2016; Ali et al., 2013; Asghar et al., 2010). As an exhaustive crop maize required all essential nutrients at all crop growth stages. Among essential nutrients nitrogen involved with the greenish colors of the vegetative parts, leaves production, branching and end up with more dry biomass (Ali et al., 2014; Ali et al., 2016; Rashidi et al., 2015). In maize crop zinc (Zn) deficiency is very common (Cakmak et al., 1999 and Graham et al., 1992) and maize crop found very sensitive to Zn deficiency (Mengel and Kirkby 1982). For plant growth and metabolism processes micronutrient Zn is very essential. Zn plays vital role in root development, enzyme formation, carbohydrate regulation, and chlorophyll cytochrome pigment and

auxins formation. Due to the high solvency the use of zinc sulphate is common as compared to any other Zn fertilizer (Ali et al., 2017; Rehm and Schmitt 1997; Zubair et al., 2016). Whereas in Pakistan only 5 percent farming community use proper zinc fertilizers (FAO 2004).

Pre-sowing treatment in water or any other solutions that allow the seeds to imbibe with water or other applied solution to continue the initial stage of germination is described as seed priming. Seed priming not only plays vital role in early plant stages but also significantly improve the uniform rate of seed germination (Basra *et al.*, 2005, Farooq *et al.*, 2006a, Farooq *et al.*, 2006b, Farooq *et al.*, 2006c). Now a day's a number of seed priming techniques are used by the farmers and reported by researcher that performs better under unfavorable conditions. Hydro-priming and osmo-priming are the commonly used priming techniques. In both techniques the seeds are soaked in treatments for overnight followed by air drying before sowing (Ashraf and Foolad 2005). The rate of seed germination in tropical crops such as chickpea, rice, wheat, maize and sorghum enhanced with hydro-priming (Harris, D., 1996). To overcome several a-biotic stresses of field crops seed priming techniques have been used globally (Farooq *et al.*, 2008a, and Farooq *et al.*, 2009). Seed priming with ZnSO₄ solution significantly improved the grain yield in maize (27%), chickpea (18%) and wheat (17%) under diverse climatic conditions whereas, the outcomes shows similar trends maize (26%) and wheat (16%) reported by Harris *et al.*(2005) and (Harris *et al.*, 2007). In fine and coarse rice the rate of nursery seedlings considerably improved by priming with CaCl₂ (Farooq *et al.*, 2007b) moreover in rice low temperature tolerance also improved (Zheng *et al.*, 2002). Seed priming in late sown wheat with CaCl₂ shows resistant against low temperature (Farooq *et al.*, 2008a) similarly cotton seeds priming with glycinebetaine enable cotton to perform in drought (Naidu *et al.*, 1998). Seed priming techniques not only found vital to enhance the uniform seed germination and rate of seed germination but also are environment friendly, simple, low cost low risk techniques and easily adoptable (Harris, D., 2006).

Materials and methods

The current study was performed at Laboratory of Institute of Molecular Biology and Biotechnology, University of Lahore. Seeds of two varieties (Raka-Poshi and Pak-Afgoi) of *Zea mays* were obtained from Ayub Agricultural Research Institute, Faisalabad. For this study three salts were selected ZnSO₄, MgSO₄ and NaCl. 30 mg/l salicylic acid solution was used for seed priming before sowing. The treatments of salt solutions used were as followed:

- | | | |
|--------------|-----------------|--|
| i. | T ₀ | Control |
| ii. | T ₁ | ZnSO ₄ (0.5M) |
| iii. | T ₂ | ZnSO ₄ (0.25M) |
| iv. | T ₃ | MgSO ₄ (0.5M) |
| v. | T ₄ | MgSO ₄ (0.25M) |
| vi. | T ₅ | NaCl (0.5M) |
| vii. | T ₆ | NaCl (0.25M) |
| viii. | T ₇ | ZnSO ₄ (0.5M) + MgSO ₄ (0.5M) |
| ix. | T ₈ | ZnSO ₄ (0.25M) + MgSO ₄ (0.5M) |
| x. | T ₉ | ZnSO ₄ (0.5M) + MgSO ₄ (0.25M) |
| xi. | T ₁₀ | ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) |
| xii. | T ₁₁ | ZnSO ₄ (0.5M) + NaCl (0.5M) |
| xiii. | T ₁₂ | ZnSO ₄ 0.25M + NaCl (0.5M) |
| xiv. | T ₁₃ | ZnSO ₄ (0.5M) + NaCl (0.25M) |
| xv. | T ₁₄ | ZnSO ₄ (0.25M) + NaCl (0.25M) |
| xvi. | T ₁₅ | ZnSO ₄ (0.5M) + MgSO ₄ (0.5M) + NaCl (0.5M) |
| xvii. | T ₁₆ | ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M) |

Before priming, the seeds were sterilized with 10 percent solution of sodium hypochlorite. Ten seeds of each variety were soaked in 30 mg/l salicylic acid solution of each treatment for 24 hours in a petri dish. Ten seeds of control were dipped in 10 ml of distilled water. After seed priming the seeds were rinsed with distilled water and air dried at room temperature before sowing to avoid any microbial growth on seeds after sowing. All the seeds were sowed within 24 hours of the pre sowing treatment of seeds with salt solutions. Peat moss was used in pots to grow plants. Two pots containing five seeds of each treatment was sowed. Thirty two pots of each variety was sown and total of 66 pots were filled for sowing of the experiment for both varieties and the control. Two pots were of control where seeds having no treatment of salt but were dipped in distilled water. After sowing the pots were irrigated with distilled water. The parameters under study were Shoot Length (cm), Root Length (cm), Leaf Length (cm), Leaf Width (cm), Fresh Shoot Weight (g), Fresh Root

Weight (g), Dry Shoot Weight (g), Dry Root Weight (g). First data were recorded seven days after the emergence of seedlings and subsequent data were recorded after a week interval for two weeks. On each data collection three plants were uprooted from the pots. Shoots were carefully separated from the roots and roots were thoroughly washed with distilled water. Shoot length, root length, leaf length and leaf width were measured in centimeters with measuring tape. Freshly emerging leaves and roots were not taken under consideration while recording the data of root length, leaf length and leaf width. Fresh shoot weight and fresh root weight were also measured in grams by using weigh balance. For dry shoot weight and dry root weight the sample of shoots and roots were than oven dried at 100°C overnight in hot air oven and then the dry shoot and root weight was recorded. The data were analyzed by analysis of variance using the Statistix 8.1 and means were compare using least significant difference.

Results and discussion

The data regarding shoot length of both the varieties revealed that the plants of Raka-Poshi maize seeds priming with 30 mg/l salicylic acid solution have the longest shoot length throughout the growth period however in Pak-Afgoi maize variety seeds priming with 30 mg/l salicylic acid solution under treatments of NaCl, ZnSO₄ salt have the longest shoot length during first week and in 2nd and 3rd weeks of growth the plants seeds priming with 30 mg/l salicylic acid solution have the longest shoot length respectively. In Raka-Poshi maize minimum growth regarding shoot length was recorded in plants treated with salts ZnSO₄ 0.5M, MgSO₄ 0.5M and NaCl 0.5M during first week of growth, ZnSO₄ 0.25M, NaCl 0.25M during second week of growth and NaCl 0.25M in third week of growth. In Pak-Afgoi maize the minimum growth was observed in the plants treated with NaCl @ 0.5 M and 0.25M solution (Table 1). In Raka-Poshi maize the maximum growth in roots was observed in T₉ (ZnSO₄ 0.5M + MgSO₄ 0.25M) followed by T₁₁ (ZnSO₄ (0.5M) + NaCl (0.5 M)) during first and third week of plant development, however plants treated with (ZnSO₄ 0.25M) also have a significant positive effect on the development of roots. The minimum growth rate was observed in the plants treated with T₅ (NaCl 0.5 M) and T₆ (NaCl

0.25M). The same trend was observed in Pak-Afgoi maize where the minimum and underdeveloped roots was observed in NaCl 0.5 M) and T₆ (NaCl 0.25M), also in the plants treated with T₁₂ (ZnSO₄ (0.25M) + NaCl (0.5 M)) and T₁₃ (ZnSO₄ (0.5M) + NaCl (0.25M)) less development of roots was observed than control. In Pak-Afgoi maize maximum growth was observed in T₁ (ZnSO₄ 0.5 M), T₂ (ZnSO₄ 0.25M) and T₃ (MgSO₄ (0.5M) where no significant difference was observed among these.

The leaf length and leaf width were also affected by the application of different salts and same trend was observed in the data regarding the effect of salts on leaf length and leaf width. Maximum leaf length and width was observed in the plants treated mainly with ZnSO₄. In raka-Poshi maize throughout the growth period of the plants the maximum leaf length was observed T₁, T₂ and T₁₂ where plants were treated with 0.5M, 0.25M concentration of ZnSO₄ salt. Also in Pak-Afgoi maize same trend was observed regarding leaf length where maximum leaf length was observed T₁ and T₈ where the seeds were treated with 0.5M and 0.25M ZnSO₄ separately and in combination with MgSO₄ 0.5M respectively. The maximum number of leaf width was observed in T₁₀ (ZnSO₄ 0.25M + MgSO₄ 0.25M) the other data show a non-significant improvement in leaf width with different salt treatments. The significantly low leaf length and leaf width was observed in the plants that were primed 30 mg/l salicylic acid solution under NaCl treatments and in terms of both leaf length and leaf width throughout the growth period of the plants the minimum leaf length and leaf width was observed in T₅ and T₆ where the plants were primed with 30 mg/l salicylic acid solution under treatment of 0.5M and 0.25M of NaCl solution. The Maximum fresh shoot weight was observed in T₂ where the plants that were primed with 30 mg/l salicylic acid solution in both of Raka-Poshi and Pak-Afgoi maize genotypes under 0.5M ZnSO₄ which was significantly higher than all other treatments however the lowest fresh shoot weight was observed in the plants treated with NaCl 0.5M and 0.25M in the treatments T₅ and T₆ which was significantly different than all other treatments. The lowest fresh root weight was also observed in T₅ and T₆ where the seeds were primed with 30 mg/l salicylic acid solution. However, in Raka-Poshi maize genotype the maximum fresh root

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weight was observed in T₉ followed by T₁₁ and T₁₂ in which ZnSO₄ was used in combination with MgSO₄ 0.25M and NaCl @ 0.5M treatments respectively. In Pak-Afgoi maize genotype the maximum fresh root weight was observed in the plants that were primed with 30 mg/l salicylic acid solution under ZnSO₄ 0.25 M treatments throughout the growth period.

The maximum dry shoot and dry root weight in both white and yellow maize was also observed in T₁ and T₂ where the seeds were primed with water under 0.5M and 0.25M of NaCl treatments. Minimum dry shoot and root weight was observed in the plants that were primed with 30 mg/l salicylic acid solution under NaCl treatment separately or in combination with other salts. In Raka-Poshi genotype throughout the plant growth period minimum dry shoot weight was observed in T₅ and T₆ where the seeds were primed 30 mg/l salicylic acid solution while under with 0.5M and 0.25M NaCl treatments respectively.

However regarding dry root weight of the plants the minimum weight was observed T₁₃ and T₁₄ where 0.25M NaCl solution was used with 0.5M and 0.25M of ZnSO₄ respectively. It was observed from this study that the plant growth parameters improved with the use of ZnSO₄ @ 0.5M and 0.25M solution used for seed priming alone or in combination with MgSO₄. However, no significant improvement in plant growth traits was observed when seed was primed with 30 mg/l salicylic acid solution under salt treatments of ZnSO₄ was use in combination with other salts. It was also observed from the study that NaCl retard the growth of plant when even 30 mg/l salicylic acid solution used for priming. Minimum number of plant parameters reading was observed in the case where treated with NaCl alone @0.5M and 0.25M. However when NaCl is used in combination with other salts it also slow the capacity of plant growth.

TABLE 1. EFFECT OF DIFFERENT SALTS ON SHOOT LENGTH OF ZEA MAYS

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)		
	1 st WEEK	2 nd WEEK	3 rd WEEK	1 st WEEK	2 nd WEEK	3 rd WEEK
T ₀ Control	35.6	40.9	50.8	32.7	41.4	49.6
T ₁ ZnSO ₄ (0.5 M)	43.7	49.3	57.2	36.3	49	56.8
T ₂ ZnSO ₄ (0.25M)	38.1	45.7	55.1	33.8	43.6	52.8
T ₃ MgSO ₄ (0.5 M)	35.2	42.6	52.0	32.1	40.9	50.1
T ₄ MgSO ₄ (0.25M)	40.6	43.8	51.5	37	45.5	51.3
T ₅ NaCl (0.5 M)	32.5	38.2	45.6	29.5	35.8	41.2
T ₆ NaCl (0.25M)	33.1	37.4	43.9	23.8	33.2	39.6
T ₇ ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	37.4	44.3	52.3	33.8	38.0	50.2
T ₈ ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	41.3	48.4	53.4	39	45.1	53.2
T ₉ ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	31.0	37.5	47.5	30.5	41.4	48.8
T ₁₀ ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	34.2	39.4	48.9	33.2	42.8	50.8
T ₁₁ ZnSO ₄ (0.5M) + NaCl (0.5M)	34.4	38.7	47.5	31.5	35	48.6
T ₁₂ ZnSO ₄ (0.25M) + NaCl (0.5M)	38.0	44.1	52.2	33.4	37	47.8
T ₁₃ ZnSO ₄ (0.5 M) + NaCl (0.25M)	32.0	38.2	49.5	30	39.3	47.5
T ₁₄ ZnSO ₄ (0.25M) + NaCl (0.25M)	34.0	36.4	45.5	31.2	37	46.4
T ₁₅ ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	38.0	43.0	51.2	32.5	42.6	50
T ₁₆ ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	42.0	48.1	51.9	39.8	46.5	50.7
CV	16.41	5.2	3.77	14.9	3.19	2.64
S.E ±	4.8	1.796	1.54	3.82	1.070	2.159

TABLE 2. EFFECT OF DIFFERENT SALTS ON ROOT LENGTH OF ZEA MAYS

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)		
	1 st WEEK	2 nd WEEK	3 rd WEEK	1 st WEEK	2 nd WEEK	3 rd WEEK
T ₀ Control	11.3	16.8	22.4	13.5	17.8	22.4
T ₁ ZnSO ₄ (0.5 M)	10.5	16.7	23.6	17.333	21.6	26.4

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T ₂	ZnSO ₄ (0.25M)	10	22.67	26.1	15.5	22	25.4
T ₃	MgSO ₄ (0.5 M)	13.0	15.8	28	9.5	14	26.5
T ₄	MgSO ₄ (0.25M)	11	15.5	23.1	17	24.2	25.1
T ₅	NaCl (0.5 M)	5.6	10	24	10.1	13.2	15.4
T ₆	NaCl (0.25M)	10.5	12.3	15.1	11	15.3	17.5
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	13.73	18.5	24.7	16	21	23.2
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	15.8	19.2	21.47	19	20	24.5
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	16.6	18.3	30.23	16.2	20.1	24
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	14	17.5	25.4	12.5	18.9	24.1
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	16	20.3	28.5	9.8	15.7	23.1
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	14.23	19.5	25.8	9	15.4	20.3
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	14	18.5	27.1	9	13.1	19.5
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	13.3	19	24.03	12	17	21.2
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	12	13	19.6	11.6	18.4	23.5
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	12.23	14.6	18.9	16.5	20.3	25.4
	CV	16.45	7.07	4.97	3.09	5.54	13.68
	S.E +	1.65	0.97	0.97	0.57	0.828	1.454

TABLE: 03 EFFECT OF DIFFERENT SALTS ON LEAF LENGTH OF ZEA MAYS

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st	2 nd	3 rd	1 st	2 nd	3 rd	
	WEEK	WEEK	WEEK	WEEK	WEEK	WEEK	
T ₀	Control	17.6	24.9	30.1	19.5	25.7	32.2
T ₁	ZnSO ₄ (0.5 M)	22.8	28.2	33.1	22.1	31.3	36.8
T ₂	ZnSO ₄ (0.25M)	21.67	30.4	32.9	20.5	29.567	35.2
T ₃	MgSO ₄ (0.5 M)	17.7	21.1	30	17.7	27	33
T ₄	MgSO ₄ (0.25M)	22	24	32.17	22.667	24.5	34.5
T ₅	NaCl (0.5 M)	13.6	19.9	32.33	14.6	18.9	23.6
T ₆	NaCl (0.25M)	14.7	19.8	25.4	12.3	16.5	22.2
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	18.6	26.8	28.2	25.4	29.1	36.8
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	25.5	29.8	36.9	25.3	32	38.5
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	17.5	26.53	34.4	23.733	30.3	35.9
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	15.7	23.4	31.2	24.8	30.2	34.7
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	18	26.1	36.6	17.3	25.5	33.4
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	17.3	31.2	38.83	18.1	28.9	34.5
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	15.7	19.8	26	18.333	23.4	31.4
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	18.2	23.97	26.5	18.4	27.3	33.2
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	22.07	25.9	29.8	18.4	23.2	30.8
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	14.6	22.3	27.9	22.4	28.6	33.1
	CV	18.49	4.81	3.82	13.66	3.80	2.14
	S.E +	1.42	0.979	0.975	2.19	0.830	0.573

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st	2 nd	3 rd	1 st	2 nd	3 rd	
	WEEK	WEEK	WEEK	WEEK	WEEK	WEEK	
T ₀	Control	1.9	2.4	2.9	1.6	2.1	2.8
T ₁	ZnSO ₄ (0.5 M)	2.1	2.4	3.24	1.867	2.5	3.3
T ₂	ZnSO ₄ (0.25M)	2.3	2.7	3.12	2.133	2.4	3.4
T ₃	MgSO ₄ (0.5 M)	1.94	2.43	2.833	1.7	2.5	2.9
T ₄	MgSO ₄ (0.25M)	1.83	1.97	3.167	2.2	2.733	3

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T ₅	NaCl (0.5 M)	1.37	1.9	2.567	1.2	1.6	2.1
T ₆	NaCl (0.25M)	1.7	2.2	2.61	1.1	1.6	1.9
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	1.9	2.3	2.667	1.7	2.3	2.8
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	2.133	2.2	2.867	1.8	2.6	3.3
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	2.2	2.4	2.63	1.9	2.4	3.4
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	2.067	2.933	3.13	2.3	2.7	3.5
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	2.133	2.23	2.95	1.5	2.4	2.9
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	2.033	2.133	2.76	1.6	2.4	3.1
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	1.76	2.03	2.867	1.1	1.7	2.6
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	1.25	1.9	2.133	1.5	2.2	2.4
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	1.933	2.14	2.5	1.7	2.3	2.9
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	2.27	2.43	2.86	2.2	2.967	3.1
	CV	24.42	17.62	14.47	17.59	17.21	16.53
	S.E +	0.379	0.324	0.32	0.518	0.326	0.420

TABLE: 05 EFFECT OF DIFFERENT SALTS ON FRESH SHOOT WEIGHT OF ZEA MAYS

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st	2 nd	3 rd	1 st	2 nd	3 rd	
	WEEK	WEEK	WEEK	WEEK	WEEK	WEEK	
T ₀	Control	6.282	7.218	8.965	6.056	7.667	9.185
T ₁	ZnSO ₄ (0.5 M)	7.712	8.7	10.09	6.722	9.074	10.519
T ₂	ZnSO ₄ (0.25M)	6.724	8.059	9.724	6.259	8.074	9.778
T ₃	MgSO ₄ (0.5 M)	6.212	7.518	9.176	5.944	7.574	9.278
T ₄	MgSO ₄ (0.25M)	7.165	7.729	9.088	6.852	8.426	9.500
T ₅	NaCl (0.5 M)	5.735	6.741	8.047	5.463	6.630	7.630
T ₆	NaCl (0.25M)	5.841	6.6	7.747	4.407	6.148	7.333
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	6.6	7.824	9.229	6.259	7.049	9.296
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	7.294	8.541	9.424	7.222	8.364	9.852
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	5.471	6.624	8.382	5.648	7.679	9.037
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	6.035	6.953	8.629	6.148	7.926	9.407
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	6.065	6.829	8.382	5.833	6.481	9.000
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	6.706	7.782	9.212	6.185	6.852	8.852
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	5.647	6.747	8.735	5.556	7.278	8.796
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	6	6.424	8.035	5.778	6.852	8.593
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	6.706	7.594	9.035	6.019	7.889	9.259
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	7.412	8.488	9.159	7.377	8.611	9.389
	CV	16.22	5.18	4.47	17.71	5.67	5.56
	S.E +	0.837	0.314	0.323	0.866	0.349	0.421

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st	2 nd	3 rd	1 st	2 nd	3 rd	
	WEEK	WEEK	WEEK	WEEK	WEEK	WEEK	
T ₀	Control	0.969	1.44	1.92	1.184	1.561	1.965
T ₁	ZnSO ₄ (0.5 M)	0.9	1.431	2.023	1.520	1.895	2.316
T ₂	ZnSO ₄ (0.25M)	0.857	1.943	2.237	1.360	1.930	2.228
T ₃	MgSO ₄ (0.5 M)	1.114	1.354	2.4	0.833	1.228	2.325
T ₄	MgSO ₄ (0.25M)	0.943	1.329	1.98	1.491	2.123	2.202
T ₅	NaCl (0.5 M)	0.48	0.857	2.057	0.886	1.158	1.351
T ₆	NaCl (0.25M)	0.9	1.054	1.294	0.965	1.342	1.535
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	1.177	1.586	2.117	1.404	1.842	2.035
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	1.354	1.646	1.84	1.667	1.754	2.149

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T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	1.423	1.569	2.591	1.421	1.763	2.105
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	1.2	1.5	2.177	1.096	1.658	2.114
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	1.371	1.74	2.443	0.863	1.377	2.026
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	1.22	1.671	2.211	0.789	1.351	1.781
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	1.2	1.586	2.323	0.789	1.149	1.711
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	1.14	1.629	2.06	1.053	1.491	1.860
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	1.029	1.114	1.68	1.018	1.614	2.061
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	1.049	1.251	1.62	1.447	1.781	2.228
	CV	19.08	9.26	8.84	21.82	8.99	8.52
	S.E ±	0.164	0.109	0.150	0.204	0.116	0.140

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st WEEK	2 nd WEEK	3 rd WEEK	1 st WEEK	2 nd WEEK	3 rd WEEK	
T ₀	Control	0.538	0.619	0.7684	0.507	0.642	0.770
T ₁	ZnSO ₄ (0.5 M)	0.661	0.746	0.8652	0.563	0.760	0.881
T ₂	ZnSO ₄ (0.25M)	0.576	0.691	0.8334	0.525	0.677	0.819
T ₃	MgSO ₄ (0.5 M)	0.532	0.644	0.7866	0.498	0.635	0.777
T ₄	MgSO ₄ (0.25M)	0.614	0.663	0.779	0.574	0.706	0.796
T ₅	NaCl (0.5 M)	0.492	0.578	0.6897	0.458	0.556	0.639
T ₆	NaCl (0.25M)	0.501	0.566	0.664	0.369	0.515	0.615
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	0.566	0.671	0.7911	0.525	0.591	0.779
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	0.625	0.732	0.8077	0.605	0.701	0.826
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	0.469	0.568	0.7185	0.473	0.643	0.757
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	0.517	0.596	0.7397	0.515	0.664	0.788
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	0.52	0.585	0.7185	0.489	0.543	0.754
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	0.575	0.667	0.7896	0.518	0.574	0.742
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	0.484	0.578	0.7487	0.466	0.610	0.737
T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	0.514	0.551	0.6887	0.484	0.574	0.720
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	0.575	0.651	0.7745	0.504	0.661	0.776
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	0.635	0.728	0.785	0.618	0.722	0.787
	CV	17.71	5.67	5.64	16.22	5.19	4.48
	S.E ±	0.154	0.662	0.075	0.149	0.562	0.579

TREATMENTS	VARIETY 1 (Raka-Poshi)			VARIETY 2 (Pak-Afgoi)			
	1 st WEEK	2 nd WEEK	3 rd WEEK	1 st WEEK	2 nd WEEK	3 rd WEEK	
T ₀	Control	0.077	0.088	0.110	0.167	0.220	0.277
T ₁	ZnSO ₄ (0.5 M)	0.094	0.107	0.124	0.214	0.267	0.326
T ₂	ZnSO ₄ (0.25M)	0.082	0.099	0.119	0.191	0.272	0.314
T ₃	MgSO ₄ (0.5 M)	0.076	0.092	0.112	0.117	0.173	0.327
T ₄	MgSO ₄ (0.25M)	0.088	0.095	0.111	0.210	0.299	0.310
T ₅	NaCl (0.5 M)	0.070	0.083	0.099	0.125	0.163	0.190
T ₆	NaCl (0.25M)	0.072	0.081	0.095	0.136	0.189	0.216
T ₇	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M)	0.081	0.096	0.113	0.198	0.259	0.287
T ₈	ZnSO ₄ (0.25M) + MgSO ₄ (0.5 M)	0.089	0.105	0.115	0.235	0.247	0.303
T ₉	ZnSO ₄ (0.5 M) + MgSO ₄ (0.25M)	0.067	0.081	0.103	0.200	0.248	0.297
T ₁₀	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M)	0.074	0.085	0.106	0.154	0.234	0.298
T ₁₁	ZnSO ₄ (0.5M) + NaCl (0.5M)	0.074	0.084	0.103	0.121	0.194	0.285
T ₁₂	ZnSO ₄ (0.25M) + NaCl (0.5M)	0.082	0.095	0.113	0.111	0.190	0.251
T ₁₃	ZnSO ₄ (0.5 M) + NaCl (0.25M)	0.069	0.083	0.107	0.111	0.162	0.241

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T ₁₄	ZnSO ₄ (0.25M) + NaCl (0.25M)	0.073	0.079	0.098	0.148	0.210	0.262
T ₁₅	ZnSO ₄ (0.5 M) + MgSO ₄ (0.5 M) + NaCl (0.5 M)	0.082	0.093	0.111	0.143	0.227	0.290
T ₁₆	ZnSO ₄ (0.25M) + MgSO ₄ (0.25M) + NaCl (0.25M)	0.091	0.104	0.112	0.204	0.251	0.314
	CV	7.48	2.33	2.09	8.20	1.33	1.12
	S.E ±	0.010	0.003	0.003	0.017	0.003	0.002

Conflict of interest

The authors declared absence of conflict of interest.

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