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Remediation of Salt Stress on Growth Parameters of Bina Dhan 8 by Fertilization Method

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Abstract: An experiment was conducted at the net house of Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka-1207 under pot-culture during the Boro season (December-June) of the year 2013-14 to study the reclamation of salinity by potassium fertilization methods. The experiment was conducted using 4 salinity levels (0, 4, 8 and 12 dS m^{-1}) and 4 potassium fertilization processes (K_1 = Total soil application of recommended dose of MoP fertilizer, K_2 = 1/3 rd foliar spray, 2/3rd soil application of recommended dose of MoP fertilizer, K_3 = 2/3rd foliar spray, 1/3rd soil application of recommended dose of MoP fertilizer, K_4 =Total foliar spray of MoP fertilizer). BINA dhan 8 was used as variety. Data were taken on plant height, number of leaves $hill^{-1}$, root length, dry weight of stem and root, number of effective tiller $hill^{-1}$ of the selected rice cultivar. Results deciphered that salinity adversely affected all the growth parameters of BINA dhan 8. Use of potassium alleviated the adverse effects of high salinity on rice plant till 8 dSm^{-1}. But at 12 dSm^{-1} rice plants did not survive. Most of the growth attributes varied significantly due to the different fertilization processes of potassium. Among them 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer gave better performances compared to others till 8 dSm^{-1}.

Key words: Salinity · Potassium · Foliar Fertilization · BINA dhan 8

INTRODUCTION

Rice (*Oryza sativa* L. spp. *indica*) is one of the top five major carbohydrate crops for the world's population, especially in Asia. It is a major staple food, supporting more than 3 billion people, comprising 50-80% of their daily calorie intake [1]. The present yield of rice is not sufficient to ensure the food security for the increasing population. In Bangladesh, there is no scope for horizontal expansion of land area; rather it will be decreased due to use of arable land for infrastructural development of increased population. It is one of the country's most threatened by sea-level rise and saltwater intrusion. In Bangladesh, about 30% of the cultivable land is in coastal areas where salinity is affected by tidal flooding during the wet season, direct inundation by storm surges and movement of saline ground and surface water and on the other introduction of irrigation with saline waters during the dry season [2, 3, 4]. Out of 2.85 m ha of the coastal and off-shore areas, about 1.0 m ha of which are affected by different degrees of soil salinity [5].

The deleterious effects of salinity on plant growth are associated with low osmotic potential of soil solution (water stress), nutritional imbalance, specific ion effect, or a combination of these factors [6]. Finck [7] suggested that deficiency of both K^+ and Ca^{2+} elements might play a significant role in plant growth depression in many saline soils. Addition of K to a saline culture solution and foliar fertilization soil has been found to increase the dry weight and K content of shoots with a corresponding decrease in Na content in rice. According to Yoshida [8] rice is sensitive to salinity especially during early seedling growth and flowering. Therefore, maintain a low Na/k ratio on the soil during these two critical stages may benefit the rice plants. The yield parameters, tiller number per plant and spikelet number per panicle, have proved most sensitive to salinity and are highly significantly correlated to final seed yield in rice cultivar under salt stress [9].

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Under saline condition the foliar fertilization is an effective method of providing a steady flow of nutrients, in combination with some traditional types of root-uptake fertilizers, to achieve better control of nutrients. Foliar application of nutrients is partially overcoming the negative effect of stress condition influencing root growth and absorption capacity [10, 11]. The advantages of foliar spray compared to soil fertilization include: immediate response, convenience of combination spray and comparatively low cost. In Bangladesh, the only feasible alternative is to increase the cultivated areas by bringing salt affected soils under cultivation with high yielding salt tolerant rice by foliar fertilization. But as far as the review of literature is concerned there are very few research works done on the effect of foliar fertilizer application on the production of rice in saline affected areas of Bangladesh. In this aspect, the present study was therefore undertaken to investigate the effect of foliar spray of K as a remediator of deleterious consequence of salinity on growth parameters of BINA dhan8.

MATERIALS AND METHODS

The experiment was conducted in pot-culture at the net house of Department of Agricultural Chemistry Sher-e-Bangla Agricultural University, Dhaka-1207 from November 2013 to October 2014 in two factors completely randomized design (CRD) with three replications each. One rice genotype (BINA dhan 8) with four levels of salinity viz. 0, 4, 8 and 12 dS m^{-1} designated as S_0, S_1, S_2 and S_3, respectively and 4 levels of K (total soil application of recommended dose of MoP fertilizer; ⅓ rd foliar spray & ⅔ rd soil application of recommended dose of MoP fertilizer; ⅔ rd foliar spray & ⅓ rd soil application of recommended dose of MoP fertilizer and total foliar spray of recommended dose of MoP fertilizer as K) with three replications were randomly assigned in 48 experimental plastic pots.

The soil of the experiment was collected from the field of Sher-e-Bangla Agricultural University (SAU) Farm. The soil was Shallow Red Brown Terrace soil under Tejgaon series belonging to the Agro-Ecological Zone 28 (Modhupur Tract). The soils were clay loam in texture with common fine medium distinct dark yellowish brown mottles. The collected soil was prepared according to Razzaque *et al.* [12]. Recommended doses of N, P and S @ 100 kg N from urea, 20kg P from TSP and 12 kg S from gypsum were applied respectively. The whole amount of TSP, gypsum and 1/3rd of urea were applied prior to final preparation of the pots. According to treatment rate, the whole amount of supplemental K (as KCl) was also added in the respective pots. Thereafter the pots containing soil were moistened with water. Six weeks-old seedlings were transplanted on the 22th January 2014 in the respective pots. Two weeks after transplanting the salt solutions were applied in each pot according to the treatments. To avoid osmotic shock, the required amount @ 640 mg per litre distilled water for 1 dS m^{-1} of salt solution was added in three equal installments on alternate days until the expected conductivity was reached. The salinity i.e. Electrical Conductivity (EC) of each pot was measured with a conductivity meter (Model-DiST 4 HANNA HI 98304) and the necessary adjustments of salinity were made. The remaining 2/3rd urea were top dressed at two equal divisions after 25 and 50 days of transplanting. The foliar application of K (as MoP) according to each treatment was done in every 10 days interval after two weeks of transplanting.

Plant height (cm) and number of leaves per hill was measure at 30, 60 and 90 days after transplanting (DAT) and number of effective tillers $hill^{-1}$, root length (cm), stem dry weight (g) and root dry weight (g) were measured at harvest according to Razzaque M.A. *et al*. [12].

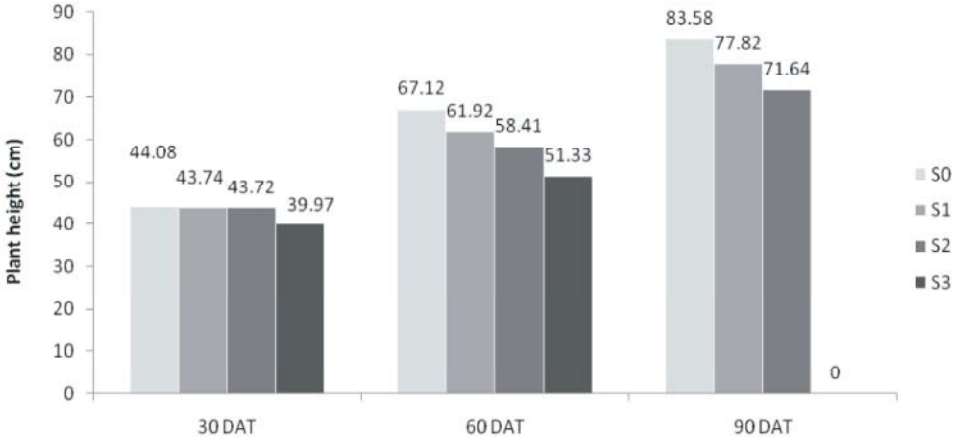
Statistical Analysis: The collected data were analyzed statistically following CRD design by MSTAT-C computer package programme developed by Russel [13]. The treatment means were compared by Least Significance Differences (LSD), or Duncans Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Plant Height

Effects of Salinity: The plant height of BINA dhan 8 decreased as the level of salinity increased due to the mean effect of different K applications (Fig. 1) at different days after transplanting (DAT). Among the different salinity levels, the highest plant height was observed at 0 dSm^{-1}. The plant height was maximum (44.08, 67.12 and 83.58 cm at 30 DAT, 60 DAT and at harvest respectively) by 0 dSm^{-1} and the shortest plant height (39.97, 51.33 and 0 cm) was obtained by 12 dSm^{-1} at 30 DAT, 60 DAT and at harvest.

Effects of Potassium (K): The plant height of BINA dhan 8 differed significantly due to the different types of K application over all the levels of salinity (Fig. 2). Among the different K application methods, the highest plant height at 30 DAT, 60 DAT and at harvest (46.72, 63.42 and



S_0=0 dSm^{-1}, S_1 = 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}

Fig. 1: Effects of salinity on plant height at different growth stages of BINA dhan 8.

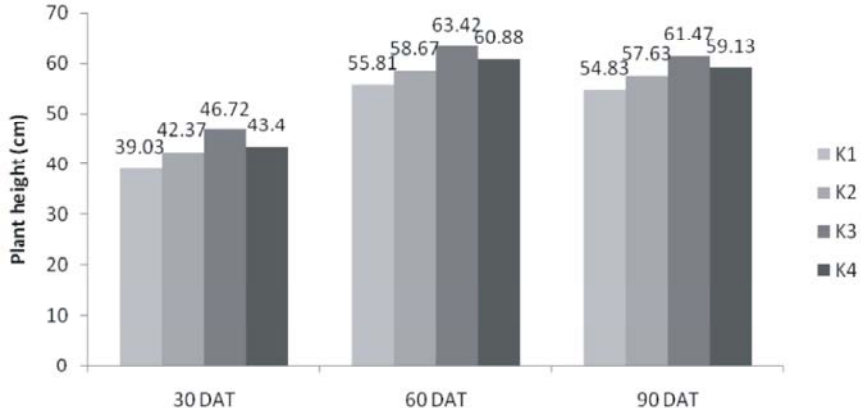


Fig. 2: Effects of different fertilization methods of potassium on plant height at different stages of BINA dhan 8. K_1 = Total soil application of MoP fertilizer, K_2=1/3 rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3 = 2/3 rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4=Total foliar spray of MoP fertilizer

61.47 cm respectively) was demonstrated by K_3 (2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) and the shortest plant (39.03, 55.81 and 54.83 cm) was obtained from K_1 (total soil application of MoP fertilizer) at all stages (Fig. 2).

Interaction Effects of Salinity and Potassium: The effect of different application methods of K on plant height of BINA dhan 8 at different salinity levels was found significant. At 30 DAT the highest plant height (47.9 cm) was recorded in S_2K_3 (8 dSm^{-1} treated with 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) while at 60 DAT and at harvest it was highest (72.07 and 87.40 cm) in S_0K_3 (0 dSm^{-1} treated with 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) treatment. At 30 and 60 DAT the lowest plant height (34.17 and 47.57 cm) was recorded in S_3K_1 (12 dSm^{-1} treated with total soil application of MoP fertilizer). At harvest it was lowest in all combinations where potassium treatments were treated with 12 dSm^{-1} salinity (0 cm) as no plant survived (Table 1).

These results are in agreement with that of Qadar [14] who found that the supplementation of K (30 kg K_2O ha^{-1}) in sodic soil increased plant height, shoot dry weight and grain yield of rice, where these growth and yield components of rice adversely affected by increasing the sodicity. The increasing levels of K application improved plant height, tiller numbers, shoot dry weight of both salt tolerant and susceptible cultivars and this beneficial effect of K application under saline conditions may be attributed to its influence on net photosynthesis [15].

Table 1: Interaction effect of salinity level and different fertilization methods of potassium on plant height and number of leaves hill^{-1} of BINA dhan 8

Treatment		Plant height (cm)			Number of leaves hill^{-1}		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
S_0	K_1	41.63d-g	62.53cd	80cd	23.33b	34.67c	14.33b
	K_2	42.73c-f	65.30c	82.37bc	26.33a	36.00c	17.67a
	K_3	46.87ab	72.07a	87.40a	26.67a	43.33a	19.00a
	K_4	45.10a-c	68.57b	84.57ab	26.33a	41b	17.67a
S_1	K_1	39.63g	57.93e-g	72.97ef	15fg	23d	11.33c
	K_2	43.87cd	62.13cd	77.33d	21.33c	17.67e	14.33b
	K_3	46.97ab	64.9c	82.40bc	22.67bc	23.33d	14.67b
	K_4	44.50bc	62.73cd	78.60cd	19.00d	22.33d	14.67b
S_2	K_1	40.70e-g	55.20g	66.33g	15.67fg	17e	3.33e
	K_2	42.80c-f	57.07fg	70.83f	18.67d	11g	3.67e
	K_3	47.9a	61.17de	76.07de	23.33b	14f	2.67e
	K_4	43.47c-e	60.20d-f	73.33ef	16.67ef	14f	5.33d
S_3	K_1	34.17h	47.57i	0h	14g	2.33i	0f
	K_2	40.07fg	50.17hi	0h	16f	2.67i	0f
	K_3	45.13a-c	55.57g	0h	18de	4.67h	0f
	K_4	40.53fg	52.00h	0h	15.67fg	3.67hi	0f
LSD		2.612	3.199	3.694	1.752	1.781	1.652
CV%		6.36	4.53	3.99	13.87	17.79	22.28
Level of significance		**	**	*	*	*	*

*=Significant at 5% level, **= Significant at 1% level

S_0=0 dSm^{-1}, S_1= 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}

K_1= Total soil application of MoP fertilizer, K_2=1/3rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3 rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4=Total foliar spray of MoP fertilizer

Number of Leaves Hill^{-1}

Effects of Salinity: Number of leaves hill^{-1} of BINA dhan 8 decreased as the level of salinity increased due to the mean effect of different sort of K applications (Fig. 3) at different days after transplanting (DAT). At 30 and 60 DAT and at harvest the highest number of leaves hill^{-1} (25.67, 38.75 and 17.17 respectively) was recorded in S_0 (0 dSm^{-1}). The lowest number of leaves hill^{-1} at 30 DAT, 60 DAT and at harvest(16.17, 3.33 and 0 respectively) was obtained from 12 dSm^{-1}.

Effects of Potassium (K): Number of leaves hill^{-1} of BINA dhan 8 differed significantly due to the different types of K application over all the levels of salinity (Fig. 4) in all stages except at harvest. The highest number of leaves hill^{-1} at 30 DAT, 60 DAT and at harvest (22.58, 21.33 and 9.417 respectively) was given by K_3 (2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) and the lowest number of leaves hill^{-1} (17.00, 16.83 and 7.25) was obtained K_1 (total soil application of MoP fertilizer) at all stages (Fig. 4).

Interaction Effects of Salinity and Potassium: The effect of different application methods of K on number of leaves hill^{-1} of BINA dhan 8 at different salinity levels was found significant. At 30 and 60 DAT and at harvest the highest number of leaves hill^{-1} (26.67, 43.33 and 19 respectively) was recorded in S_0K_3 (0 dSm^{-1} treated with 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer). At 30 DAT it was lowest (14) in S_0K_1 treatment (4 dSm^{-1} treated with total soil application of MoP fertilizer). At 60 DAT the lowest number of leaves hill^{-1} (2.33) was recorded in S_3K_1 (12 dSm^{-1} treated with total soil application of MoP fertilizer). At harvest it was lowest in all combinations where potassium treatments were treated with 12 dSm^{-1} salinity (0) as no plant survived (Table 1).

Root Length

Effects of Salinity: The root length of BINA dhan 8 decreased significantly as the level of salinity increased due to the mean effect of different K applications (Table 2). The root length was highest (32.25 cm) in 0 dSm^{-1} followed by 4 dSm^{-1} (29.50 cm) and the shortest roots length (20.17 cm) was obtained by 12 dSm^{-1} at harvest.

Effects of Potassium (K): The root length of BINA dhan 8 differed significantly due to the different sorts of K application over all the levels of salinity (Table 3). Among the treatments the highest root length (29.17 cm) was observed from K_3 (2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) which was closely

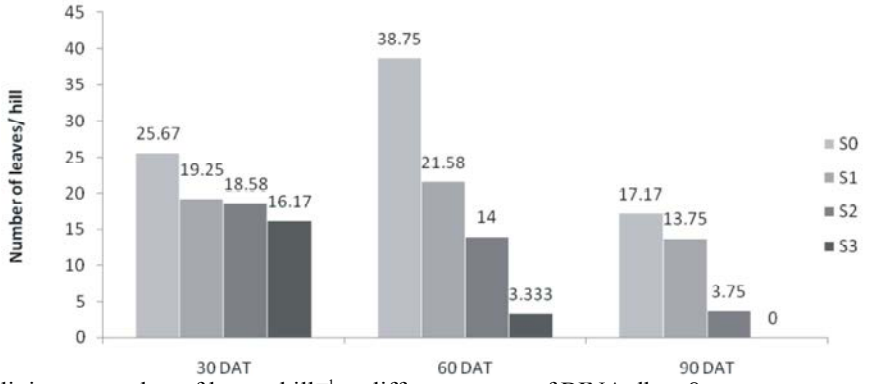


Fig. 3: Effects of salinity on number of leaves hill^{-1} at different stages of BINA dhan 8.
S_0=0 dSm^{-1}, S_1= 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}.

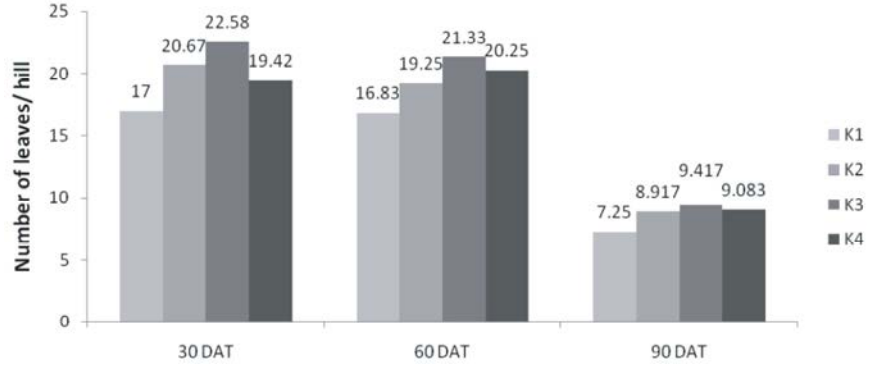


Fig. 4: Effects of different fertilization methods of potassium on number of leaves hill^{-1} at different stages of BINA dhan 8.
K_1= Total soil application of MoP fertilizer, K_2=1/3 rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4=Total foliar spray of MoP fertilizer

Table 2: The effect of different salinity levels on root length, dry weight of stem and dry weight of root of BINA dhan 8

Treatment	Root length(cm)	Dry weight of stem(g)	Dry weight of root(g)
S_0	32.25a	13.36a	9.067a
S_1	29.50ab	11.31a	5.724b
S_2	27.67b	6.744b	2.242c
S_3	20.17c	2.846c	0.5883d
LSD	2.938	2.944	1.373
CV%	8.26	23.63	6.53
Level of significance	**	*	**

*=Significant at 5% level, **= Significant at 1% level
S_0=0 dSm^{-1}, S_1= 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}

Table 3: The effect of different foliar and soil fertilization of potassium on root length, dry weight of stem and dry weight of root of BINA dhan 8

Treatment	Root length(cm)	Dry weight of stem(g)	Dry weight of root(g)
K_1	25.04b	8.205a	3.507b
K_2	27.29ab	8.043a	4.762ab
K_3	29.17a	9.060a	3.747ab
K_4	28.08a	8.954a	5.603a
LSD	2.497	2.417	1.322
CV%	8.26	23.63	6.53
Level of significance	**	*	*

*=Significant at 5% level, **= Significant at 1% level
K_1= Total soil application of MoP fertilizer, K_2=1/3 rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4=Total foliar spray of MoP fertilizer.

Table 4: Interaction effect of salinity level and different fertilization methods of potassium on root length, dry weight of stem and dry weight of root of BINA dhan8

Treatment		Root length (cm)	Dry weigh of stem (g)	Dry weight of root (g)
S_0	K_1	33a	11.33b	5.890c
	K_2	31.33a-c	13.10ab	6.980c
	K_3	32.33ab	15.39a	10.33b
	K_4	32.33ab	13.62ab	13.07a
S_1	K_1	27.67d	10.12bc	5.170cd
	K_2	30.00b-d	10.25bc	5.200cd
	K_3	30.33a-d	12.72ab	5.687c
	K_4	30.00b-d	12.16ab	6.840c
S_2	K_1	21.67ef	5.667d-f	2.057e
	K_2	28.33d	7.303cd	2.247e
	K_3	31.33a-c	6.647de	2.627de
	K_4	29.33cd	7.360cd	2.037e
S_3	K_1	17.83g	2.177g	0.3967e
	K_2	19.50fg	2.997fg	0.5633e
	K_3	22.67e	3.667e-g	0.9233e
	K_4	20.67ef	2.543fg	0.4700e
LSD		2.677	3.199	2.612
CV%		8.26	23.63	6.53
Level of significance		**	*	*

*=Significant at 5% level, **= Significant at 1% level

S_0 =0 dSm^{-1}, S_1 = 4 dSm^{-1}, S_2 =8 dSm^{-1} and S_3 =12 dSm^{-1}

K_1 = Total soil application of MoP fertilizer, K_2 = 1/3rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4 =Total foliar spray of MoP fertilizer

followed by and statistically similar with K_4 (28.08 cm) and K_2 (27.29 cm). The shortest root length (25.04 cm) was obtained from K_1 (total soil application of MoP fertilizer.

Interaction Effects of Salinity and Potassium: The effect of different application methods of K on root length of BINA dhan 8 at different salinity levels was found significant. The highest root length (33 cm) was recorded in S_0K_1 (0 dSm^{-1} treated with total soil application of MoP fertilizer) which was statistically same with S_0K_3 (32.33 cm), S_0K_4 (32.33 cm), S_0K_2 (31.33 cm), S_2K_3 (31.33 cm) and S_1K_3 (30.33 cm). Root length was found lowest (17.83 cm) in S_3K_1 (12 dSm^{-1} treated with total soil application of MoP fertilizer) which was statistically same with S_3K_2 (19.50 cm) (Table 4).

Dry Weight of Stem

Effects of Salinity: The dry weight of stem (g) of BINA dhan 8 decreased significantly as the level of salinity increased (Table 3). Among the different salinity levels the highest dry weight of stem (13.36 g) was found in 0 dSm^{-1} which was statistically similar and closely followed by 4 dSm^{-1} (11.31 g) and the lowest stem dry weight (2.846 g) was obtained by 12 dSm^{-1} at harvest.

Effects of Potassium (K): The dry weight of stem of BINA dhan 8 differed non-significantly due to the different sorts of K application over all the levels of salinity (Table 3). Though the highest dry weight of stem (9.060 g) was found in K_3 (2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) which was closely followed by K_4 (8.954 g) and K_2 (8.205 g). The lowest stem dry weight (8.043 g) was obtained from K_1 (total soil application of MoP fertilizer).

Interactive Effects of Salinity and Potassium: The effect of different application methods of K on stem dry weight of BINA dhan 8 at different salinity levels was found significant. Among all the treatments the highest stem dry weight (15.39 g) was recorded in S_0K_3 (0 dSm^{-1} treated with 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) which was statistically same with S_0K_2 (13.10 g), S_0K_4 (13.62 g), S_1K_4 (12.72 g) and S_1K_1 (12.16 g). The lowest stem dry weight (2.177 g) was found in S_3K_1 (12 dSm^{-1} treated with total soil application of MoP fertilizer) which was closely followed by S_3K_4 (2.543 g) (Table 4). It was observed that, in all salinity levels, foliar K application incorporated with soil fertilization increased the dry weight of stem than sole foliar or soil application of potassium.

Dry Weight of Root

Effects of Salinity: The dry weight of root (g) of BINA dhan 8 decreased significantly as the level of salinity increased (Table 2). Dry weight of root was highest (9.067 g) in 0 dSm^{-1} which followed by 4 dSm^{-1} (5.724 g) and the lowest root dry weight (0.588 g) was obtained from 12 dSm^{-1} at harvest.

Table 5: The effect of different salinity levels on number of effective tillers hill^{-1} of BINA dhan 8

Treatment	S_0	S_1	S_2	S_3	LSD	CV%	Level of significance
Number of effective tillers hill^{-1}	6.833a	6.583a	2.250b	0.0c	1.158	24.44	**

**= Significant at 1% level

S_0=0 dSm^{-1}, S_1= 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}

Table 6: The effect of different foliar and soil fertilization of potassium on number of effective tillers hill^{-1} of BINA dhan8.

Treatment	K_1	K_2	K_3	K_4	LSD	CV%	Level of significance
Number of effective tillers hill^{-1}	3.333b	3.833a	4.500a	4.000a	1.660	24.44	*

*=Significant at 5% level, K_1 = Total soil application of MoP fertilizer, K_2 =1/3rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4 =Total foliar spray of MoP fertilizer

Table 7: Interaction effect of salinity level and different fertilization methods of potassium on number of effective tillers hill^{-1} of BINA dhan 8

Treatment		Number of effective tillers hill^{-1}
S_0	K_1	6.000b
	K_2	7.000ab
	K_3	8.333a
	K_4	7.333ab
S_1	K_1	5.667b
	K_2	6.000b
	K_3	6.000b
	K_4	7.333ab
S_2	K_1	1.667cd
	K_2	2.333c
	K_3	2.667c
	K_4	2.333c
S_3	K_1	0.0d
	K_2	0.0d
	K_3	0.0d
	K_4	0.0d
LSD		1.742
CV%		24.44
Level of significance		*

*=Significant at 5% level, **= Significant at 1% level

S_0=0 dSm^{-1}, S_1= 4 dSm^{-1}, S_2=8 dSm^{-1} and S_3=12 dSm^{-1}

K_1 = Total soil application of MoP fertilizer, K_2 = 1/3rd foliar spray, 2/3rd soil application of total MoP fertilizer, K_3= 2/3rd foliar spray, 1/3rd soil application of total MoP fertilizer, K_4 =Total foliar spray of MoP fertilizer

Effects of Potassium (K): The dry weight of root of BINA dhan 8 differed significantly due to the different sorts of K application over all the levels of salinity (Table 2). The highest dry weight of root (5.603 g) was found in K_4 (Total foliar spray of MoP fertilizer) which was statistically same with K_3 (4.762 g) and K_2 (3.747 g). The lowest root dry weight (3.507 g) was obtained from K_1 (total soil application of MoP fertilizer).

Interactive Effects of Salinity and Potassium: The effect of different application methods of K on root dry weight of BINA dhan 8 at different salinity levels was found significant. The highest root dry weight (13.07 g) was recorded in S_0K_4 (0 dSm^{-1} treated with total foliar spray of MoP fertilizer) while lowest root dry weight (0.3967 g) was found in S_3K_1 (12 dSm^{-1} treated with total soil application of MoP fertilizer) which was closely followed by S_3K_4 (0.4700 g) (Table 4). It was observed that, in all salinity levels, foliar K application incorporated with soil fertilization increased the root dry weight than sole soil application of potassium.

Our results corroborate with that of Qadar [14] who found that application of P or P + K fertilizers at sodic soil significantly increased root and shoot dry weights of rice cultivars. Ebrahimi *et al.* [16] found that dry weight was significantly (P<0.05) affected by salt levels, methods of potassium application and the interaction of both (P<0.01).

Number of Effective Tillers Hill^{-1}

Effects of Salinity: It was observed that, as the salinity level increased, the number of effective tillers hill^{-1} decreased significantly (Table 5). Highest number of effective tillers hill^{-1} was recorded in S_0 (6.833) which was statistically same with S_1 (6.583) and lowest number of effective tillers hill^{-1} (0) was found from S_4.

Effects of Potassium (K): Different methods of MoP application not showed any significant variation among them for number of effective tillers hill^{-1}. Though the highest number of effective tillers hill^{-1} (4.500) was recorded in K_3 (2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) followed by K_4 (Total foliar spray of MoP fertilizer) (4.000) and lowest was in K_1 (total soil application of MoP fertilizer) (3.333) (Table 6).

Interactive Effects of Salinity and Potassium: The effect of different application methods of K on number of effective tillers hill^{-1} of BINA dhan 8 at different salinity levels was found significant. The highest number of effective tillers hill^{-1} (8.333) was recorded in S_0K_3 (0 dSm^{-1} treated with 2/3rd foliar spray and 1/3rd soil application of total MoP fertilizer) which was statistically same with S_0K_4

(7.333), S_1K_4(7.333), S_0K_2(7.000) and S_0K_2(7.000). Lowest number of effective tillers hill^{-1} (0) was found in combinations of 12 dSm^{-1} treated with all sort of application of MoP fertilizer as no plant survived (Table 7). It was observed that, in saline soil foliar application of K along with soil fertilization increased the number of effective tillers. Ebrahimi *et al*. [16] also found that foliar application of 2/3rd K and 1/3rd soil application of K significantly increased the number of effective tillers hill^{-1} in saline soil (EC= 6 dSm^{-1}).

These results corroborate with that of Qadar [14] who found that application of P or P + K fertilizers at sodic soil significantly increased effective tiller hill^{-1} of rice cultivars. The results are also in agreement with those reported by Mohiti *et al*. [17].

CONCLUSION

From this study it was observed that salinity adversely affected all the growth attributes of BINA dhan 8. It was found that 2/3rd foliar application alone with 1/3rd soil application of recommended dose of potassium most significantly alleviated the adverse effects of high salinity till 8dSm^{-1} on BINA dhan8 and improved all traits mentioned above.

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