Quantitative and qualitative responses of rice genotypes (*Oryza Sativa*) to salinity levels of drained water

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Abstract
High quality water deficiency and consecutive drought obligate use of uncommon water. Therefore evaluation of tolerance potential of crops to stress is necessary. However, responses of four rice varieties (G28, Rahmatabadi, Hassani, and Shahpasand) to four salinity levels water for irrigated (control, 4, 6, and 8dS/m) investigated. This study was carried out in split experimental with based on RCBD with 3 replications for 3 years. Results showed that by increasing of salinity levels, mean weight of shoot dry matter, grain yield of paddy, and stubble weight decreased from 12100 to 4206, 4067 to 861, and 8036 to 3345 kg/ha respectively. Also, by increasing of salinity levels, plant height, total number of tiller, number of fruitful tiller, number of full grain per cluster, and kernel weight decreased from 88 to 65, 38 to 18, 24 to 9, 44 to 22, and 24.5 to 19.5 respectively. But number of hollow grain per cluster increased from 21 to 33. Responses of varieties was different, that G28 with foliage dry matter weight, grain yield, stubble weight, plant height, number of full and hollow grain per cluster, 9739, 3926, 5814 kg/ha, 84.1 cm, 48, and 13 was the best respectively. On the contrary, this indices for Hassani cultivar with 6080, 1376, 4704 kg/ha, 66.1 cm, 17, and 32 was the worst. Every four varieties with a view to quality affected from salinity, because gelatinization temperature was over the range of 3-5, and gel consistency below the range of 41-60. But Amylose percent was at the range of acceptable (20-25). In the meantime, G28 with gelatinization temperature of 5.6 and gel consistency of 30.5 is the best, but these indices at Hassani cultivar with 6.5 and 29.3 respectively is the worst. Amount of elements (N, P, K, Na, Cl, and Mg) of grain with 2.2, 0.46, 0.58, 0.123, 0.393, and 0.171 percent is the most at 8dS/m treatment respectively. By increasing of salinity amount of Mn decreased from 77 to 44, but Zn increased from 20 to 27mg/kg.

Introduction

Salinity is a major threat to crop productivity in Iran especially south of Iran. Deficiency of high quality water, and to appear of consecutive drought use of uncommon water is unavoidable. Salinity by reducing turgor, expanding tissues and osmotic regulation seriously effected on plant growth (Heidari and Mirzaie 2006).

Tolerance of plants isn't a constant characteristic and maybe at different stage of growth for various species will be different (Linghe and Shannon 2000). Percent of embryo settlement, dry weight of plant, and rice yield, significantly decreased with increasing of salinity (6). Rice plant is moderately tolerance to salinity at seedling stage and the embryo stage is high sensitive, and again at vegetative growth stage is resistant, also at pollination stage become sensitive, and at ripening stage to become exceedingly tolerance (Lang *et al.* 2001a, Lang *et al.* 2001b, and Moradi 2002). By increasing salinity levels (1-16 dS/m) germination, plant settlement, wet and dry matter of shoot and root decreased and Na and Cl of leaf 5 and 3 times of control treatment at 16 dS/m respectively, and K of leaf abut 40 percent decreased, but Ca and Mg isn't affected (Shannon *et al.* 1998).

Salinity significantly effected on grain yield, plant settlement, and grain weight per plant and per cluster, number of spikelet per cluster, but no significantly effect on compression of cluster, kernel weight, shoots weight (Zeng and Shannon 2000). Gain *et al.* (2004) showed that plant height and plant biomass reduced significantly from 7.81dS/m salinity. Salinity tolerance rice genotypes had better expression of morphological characters than the salinity susceptible under saline condition, and salinity above 3dS/m sharply reduced all growth characters (Razzaque *et al.* 2009).In spite of spread study on rice and salinity, there aren't enough quantities information's about rice cultivars threshold of responses. Therefore aim of this study is to search the possibility of some salinity tolerance cultivar for successfully rice producing with brackish water.

Materials and methods

In this research responses of 4 varieties of G28, Rahmatabadi, Hassani and shahpasand to 4 levels of irrigation water salinity including: control (no brackish), 4, 6 and 8 dS/m at split plot experimental with based on randomized complete block design with 3 replication, during 3 years was investigated. Experimental plots besieged with galvanize sheet iron and salinity treatments to exert by mixture and composed of drained water with irrigation water. Salinity of water under rice plant controlled with portable EC meter. Growth, yield and yield component including: total shoot weight, grain yield, stubble weight, plant height, cluster length, total number of tiller, fruitful tillers, sterile tillers, number of full and hollow grain per cluster, kernel weight, amount of nutrient elements in grain including: N, P, K, Ca, Mg. Na, Cl, Fe, Zn, Cu, Mn, and quality characteristics of rice including Amylase percent, gelatinization temperature, and gel consistency measured and investigated.

Results and Discussion

Mean soil test result at different experimental plots showed in table1.

Table1. Mean soil test result at different experimental plots

pH	SP %	EC	K(mg/kg)	P(mg/kg)	OC %	N%	Sand%	Silt%	Clay%	TNV %
7.58	49	1.63	313	12.5	1.01	0.1	12.9	42	45.1	39

Mean comparison of paddy yield and yield components under affected of salinity level treatments, showed in table 2.

Table2. Mean comparison of salinity levels affected on yield and yield component of rice plant.

Treatments	Total foliage weight per ha	Grain yield per ha	Stubble weight per ha	plant height	Total number of tiller	Number of fruitful tiller	Number of full grain per cluster	Number of hollow grain per cluster	Kernel weight
Control	12100A**	4067A**	8036A**	88A**	38A**	24A**	44A**	21B**	24.5A**
4 dS/m	9851B**	2859B**	6992A**	83B**	38A**	23B**	42B**	22B**	23.2A**
6 dS/m	7531C**	2209B**	5321B**	79B**	25B**	15B**	35B**	25B**	23.1B**
8 dS/m	4206D**	861.3C**	3345C**	65C**	18C**	9C**	22C**	33A**	19.5C**

Table2 showed that by increasing of salinity levels mean foliage weight, paddy grain yield, stubble weight, plant height, total number of tiller, number of fruitful tiller, number of full grain per cluster, and kernel weight decreased, but number of hollow grain increased, that indicating bad effect of salinity on pollination of paddy. Maximum yield of paddy obtained from no saline water and its minimum obtained from 8dS/m treatment, and salinity levels of 4 and 6dS/m was intermediate.

Mean comparison paddy yield and yield components of different varieties of under affected of salinity treatments showed in table 3.

Table3. Mean comparison of different rice varieties yield and yield components under salinity effects.

Treatments	Total weight of foliage per ha	Grain yield per ha	Stubble weight per ha	plant height	Number of full grain per cluster	Number of hollow grain per cluster	Kernel weight
G28	9739A**	3926A**	5814BC**	84.1A**	48A**	13B**	19D**
Rahmatabadi	9014A**	2827B**	6187AB**	81.4A**	39B**	25A**	20.9C**
Hassani	6080B**	1376C**	4704C**	66.1B**	17C**	32A**	24.1B**
Shahpasand	8857A**	1868C**	6989A**	83.6A**	40AB**	31A**	26.3A**

Minimum total foliage weight, grain yield of paddy, stubble weight, plant height, and full grain per plant, obtained from Hassani. On the contrary maximum total foliage weight, grain yield, plant height, and number of full grain per cluster, obtained from G28 cultivar. After G28 cultivar, maximum grain yield obtained from Rahmatabadi, whereas Hassani and Shahpasand cultivars produced minimum grain yield. Maximum stubble yield obtained from Sahpasand, because this cultivar had good vegetative growth but its grain didn't become full. Minimum plant height and stubble yield obtained from Hassani because it's had low tolerance to salinity. Maximum full grain, minimum hollow grain, and maximum grain yield obtained from G28, and Shahpasand, Rahmatabadi, and Hassani had the less full grain, but for propose of hollow grain their had similar group.

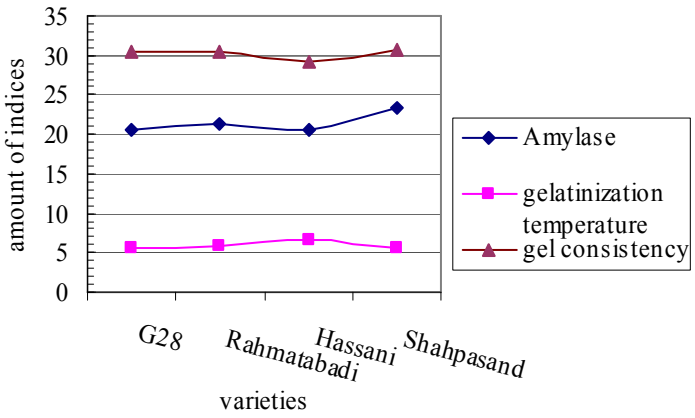

Figure1. Quality indices of different varieties under effected of salinity levels.

Suitable range of amylase percent is 20 to 25, and below from this amount, cooked rice is much sticky, and above from that rice is much hard. In this study amount of amylase of even 4 varieties was in the suitable range. But suitable range of gelatinization temperature index is 3-5, amounts of below from 3 means that threshold of converted to gel is upper and to take more boil, but number of more than 5 indicated rice at less degree of temperature converted to gel. In this research maximum amount of this index is 6.53 obtained from Hassani and amounts of 5.89, 5.63 and 5.56 obtained from Rahmatabadi, Shahpasand and G28 respectively.

Suitable range of gel consistency is 41-60, that number of below from 41 is indicating that rice after cooking will be hard. This index divided three stage of hard, medium, and soft. Analysis result of this research showed that amount of gel consistency for 4 varieties was below from 41. Therefore, rice after cooking will be hard. Nearest variety to suitable range was G28, and the worst variety was Hassani.

Grain nutrient elements were measured and its mean amounts under affected of salinity levels on different varieties investigated.

Table4. Mean comparison of salinity levels affect on amounts of nitrogen (N), Phosphorus (P), Potassium (K), Sodium (Na), Chlorite (Cl), Magnesium (Mg), Manganese (Mn), and Zinc (Zn).

Treatments	N (%)	P (%)	K (%)	Na (%)	Cl (%)	Mg (%)	Mn (mg/kg)	Zn (mg/kg)
Control	1.744B**	0.304C**	0.535AB*	0.013B**	0.154B**	0.148C*	77A**	20B**
4 dS/m	1.84AB**	0.35BC**	0.515AB*	0.015B**	0.159B**	0.158B*	65A**	25A**
6 dS/m	1.89AB**	0.366B**	0.473B*	0.027B**	0.213B**	0.142D*	44B**	25A**
8 dS/m	2.167A**	0.455A**	0.577A*	0.123A**	0.393A**	0.171A*	44B**	27A**

With due attention to table 4 by increasing of salinity levels amount of nitrogen, phosphorus, sodium, chlorite, and zinc at grain increased, but manganese decreased. Further, maximum amount of potassium obtained from 8dS/m, and minimum amount of K obtained from 6dS/m treatment.

Maximum amount of Na and Cl obtained from 8dS/m treatment, that high significantly different from other salinity treatments. Also maximum Mg obtained from 8dS/m treatment, but different between treatments are at 5 percent. Trend of variation of Mn and zn is completely inversed. By increasing of salinity amount of Mn decreased and the least amount of it's obtained from 8dS/m treatment. But Zn of grain increased with increasing of salinity levels, and its maximum amount obtained from no salinity water. Maximum amount of Fe obtained from G28 at 4dS/m treatment.

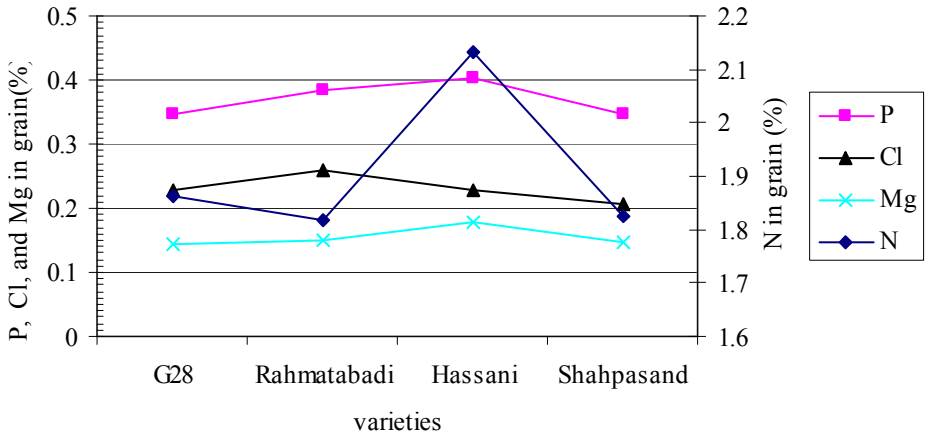

Figure2. Mean amounts of nutrient elements at grain of different varieties.

Maximum amount of nitrogen at grain observant in Hassani cultivar, that it's high significantly different from other cultivar. Also the most amount of Phosphorous was accumulated in Hassani grain. Maximum amount of chlorite accumulated in Rahmatabadi cultivar that it cultivated in brackish Corbal Area. The most amount of Magnesium accumulated in Hassani cultivar, and after it arrangement Rahmatabadi, and the less amount of this element there is in G28, and Shahpasand Cultivars.

Conclusion

Vast area in this region affected from salinity that cultivated paddy. There is lacking of suitable salinity tolerant rice Variety for south of Iran. Therefore, new research to find opportunity salinity resistant varieties with high quality and yield is necessary. In this research between 4 varieties G28 was better than others, because it is a native variety and agreeable for this region. The most sensitive varieties to salinity at this region was Hassani, and had the least yield and yield components. Shahpasand varieties had good vegetative growth, but at pollination stage was very sensitive to salinity, it can not to fill its grain. Quality and nutrient elements of rice grain affected from salinity, that between varieties G28 was the best and Hassani was the worst. Finally by increasing of salinity levels decreased quantity and quality of rice.

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