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Original article

Evaluation of emergence behavior of common millet (*Panicum miliaceum* L.) tumble pigweed (*Amaranthus albus* L.), lambsquarters (*Chenopodium album* L.) and purslane (*Portulaca oleracea* L.) under salinity stress

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Extended abstract

Introduction

Plants in arid and semi-arid regions are constantly exposed to environmental stresses such as salinity. The sensitivity of different plants to salinity stress at different growth stages is quite different. In many plants, perhaps the most sensitive stage of the plant growth cycle to salinity, is germination and emergence stages. Germination and emergence of seeds are the first important stages in plant establishment which is affected by most environmental stresses. In South Khorasan, which has saline soil and water, conventional millet cultivation is common, and it's most important weeds are lambsquarters, tumble pigweed and purslane. Since the irrigation of millet fields in this region of the country is performed with saline water, this experiment was conducted out to investigate the emergence response of millet and lambsquarters, tumble pigweed and purslane weeds, under sodium chloride salinity in Hoagland solution.

Materials and methods

In order to evaluate the effect of salinity stress on quality and emergence rate of common millet, lambsquarters, tumble pigweed and purslane, four separate experiments were conducted out in a randomized complete block design with three replications in 2017 in the research greenhouse of agricultural faculty at Birjand University. Experimental treatments consisted of 10 salinity levels including Hoagland solution with 2 dS/m as control, 4, 6, 8, 10, 12, 14, 16, 18 and 20 dS/m (created sodium chloride in Hoagland solution). Hoagland formula was used for preparation of nutrient solution and sodium chloride was used for preparation of different salinity levels. After filling each pot with 1.5 liters of acid washed sand, 25 seeds from each species were placed at 1 cm depth from soil surface. Seedling emergence were counted daily. In order to investigate the response of each species to salinity stress, the emergence percentage in each species was analyzed in a randomized complete block design without considering treatments with zero emergence percentage. Data analysis was performed using SAS software. GLM procedure was used for analysis of variance and comparison of mean performed with protected LSD at 5% probability level.

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Results and discussion

The results showed that common millet, purslane, tumble pigweed and lambsquarters seeds had the ability to germinate up to 20, 16, 12 and 12 dS/m, respectively. The start of emergence for common millet seeds up to 10 dS/m and tumble pigweed up to 8 dS/m was 3 days after sowing. Meanwhile, the seeds of lambsquarters emergence up to 6 dS/m on the fourth day, and purslane in 2 dS/m on the second day after sowing. Millet plants were emergence up to 18 dS/m salinity in the first five days after sowing. The results also showed that for common millet and tumble pigweed, no significant difference were observed for single seedling dry weight at 2 and 4 dS/m. Increasing salinity from 2 to 4 dS/m led to a significant decrease in purslane seedling dry weight but with increasing salinity stress from 4 to 8 dS/m, the reduction in seedling dry weight was not significant. In this study, with increasing salinity stress from 2 to 8 dS/m, dry weight of common millet, purslane, lambsquarter and tumble pigweed decreased by 55, 73.8, 80.7 and 79.5%, respectively. In this study, after ensuring that the seeds did not emerge, to determine the viability of non-emerged seeds, the pots were irrigated with distilled water. Under this condition, non-emerged millet seeds in the pots were not able to germinate at any levels of salinity stress. Purslane had no germination under salinity stress of 18 and 20 dS/m, but there were 34% and 62% emergence percentage respectively, when the salinity were terminated. Under mild stress, the percentage of germinated purslane seeds was 18% after recovery, which decreased with increasing salinity up to 12 dS/m and then increased.

Conclusion

In general, the results showed that salinity stress caused a change in the emergence behavior of millet and purslane, tumble pigweed and lambsquarters weeds. Common millet had the ability to germinate at all levels of salinity stress, but tumble pigweed and lambsquarters had the potential to emerge up to 12 dS/m and for the purslane up to 16 dS/m. Also, with increasing salinity stress from 8 to 16 dS/m, dry weight of seedling of common millet, purslane, tumble pigweed and lambsquarters decreased by 66, 82, 100 and 100 percent, respectively. At the end, the results showed that occurrence of salinity stress and its removal, the purslane seeds had a greater ability to keep their viability, whereas the common millet seeds completely lost their viability.

Keywords: Hoagland solution, Purslane, Sodium chloride, Stress recovery, Weeds

Table 1. Concentrations and salts used to prepare Hoagland Stoke solution

Compound		Molecular weight ($g.mol^{-1}$)	Concentration of stock solution		Volume of stock solution per liter of final solution (mL)
			mM	$g.L^{-1}$	
Macro-nutrients	KNO_3	101.10	1000	101.10	6
	$Ca(NO_3)_2.4H_2O$	236.16	1000	236.16	4
	$NH_4H_2PO_4$	115.08	1000	115.08	2
	$MgSO_4.7H_2O$	246.48	1000	246.49	1
Micro-nutrients	KCl	74.55	25	1.864	2
	H_3BO_3	61.83	12.5	0.773	
	$MnSO_4.H_20$	169.01	1	0.269	
	$ZnSO_4.7H_2O$	287.54	1	0.288	
	$CuSO_4.5H_2O$	249/68	0.25	0.062	
	H_2MoO_4 (85% MoO_3)	161.97	0.25	0.040	
	(10% Fe) NaFeDTPA	468.2	64	30	1-0.3

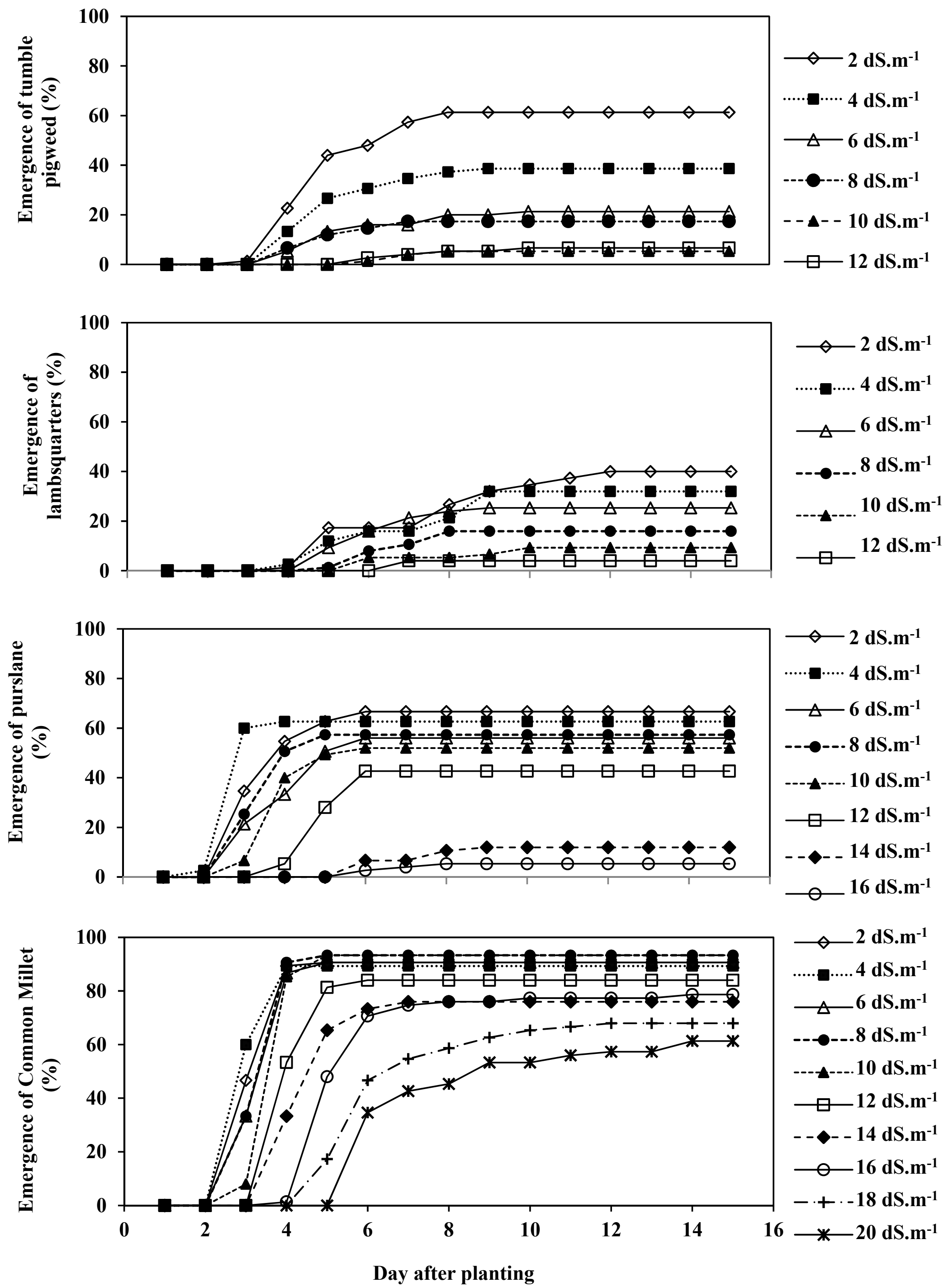

Fig. 1. Cumulative emergence of common millet, common purslane, lambsquarters and tumble pigweed under different levels of salinity stress

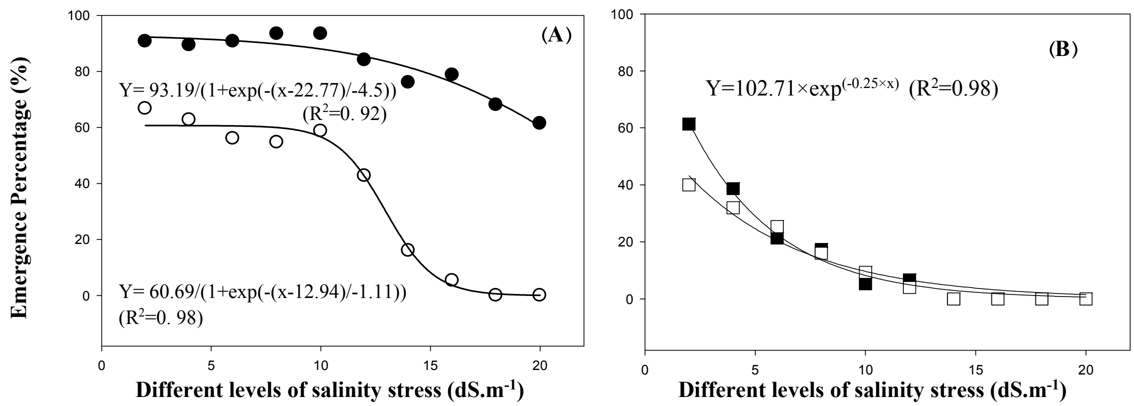

Figure 2: The effect of salinity on the seed emergence percentage. A: Common millet (●) and common purslane (○). The points represents the actual values of the measured traits and the drawn line represents the fitted Sigmoid model. B: tumble pigweed (■) and lambsquarters (□) the points represents the actual values of the measured traits and the drawn line represents the exponential reduced model.

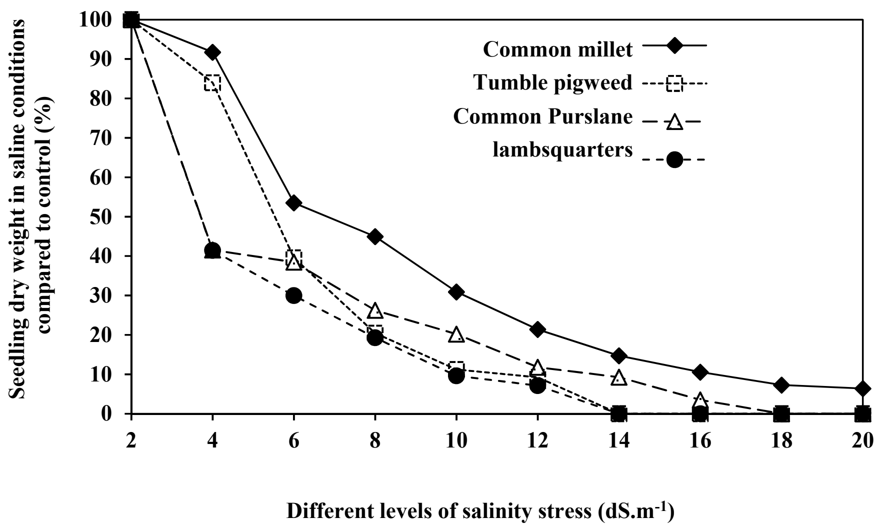

Fig. 3. Changes in dry weight of common millet, common purslane, lambsquarters and tumble pigweed in saline conditions compared to control in percentage

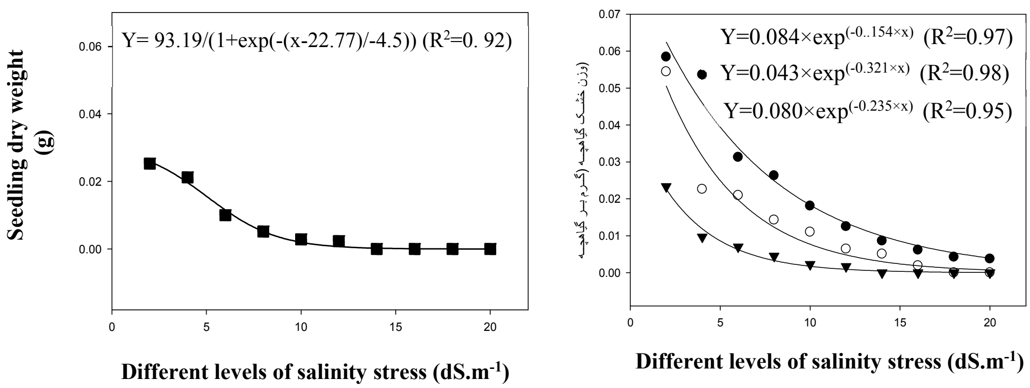

Fig. 4. Effect of salinity on seedling dry weight. A: tumble pigweed (■). The points represents the actual values of the measured traits and the drawn line represents the fitted sigmoid model. B: Common millet (●), common purslane (○) and lambsquarters (▼). The points represents the actual values of the measured traits and the drawn line represents the exponential reduced model.

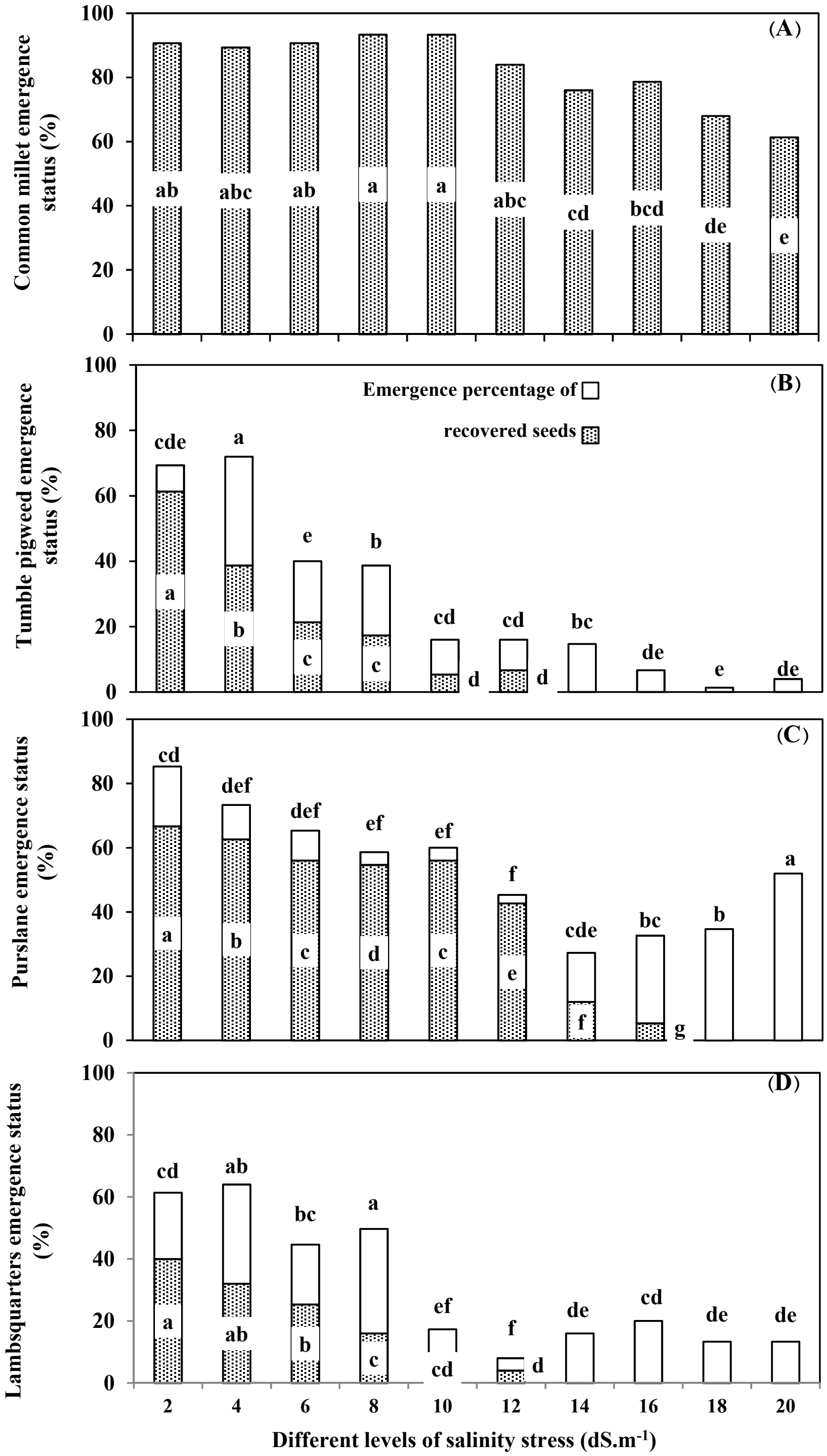

Fig. 5. Mean comparison of emergence percentage and emergence percentage of recovered seeds for the studied plants under the influence of different levels of salinity stress. A: Common millet, B: tumble pigweed, C: common purslane and D: Lambsquarters