



Germination and Seedling Growth of Sesame Cultivars Under Salinity Stresses

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Abstract

Among the most common abiotic stresses that retard the development and growth of plants is salt stress. This study examined the impact of various salt levels (NaCl and Na₂SO₄) on the germination behaviour of sesame cultivars. Under various simulated salt concentrations (0.05M, 0.01M, 0.15M, 0.2M, 0.25M, 0.3M, 0.35M, 0.4M, and 0.5M), the degree of salinity tolerance of two sesame cultivars, viz., GT-10 and JTS-8 were assessed. The radicle, hypocotyl length, and fresh weight measurements were made separately after 96 and 144 hours. The results revealed that germination and seedling growth drastically decreased as the salt concentration increased. In comparison to GT-10, JTS-8 exhibits greater tolerance to different NaCl concentrations and greater sensitivity to varying Na₂SO₄ concentrations.



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Keywords

Abiotic Stress;
Germination; Salt Stress;
Salinity Tolerance;
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Introduction

The first few months of seedling growth and seed germination are critical periods in the establishment of any plant species. Variations in temperature, water stress and light conditions significantly impact seed germination.¹ One of the leading environmental factors contributing to the degradation of agricultural land and a decline in crop productivity is soil salinity. Salinity is a crucial abiotic element that negatively impacts crops and yield.² High salinity reduces the osmotic potential of ambient soil water and tends to result in less water uptake by dry seeds. The process of seed germination ends when the radicle protrudes. Salt stress affects soil productivity and


crop yield in dry and semi-arid regions.³ Salinity stress has a significant negative effect on crop plants' physiology and performance, and as a result, growth is arrested, and metabolic damage results in plant death.⁴ Minimized dry matter accumulation by plants and grain production is the ultimate impact of salt stress on plants. When cultivated in salty soils, most plants accumulate high sodium (Na⁺) ions in their shoot tissues.

As a result, plants exhibit toxic consequences due to Na⁺ accumulation.⁵ In India, soil salinity is the most significant and enduring danger to irrigated agriculture. In India, over 6.74 million hectares

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of land have been reported to be salt affected with states of Gujrat, U.P., Maharastra, West Bengal and Rajasthan accounting for almost 75 % of saline soils in the country. Agricultural production is greatly affected by soil salinity. One of the oldest oilseed crops, Sesame (*Sesamum indicum* L.), is cultivated extensively in Africa and Asia for its nutritious seeds. Sesame is often referred to as the "Queen of Oil Seeds" due to its exceptional properties. For thousands of years, people have utilized it to make edible oil, paste, cakes, and confections.⁶ Taking into account the details as mentioned earlier, the investigation was conducted to evaluate the effect of salinity on two sesame varieties by assessing germination efficiency and seedling health under simulated salt stress conditions at laboratory conditions.

Materials and Methods

This investigation was performed in March 2020 using sterilized glass Petri dishes with a tight-fitting lids to examine the germination behaviour of sesame cultivars under different salt stresses. Sterilized filter paper lined with thin cotton pads was kept on the Petri dishes. For seed germination, filter sheets were utilized as a matrix. Seeds of two sesame cultivars (GT-10 and JTS-8) were obtained from the Bihar Agricultural University at Sabour in Bhagalpur. Both cultivars' uniformly sized seeds were picked, surface sterilized in a 2% sodium hypochlorite solution, and washed several times in distilled water. For two treatments, ten seeds were selected for each replicate. These filters were saturated with NaCl and Na₂SO₄ solutions of known concentrations (Control, 0.05M, 0.1M, 0.15M, 0.2M, 0.25M, 0.3M, 0.35M, 0.4M and 0.5M). We regarded the seeds to have germinated when the radicles began to emerge, and after soaking for 24 to 144 hours, these seeds were scored daily at definite intervals. The average germination rate was determined by averaging the results of several separate experiments. The radicle and hypocotyl lengths were measured individually in cm. 96 hours later. Radicles, hypocotyls, and cotyledons were measured on a digital balance for fresh weights. The Petri dishes were kept in the incubator at 28°C.

Results and Discussion

The NaCl solution significantly altered both cultivars' germination rate and early growth. A study showed that the germination rate for GT-10 dropped from

95% to 40%, and JTS-8 dropped from 60% to 15%. Seeds of both cultivars failed to germinate above a concentration of 0.2M NaCl solution. With an increased NaCl concentration, seedling length and fresh weight steadily decreased (table-1-3 and fig.-1&2). The JTS-8 showed more salt tolerance than GT-10 having maximum seedling fresh weight (8.594 mg) and seedling length (0.655 cm.), whereas GT-10 had a maximum (6.301 mg) and seedling length (0.87cm.) after 144 hours under 0.2 M NaCl solution concentrations.

Salt stress causes reduced seedling growth.^{7,8} After 96 hours of germination, seeds of both cultivars showed similar results, demonstrating that seeds could germinate well at lower concentrations of NaCl (0.05 M).⁹ Numerous studies have demonstrated that higher NaCl concentrations can reduce plant germination and growth.^{10,11,12,13} It was discovered that the deleterious effects of soil salinity on crops occur at critical growth stages and, in extreme cases, result in a reduction of the crop's overall yield.¹⁴

Table 1: Effect of Different NaCl Concentrations on the Germination percentage of Sesame Cultivars (GT-10 and JTS-8)
Germination %

Treatment	GT-10	JTS-8
Control	95	60
0.05M	65	40
0.1M	55	30
0.15M	50	20
0.2M	40	15
0.25M	---	---
0.3M	---	---
0.35M	---	---
0.4M	---	---
0.5M	---	---

Because of the Na₂SO₄ solution's stress, the germination percentage for GT-10 dropped from 95% to 15%, while for JTS-8, it dropped from 65% to 10%. (table-4-6 and fig.-3&4). In both cultivars, there is no germination above 0.3M concentration. For GT-10 and JTS-8, the seedling growth was shown up to 0.2 M concentration and 0.15 M concentration after 144 hours, respectively. Length and fresh weight of seedlings steadily decreased in both cultivars with an increase in solution concentration.¹⁵

The JTS-8 exhibited a more severe effect that could not tolerate beyond 0.15 M salt concentration than GT-10. In this regard, it was observed that in most cases, the stress, whether it might be from NaCl or Na₂SO₄, adversely affected elongates of radicle.¹⁶ They also discovered the deleterious impact of stress and took note of the variation in chloride

or sulphate ion magnitude. Due to the harmful effects of NaCl and Na₂SO₄ and the seedling's unbalanced nutritional intake, radicle length and weight decreased. Numerous researchers have found that crop seedlings grow more slowly under situations of salt stress, supporting the conclusion of this study.¹⁷⁻²¹

Table 2: Effect of Different NaCl Concentrations on the Seedling length of Sesame cultivars (GT-10 and JTS-8)

Treatment	Seedling length (cm) after 96 hrs.						Seedling length (cm) after 144 hrs.					
	GT-10			JTS-8			GT-10			JTS-8		
	R	H	T	R	H	T	R	H	T	R	H	T
Control	4.544	3.133	7.677	9.101	5.583	14.684	4.281	3.883	8.164	5.95	3.54	9.49
0.05M	2.902	1.056	3.958	6.483	3.605	10.088	3.694	1.398	5.092	3.616	1.32	4.937
0.1M	2.713	0.935	3.648	5.288	1.613	6.901	3.261	0.852	4.113	1.651	0.43	2.077
0.15M	1.665	0.665	2.32	2.034	0.676	2.71	0.649	0.193	0.842	0.796	0.35	1.142
0.2M	0.857	0.425	1.282	1.322	0.581	1.903	0.687	0.183	0.87	0.629	0.03	0.655
0.25M	---	---	---	---	---	---	---	---	---	---	---	---
0.3M	---	---	---	---	---	---	---	---	---	---	---	---
0.35M	---	---	---	---	---	---	---	---	---	---	---	---
0.4M	---	---	---	---	---	---	---	---	---	---	---	---
0.5M	---	---	---	---	---	---	---	---	---	---	---	---

(R= Length of Radicle , H=Length of Hypocotyl , T=Total)

Table 3: Effect of Different NaCl Concentrations on the Seedling Fresh Weight of Sesame cultivars (GT-10 and JTS-8)

Treatment	Seedling fresh wt. (mg) after 96 hrs.						Seedling fresh wt. (mg) after 144 hrs.					
	GT-10			JTS-8			GT-10			JTS-8		
	R	H	T	R	H	T	R	H	T	R	H	T
Control	6.444	14.333	20.777	22.492	15.982	38.474	8.833	15.0	23.333	7.0	17.1	24.1
0.05M	3.743	13.613	17.356	13.5	11.833	25.335	3.888	14.245	18.133	4.512	11.885	16.397
0.1M	2.142	13.501	15.643	11.257	10.534	21.791	2.508	11.117	13.625	4.511	11.111	15.622
0.15M	2.871	12.25	15.121	2.989	10.092	13.081	0.275	9.619	9.894	4.281	8.650	12.931
0.2M	1.961	6.761	8.722	0.455	1.473	11.928	0.196	6.105	6.301	2.489	6.105	8.594
0.25M	---	---	---	---	---	---	---	---	---	---	---	---
0.3M	---	---	---	---	---	---	---	---	---	---	---	---
0.35M	---	---	---	---	---	---	---	---	---	---	---	---
0.4M	---	---	---	---	---	---	---	---	---	---	---	---
0.5M	---	---	---	---	---	---	---	---	---	---	---	---

(R= Length of Radicle , H=Length of Hypocotyl , T=Total)

Table 4: Effect of Different Na₂SO₄ concentrations on the Germination percentage of Sesame Cultivars (GT-10 and JTS-8)
Germination %

Treatment	GT-10	JTS-8
Control	95	65
0.05M	65	50
0.1M	60	45
0.15M	50	30
0.2M	40	25
0.25M	35	20
0.3M	15	10
0.35M	---	---
0.4M	---	---
0.5M	---	---

Table 5: Effect of Different Na₂SO₄ Concentrations on the Seedling length of Sesame cultivars (GT-10 and JTS-8)

Treatment	Seedling length (cm) after 96 hrs.						Seedling length (cm) after 144 hrs.					
	GT-10			JTS-8			GT-10			JTS-8		
	R	H	T	R	H	T	R	H	T	R	H	T
Control	4.629	3.987	8.616	6.412	6.183	12.595	5.852	3.261	9.113	3.015	2.019	5.034
0.05M	3.676	3.612	7.288	6.235	3.316	9.551	2.868	0.909	3.771	2.768	1.123	3.891
0.1M	0.925	1.011	1.936	1.578	0.821	2.399	0.698	0.468	1.166	0.705	0.217	0.922
0.15M	0.719	0.953	1.672	1.034	0.48	1.514	0.397	0.126	0.523	0.164	0.096	0.26
0.2M	0.268	0.146	0.414	0.595	0.402	0.997	0.367	0.091	0.458	.....	....	....
0.25M	0.256	0.109	0.365	0.517	0.369	0.886	.....	....	...	...	....	...
0.3M	....	---	---	0.098	0.163	0.234	....	...	....	....	....	....
0.35M	---	---	---	---	---	---	....	...	....	....	....	....
0.4M	---	---	---	---	---	---	....	....	....	....	....	....
0.5M	---	---	---	---	---	---	....	....	....	....	....	....

(R= Length of Radicle , H=Length of Hypocotyl , T=Total

Table 6: Effect of Different Na₂SO₄ Concentrations on the Seedling Fresh Weight of Sesame cultivars (GT-10 and JTS-8)

Treatment	Seedling fresh wt. (mg) after 96 hrs.						Seedling fresh wt. (mg) after 144 hrs.					
	GT-10			JTS-8			GT-10			JTS-8		
	R	H	T	R	H	T	R	H	T	R	H	T
Control	6.513	20.325	26.838	22.384	12.843	35.227	6.141	16.341	22.48	7.982	15.957	23.939
0.05M	6.062	13.153	19.215	14.123	12.612	26.735	1.064	10.62	11.68	4.07	13.251	17.33

0.1M	0.858	10.331	11.189	4.037	9.988	14.025	0.851	7.842	8.693	1.334	8.293	9.627
0.15M	0.386	9.938	10.324	3.784	8.965	12.794	0.499	7.679	8.178	0.553	7.197	7.75
0.2M	0.316	9.631	9.947	1.873	7.527	9.4	0.254	7.352	7.606	....	....	....
0.25M	0.125	9.117	9.242	1.594	6.724	8.273	....	....	...	...	....	...
0.3M	---	---	---	0.949	5.615	6.564	....	...	....	....	....	....
0.35M	---	---	---	---	---	---	....	...	....	....	....	....
0.4M	---	---	---	---	---	---	....	....	....	....	....	....
0.5M	---	---	---	---	---	---	....	....	....	....	....	....

L= length of Radicle , H=Length of Hypocotyl , T=Total)

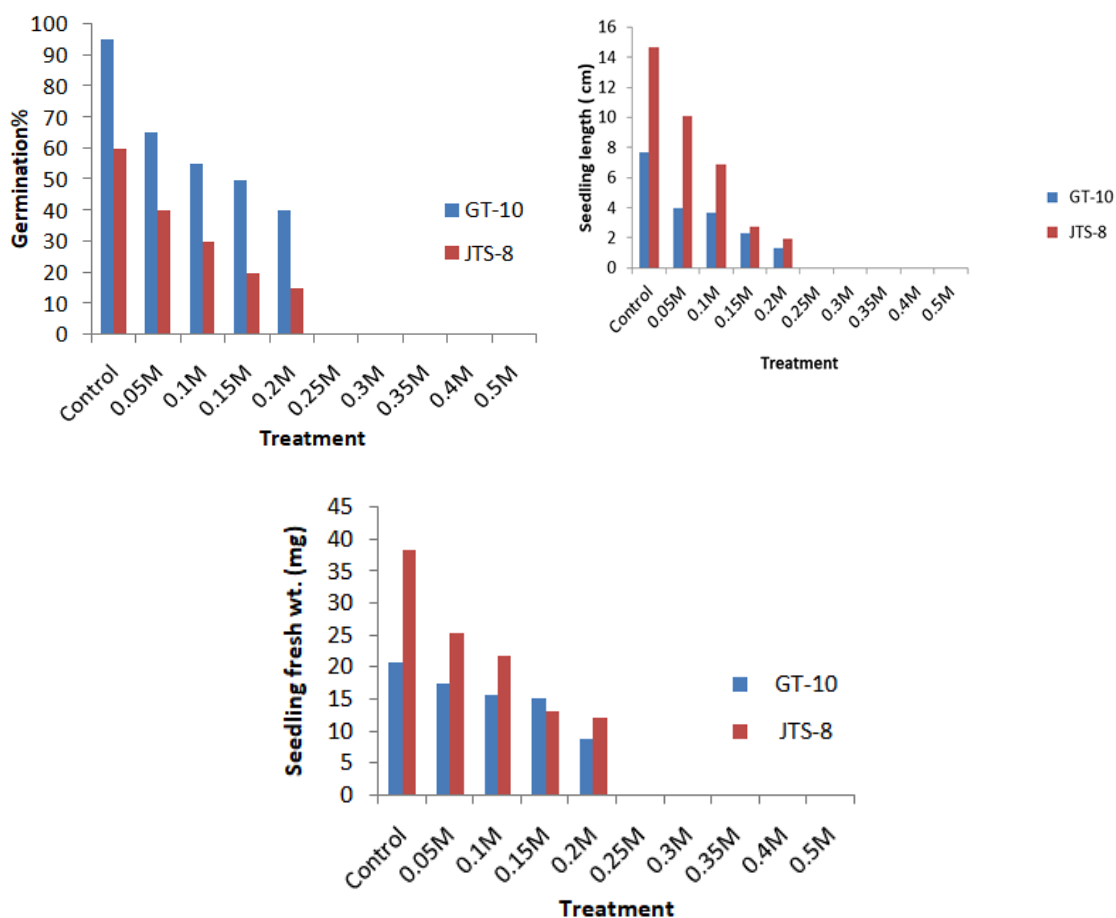


Fig.1: Effect of Different NaCl Concentrations on Germination Percentage (%), Seedling Length (cm) and Seedling Fresh Weight(mg) of Sesame Cultivars (GT-10 and JTS-8) after 96 hrs.

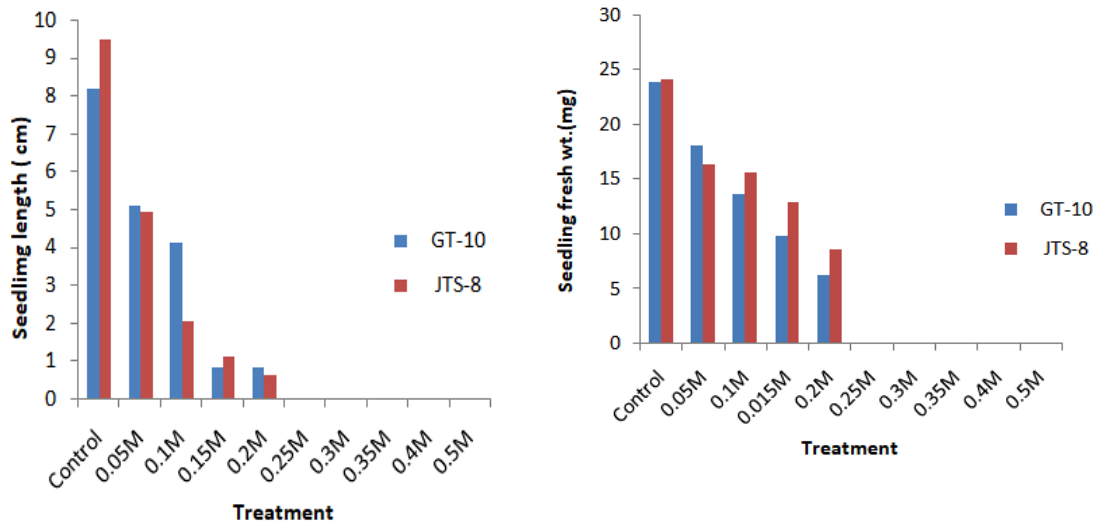


Fig. 2: Effect of Different NaCl Concentrations on Seedling Length (cm) and Seedling Fresh Weight (mg) of Sesame Cultivars (GT-10 and JTS-8) after 144hrs.

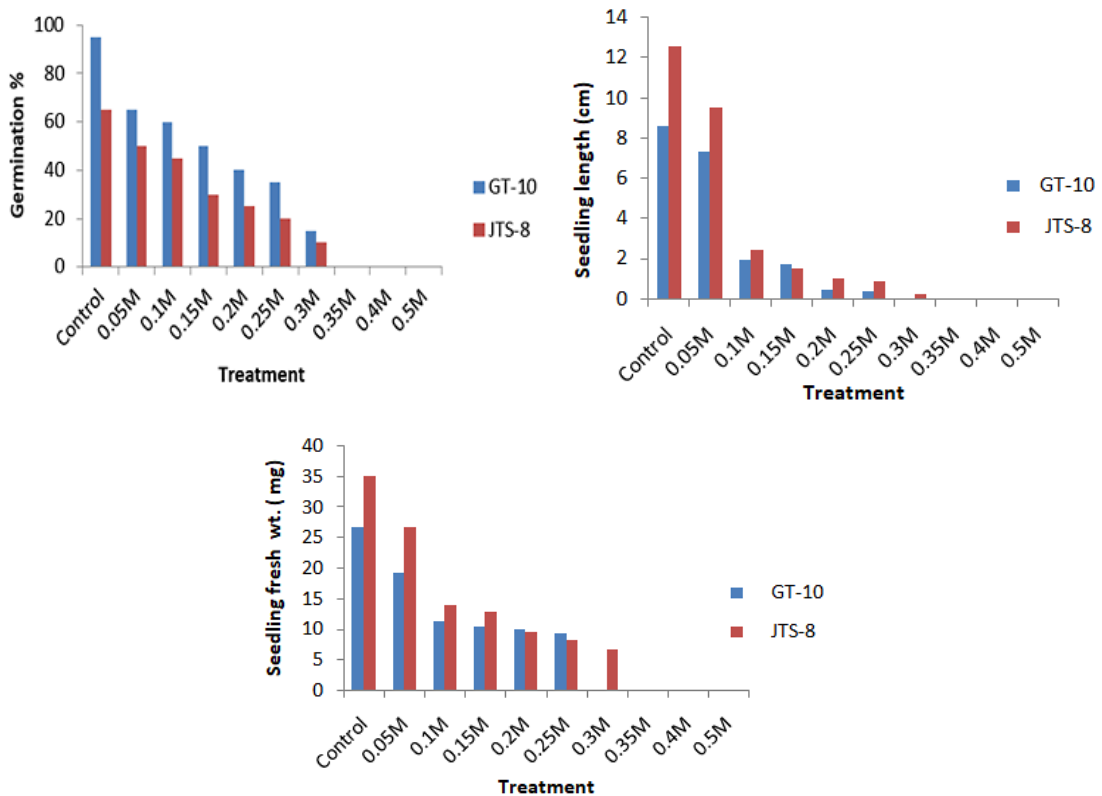


Fig. 3: Effect of Different Na₂SO₄ Concentration on Germination Percentage(%), Seedling Length (cm) and Seedling Fresh Weight (mg) of Sesame Cultivars (GT-10 and JTS-8) after 96 hrs.

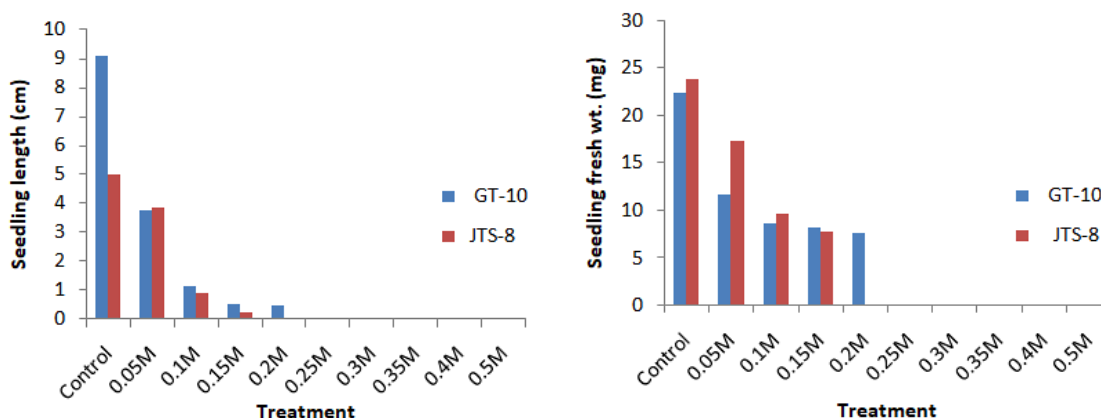


Fig. 4: Effect of Different Na₂SO₄ Concentrations on Seedling Length (cm) and Seedling Fresh Weight (mg) of Sesame Cultivars (GT-10 and JTS-8) after 144 hrs.

The behaviour of sorghum genotypes to different salt levels revealed that salinity was adverse to plant growth and development.²² The germination of oat plant seeds and vegetative growth were substantially inhibited by increased salinity.²³ In addition to the harmful effects of specific ions, it is also considered that increased salt concentrations lowered the water potential in media, affecting germination efficiency by preventing seeds from absorbing water. It is assumed that overall seed germination would decrease with a reduction in the water transport into seeds during water uptake. Osmotic potential caused by salinity stress might inhibit the water uptake by the root or seed, followed by poor seed germination. Osmotic stress or sodium ions toxicity may be responsible for the salt-induced reduction of seed germination. The results showed a substantial negative linkage between seed germination %, seed germination time, and salinity level.

Conclusion

Overall, it was possible to conclude that both *Sesamum indicum* L. cultivars developed satisfactorily under the control conditions. However, when salinity stress (NaCl and Na₂SO₄) was increased, seedling growth and development decreased, as did both varieties' germination percentages. The findings of

this investigation show that beyond the concentration of 0.2M NaCl, both seed germination percentage and seedling development are entirely inhibited. The JTS-8 variety was tolerable under various NaCl concentrations, however, GT-10 was more sensitive under various Na₂SO₄ concentrations.

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Conflict of Interest

There is no conflict of interest among the authors.

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