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Effect of NaCl Salt Stress on Germination and Seedling Growth of Black Gram (*Vigna mungo*)

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ABSTRACT

Background: Dehulled and split seeds of black gram (*Vigna mungo*) are used in the preparation of several dishes all over India. Salt stress is a troublesome issue in the arid and semi-dry areas and is seen as a critical constraint for growth and yield. It is very sensitive to salt especially during the seedling stage. Hence, a study was conducted to assess the impact of salt stress induced with NaCl on the germination and seedling growth of black gram.

Methods: The different levels of salt concentration (20 ppm, 40 ppm, 60 ppm, 80 ppm) were prepared in the laboratory. Selected black gram (ADT-6) seeds were sown in small poly pots (soil, sand and farmyard manure at 1:1:1 ratio) with 3 replications and irrigated with a respective dose of saline water. The distilled water (0 ppm) was used as a control. The germination (%), shoot length (cm) and root length (cm) in the black gram were recorded after two weeks. The inhibition effect was studied by the response index (RI) method.

Result: Increase in salt concentration diminished seed germination percentage, shoot length and root length of seedling and vigor index in black gram. Further, the response index indicated that all the salt concentration treatments had negative values.

Key words: Black gram, NaCl, Response index, Vigor index.

INTRODUCTION

Black gram [*Vigna mungo* (L.) Hepper] is the most important crop cultivated in all parts of the country. It contains high levels of protein, potassium, calcium, iron, niacin, thiamine and riboflavin. Because of its nourishing quality, black gram is called as King of Pulses. Salinity is quite possibly the most pressing issue of farmers on the agricultural land (Sivakumar and Priya, 2021). Almost 20% of the world's cultivated area and almost half of the world's irrigated lands are affected by salinity. Salinity stress is a difficult issue in arid and semi-arid tropics and is perceived as a significant limitation of harvest produce where 50 mM NaCl can cause yield misfortunes of more than 70% (Balachandran *et al.,* 2009). In India, about 6.73 Mha land is salt-affected. Black gram is extremely sensitive to salinity particularly at the early phase of development (Veeral *et al.,* 2018) and influences the capacity to use salt water which causes a decrease in germination and development rate just as plant metabolic cycles (Sunanda and Ranganayakulu, 2019). With this background, the present study was undertaken to assess the effect of salt (NaCl) on germination and seedling growth and development of black gram (*Vigna mungo*) along with the analysis of the response index.

MATERIALS AND METHODS

A laboratory study was conducted during June - August 2021 in the Department of Agronomy at JSA Agriculture College and Technology (Affiliated with Tamil Nadu Agricultural University), Avatti, Cuddalore district Tamil Nadu. The objective of the study was to assess the effect of different levels of salt (NaCl) concentration on seed germination and seedling growth and development of black gram (ADT-6). The seeds were treated by immersing it in solutions having varying concentration of NaCl (T1 - distilled water (control), T2-20 ppm, T3-40 ppm, T4-60 ppm and T5-80 ppm) for 3 hours. The pot culture study was set up as a completely randomized design with three replications. The NaCl experimental solutions were checked for their pH and EC (Table 1).

The treated seeds were sown in small poly pots (soil, sand and farmyard manure at 1:1:1 ratio) in the laboratory. The poly pot culture was kept in open and irrigated with the respective doses of saline water. Distilled water served as control. The germination (%), shoot length (cm), root length (cm) and vigour index (Standard germination (%) × seedling length (cm) (Abdul-Baki and Anderson, 1973) of black gram were recorded after 14 days. The effect of salt on germination, seedling growth and development of black gram was also rated in terms of the response index (RI)

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suggested by Richardson and Williamson (1988) is determined as follows:

if T > C, RI = 1 - (C/T)

if T = C, then RI = 0

if T < C, then RI = (T/C) – 1

Where, T is the treatment mean value and C is the control mean. A negative RI reflects the proportional disparity in output (germination (%), shoot length (cm) and root length (cm) of test crop in the treatment relative to output in the control. The results were subjected to analysis of variance (Gomez and Gomez, 1984) and mean RI values were tested for standard error.

RESULTS AND DISCUSSION

The germination percentage progressively diminished with increasing concentrations compared to control under salinity induced by NaCl concentration. The increased salinity diminished the germination as well as postponed the germination inception (Hajar *et al.,* 1996). The highest reduction of germination percentage was found at 80 ppm of NaCl (64.1±0.167). Growth of the seedling in terms of shoot length (4.38±0.021 cm) and root length (3.82±0.004 cm) was retarded significantly compared to the control (shoot length of 8.74±0.154 cm and root length of 5.92±0.020 cm). The difference between the 80 ppm of NaCl concentration over the distilled water (0 ppm of NaCl) is the germination percentage (35.6), shoot length (4.36 cm) and root length (2.1 cm) growing respectively (Table 2). The same result was revealed in the vigor index; the lowest index (524.63±11.74) was registered at 80 ppm of NaCl compared to the control which recorded the highest vigor index (1460.85±21.13). Hindrance or deferral in germination under saline conditions is because of an osmotic impact (Gosset *et al.,* 1994; El-Baz *et al.,* 2003). Which is restricts the take-up of water during seed germination by obstructing film or cytosolic catalysts and chemicals (Flowers *et al.,* 1986; Horoun, 2002). The presence of NaCl even at a low concentration enters the plant to break the osmotic capability of sprouting structures (Huang and Liu, 2002).

Seedling growth was retarded under the highest level of (80 ppm) salinity conditions due to salts accumulating in transpiring leaves at excessive levels, exceeding the ability of the cells to compartmentalize salts in the vacuole. The root was damaged and it takes time to recover from internal injury (Khatkar and Kuhad, 2000). A disturbance in mineral supply, either an excess or a deficiency, induced by changes in concentrations of specific ions in the growth medium,

Table 1: pH and EC of NaCl solution at varying concentrations.

Concentration	pH	EC (dS/m)
T1- 0 ppm of NaCl	7.1	2.9
T2- 20 ppm of NaCl	7.5	4.1
T3- 40 ppm of NaCl	7.7	6.9
T4- 60 ppm of NaCl	8.2	8.1
T5- 80 ppm of NaCl	8.7	8.7

Table 2: Effect of NaCl on germination (%), shoots length (cm), root length (cm) and vigour index of black gram.

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Vigour index
T1- Control (0 ppm)	99.7±2.470	8.74±0.154	5.92±0.020	1460.85±21.13
T2- 20 ppm of NaCl	89.0±0.185	7.74±0.137	5.48±0.077	1176.34±8.57
T3- 40 ppm of NaCl	79.0±0.329	4.76±0.107	5.04±0.050	773.99±9.67
T4- 60 ppm of NaCl	74.0±1.502	6.64±0.142	3.94±0.059	782.72±2.85
T5- 80 ppm of NaCl	64.1±0.167	4.38±0.021	3.82±0.004	524.63±11.74

Data are the mean values of three replicates with±standard error.

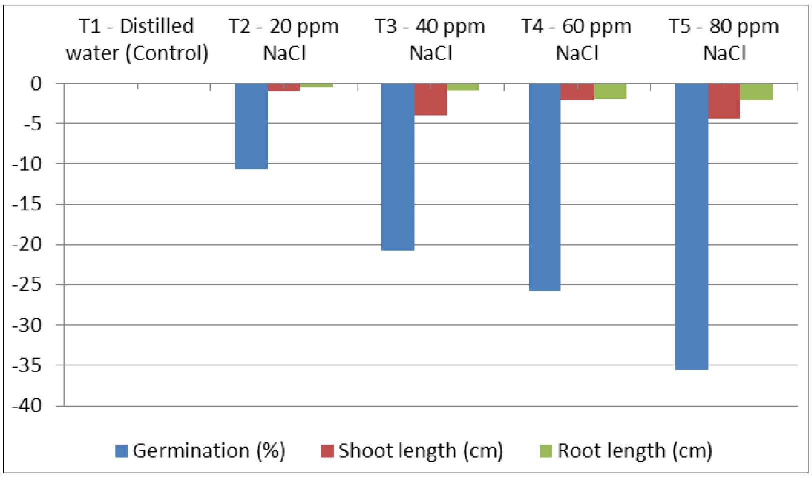

Fig 1: Response index values of different level of salt (NaCl) on germination (%), shoot length (cm) and root length (cm) of black gram.

Table 3: Response index based on germination (%), shoot length (cm), root length (cm) and vigor index of black gram.

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Vigour index
T1 - Control (0 ppm)	0	0	0	0
T2 - 20 ppm of NaCl	-10.7	-1	-0.44	-284.51
T3 - 40 ppm of NaCl	-20.7	-3.98	-0.88	-686.86
T4 - 60 ppm of NaCl	-25.7	-2.1	-1.98	-678.13
T5 - 80 ppm of NaCl	-35.6	-4.36	-2.1	-936.22

might directly affect seedling growth (Meneguzzo *et al.,* 1999). The inhibitory effect of NaCl on the germination and seedling growth of black gram was measured by the Response index (Table 3 and Fig 1). The result revealed that all the treatments presented negative (-) values, which meant growth retardation compared to control. Suppression was the highest at 80 ppm concentration of NaCl, as indicated by the higher negative values of RI for germination percentage (-35.6), shoot length (-4.36), root length (-2.1) and vigor index (-936.22).

CONCLUSION

The present study indicated that the salinity (NaCl) had negative effect on the germination, seedling growth and development of black gram. It was observed that increase in concentration of NaCl induced salinity decreased the germination percentage, seedling growth and development of black gram.

Conflict of interest: None.

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