Plant Archives Vol. 25, Supplement 1, 2025 pp. 1076-1082 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.146

AN INCUBATION EXPERIMENT ON SCREENING OF GREEN GRAM VARIETIES FOR TOLERANCE TO SALINE IRRIGATION WATER

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(Date of Receiving : 24-08-2024; Date of Acceptance : 20-10-2024)

ABSTRACT

Water is a second most important resource in agriculture followed by land. The water availability for irrigation is often scarce, is one of the most critical input for agriculture production in most areas. Productivity in these areas can be enhanced by better management of rainwater and /or development of groundwater. So, the present investigation was carried out to study the effect of saline water irrigation on the growth of green gram. In order to screen a saline/salt tolerant green gram variety, a laboratory experiment was conducted in the Department of Soil Science and Agricultural Chemistry, IIAT. The various treatment included in the study were three ruling varieties of greengram as factor V *viz.*, V_1- CO6 6, V_2- VBN 2 and V_3- CO 4 and four salinity levels as factor S *viz.*, S_1-EC-3 dS m^{-1} and SAR-4; S_2-EC- 3 dS m^{-1} and SAR-6; S_3-EC-3 dS m^{-1} and SAR-8; S_4-EC-6 dS m^{-1} and SAR-6. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with two replications. The results of the study concluded that the soil application of saline water (EC-3 dS m^{-1} and SAR-4) irrigation to saline tolerant greengram variety CO 4 (S_1V_3) was identified as best treatment combination to realize the maximum germination of greengram under saline water irrigation.
***Keywords* :** Salinity, greengram, Irrigation water and saline tolerance

Introduction

Salinity is defined as the presence of excessive concentration of soluble salts in the soil, which suppressed plant growth. In more specific definition soil with low pH (<8.5), high Electrical Conductivity (EC > 4.0 dS m^{-1}) and low Exchangeable Sodium Percentage (ESP <15%). The main salt present in saline soil is NaCl. However, some other salts like Na_2SO_4, $MgSO_4$, $CaSO_4$, $MgCl_2$ and KCl are also present. The deleterious effects of salinity on plant growth are associated with: 1. Low osmotic potential of soil solution (water stress), 2. Nutritional imbalance, 3. Specific ion effect (salt stress), or a combination of these above factors (Turan, 2010). Nowadays, the competition for freshwater in the development of urbanization, industry and agriculture caused the decline of fresh water for irrigation. The progressive decrease of fresh water resources is leading towards the inevitable use of saline water for irrigation purpose (Chowdary, 2014). Saline waters are characterized by their high EC (> 4.0 dS m^{-1}), low SAR (<10 mmols L^{-1}) and low RSC (< 2.5 meq lit^{-1}) which constitute most important source of supplemental irrigation, provided they are used judiciously and carefully. Such waters are found in vast areas of entire coastal belts of Tamilnadu. The scarcity of fresh water restricts sustainable agricultural development in coastal regions. At the same time, the quality of irrigation water has also deteriorated. As a result, deficit irrigation and saline water irrigation have been used more prevalently in agriculture to overcome drought and sustain crop yields. Salt stress in arid and semi-arid regions is one of the major stresses that can severely limit plant growth and productivity. Overcoming salt stress is a main issue in these regions to ensure agricultural sustainability and crop production. In this context, salinity is currently one of the most severe abiotic factors, limiting agricultural production. In majority of the coastal soils, the plants are subjected throughout their life cycle to different stresses; some of these plants can tolerate these stresses in different ways depending upon that plant species and type of stress. Excessive salinity reduces the productivity of many agricultural crops including most of the pulses. Knowledge of salt tolerance in pulse crops is necessary to increase productivity and profitability of crops irrigated with saline waters.

Greengram [*Vigna radiata*] is the third important pulse crop of India which is cultivated over a wide range of agro-climatic zones of the country. It grows well in both abnormal and normal weather situation. It occupies about 40.38 lakh ha area in the country producing 31.5 lakh tonnes of seed with average productivity of 783 kg ha^{-1} (ANGRAU, 2021-22). Rajasthan occupies 2147000 ha area with average productivity of 721 kg ha^{-1}(ANGRAU, 2021-22) of mung bean. In Tamil Nadu, it is cultivated in 1.04 lakh hectares of area with a production of 0.84 lakh tonnes and the average productivity is 675 kg ha^{-1}. The average productivity of pulses in Tamil Nadu is very low when compared to India's average of 932 kg ha^{-1}. Production of green gram is low in general due to poor management and low soil fertility status. The main green gram growing states of India are Rajasthan, Karnataka, Maharashtra, Madhya Pradesh, Bihar and Andhara Pradesh. The productivity potential of pulses is not realized and the reason for low productivity of greengram is large scale cultivation under rainfed and marginal lands and may be under low input conditions (Rathore, 2002). The productivity of pulse crops including greengram is not sufficient enough to meet the domestic demand of the population. Hence, there is need for enhancement of the productivity of greengram by proper management practices. Green gram production in India is less and imported from other countries to meet out the requirement.

Green gram production in India is less and imported from other countries to meet out the requirement. Among the entire yield limiting factors, poor irrigation is imperative to ensure better crop production on exhausted soils as irrigation play a vital role in increasing the seed yield in pulses (Chaudhary, 2011).

Materials and Methods

A laboratory experiment was conducted to optimize the salinity level and identify the best saline tolerant greengram variety to grown under saline water condition. In order to screen a saline/salt tolerant greengram variety, a laboratory experiment was conducted in the Department of Soil Science to and Agricultural Chemistry, IIAT. Three ruling varieties of greengram namely V_1- CO 6, V_2- VBN 2 and V_3- CO 4 were collected and used in this study. The treatments consisted of four salinity levels *viz.,* S_1-EC-3 dS m^{-1} and SAR-4; S_2-EC- 3 dS m^{-1} and SAR-6; S_3-EC-3 dS m^{-1} and SAR-8; S_4-EC-6 dS m^{-1} and SAR-6. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with three replications. The 25 seeds of 3 ruling varieties were soaked in saline water as per treatment schedule for 12 hours and placed on the country filter paper in the petridish. Each treatment was replicated thrice. The experiment was maintained up to 21 days. The germination of seeds and vigour index of the seedling were observed at every two days interval up to 10^{th} day. Based on the observation speed of germination, germination energy, germination percentage and vigour index were worked out using the formula given below.

Speed of Germination:

Speed of germination =

$$\frac{\text{No. of germinated seeds}}{\text{Days to first count}} + \frac{\text{No. of germinated seeds}}{\text{Days to final count}}$$

Germination energy:

Germination energy =

$$\frac{\text{No. of germinated seeds at 6 DAS}}{\text{Total number of seeds tested}} \times 100$$

Final germination percentage:

Final germination percentage =

$$\frac{\text{No. of final germinated seeds}}{\text{Total number of seeds tested}} \times 100$$

Seedling length:

Seedling length = Shoot length + Root length (cm)

Vigour index:

Vigour index = Germination percentage × (Root length + Shoot length) cm

The calculation of different concentration of water salinity levels or EC and SAR ratios (calculating the quantities of different salts) was carried out according to Dagar (2005). The saline water was prepared by dissolving different levels of salts per liter of deionised water respectively thus, prepared saline water was used for laboratory experiments. The quantity of salts used to prepare the different level of salinity water were EC–3 and SAR–4 (Nacl – 1.5g, Na_2SO_4 – 10.5 g, $CaCl_2$ – 13.5 g and $MgSO_4$ – 4.5 g), EC -3 and SAR - 6 EC–3 (Nacl – 4.4g, Na_2SO_4 – 11.4 g, $CaCl_2$ – 10.5 g and $MgSO_4$ – 3.5 g), EC – 3 and SAR -8 (Nacl – 6.6 g, Na_2SO_4 – 12.2 g, $CaCl_2$ – 8.3 g and $MgSO_4$ – 2.7 g) and EC – 6 and SAR -6 (Nacl – 3.8 g, Na_2SO_4 – 21.2 g, $CaCl_2$ – 26.1 g and $MgSO_4$ – 8.7 g). Data obtained from laboratory experiments were statistically analysed as suggested by Gomez and Gomez (1984). For significant results, the critical difference was worked at five per cent probability level.

Results and Discussion

Germination energy of green gram seeds (Table 1)

Increase in the salinity level of water decreased the germination energy of all the three green gram varieties tried. The highest mean germination energy of 83.14 was noticed with saline water (S_1). This was followed by S_2 (78.18 per cent), S_3 (72.70 per cent) and S_4 (66.77per cent), respectively. All the three varieties tried; the observation showed that a significant variation in saline tolerance. Among the three varieties, CO4 recorded the highest mean speed of germination energy of 90.44 per cent. This was followed by VBN 2 (80.44 per cent) and CO6 (54.71 per cent). The interaction between the salinity levels and green gram varieties was significant. The variety CO4 germinated in saline water recorded the highest germination energy of 94.77per cent (V_3S_1). This was followed by the treatments V_2S_1 (85.25 per cent) and V_1S_1 (63.44 per cent). Among the three varieties tried CO4 recorded the highest germination energy at all levels of salinity as compared to other varieties. It can be hypothesized that the presence of NaCl/$NaSO_4$ even at low concentration, could have contributed to a decrease in the internal osmotic potential of germinating structures. Inhibition or delay in germination under saline conditions is due to an osmotic effect, which limits the uptake of water during seed germination rather than ion toxicity by hindering of membrane of cytosolic enzymes and hormones of gibberellic acid. The earlier report of Yasar *et al.* (2006) and Zhang *et al.* (2004) corroborate the present findings.

Speed of germination (Table 2)

The speed of germination among the varieties and salinity levels screened for three green gram varieties was significant and the salinity level S_1 was superior among the other treatments and the variety CO 4 performed well among other varieties. Increase in the SAR and EC of salinity water significantly decreased the speed of germination of green gram seeds and it ranged from 6.94 to 5.54. The highest mean speed of germination of 6.94 was noticed in seeds germinated in salinity level S_1 (EC-3 & SAR-4). All the three varieties tried, showed a significant variation in saline tolerance. Among the three varieties, CO 4 recorded the highest speed of germination of 7.48. Based on the speed of germination of greengram varities, they are arranged in ascending order as V_1-CO 6 (4.54) < V_2-VBN 2(6.73) and V_3-CO 4 (7.48). The variety CO 6 received the lowest mean speed of germination of 4.54. The interaction between the levels of salinity and varieties was significant. The variety CO4 germinated in saline water recorded the highest speed of germination of 8.20. This was followed by the treatment pairs like V_2S_1 (7.38) and V_1S_1 (5.24), respectively. Among the three varieties tried, CO 4 recorded the highest speed of germination at all levels of salinity as compared to other varieties. The lowest speed of germination of 3.85 was recorded in CO 6 variety treated with (EC-6 dS m^{-1} and SAR-6) saline water. The speed of germination was positively influenced by the various salinity level to various greengram varieties. Salt stress has three-fold effects which reduces the water potential and causes ion imbalance and toxicity (De la Pena and Hughes, 2007) of salt stress affects some major process such as germination, speed of germination, root/shoot dry weight and Na^+/K^+ ratio in root and shoot (Parida and Das, 2005).

Final germination percentage of greengram seeds (Table 3)

The effect due to the different levels of salinity and different varieties of greengram on final germination percentage of greengram was significant. The variety CO4 germinated in saline water recorded the highest total germination percentage of 90.44. This was followed by the treatments V_2S_1 (80.44) and V_1S_1 (54.71). This result clearly indicated that varieties tried, CO4 recorded the highest tolerance to salinity levels S_1 (EC-3 dS m^{-1} and SAR-4) and S_2 (EC-3 dS m^{-1} and SAR-6) induced by salts. The lowest total germination percentage of 47.29 was recorded in CO 6 greengram variety treated with saline water (EC-6 dS m^{-1} and SAR-6). The increase in the osmotic stress due to increase in salinity that in turn suppressed the growth of plants and yield attributing characters of brinjal. The result obtained was in accordance with the findings of Saboora *et al*. (2006) and Sajal Roy *et al.* (2014).

Seedling length (Table 4)

The variety CO 4 recorded the highest seedling length of 9.01 cm. This was followed by the treatment pairs like V_2S_1 (7.99cm) and V_1S_1 (5.46 cm). Among the three varieties tried, CO 4 recorded the highest seedling length at all the levels of salinity as compared to other varieties. The lowest seedling length of 4.07cm was recorded in V_1 greengram variety treated with saline water (EC-6 dS m^{-1} and SAR-6). The decreased growth with the increasing salinity level was possibly due to adverse effect, which hindered seedling growth and biomass production. These results are in harmony with those obtained by Brady and Weil (2002); Kadam *et al.* (2007) and Jamal uddin *et al.* (2016).

Vigour index (Table 5)

The interaction between the level of salinity and varieties of greengram was significant. Among the three varieties tried, CO 4 recorded the highest vigour index at all levels of salinity as compared to other varieties. The variety CO 4 germinated in saline water (S_1 - EC-3 dS m^{-1} and SAR-4) recorded the highest vigour index of 547.25. This was followed by the treatment pairs like V_2S_1 and V_1S_1. These treatments recorded a mean vigour index of 493.18 and 359.56, respectively. The lowest vigour index of 281.53 was recorded in CO 6 variety (V_1) treated with saline water (EC-6 dS m^{-1} and SAR-6). In general, increase in irrigation water salinity, increased the value of total soluble solids with a consequent reduction of water content in the fruits. Mitchell *et al.* (1999) also reported that irrigation with saline water slightly reduced the fruit water content and then vigour index.

Conclusion

The present investigation was clearly brought out the saline water irrigation for improving the growth of brinjal. From the results of the study, it was concluded that the soil application of saline water (EC-3 dS m^{-1} and SAR-4) irrigation to saline tolerant greengram variety CO 4 was identified as best treatment combination (S_1V_3) to realize the maximum germination of greengram under saline water irrigation. However, the results should be test verified under field condition for recommendation to the farmers.

Table 1 : Effect of different salinity levels and greengram varieties on the germination energy

V / *S*	**S_1 (EC-3 & SAR-4)**	**S_2 (EC-3 & SAR-6)**	**S_3 (EC-3 & SAR-8)**	**S_4 (EC-6 & SAR-6)**	**Mean**
V_1 (CO 6)	63.44	59.51	52.21	50.01	**56.29**
V_2 (VBN 2)	85.25	80.64	76.32	71.65	**78.47**
V_3 (CO 4)	94.77	90.35	85.44	80.48	**87.76**
Mean	**81.15**	**76.83**	**71.32**	**67.38**	
	Sed		CD		
V	1.0		2.12		
S	1.38		2.80		
V × S	1.98		3.93		

Table 2 : Effect of different salinity levels and greengram varieties on the speed of germination

V / *S*	**S_1 (EC-3 & SAR-4)**	**S_2 (EC-3 & SAR-6)**	**S_3 (EC-3 & SAR-8)**	**S_4 (EC-6 & SAR-6)**	**Mean**
V_1 (CO 6)	5.24	4.76	4.29	3.85	**4.54**
V_2 (VBN 2)	7.38	6.94	6.52	6.03	**6.73**
V_3 (CO 4)	8.20	7.72	7.23	6.75	**7.48**
Mean	**6.94**	**6.47**	**6.01**	**5.54**	
	Sed			CD	
V	0.13			0.28	
S	0.14			0.30	
V × S	0.18			0.38	

Table 3 : Effect of different salinity levels and greengram varieties on the final germination percentage

V / *S*	**S_1 (EC-3 & SAR-4)**	**S_2 (EC-3 & SAR-6)**	**S_3 (EC-3 & SAR-8)**	**S_4 (EC-6 & SAR-6)**	**Mean**
V_1 (CO 6)	62.16	57.30	52.10	47.29	**54.71**
V_2 (VBN 2)	88.57	83.66	77.82	71.72	**80.44**
V_3 (CO 4)	98.70	93.58	88.17	81.30	**90.44**
Mean	**83.14**	**78.18**	**72.70**	**66.77**	
	Sed			CD	
V	1.05			2.01	
S	1.65			3.25	
V × S	2.60			4.83	

Table 4 : Effect of different salinity levels and greengram varieties on the seedling length (cm)

V / *S*	**S_1 (EC-3 & SAR-4)**	**S_2 (EC-3 & SAR-6)**	**S_3 (EC-3 & SAR-8)**	**S_4 (EC-6 & SAR-6)**	**Mean**
V_1 (CO 6)	5.46	5.02	4.53	4.07	**4.77**
V_2 (VBN 2)	7.99	7.54	7.08	6.57	**7.30**
V_3 (CO 4)	9.01	8.56	8.07	7.61	**8.31**
Mean	**7.49**	**7.04**	**6.56**	**6.08**	
	Sed			CD	
V	0.13			0.27	
S	0.17			0.36	
V × S	0.20			0.41	

Table 5 : Effect of different salinity levels and greengram varieties on the vigour index

V / *S*	**S_1 (EC-3 & SAR-4)**	**S_2 (EC-3 & SAR-6)**	**S_3 (EC-3 & SAR-8)**	**S_4 (EC-6 & SAR-6)**	**Mean**
V_1 (CO 6)	359.56	332.54	308.49	282.53	**320.53**
V_2 (VBN 2)	493.18	467.76	438.16	411.38	**452.62**
V_3 (CO 4)	547.25	521.88	491.56	465.42	**506.53**
Mean	**466.66**	**440.73**	**412.74**	**386.11**	
	Sed			CD	
V	10.59			20.05	
S	11.41			21.77	
V × S	12.09			24.61	

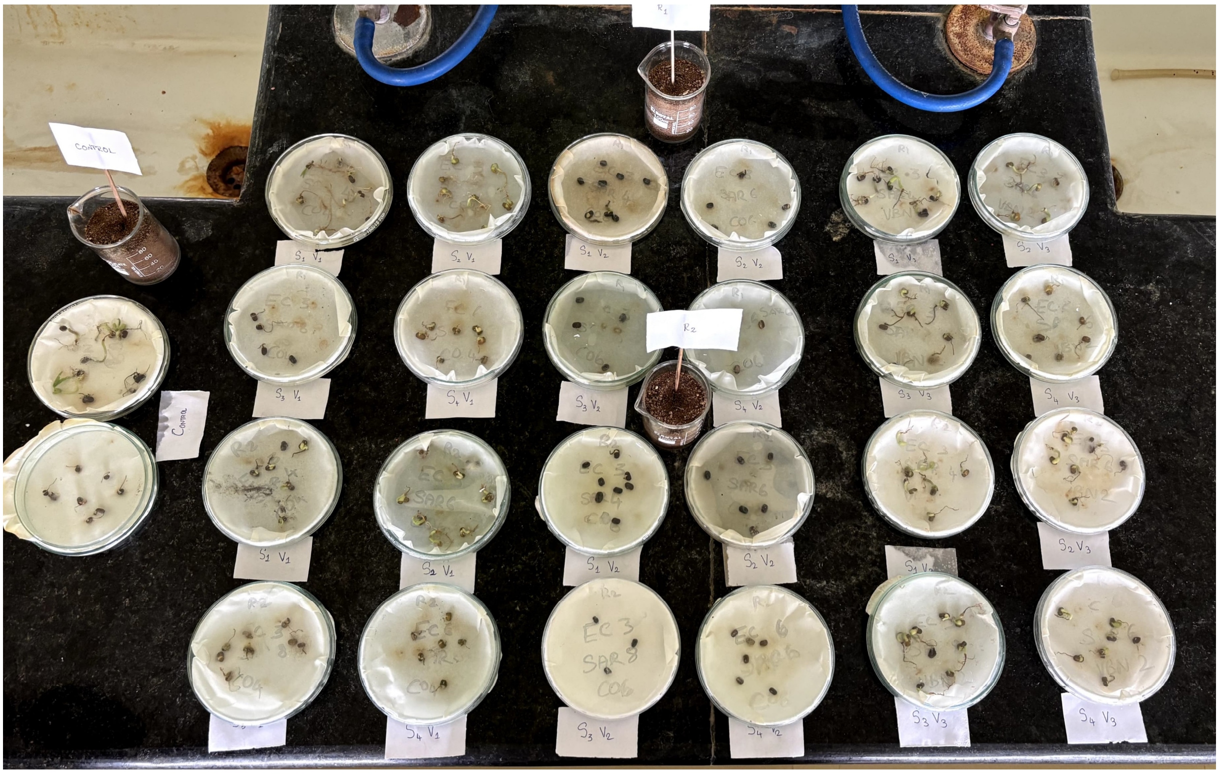

Plate 1 : Laboratory experiment showing different salinity treatments

Plate 2: Seed germination in different salinity levels

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