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Effect of Saline Water Irrigation and Organic Amendments on the Growth and Quality Characters of Cluster Bean

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The pot experiment was carried out to test the salinity tolerance level of MDU - 1 in the presence of organic manures. A pot experiment was conducted in the pot culture yard of the Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Cuddalore District, during January - May, 2024. Crop was raised using selected saline tolerant Cluster bean variety MDU -1 as test crop. The experimental soil was sandy loam in texture and

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taxonomically classified as *Typic Ustifluvent.* The treatments consisted of three levels of salinity *viz.,* S1–Control (bore well water), S2 (EC-2.5 dS m^{-1}) and S3 (EC-5.0 dS m^{-1}) and four different sources of organic manures *viz.,* O1- Humic acid (HA), O2-FYM, O3-Vermicompost (VC) and O4-Composted coirpith (CCP). The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with three replications. The results of the pot experiment clearly indicated the response of cluster bean to saline water irrigation and soil application of different organic manures. Among the three levels of salinity tried, the treatment S1, irrigated through bore well water recorded the highest response in respect of growth and quality characters of *Clusterbean* as compared to saline water irrigation treatment S2 and S3. All the sources of organics evaluated proved significant to increase the growth and quality characters of *clusterbean*. However, the effect was much pronounced with vermicompost applied treatments as compared to humic acid, composted coirpith and FYM. Among the various treatment combinations, application of vermicompost at 12.5 t ha^{-1} through soil and irrigated with bore well water (S1O3) excelled the other treatments in respect of the growth, yield and nutrient uptake by clusterbean. However, this was followed by the treatment S1O1, which received soil application of humic acid at 30 kg ha^{-1} and irrigated with borewell water. Further, the quality parameters like crude protein, crude fibre and gum content in clusterbean pods were also positively improved by the application of vermicompost @ 12.5 t ha^{-1} through soil and irrigated with bore well water (S1O3). However, it was followed by treatment S2O3 (VC + saline water irrigation). Hence, soil application of vermicompost @ 12.5 t ha^{-1} and saline water (EC-2.5 dS m^{-1}) irrigation to saline tolerant clustebean variety MDU-1 was identified as best treatment combination for sustainable clusterbean production under saline water irrigation.

Keywords: Saline water; organic amendments; clustebean; farming community.

1. INTRODUCTION

Salinity is a major problem throughout the world when excess soluble salts adversely affect soil behaviour by changing its physico – chemical properties and in turn have a strong bearing on the activity of plant growth especially during the early seedling stage. Efforts have to be made to identify crop species which can able to tolerate increasing soil salinity levels. Such a selection of salinity resistance crops is one of the wider objectives required primarily to increase crop productivity on salt affected lands, thereby enhancing food and income generation option for the poor section of the farming community (Ramanjineyulu et al., 2024; Banti, and Victor Debbarma, 2023). “The most crucial and important stage in the life cycle of species growing in saline environment is the period of seed germination and early development of the seeding” (Ranganathan and Rajalakshmi, 2006). “Salinity stress negatively impacts agricultural yield throughout the world affecting crop production” (Shuji et al*.,* 2002). “The declining availability of fresh water has become a worldwide problem, which endorses the development of alternative, secondary quality water resources for agricultural use. 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). Moreover, “the continuous use of saline waters without amendments adversely affects the soil physico-chemical and biological properties and at the same time, it adversely affects the mineral composition, uptake and yield of crops under most situations” (Ayers and Westcot, 1985 and Oster and Jayawardene, 1998). Application of organic manures and increased rate of nutrient application for crops in such soils hold promise in improving the fertility and productivity of crops. Several investigators reported that application of organic manures like FYM, compost and or green manuring is one of the easiest methods to mitigate the adverse-effects of use of poor quality of waters like saline or sodic water. Hence the present investigation was carried out to study the effect of saline water irrigation and organic amendments on the growth, quality and nutrient uptake of clusterbean.

2. MATERIALS AND METHODS

The pot experiment was carried out in department of Soil Science and Agricultural Chemistry, Annamalai University during January– May 2024. The texture of the soil was sandy loam and taxonomically classified as Typic ustifluvent with pH-7.9, EC - 0.86 dS m^{-1} and represented low status of organic carbon (4.2 g kg^{-1}). The soil had low in available

nitrogen (174.36 kg ha^{-1}), low in available phosphorus (7.6 kg ha^{-1}) and medium in available potassium (118.3 kg ha^{-1}). The Twelve treatments consisted of three levels of saline water viz., S_1 – control (Bore well water), S_2-Saline water (EC- 2.5) and S_3-Saline water (EC- 5.0) as factor-A and four different sources of organic manures viz., O_1- Humic Acid (HA), O_2-Farm yard manure (FYM), O_3 – Vermicompost (VC) and O_4–Composted coirpith (CCP) as factor-B. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with three replications using selected saline tolerance clusterbean variety MDU-1 as test crop. The calculated amount of different organics viz.,Humic Acid, FYM, vermicompost and composted coir pith was applied just before sowing. A uniform NPK dose of 25:50:25 mg Kg^{-1} was supplied through urea, super phosphate and muriate of potash to all the pots. The entire dose of NPK were applied as basal. Various growth components like plant height, number of branches $plant^{-1}$, chlorophyll content, leaf area index(LAI) and dry matter production (DMP). Quality parameters like crude protein, cude fibre,and gum content.The plant samples were collected and analyzed for the concentration of nutrients like N, P and K were estimated using the standard procedure as outlined by Jackson (1973) and uptake were calculated.

3. RESULTS AND DISCUSSION

3.1 Growth Characters

Irrigation with different salinity level water and application of different organic amendments favourably influenced the growth characters of clusterbean. Among the three levels of saline water irrigation treatments tried, the treatment S_1, irrigated through bore well water recorded the highest plant height, number of branches per plant, chlorophyll content, leaf area index and Dry matter production (76.92,11.57, 50.85, 1.14 and 90.58 cm). This was followed by the salinity level S_2 and S_3 saline water irrigation. Irrespective of the salinity levels, all the organic amendments evaluated significantly improved the growth characters of clusterbean. Application of vermicompost @ 12.5 t ha^{-1} (O_3) recorded the maximum plant height, number of branches per plant, chlorophyll content, leaf area index and Dry matter production (77.26, 10.73, 52.76, 1.17 and 92.42 cm) of clusterbean. This was followed by the treatments (O_1), applied with humic acid @ 30 kg ha^{-1} and application of composted coirpith @ 12.5 t ha^{-1} (O_4,). The interaction effect due to different saline water irrigation and organic manures on the plant height was significant. Application of vermicompost @ 12.5 t ha^{-1} by soil application and bore well water irrigation (S_1O_3) recorded the maximum plant height, number of branches per plant, chlorophyll content, leaf area index and Dry matter production, number of branches per plant, chlorophyll content, leaf area index and Dry matter production (82.30, 12.30, 54.70, 1.25 and 96.25cm) of clusterbean. However, this was followed by the treatment (S_1O_1). All the growth characters *viz.,* plant height, chlorophyll, leaf area index, dry matter production and number of branches at all the growth stages of clusterbean were significantly decreased with increasing levels of salinity. “The decreased growth with the increasing salinity level was possibly due to adverse soil chemical and physical properties, which hindered plant growth and biomass production”. These results are in harmony with those obtained by Kadam et al. (2007); Jamal uddin et al. (2016) and Patel et al. (2024). The results of the study clearly brought out the usefulness of all the organic amendments evaluated in improving the growth and yield of clusterbean. Among various organic amendments, the application of vermicompost accounted for a significantly superior effect in promoting all the growth characters of clusterbean for saline water irrigation. Increased growth of clusterbean with the application of organics might be due to the improvement in nutrient availability and soil property due to the decomposition products such as polysaccharides, polyurenoids, amino acids, humic and growth promoting substances. The earlier report of Rangarajan (1991) corroborates the present findings. Arancon et al. (2004) reported that “leaf area increases in vermicompost treated strawberry” (Fragaria ananassa Duch.) is due to an increase in microbial population in vermicompost. (Gomes et al., 2011; Xing et al., 2013) who reported “the chlorophyll concentrations of leaves significantly decreased by salinity stress”. However, inconsistent results were reported by Jungai et al. (2011), Akhzari et al. (2012) and Chaudhary et al.(2021) who stated salinity stress caused increasing chlorophyll concentrations of leaves. Results of the present study are consistent with Berova and Karanatsidis, (2009) and Seerangan et al. (2019) “who stated chlorophyll contents increased significantly with vermicompost application”. The

improved growth characters due to organic manures in saline water irrigated plants might be due to the improved nutrient availability, microbial activity, reduced soluble salts in soil-water, lowered osmotic potential of the soil water and lower leaf water potential required to sustain transpiration. Therefore, plants spent more energy for making osmotic adjustments as reported by Leone et al. (2000). Similar results was observed by Abid et al. (2002), Ashraf et al.,(2004) and Aslam et al.,(2020). "Vermicompost contains plant nutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B. The high percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality" (Theusnissen et al., 2010) and (Tharun Kumar et al.,2022).

3.2 Quality Parameters

The quality parameters of clusterbean *viz.,* Crude protein, Crude fibre and gum content were significantly increased with saline water irrigation and soil application of organic manures. Among the different levels of salinity water tried, the treatment S_1, irrigated through bore well water recorded the highest crude protein (3.14 percent), fibre (13.65 per cent), and gum content (19.47 per cent) of clusterbean. This was followed by the treatments S_2 (EC-2.5 dS m^{-1}) and S_3 (EC-5.0 dS m^{-1}) saline water irrigation. Among the various organic manures evaluated, application of vermicompost @ 12.5 t ha^{-1} (O_3) was significantly superior in increasing the crude protein (3.24 percent), crude fibre (12.73 percent), and gum content (19.09 percent). This was followed by the treatments applied with humic acid(HA) @ 30 kg ha^{-1} (O_1) and application of composted coirpith @12.5 t ha^{-1} (O_4). These treatments recorded the mean crude protein of 3.04 and 2.90 per cent, crude fibre content 12.16 and 11.56 per cent and gum content 17.86 and 16.56 per cent, respectively. Interaction effect due to saline water irrigation and soil application of organic manures on quality characters of clusterbean was significant. Application of VC @ 12.5 t ha^{-1} through soil and bore well water irrigation (S_1O_3) to clusterbean fruits registered the highest quality characters like crude protein (3.36 per cent), crude fibre (14.70 per cent) and gum content (21.40 per cent). This was closely followed by the treatment (S_1O_1) which received humic acid @ 30 kg ha^{-1} and irrigated with bore well water. This might be due to improved nutrient environment in the rhizosphere as well as its utilization in the plant system, leading enhanced translocation of nutrient, vitamins and proteins in pods. Another reason might be due to the increased activity of nitrate reductase which helped in synthesis sustains amino acid proteins as reported by Chinaswamy and Marikulandi (1966); Lopes et al. (1996); Yadav and Vijayakumari (2004); Meena et al. (2016); Nagar et al. (2017). "Application of organic manures through soil might have increased the nutrient availability which resulted in better accumulation of N content and hence the increased protein content in pods". These resulted are in accordance with earlier reports of (Olaniyi et al*.,* 2010); (Nithya et al.,2024); Elayaraja et al. (2024). "Irrigation with saline water to humic acid supplied with clusterbean also recorded the high protein content, crude fibre content and gum content. This might be due to the direct effect of humic substances depend on biochemical action on cell wall, membrane or cytoplasm, mainly hormonal acting in manner similar to plant growth substances and agricultural humic substances are reputed drought tolerance , enhance nutrient uptake and overall plant performance resulting in increasing quality characters of clusterbean". These results are in partly with results reported by Bhuvaneswari et al. (2020).

3.3 NPK Uptake

Irrigation of clusterbean with saline water and organics positively increased the uptake of nitrogen by both pod and stover of clusterbean. Among the different levels of salinity tried, the treatment S_1, irrigated through bore well water recorded the highest mean NPK uptake of (513.07, 209.53, 324.98) and (286.42, 77.72, 155.20) mg pot^{-1} in pod and stover respectively. This was followed by the treatments S_2 (EC-2.5 dS m^{-1}) and S_3 (EC-5.0 dS m^{-1}) saline water irrigated plants by recording the N uptake by pod and stover respectively. Among the various organics evaluated, vermicompost application @ 12.5 t ha^{-1} (O_3) recorded the highest mean NPK uptake by pod (537.04, 225.93, 339.64 mg pot^{-1}) and stover (297.39, 82.80, 161.70 mg pot^{-1}). This was followed by the treatments, the application of humic acid @ 30 kg ha^{-1} (O_1), application of CCP @ 12.5 t ha^{-1} (O_4) and FYM 12.5 t ha^{-1} (O_2). Regarding the interaction, the application of vermicompost @ 12.5 t ha^{-1} and irrigated with bore well water irrigation (S_1O_3) recorded the highest nitrogen uptake of (585.39, 245.33, 372.88) and (342.82, 90.69, 177.28 mg pot^{-1} in

Table 1. Effect of different salinity levels and organic amendments on the plant height, number of branches per plant and chlorophyll content of Clusterbean

	Plant Height(cm)					Number of Branches					Chlorophyll(mg 100g^{-1})				
O / S	O1	O2	O3	O4	Mean	O1	O2	O3	O4	Mean	O1	O2	O3	O4	Mean
S1	79.40	70.90	82.30	75.10	76.92	11.90	10.70	12.30	11.40	11.57	52.40	46.90	54.70	49.40	50.85
S2	72.90	65.30	76.80	69.39	71.09	9.90	8.90	10.20	9.50	9.62	51.50	45.40	53.20	48.70	49.70
S3	69.10	61.80	72.70	66.20	67.45	9.40	8.19	9.70	8.90	9.04	48.30	43.10	50.40	45.90	46.92
Mean	73.80	66.00	77.26	70.23		10.40	9.26	10.73	9.34		50.73	45.13	52.76	48.00	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		1.13		2.34			0.16		0.33			0.77		1.59	
O		1.31		2.70			0.18		0.38			0.89		1.84	
S □ O		2.27		4.68			0.32		0.66			1.54		3.19	

S- Salinity level : S1– Borewell Water Control; S2–EC-2.5 dS m^{-1}; S3–EC-5.0 dS m^{-1}

O-Organic manures : O1–Humic Acid 30 @ kg ha^{-1}; O2–Farmyard manure @ 12.5 t ha^{-1}; O3–Vermicompost @ 12.5 t ha^{-1} and O4–Composted coir pith @ 12.5 t ha^{-1}

Table 2. Effect of different salinity levels and organic amendments on the leaf area index and dry matter production of Clusterbean

	Leaf Area Index					Dry Matter Production (g pot^{-1})				
O / S	O1	O2	O3	O4	Mean	O1	O2	O3	O4	Mean
S1	1.16	1.05	1.25	1.11	1.14	93.49	83.64	96.25	88.95	90.58
S2	1.12	1.02	1.15	1.05	1.08	88.33	78.64	92.39	83.72	85.77
S3	1.07	0.96	1.13	1.01	1.04	83.15	73.41	88.63	77.12	80.57
Mean	1.11	1.01	1.17	1.05		88.32	78.56	92.42	83.26	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		0.016		0.035			1.36		2.80	
O		0.019		0.040			1.57		3.24	
S □ O		0.033		0.070			2.72		5.61	

S- Salinity level : S1– Borewell Water Control; S2–EC-2.5 dS m^{-1}; S3–EC-5.0 dS m^{-1}

O-Organic manures: O1–Humic Acid 30 @ kg ha^{-1}; O2–Farmyard manure @ 12.5 t ha^{-1}; O3–Vermicompost @ 12.5 t ha^{-1} and O4–Composted coir pith @ 12.5 t ha^{-1}

Table 3. Effect of different salinity levels and organic amendments on the quality parameters of Clusterbean

O / S	Crude Protein (%)					Crude Fibre (%)					Gum Content (%)				
	O1	**O2**	**O3**	**O4**	**Mean**	**O1**	**O2**	**O3**	**O4**	**Mean**	**O1**	**O2**	**O3**	**O4**	**Mean**
S1	3.21	2.91	3.36	3.08	3.14	14.10	12.90	14.70	13.3	13.65	20.10	17.30	21.40	18.90	19.47
S2	3.05	2.76	3.23	2.90	2.98	12.40	11.10	12.90	11.70	12.02	17.60	14.28	18.70	16.29	16.71
S3	2.84	2.62	3.13	2.74	2.84	10.80	9.00	10.60	9.70	9.82	15.90	13.00	17.19	14.30	15.15
Mean	3.04	2.76	3.24	2.90		12.16	10.86	12.73	11.56		17.86	14.92	19.09	16.56	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		0.046		0.096			0.192		0.397			1.278		0.573	
O		0.053		0.111			0.222		0.458			0.321		0.662	
S □ O		0.093		0.192			0.385		0.795			0.556		1.147	

S- Salinity level : S_1– Borewell Water Control; S_2–EC-2.5 dS m^{-1}; S_3–EC-5.0 dS m^{-1}

O-Organic manures : O_1–Humic Acid 30 @ kg ha^{-1}; O_2–Farmyard manure @ 12.5 t ha^{-1}; O_3–Vermicompost @ 12.5 t ha^{-1} and O_4 –Composted coir pith @ 12.5 t ha^{-1}

Table 4. Effect of different salinity levels and organic amendments on the nitrogen uptake by Clusterbean

O / S	Nitrogen uptake - Fruit (mg pot^{-1})					Nitrogen uptake - Stover (mg pot^{-1})				
	O1	**O2**	**O3**	**O4**	**Mean**	**O1**	**O2**	**O3**	**O4**	**Mean**
S1	537.14	437.52	585.39	492.26	513.07	312.12	235.43	342.82	255.34	286.42
S2	485.33	387.73	535.56	430.24	459.71	262.83	207.64	287.26	230.92	247.16
S3	427.26	342.28	490.19	387.52	411.81	227.54	182.20	262.10	207.26	219.77
Mean	483.24	389.17	537.04	436.67		267.49	208.42	297.39	231.17	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		7.62		15.73			4.20		8.67	
O		8.80		18.16			4.85		10.02	
S □ O		15.24		31.46			8.10		17.35	

S- Salinity level : S_1– Borewell Water Control; S_2–EC-2.5 dS m^{-1}; S_3–EC-5.0 dS m^{-1}

O-Organic manures : O_1–Humic Acid 30 @ kg ha^{-1}; O_2–Farmyard manure @ 12.5 t ha^{-1}; O_3–Vermicompost @ 12.5 t ha^{-1} and O_4–Composted coir pith @ 12.5 t ha^{-1}

Table 5. Effect of different salinity levels and organic amendments on the Phosphorous uptake by Clusterbean

O / S	Phosphorous uptake - Fruit (mg pot^{-1})					Phosphorous uptake - Stover (mg pot^{-1})				
	O1	**O2**	**O3**	**O4**	**Mean**	**O1**	**O2**	**O3**	**O4**	**Mean**
S1	222.11	180.67	245.33	190.02	209.53	84.54	65.26	90.69	70.42	77.72
S2	201.25	160.48	227.08	180.19	192.25	72.13	57.70	82.28	65.11	69.30
S3	177.79	140.25	205.40	162.00	171.36	62.88	50.38	75.44	60.88	62.39
Mean	200.38	160.46	225.93	177.40		73.18	57.78	82.80	65.47	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		3.16		6.52			1.15		2.37	
O		3.65		7.53			1.32		2.27	
S □ O		6.32		13.05			2.30		4.75	

S- Salinity level : S_1– Borewell Water Control; S_2–EC-2.5 dS m^{-1}; S_3–EC-5.0 dS m^{-1}

O-Organic manures : O_1–Humic Acid 30 @ kg ha^{-1}; O_2–Farmyard manure @ 12.5 t ha^{-1}; O_3–Vermicompost @ 12.5 t ha^{-1} and O_4–Composted coir pith @ 12.5 t ha^{-1}

Table 6. Effect of different salinity levels and organic amendments on the Potassium uptake by Clusterbean

O / S	Potassium uptake - Fruit (mg pot^{-1})					Potassium uptake - Stover (mg pot^{-1})				
	O1	**O2**	**O3**	**O4**	**Mean**	**O1**	**O2**	**O3**	**O4**	**Mean**
S1	342.56	272.06	372.88	312.42	324.98	162.64	130.56	177.28	150.32	1545.20
S2	312.98	240.72	342.29	272.52	291.12	147.18	112.12	165.72	130.44	138.86
S3	272.32	220.53	303.76	245.20	260.45	130.55	90.93	142.11	115.01	119.65
Mean	309.28	244.43	339.64	276.71		146.79	111.20	161.70	131.92	
		SEd		**CD (p=0.05)**			**SEd**		**CD (p=0.05)**	
S		4.84		9.98			2.30		4.75	
O		5.58		11.53			2.66		5.49	
S □ O		9.68		19.79			4.60		9.51	

S- Salinity level : S_1– Borewell Water Control; S_2–EC-2.5 dS m^{-1}; S_3–EC-5.0 dS m^{-1}

O-Organic manures : O_1–Humic Acid 30 @ kg ha^{-1}; O_2–Farmyard manure @ 12.5 t ha^{-1}; O_3–Vermicompost @ 12.5 t ha^{-1} and O_4–Composted coir pith @ 12.5 t ha^{-1}

pod and stover respectively. However, it was followed by the treatment pairs like S_1O_1, S_2O_3. The lowest nitrogen uptake by clusterbean pod and stover was noticed in the treatment S_3O_2 (saline water irrigation and FYM 12.5 t ha^{-1}). The addition of organics through soil and saline water irrigated plants enhanced the uptake of nutrients by clusterbean. This might be due to increased availability of nutrients, minimized soluble salt concentration due to slow and steady release of organic acid during decomposition of organic matter and improvement of favorable soil conditions as created by addition of organic amendments. Similar results were earlier made by El-Missery. (2003). Further, increased major (N, P and K) and micro (Fe, Cu, Zn and Mn) nutrients uptake by crops with application of organics along with saline water irrigation may be due to improvement of the soil environment which encouraged prolification of roots resulting in more absorption of water and nutrients from larger rhizosphere. Moreover, organic manures, during decomposition release nutrients, which became available to the plants and increased NPK concentration. The higher nutrients uptake with organic manure might be attributed to solubilization of native nutrients better availability of fertilizers, chelation of micronutrient complex with intermediate organic compounds, their mobilization and accumulation of nutrients by crop plants. These results are in parity with results reported by Salwa et al. (2010); Grzebisz et al. (2010) and Chesti et al. (2015). “Vermicompost contains higher nutrient contents compared to conventional compost and they are more balanced so that their uptake by plant roots is more effective for plant growth stimulation” (Vinothini et al. 2016). “The increase in N, P and K concentration might be due to PGPR nitrogen fixation, the enhancement of plant growth by mycrorrhizal colonization and enhanced uptake of phosphorous has been reported by cavender et al., 2003. Increased plant uptakes might be related to increased nutrient availability on the soil” (Roy et al., 2006) due to vermicompost application that resulted in increasing soil pH, Physico-chemical properties.

4. CONCLUSION

The present investigation clearly indicated that organic manure application under saline water irrigation improving growth, quality parameters and nutrient uptake of clusterbean. From the results of the study, it was concluded that the soil application of vermicompost @ 12.5 t ha^{-1} and saline water (EC-2.5 dS m^{-1}) irrigation to saline tolerant clusterbean variety MDU-1 was significantly improved the growth and nutritional quality characters of clusterbean.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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