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Response of Saline Water Irrigation and Organic Amendments on the Yield Attributes and Yield of Cluster bean (*Cyamopsis tetragonoloba*)

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Abstract

Salinity is a major problem throughout the world when excess soluble salts adversely affect physico-chemical properties of soil and in turn physiological activity of plant growth especially during the early seedling stage. A pot experiment was carried out to study the effect of saline water irrigation and organic amendments on the nutrient availability, yield attributes and yield of cluster bean. The texture of the soil was sandy loam and taxonomically classified as *Typic istifluvent.* The twelve treatments consisted of three levels of saline water viz., S_1–Control (Bore well water), S_2- Saline water 1 (EC – 2.5) and S3-Saline water 2 (EC-5.0) and four different sources of organic amendments viz., O_1-Humic acid (HA), O_2-Farm yard manure (FYM), O_3–Vermicompost (VC) and O_4–Composted coir pith (CCP). The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with three replications using selected saline tolerance cluster bean variety MDU - 1 as test crop. The results revealed that the combined application of vermicompost @ 12.5 t ha^{-1} with bore well water irrigated treatment (S_1O_4) recorded the highest yield attributes and yield of cluster bean. Among the various treatments, the combined application of vermicompost @ 12.5 t ha^{-1} through soil and irrigation with bore well water (S_1O_3) registered the highest pod yield (1.25 kg pot^{-1}) and stover yield (90.17 g pot^{-1}). The lowest pod and stover yield of 0.93 kg pot^{-1} and 68.88 g pot^{-1} were noticed with S_3O_2 (FYM @ 12.5 t ha^{-1} and irrigated with saline water) respectively. This was 25.6 (pod) and 23.61 (stover) per cent decrease as compared to S_1O_3. The treatment which received humic acid @ 30 kg ha^{-1} through soil application and irrigated with borewell water registered a comparable pod and stover yield of 1.20 kg pot^{-1} and 87.46 g pot^{-1} respectively, which was 4.0 and 3.0 per cent decrease over S_1O_3. However, the treatment S_1O_1 was comparable with S_1O_3.

Key words: *Cyamopsis tetragonoloba* L, Saline water, Organic amendments

Cluster bean (*Cyamopsis tetragonoloba* L.) is an important arid leguminous crop, highly suitable for arid and semi-arid regions. It is one of the important arid crops with tremendous potential for vegetable purpose (tender pods) and more specifically for its industrial usage (gum). The tender pods of cluster bean are consumed as a vegetable, offering nutritional value with high protein, fiber, and essential vitamins. It is widely cultivated in regions where water availability is limited, as it thrives under drought conditions. Cluster bean is highly drought-tolerant and grows well in sandy to loamy soils with good drainage. It requires minimal inputs and has a short growth cycle, making it an economical crop for resource-limited regions. Additionally, as a legume, it improves soil fertility by fixing atmospheric nitrogen through symbiotic association with rhizobia. The productivity of cluster bean ranges from 474 kg/ha in Rajasthan to 1200 kg/ha in Haryana [1]. In India, cluster bean is grown in 4.10 million hectares area with production of 1.85 million tonnes and annually contributing to around 80% share to the world's total production [2]. In Tamil Nadu, the total area of cluster bean is cultivated in 1594.43 hectare with the production of 10564.70 million tons in 2021-2022. In addition to water scarcity and salinity, rapid increase in population has put more pressure on these fragile ecosystems to produce more food and fodder. This has further aggravated the problem by further intensification of cropping system. Salinity plays an important role in survival and distribution of crops. Crops which are able to grow and yield under saline condition show certain physiological attributes which make the crops adapted to salinity. Generally, NaCl causes salt stress in nature. The general effect of soil salinity on plants is called the physiological drought effect. A high salt content decreases the osmotic potential of the soil - water and consequently reduces the availability of the soil water for plants [3]. 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. Application

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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, saline water irrigation to cluster bean with application of organic manures to soil helps in maintaining and improving soil fertility and crop productivity.

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 coir pith (CCP) as factor-B. The experiment was laid out in a factorial completely randomized design (FCRD) with three replications using selected saline tolerance cluster bean 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 doses of 25:50:25 mg Kg^{-1} was supplied through urea, super phosphate and muriate of potash to all the pots. The entire doses of NPK were applied as basal. Yield components like number of pods $plant^{-1}$, fruit length, hundred seed weight and single pod weight were recorded at harvest stage. The yield of fruits and stover yield were recorded separately and expressed in g pot^{-1}. The soil sample were collected and analyzed for available NPK, Exchangeable Na, K and DTPA Zn, Cu, Fe and Mn using standard procedure of Jackson [4]. At harvest fruit and stover yield was separately recorded.

RESULT AND DISCUSSION

Yield attributes

Irrespective of the level of salinity, application of organic manures significantly influenced the yield characters of cluster bean.

As compared to saline water irrigation, bore well water irrigation was significantly superior in increasing the number of pods $plant^{-1}$, pod length, single fruit weight and 100 seed weight of cluster bean. Between the two levels of salinity, the plants irrigated with S2 (EC-2.5 dS m^{-1}) saline water recorded highest number of pods $plant^{-1}$ (38.22), pod length (13.46 cm), single pod weight (5.27 g) and 100 seed weight (2.59) as compared to treatment S_3, irrigated with saline water irrigation (EC-5.0 dSm^{-1}). Among the various organics evaluated, application of vermicompost @12.5 t ha^{-1} (O_3) was significantly superior in increasing the yield characters viz., number of pods $plant^{-1}$ pod length (14.52 cm), single pod weight (5.83 g) and 100 seed weight (2.87g). Application of humic acid @ 30 kg ha^{-1} (O_1) also significantly increased the yield characters as compared to composted coir pith and FYM.

Table 1 Effect of different salinity levels and organic amendments on the number of pods per plant and pod length of cluster bean

S \ O	Number of pods per plant					Pod length (cm)				
S	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	42.20	37.79	43.90	40.30	41.05	14.80	13.30	15.40	14.10	14.40
S_2	39.70	34.80	40.90	37.50	38.22	14.20	12.40	14.16	13.10	13.46
S_3	36.30	31.19	37.158	33.40	34.52	13.50	11.90	14.00	12.70	13.02
Mean	39.40	34.59	40.66	37.06		14.16	12.53	14.52	13.30	
		SEd		CD (p=0.05)			SEd		CD (p=0.05)	
S		0.030		0.062			0.255		0.527	
O		0.035		0.072			0.295		0.609	
S × O		0.060		0.125			0.511		1.054	

S- Salinity level: S_1 – Borewell water control; S_3 – 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 2 Effect of different salinity levels and organic amendments on the single pod weight and 100 seed weight of cluster bean

S \ O	Single pod weight (gm)					100 seed weight (gm)				
S	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	6.03	5.36	6.25	5.70	5.83	3.05	2.74	3.16	2.91	2.96
S_2	5.42	4.76	5.79	5.14	5.27	2.59	2.36	2.82	2.52	2.59
S_3	5.18	4.47	5.46	4.82	4.98	2.44	2.20	2.64	2.39	2.44
Mean	5.54	4.86	5.83	5.22		2.75	2.43	2.87	2.60	
		SEd		CD (p=0.05)			SEd		CD (p=0.05)	
S		0.122		0.252			0.042		0.087	
O		0.141		0.291			0.048		0.101	
S × O		0.244		0.505			0.084		0.175	

S- Salinity level: S_1 – Borewell water control; S_3 – 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}

The interaction effect between saline water irrigation and organic amendments in improving yield characters of cluster bean was significant. Application of vermicompost @ 12.5 t ha^{-1} through soil and irrigated with bore well water (S_1O_3) registered the highest yield characters like number of pods $plant^{-1}$ (43.90), pod length (15.40 cm), single pod weight (6.25 g) and 100 seed weight (3.16g). However, it was followed by the treatment S_1O_1, which received humic acid @ 30 kg ha^{-1}

through soil application and irrigated with saline water. The lowest number of pods plant^{-1}, pod length, single pod weight and 100 seed weight was noticed in the treatment (S_3O_2) irrigated with saline water (EC-5.0 dS m^{-1}) with the application of FYM @ 12.5 t ha^{-1}. It was probably due to more readily available nutrients and growth regulating substances such as urease, phosphomonoesterase, phosphodiesterase and arylsulphatase in the vermicompost treated soils. These results are in consonance to findings of Pritam *et al*. [5], Tyagi and Upadhay [6] and Yadav *et al*. [7], who attributed plant growth was due to more readily available nutrients and growth regulating substances of PGPR present in the vermicompost. Vermicompost provides aggregate formation in the soil in order to increase productivity. It improves the structure of the soil, increases the porosity of the soil, and ensures that the air intake and water holding capacity are high. These also help the plant to complete root development better. Thus, the plant absorbs useful nutrients in the soil and causes an increase in plant characteristics and yield. In addition, the vermicompost applied to the soil improved the nutrient availability in soil [8-9]. Further betterment in yield components of cluster bean might be due to supplementary effect of organics which improved the better soil environment, physico-chemical and biological conditions which helped to improve the cluster bean yield attributing characters as reported by [10-11]. This was followed by the similar findings of Yadav *et al*. [7], Singh *et al*. [12].

Yield

The pod and stover yield of cluster bean were significantly influenced by the application of different organic amendments and saline water irrigation. Among the different salinity level water, bore well water irrigation (S_1) was significantly superior in increasing the pod and stover yield of cluster bean as compared to other levels of saline water. This treatment recorded 1.20 kg pod yield pot^{-1} and 84.84 g stover yield pot^{-1}. This was followed by S_2 (1.12 kg pod yield pot^{-1} and 80.65g stover yield pot^{-1}) and S_3 (1.06 kg pod yield pot^{-1} and 75.82 g stover yield pot^{-1}) saline water irrigated plants. All the organic manures evaluated in the experiment significantly increased the yield of cluster bean. However, the effect due to the application of vermicompost was superior which recorded 1.17 kg pod yield pot^{-1} and 86.67 g pot^{-1} of stover yield. This was followed by application of humic acid @ 30 kg ha^{-1} which recorded 1.13 kg pod yield pot^{-1} of pod and 83.13 g stover yield pot^{-1}. The interaction effect due to the soil application of different organic manures and saline water irrigation on yield of cluster bean was significant. The treatment (S_1O_3) supplied with VC @ 12.5 t ha^{-1} through soil application and bore well water irrigated plants recorded the highest pod yield (1.25 kg pot^{-1}) and stover yield (90.17 g pot^{-1}). This was followed by the treatment S_1O_1. The treatment which received humic acid @ 30 kg ha^{-1} through soil application and bore well water irrigated plants registered a comparable pod and stover yield of 1.20 kg and 87.46 g pot^{-1}. The lowest yield was noticed in (S_3O_2) saline water (EC-5.0 dS m^{-1}) and soil application of FYM @ 12.5 t ha^{-1} (0.93kg pod yield pot^{-1} and 68.88g stover yield pot^{-1}.

The significantly higher pod and stover yields recorded in saline water irrigation with lower salinity level (S_2) and VC application could be attributed to the supply of nutrients through mineralization and improvement in physico-chemical properties of the soil and the resultant increase in growth and yield characters [13-15]. The higher pod yield of cluster bean to applied with organic amendments and irrigated with saline water could be ascribed to the slow and steady rate of nutrient release into soil solution to match the required absorption pattern of cluster bean, probably, the adequate nutrient supply might have promoted its translocation from source to sink resulting in higher pod yield. The increased cluster bean yield due to the application of organics and saline water irrigation have already been well documented by Mondal [16]. Further, the number of fruits per plant was not affected in lower salinity, and the yield reduction was entirely due to smaller fruit and reduced DMP [17]. However, the number of harvested fruits per plant reduced with only higher level of salinity [18-19].

Table 3 Effect of different salinity levels and organic amendments on the yield of cluster bean

S \ O	Pod yield (Kg pot^{-1})					Stover yield (g pot^{-1})				
	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	1.20	1.08	1.25	1.14	1.20	87.46	78.31	90.17	83.43	84.84
S_2	1.12	1.02	1.17	1.08	1.12	83.39	73.39	87.09	78.74	80.65
S_3	1.06	0.93	1.11	1.01	1.06	78.55	68.88	82.77	73.10	75.82
Mean	1.13	1.01	1.17	1.07		83.13	73.52	86.67	78.42	

	Pod yield SEd	Pod yield CD (p=0.05)	Stover yield SEd	Stover yield CD (p=0.05)
S	0.017	0.036	1.27	2.63
O	0.020	0.042	1.47	3.04
S × O	0.035	0.073	2.55	5.27

S- Salinity level: S_1 – Borewell water control; S_3 – 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}

Available NPK

Irrigation of cluster bean with different salinity level and soil application of various organics was significantly influenced the available nitrogen content of post-harvest soil. Among the different levels of salinity tried, bore well water irrigation (S_1) recorded the lowest available NPK content of (82.16, 17.91, 87.04) kg ha^{-1} at post-harvest soil. This was followed by the treatments S2 (EC-2.5 dS m^{-1}) and S3 (EC-5.0 dS m^{-1}) respectively.

Among the different organics studied, application of VC @ 12.5 t ha^{-1} (O_4) registered lowest mean available nitrogen, phosphorous, potassium content of (80.90, 19.12, 88.39) kg ha^{-1} in post-harvest soil. This was followed by the treatment O_4, application of composted coir pith @ 12.5 t ha^{-1} and treatment (O_2) application of farm yard manure @ 12.5 t ha^{-1}. Interaction effect due to different saline water irrigation and organic manures through soil application an available N status of post-harvest soil was significant. Cluster bean irrigated with bore well water and addition of vermicompost @ 12.5 t ha^{-1} through soil (S_1O_3) registered the lowest available NPK (77.10, 16.86, 81.45) kg ha^{-1} at post-harvest soil. However, it was found to be comparable with the treatment S_1O_4, which received CCP @ 12.5 t ha^{-1} through soil and irrigated with borewell water.

The profound influence of various organics increasing the availability of major nutrients in soil was well evidenced in the present study. The increase in availability of nutrients in organic manure applied treatments might be due to the release of nutrients from the organic manure due to decomposition by the various microorganisms in soil. The improvement in the physico-chemical properties by the way of reduction in soil pH and EC might have improved the soil physical properties, which contributed for an increase in soil available nutrient status. Further, with the release of organic acids and chelation mechanism of the decomposition products of added organic manures have solubilized the different forms of nutrient in soil [20-22]. The addition of FYM might have improved physical properties of the soil, thus created favourable conditions for microbial activity. The increase in NPK availability of soil with the addition of organic manure was reported by Sajal Poy [23]. In addition, the added organic manure as an energy source for a majority of the heterotrophic bacteria stimulated native beneficial microbial activity, thus resulting in higher N availability of soil under salt stress condition [24-25].

The addition of organics along with recommended dose of Nitrogen (N), Phosphorus (P), and Potassium (K) fertilizers reduced the K fixation and release of K due to the interaction of organic matter with clay besides the direct addition of potassium to available pool of the soil contributed for increased K availability. Organics also minimized the leaching loss of K by retaining K ions on exchange sites of the decomposition products [26-28]. Under saline condition Sulphur oxidized biologically in the presence of organic matter in soil produce sulphuric acid which react with native $CaCO_3$ to from $CaSO_4$. Moreover, addition of organics also produced acid and decrease pH, which is a well-known effect upon the availability of some nutrients in the soil [29-30].

Table 4 Effect of different salinity levels and organic amendments on the available N, P, K content of the post-harvest soil

S \ O	Available - N (kg ha^{-1})					Available - P (kg ha^{-1})					Available - K (kg ha^{-1})				
	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	89.15	82.95	77.10	79.45	82.16	19.29	18.12	16.86	17.40	17.91	93.59	88.80	81.45	84.33	87.04
S_2	92.40	88.15	80.45	82.90	86.05	21.54	20.28	18.56	19.40	19.94	100.64	97.27	87.60	91.76	94.32
S_3	96.60	92.10	85.15	88.15	90.50	25.26	23.94	21.96	22.74	23.47	106.61	102.97	96.14	98.66	101.09
Mean	92.81	89.50	80.90	87.73		22.03	20.77	19.12	19.85		100.28	96.34	88.39	91.58	

	SEd (N)	CD (p=0.05) (N)	SEd (P)	CD (p=0.05) (P)	SEd (K)	CD (p=0.05) (K)
S	1.27	2.16	0.30	0.61	1.39	2.87
O	1.47	3.04	0.34	0.71	1.60	3.31
S × O	2.55	5.26	0.60	1.23	2.78	5.74

S- Salinity level: S_1 – Borewell water control; S_3 – 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 available Zn and Cu content of the post-harvest soil

S \ O	DTPA - Zinc (mg kg^{-1})					DTPA - Copper (mg kg^{-1})				
	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	0.610	0.253	0.410	0.323	0.399	0.243	0.130	0.180	0.150	0.175
S_2	0.730	0.316	0.503	0.380	0.482	0.280	0.160	0.210	0.180	0.207
S_3	0.910	0.380	0.753	0.480	0.630	0.360	0.200	0.216	0.216	0.261
Mean	0.750	0.316	0.555	0.394		0.294	0.163	0.220	0.182	

	SEd (Zn)	CD (p=0.05) (Zn)	SEd (Cu)	CD (p=0.05) (Cu)
S	0.007	0.015	0.003	0.009
O	0.008	0.017	0.004	0.011
S × O	0.014	0.030	0.006	0.019

S- Salinity level: S_1 – Borewell water control; S_3 – 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 available Fe and Mn content of the post-harvest soil

S \ O	DTPA - Iron (mg kg^{-1})					DTPA - Manganese (mg kg^{-1})				
	O_1	O_2	O_3	O_4	Mean	O_1	O_2	O_3	O_4	Mean
S_1	31.50	28.50	29.79	26.40	29.05	9.60	7.65	9.05	8.25	8.63
S_2	32.10	29.00	30.30	26.90	29.57	9.85	8.05	9.30	8.50	8.92
S_3	33.00	29.90	31.19	27.70	30.45	10.40	8.25	9.92	9.01	9.39
Mean	32.20	29.13	30.43	27.00		9.95	7.98	9.42	8.58	

	SEd (Fe)	CD (p=0.05) (Fe)	SEd (Mn)	CD (p=0.05) (Mn)
S	0.451	0.932	0.134	0.2776
O	0.521	1.076	0.154	0.319
S × O	0.903	1.864	0.268	0.553

S- Salinity level: S_1 – Borewell water control; S_3 – 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}

Available Zn, Cu, Fe and Mn

The present study, application of different organic manures and saline water irrigation was significantly influenced the availability of DTPA-zinc, copper, iron and manganese content of post- harvest soil. Among the various salinity levels, bore well water (S_1) irrigated treatments recorded the lowest available Zn, Cu, Fe and Mn of (0.399,0.175, 29.05 and 8.63) mg kg^{-1} at post-harvest soil respectively. This was followed by the S_2 and S_3 saline water irrigated treatments. Among the different organics studied, application of FYM @ 12.5 t ha^{-1} (O_2) recorded the lowest Zn, Cu, Fe and Mn of (0.316, 0.163, 29.13 and 7.98) mg kg^{-1} at post-harvest soil. This was followed by the application of composted coir pith @ 12.5 t ha^{-1} (O_4) and vermicompost @12.5 t ha^{-1} (O_4). The highest available Zn was noticed in the treatment O_1, (HA @ 30 kg ha^{-1}). Interaction effect due to the soil application of different organic manures and irrigated with saline water on zinc availability was significant. Soil application of FYM @ 12.5 t ha^{-1} and bore well water irrigation (S_1O_2) registered the lowest Zn, Cu, Fe and Mn availability of (0.253, 0.130, 28.50 and 7.65) mg kg^{-1} respectively. This was followed by the treatment S_2O_2, which received FYM @ 12.5 t ha^{-1} through soil and saline water irrigation. The highest zinc, copper, iron and manganese availability was noticed in S_3O_1.

Saline water irrigation alone increases the pH of soil which in turn decrease the solubility and availability of micronutrients [31-32] Addition of organic manure improves the organic carbon status and increases the nutrient availability of primary, secondary nutrients and also supply of sufficient amount of micronutrients in available forms. Organic manures also help in increasing the complex and adsorptive power of soil for cations and anions particularly phosphate, nitrates and micronutrients. These adsorbed ions are released slowly for the benefit of crop during entire growth [34-35].

The application of organic manures and saline water irrigation significantly influences the availability of DTPA-extractable zinc, copper, iron, and manganese in post-harvest soil. Saline water irrigation, particularly with bore well water (S1), reduced the availability of these micronutrients, with the lowest levels observed under the combined treatment of FYM (farmyard manure) @ 12.5 t ha^{-1} and bore well water irrigation (S_1O_2). Conversely, the highest availability of micronutrients was recorded in treatments involving higher salinity levels and humic acid application (S_3O_1). The results highlight the adverse effects of saline water irrigation on micronutrient availability due to increased soil pH, while organic manures improve nutrient availability by enhancing organic carbon content and soil cation/anion exchange capacity. These findings underscore the importance of integrating organic amendments with proper irrigation management to mitigate salinity-induced nutrient deficiencies and sustain soil fertility for crop production.

CONCLUSION

The present investigation was clearly brought out the beneficial role of organic manure application under saline water irrigation for improving the soil properties, sustaining the yield and nutrient uptake by cluster bean. 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 cluster bean variety MDU-1 was identified as best treatment combination to realize the maximum yield of cluster bean (*Cyamopsis tetragonoloba*) as well as to sustain soil health.

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