J. Indian Soc. Coastal Agric. Res. 44(1):52-63(2026) https://doi.org/10.54894/JISCAR.44.1.2026.172048

Impact of Manure and Mulching Under Drip Irrigation on Salinity and Tomato Yield in Coastal Saline Soil

P.B. VANAVE[1], S.S. KHOBRAGADE[1], M.R. WAHANE[1*], K.B. BHANGARE[1], M.J. KALEDHONKAR[2], R.L. MEENA[2], B.L. MEENA[2], S. KUMAR[2], S.B. DODAKE[1], AND K.P. VAIDYA[1]

[1]Khar Land Research Station, Dr. B.S. Konkan Krishi Vidyapeeth, Panvel, Raigad- 410 206, Maharashtra, India
[2]ICAR- Central Soil Salinity Research Institute, Karnal - 132 001 Haryana, India

Received: 24.09.2025 Accepted: 28.07.2026

Field experiments spanning three consecutive *Rabi* seasons (2019-20 to 2021-22) were carried out to assess the effects of different manures (no manure, farmyard manure (FYM), and vermicompost) and mulches (without mulch, plastic mulch, and paddy straw mulch) on soil salinity and tomato yield utilizing drip irrigation at the Khar Land Research Station, Panvel, Maharashtra. The results showed a notable reduction in soil salinity when using FYM at 7.5 t ha^{-1} with vermicompost at 2.5 t ha^{-1} (2.54, 3.36 dS m^{-1}) and plastic mulch (1.25, 2.75 dS m^{-1}) at 30 and 90 days, respectively after transplanting of tomato over initial salinity (6.35 dS m^{-1}). Among mulches, plastic mulch recorded the lowest salinity (1.25 and 2.75 dS m^{-1}), while the combination of paddy straw mulch with FYM + vermicompost reduced salinity to 1.09-2.56 dS m^{-1}. A significantly higher yield of tomato fruit (19.89 t ha^{-1}) was achieved with the application of FYM at 7.5 t ha^{-1} and vermicompost at 2.5 t ha^{-1} compared to the no-manure application (10.12 t ha^{-1}). The use of paddy straw mulch alone resulted in a higher tomato yield (20.44 t ha^{-1}) compared to no mulching (9.76 t ha^{-1}). In addition, it was observed that the combination of FYM at 7.5 t ha^{-1} and vermicompost at 2.5 t ha^{-1}, along with paddy straw mulch, achieved the highest yield of 25.44 t ha^{-1} with maximum benefit-cost ratio of 1.45 outperforming all other treatments followed by application of FYM at 15 t ha^{-1} with paddy straw mulch yielded 23.20 t ha^{-1}. The study indicates that blending organic manures with paddy straw mulch under drip irrigation is an effective and economical strategy for enhancing tomato productivity and managing coastal saline soils.

(***Key words:*** *Coastal salinity, Mulch, Organic manures, Tomato yield*)

In the Konkan coastal areas of Maharashtra, rice is commonly grown as a single crop during the *Kharif* season, leaving a large part of cultivable land fallow during the *Rabi* and summer periods. This leads to a major drop in farmers income (Dodake *et al.,* 2023; Khobragade *et al.,* 2025). The coastal saline soils in these regions often face entry of seawater and creek water during high tides, which increases soil salt content and keeps the soil wet for a longer time after the rice is harvested. As a result, traditional farming activities are postponed, causing the loss of stored moisture through evaporation and a rise in salt levels on the surface (Dodake *et al.,* 2022, 2023; Khobragade *et al.,* 2025; Patil *et al.,* 2024). The repeated entry of saltwater gradually worsens the soil condition, often making the land unfit for farming in the long run (Dodake *et al.,* 2022; Khobragade *et al.,* 2025; Rakhonde *et al.,* 2025). In addition to salinity, crop productivity is also affected by limited irrigation water, high temperatures, excessive moisture in the soil, and strong competition from weed (Patil *et al.,* 2024). The shortage of good-quality irrigation water and the naturally saline nature of both the soil and available water limit the ability to grow crops during the *Rabi* season. Under traditional farming practices, fields need to dry completely before ploughing, which delays planting and makes the issues of moisture and salinity even worse.

In these conditions, farmers often choose salt-tolerant legumes such as field beans, relying on the remaining soil moisture. Some farmers have built farm ponds to store rainwater, although the use of saline groundwater or the stored fresh water in these ponds is not widely used for growing high-value salt-tolerant vegetables during the *Rabi* and summer seasons. To tackle these issues, conservation agriculture practices such as reduced or zero tillage, keeping of crop residues

**Corresponding author:* E-mail: mrwahane@gmail.com

on the field, and diversifying the crops are being promoted. These methods allow for timely planting of *Rabi* crops, help in retaining soil moisture, and reduce the accumulation of surface salt (Khobragade *et al.,* 2025). In light of this, there is a need to study how well *Rabi* crops, particularly tomatoes, perform under mulching and drip irrigation in coastal saline soils.

Tomato (*Solanum lycopersicum* L.) is a significant vegetable crop grown in the coastal saline areas of Maharashtra because it can tolerate moderate levels of salinity. However, it still suffers substantial yield reductions of 20-50% at soil ECe levels of 2.5-3.0 dS m^{-1}, primarily due to stunted vegetative growth, poor fruit set, and inferior fruit quality (Cantore *et al.,* 2012). Drip irrigation has become a highly effective method in saline environments because it delivers water directly to the roots, keeps the soil evenly moist, reduces the need for frequent watering, and helps move salts away from the plants root area (Mahanta *et al.,* 2019). When used together with mulching, it further reduces water loss from the surface, prevents the upward movement of salts through capillary action, and helps retain soil moisture. Studies have found that the combining organic manures like farmyard manure and vermicomposting with plastic mulch under drip irrigation significantly lowers soil salinity, improves the physical and chemical properties of the soil, enhances nutrient availability, and leads to better plant growth and higher yields in saline soils (Hasan *et al.,* 2024; Hou *et al.,* 2016; Raut *et al.,* 2021; Wang *et al.,* 2022).

Several crops have shown positive results when grown using drip irrigation with plastic mulch, including chilli, okra, cucumber, bitter gourd, pumpkin, sunflower, brinjal, and tomato (Hasan *et al.,* 2024; Mahanta *et al.,* 2019; Sarangi *et al.,* 2021; Singaravel *et al.,* 2019; Li *et al.,* 2024). In a recent study on brinjal in coastal saline soils of Maharashtra applying farmyard manure (7.5 Mg ha^{-1}) and vermicompost (2.5 Mg ha^{-1}) along with plastic mulch under drip irrigation led to a dramatic reduction in soil salinity (from 6.13 dS m^{-1} initially to 2.57 dS m^{-1} at 30 DAT and 1.08 dS m^{-1} at 60 DAT), resulting in the highest yield of 37.25 Mg ha^{-1} and a favourable benefit-cost ratio of 1.38 (Khobragade *et al.,* 2025). Similar positive outcomes were observed for tomatoes under mulched drip irrigation in coastal region of Bangladesh (Hasan *et al.,* 2024). There is still limited field research focusing on tomatoes that evaluates different manure quantities along with various types of mulch (plastic and organic) under drip irrigation, especially with regard to change in soil salinity and economic potential in areas having high monsoonal rainfall with saline water intrusion effect. Combining best doses of organic manure with suitable mulching resources in drip irrigation will remarkably reduce root-zone salinity, improve soil physical and chemical characteristics, diminish osmotic and ionic stresses, and enhance the growth, yield, and quality of tomato in Maharashtra's coastal saline soils compared to traditional methods. With this background, the study was conducted to identify the optimal combination of manure and suitable mulch for maximizing productivity, managing salinity, and increasing economic returns. This research seeks to address the research gap by providing evidence based management methods for sustainable tomato cultivation in the saline coastal agro-ecosystems of Maharashtra.

MATERIALS AND METHODS

The field experiment was carried out utilizing a factorial randomized block design that featured four levels of manure application: Farm yard manure (FYM) at 15 t ha^{-1} (F_1), vermicompost at 5 t ha^{-1} (F_2), FYM at 7.5 t ha^{-1} in combination with vermicompost at 2.5 t ha^{-1} (F_3), and a control group with no manure (F_4). In addition, there were three types of mulch used: plastic mulch (M_1), paddy straw mulch (M_2), and no mulch (M_3), with three replications for each of the 12 treatment combinations. One-month-old tomato seedlings were transplanted during the first fortnight of November each year, spaced 60 cm × 60 cm apart. The total plot dimensions were 4.20 m × 3.0 m. Prior to planting, 25 mm of irrigation water was applied to all treatments to raise the soil water content to the field capacity level in the 0-60 cm soil depth. The suggested set of practices (cultural and pest management techniques) was adhered in order to cultivate a healthy tomato crop. The 50-micron-thick black polyethylene film and paddy straw at 3.0 t ha^{-1} was utilized for mulching. The mulch was applied by hand across the prepared field, and seedlings were transplanted by creating holes that measured 5 cm in diameter. The suggested fertilizer application rate (150:50:50 kg NPK ha^{-1}) was made

Table 1. *Initial soil properties of the experiential site*

Sr. No.	Parameters	Content
1.	Soil pH1:2.5	6.79
2.	Electrical conductivity (EC1:2.5) (dS m^{-1})	6.35
3.	Organic carbon (g kg^{-1})	5.10
4.	Bulk density (Mg m^{-3})	1.31
5.	Soil texture (%)	
	Textural class	clay loam
	Sand	26.38
	Silt	38.84
	Clay	34.78
6.	Available nitrogen (kg ha^{-1})	174.36
7.	Available phosphorus (kg ha^{-1})	95.92
8.	Available potassium (kg ha^{-1})	1275.25

Table 2. *Irrigation water quality parameters*

Sr. No.	Parameters	Content
1.	pH	7.34
2.	EC (dS m^{-1})	0.60
3.	Calcium (Ca^{2+}) meq L^{-1}	3.069
4.	Magnesium (Mg^{2+}) meq L^{-1}	0.411
5.	Sodium (Na^{+}) meq L^{-1}	7.58
6.	Carbonate (CO_3^{2-}) meq L^{-1}	0.96
7.	Bicarbonate (HCO_3^{-}) meq L^{-1}	3.16
8.	Residual sodium carbonate	0.64
9.	Sodium adsorption ratio	5.74

using urea, single super phosphate (SSP), and muriate of potash (MOP). A complete dose of phosphorus and potassium was applied, along with 50% nitrogen as the basal dose, while the remaining nitrogen was side-dressed at 45 and 90 days after transplanting (DAT). Lateral drip lines with emitters spaced 50 cm apart were installed in every row across all treatments. The water needs for tomatoes were met using collected rainwater stored in a farm pond at the KRLS Research Farm in Panvel. The quality of collected rainwater was normal from the irrigation perspective (Table 2). The tomato crop was irrigated with a drip irrigation system was used to irrigate the tomato crop where the main lines were spaced 45 cm apart and the emitters were placed 30 cm apart. Each emitter released a flow of 4.0 litres per hour. Irrigation was done daily for the first 7 days after transplanting to ensure the plants became well-establishment. Subsequently, irrigation was given at intervals of two days for each treatment. An overall irrigation depth of 400 mm was constantly applied during the entire crop growth period. The same amount of irrigation water applied to the all treatments including no manure and mulching. The overall fruit yield was documented by summing the yield from each picking and converting it to kg per hectare for every experimental plot. Soil sampling occurred prior to the start of the experiment, 30 days after transplanting (DAS), and again 30 days post-transplanting. Soil samples (0-30 cm) were collected, processed, and analysed for the soil pH and electrical conductivity in water extracts in deionized water (1:2.5 soil: water ratio) using the Jackson (1973) method. The moisture content for the respective samples was determined on a weight basis utilizing the gravimetric approach (Jackson, 1973).

The economic evaluation of tomato farming across different treatments involved analysing fruit yield, total income, and cultivation expenses to determine net income and the benefit-cost ratio (BCR). The standard values related to the cost component were obtained from the Cost of Cultivation Scheme, Department of Economics, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli. Soil pH, salinity, moisture, and fruit yield data were statistically evaluated using statistical techniques (Panse and Sukhatme, 1961). The relationship between soil salinity and moisture at 90 DAS concerning yield was assessed through multiple regression analysis to grasp the effects of these stresses on fruit yield and their relevance (Panse and Sukhatme, 1961).

RESULTS AND DISCUSSION

Influence on soil salinity

Soil salinity reduced considerably when organic manures and mulching were applied as compared to the initial soil salinity. Data (Table 3) showed that the combination of farmyard manure (FYM) at 7.5 t ha^{-1} and vermicompost at 2.5 t ha^{-1} (F3) resulted in the lowest electrical conductivity (EC) measuring 2.54 dS m^{-1} at 30 days and 3.36 dS m^{-1} at 90 days after transplanting. However, the no-manure control treatment had the highest EC at 3.09 and 3.86 dS m^{-1}, respectively. At the beginning of the season in November, the salinity in the root-zone was 6.35 dS m^{-1}. Among the mulch treatments, plastic mulch was the most effective, showing the lowest EC of 1.25 dS m^{-1} at 30 days and 2.75 dS m^{-1} at 90 days. However, paddy straw mulch shows an EC of 2.40 and 3.70 dS m^{-1}, respectively. The no-mulch control showed significantly higher salinity of 4.81 and 4.37 dS m^{-1} at 30 and 90 days after transplanting, respectively. Using drip irrigation along with mulching proved to be beneficial in reducing soil EC, especially in the top 0-30 cm soil layer. The interaction between organic manure and mulch had a highly significant effect. The combination of plastic mulch with FYM (7.5 t ha^{-1}) and vermicompost (2.5 t ha^{-1}) resulted in the lowest EC of 1.09 dS m^{-1} at 30 days and 2.56 dS m^{-1} at 90 days, indicated that using mulch with organic manures was more effective in reducing salinity than either method alone.

The reduction in soil salinity under mulched treatments can be explained by reduced water evaporation from the soil, which limits the upward movement of salts into the root area. Organic manures also enhance soil permeability, aggregation, and water infiltration, which helps in leaching salts and reduces salt concentration around the roots. These findings are consistent with previous studies by Abd El-Mageed *et al.* (2016), Hasan *et al.* (2024), Khobragade *et al.* (2025) and Samui *et al.* (2020). Mulching also helps by maintaining soil moisture, regulating soil temperature, reduced weed growth, creating a more favourable environment for root development and microbial activity (Li *et al.,* 2024; Singaravel *et al.,* 2019; Song *et al.,* 2025). In mulched plots, salt concentration generally decreased at first and then gradually increased during the growing season, while in non-mulched plots, it showed a continuous upward trend. The use of drip irrigation helped in maintaining consistent soil moisture, keeping salts diluted and reducing their accumulation. Wang *et al.* (2022) noted that combining farmyard manure with film mulch not only prevents salt buildup linked to organic fertilizer application but also enhances soil fertility by reducing evaporation. Similar mechanisms, such as reduced evaporative losses and improved leaching due to enhanced soil structure have been reported by Li *et al.* (2013), Sharma and Singh (2017) and Tejada *et al.* (2006). Throughout the season, soil salinity in coastal areas tends to reach its lowest point in January, due to lower temperatures and reduced evaporation, and then gradually increases from February onward as temperatures rise. In saline coastal soils, high EC restricts tomato growth through osmotic stress and ion toxicity. Both plastic and paddy straw mulches significantly reduced these stress factors by limiting salt capillary rise and conserving moisture, with plastic mulch performing better. Organic manures (FYM and vermicompost) further reduced salinity by improving soil structure, increasing organic matter content, and making nutrients more available, thereby reducing the negative effects of salinity. Overall, the integrated treatment F_3 (FYM + vermicompost) combined with plastic mulch consistently performed best, likely because of combined improvements in soil physical, chemical, and biological properties. These findings confirm previous studies that highlight the benefits of manure-mulch integration in managing salinity, improving water retention, and increasing crop yields in coastal areas (Hasan *et al.,* 2024; Khobragade *et al.,* 2025; Wang *et al.,* 2022).

Influence on soil pH

pH stood in a good range (6.62-7.04) during the entire growth period of the tomato plants. Data (Table 4) shows that using farmyard manure (FYM) at 7.5 t ha^{-1} and vermicomposting at 2.5 t ha^{-1} (F_3) maintain the soil pH relatively high at 30 (6.79) and 90 (6.85) days after transplanting. This treatment performed better than other combinations, showing better stability in soil pH. Organic manures help keep the soil pH stable by releasing humic substances and basic cations like calcium, magnesium, and potassium as they break down. These substances reduce changes in pH and support better soil life and nutrient movement. Among the mulching treatments, plastic mulch had the highest soil pH (6.89) at 30 days after transplanting, while the no-mulch treatment had the lowest (6.64). The same pattern continued at 90 days, with pH values varying between 6.67 to 7.01. The best results were seen when plastic mulch was combined with FYM (7.5 t ha^{-1}) and vermicompost (2.5 t ha^{-1}), leading to the highest pH of 6.94 at 30 days and 7.04 at 90 days after transplanting. This shows that using organic manures along with mulch is more effective in keeping the pH stable and favourable for the roots in salt conditions than using either method alone. Using organic materials and mulches improves the chemical condition of the soil by increasing its ability to buffer pH changes and reducing extreme shifts. These findings support previous studies by Bhattacharyya *et al.* (2015) and Mahmoodabadi *et al.* (2013). Without manure or mulch, the soil pH tends to become more acidic because of salt leaching from irrigation. On the other hand, salt accumulation through capillary action and irrigation water made the soil react more neutral or slightly alkaline in the treated areas, as noted by Dodake *et al.* (2022; 2023), Khobragade *et al.* (2025) and Rakhonde *et al.* (2025). Overall, the changes in soil pH were small but statistically important. Using mulch and organic manures together helped to keep the soil pH stable by lowering salt buildup from evaporation and increasing the organic matter in the soil, creating a better environment for tomato roots in coastal saline soils. Similar combined benefits have been found by Reta and Habita (2025).

Influence on soil moisture

Soil moisture levels were greatly affected by both mulching and manure treatments throughout the growing season of the crop. At 30 days after transplanting (DAT), plastic mulch treatment (M1) had the highest average soil moisture content at 40.34%, followed by paddy straw mulch at 34.82%, while the no-mulch had only 26.05% (Table 5). The same pattern was observed at 90 DAT, where plastic mulch remained the highest at 35.43%. Plastic mulch is effective in conserving soil moisture because it blocks direct sunlight, reduces upward evaporation, and cuts down surface water runoff. Moreover, water vapour that forms on the underside of the polyethylene sheet drips back into the soil, which further aids in maintaining moisture. Among the manure treatments, the combination of farmyard manure at 7.5 t ha^{-1} and vermicomposting at 2.5 t ha^{-1} (F_3) resulted in the highest soil moisture content at both measurement times. Organic manures help to improve soil structure, allow better aggregation and continuity of pores, and enhance its ability to hold water by increasing the amount of organic matter in the soil. This helps the soil to retain more moisture in the area where the roots grow. The combined effect of plastic mulch with F_3 (M_1F_3) was highly beneficial, achieving the highest soil moisture content of 43.13% at 30 DAT and 38.83% at 90 DAT. This excellent moisture retention is due to reduced evaporative losses and better infiltration under the integrated approach. These results are in line

Table 3. *Effect of different levels of organic manures and mulching on electrical conductivity (dS m^{-1}; 1:2.5; soil:water suspension) at 30 and 90 days after planting of tomato under drip irrigation (Pooled data of three years)*

Treatments	Electrical conductivity (dS m^{-1})									
	30 Days after planting					90 Days after planting				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
M_1	1.20	1.31	1.09	1.41	1.25	2.65	2.83	2.56	2.97	2.75
M_2	2.17	2.61	1.99	2.85	2.40	3.62	3.80	3.36	4.02	3.70
M_3	4.79	4.89	4.55	5.02	4.81	4.29	4.44	4.16	4.59	4.37
Mean	2.72	2.94	2.54	3.09	-	3.52	3.69	3.36	3.86	-
	SE± m		CD (5%)			SE± m			CD (5%)	
Mulch (M)	0.01		0.03			0.01			0.02	
Manure (F)	0.01		0.03			0.01			0.03	
Interaction (M x F)	0.02		0.06			0.02			0.05	

Table 4. *Effect of different levels of organic manures and mulching on pH (1:2.5; soil:water suspension) at 30 and 90 days after planting of tomato under drip irrigation (Pooled data of three years)*

Treatments	Soil pH									
	30 Days after planting					90 Days after planting				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
M_1	6.91	6.86	6.94	6.85	6.89	7.02	7.00	7.04	6.98	7.01
M_2	6.71	6.70	6.78	6.69	6.72	6.76	6.75	6.79	6.75	6.76
M_3	6.64	6.66	6.65	6.62	6.64	6.68	6.63	6.73	6.62	6.67
Mean	6.75	6.74	6.79	6.72	-	6.82	6.80	6.85	6.79	-
	SE± m		CD (5%)			SE± m			CD (5%)	
Mulch (M)	0.01		0.04			0.002			0.005	
Manure (F)	0.01		0.04			0.002			0.005	
Interaction (M x F)	0.03		0.07			0.003			0.009	

Treatments - M_1: plastic mulch; M_2: paddy straw mulch @ 20 kg $plot^{-1}$; M_3: no mulch; F_1: organic manures FYM @ 15 t ha^{-1}; F_2: vermicompost @ 5 t ha^{-1}; F_3: FYM @ 7.5 t ha^{-1} + vermicompost @ 2.5 t ha^{-1} and F_4: no organic manures; DAP-Days after planting with previous studies (Ayana and Olika, 2024; Iqbal *et al.,* 2024; Mahanta *et al.,* 2019; Raut *et al.,* 2021; Wang *et al.,* 2022 ; Zhang *et al.,* 2023). Higher soil moisture levels under mulched and manured conditions led to better development, improved uptake of nutrients, and eventually increased crop yield. Although plastic mulch was particularly effective in conserving moisture and managing salinity, paddy straw mulch also performed well in terms of yield, averaging 20.44 t ha^{-1}. This is possible because the straw releases more nutrients during the process of decomposition. Overall, mulching, whether plastic or organic materials, can significantly improve the efficiency of water use and decrease salt stress, especially in areas with limited water availability or high salinity. This often results in an increase in tomato yield by 20-120% (Ayana and Olika, 2024; Reta and Habita, 2025; Singh *et al.,* 2019; Zhang *et al.,* 2017).

Crop yield

Tomato fruit yield showed a notable increase when organic manures and mulching were applied. The best results were observed with the combined use of farmyard manure (FYM) at 7.5 t ha^{-1} plus vermicomposting at 2.5 t ha^{-1} (F_3), which gave an average yield of 19.84 t ha^{-1}, followed by FYM alone (18.02 t ha^{-1}) and vermicomposting alone (16.60 t ha^{-1}). The treatment without any manure produced the lowest yield of 10.12 t ha^{-1} (Table 6). The improved performance of the integrated nutrient management (F_3) is due to a regular and balanced nutrient supply, increased activity of microorganisms, better uptake of nutrients, and improved soil structure. During decomposition, organic acids and humic substances are released, which help in reducing salinity stress by making micronutrients more available to the plants (Singaravel *et al.,* 2019). Among the mulch treatments, paddy straw mulch (M_2) gave the highest yield of 20.44 t ha^{-1}, followed by plastic mulch with 18.25 t ha^{-1}. However, the no-mulch or control produced only 9.76 t ha^{-1}. The better performance of paddy straw mulch can be attributed to its ability to maintain proper soil moisture in the root area, regulate soil temperature during cooler periods, reduce water loss from evaporation, and lower soil salinity. These factors create a better root environment, which encourages faster plant growth and earlier harvests. These benefits also improve the plant's ability to absorb nutrients and overall crop productivity (Sarangi *et al.,* 2021; Li *et al.,* 2024).

The interaction between mulching and organic manure had a highly significant and positive effect. The combination of paddy straw mulch with FYM (7.5 t ha^{-1}) and vermicomposting (2.5 t ha^{-1}) (M_2F_3) produced the highest fruit yield of 25.44 t ha^{-1}, which was more than three times higher than the control treatment (M_3F_4: 7.86 t ha^{-1}). This outcome shows how the combination of organic manures with mulching can significantly improve yield in coastal saline soils. Using organic manures along with mulching helped to improve the ability of soil to retain water and nutrients, enhanced its chemical, physical, and biological properties, and supported long-term fertility (Raut *et al.,* 2021). These findings are in line with previous research by Das *et al.* (2018), who found that applying vermicomposting and using mulch-based soil management techniques considerably improved tomato growth and yield. The significant interaction between manure and mulch emphasizes that combining these two practices is far more effective than using them individually in sustainable tomato production in saline areas. This eco-friendly method not only increases yield but also gradually improves soil health. Further long-term studies on microbial activity, economic benefits, and sustainability would help to support the wider use of this practice in coastal land areas.

Effect of salinity on yield of tomato

Soil salinity at time of harvest $EC_{1:2.5}$ (dS m^{-1}) and tomato fruit production (t ha^{-1}) were plotted to show the effect of soil salinity on production (Fig. 1). The regression analysis revealed a negative relationship between soil salinity and crop yield. Soil salinity levels ranged from 2.5 to 4.6 dS m^{-1}, whereas fruit yield ranged between 9 to 25.4 t ha^{-1}. The regression coefficient indicates that for each 1 dS m^{-1} increase in salinity,

Table 5. *Effect of different levels of organic manures and mulching on soil moisture (w/w) (%) at 30 and 90 days after planting of tomato under drip irrigation (Pooled data of three years)*

Treatments	30 Days after planting					90 Days after planting				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
M1	40.79	39.22	43.13	38.22	40.34	36.71	34.04	38.83	32.13	35.43
M2	35.97	34.10	37.48	31.72	34.82	27.93	26.44	30.08	24.78	27.31
M3	26.87	25.31	28.41	23.60	26.05	21.23	19.72	22.82	18.23	20.50
Mean	34.54	32.88	36.34	31.18	-	28.63	26.73	30.58	25.05	-

	30 DAP SE± m	30 DAP CD (5%)	90 DAP SE± m	90 DAP CD (5%)
Mulch (M)	0.01	0.04	0.02	0.05
Manure (F)	0.01	0.05	0.02	0.06
Interaction (M x F)	0.03	0.08	0.04	0.10

Treatments- M_1: plastic mulch; M_2: paddy straw mulch @ 20 kg plot^{-1}; M_3: no mulch; F_1: organic manures FYM @ 15 t ha^{-1}; F_2: vermicompost @ 5 t ha^{-1}; F_3: FYM @ 7.5 t ha^{-1}+ vermicompost @ 2.5 t ha^{-1}and F_4: no organic manures; DAP-Days after planting

Table 6. *Effect of different levels of organic manures and mulching on yield of tomato (t ha^{-1}) under drip irrigation (Pooled data of three years)*

Treatments	FYM @ 15 t ha^{-1} (F_1)	Vermicompost @ 5 t ha^{-1} (F_2)	FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3)	No organic manures (F_4)	Mean
Plastic mulch (M_1)	20.46	18.89	22.82	10.82	18.25
Paddy straw mulch (M_2)	23.20	21.42	25.44	11.69	20.44
No mulch (M_3)	10.40	9.50	11.27	7.86	9.76
Mean	18.02	16.60	19.89	10.12	

	SE± m	CD @ 5%
Mulch (M)	0.21	0.62
Manure (F)	0.24	0.71
Interaction (M x F)	0.42	1.24

crop yield declined by about 5.7 t ha^{-1}. The R^2 value of 0.4254 indicates that salinity accounted for 42.5% variation in yield. These results show that as soil salinity increases, crop yield tends to decrease, possibly because of factors like osmotic stress, harmful ion effects, and lower nutrient absorption.

The inclusion of FYM and vermicompost may be linked to the direct supply of nitrogen, phosphorus, potassium and other micronutrients, which also decreases the precipitation of phosphorus and potassium fixation, thus enhancing nutrient availability. Furthermore, paddy straw mulch reduced the amount of water loss through evaporation from the soil surface. Paddy straw mulching mitigates soil salinity and conserves soil moisture (Sarangi *et al.,* 2021). Thus, the relationship between soil, plants, and water improved, leading to enhanced water productivity. Also, drip irrigation delivers water accurately and directly to the root zone, enabling the crop to utilize water more effectively and maximize the irrigation capacity by enhancing the use of accessible irrigation water and boosting the harvest. These findings are corroborated by the research of Samui *et al.* (2020) and Singaravel *et al.* (2019). The costs related to tomato farming (Table 7) utilizing farmyard manure (FYM) at 7.5 t ha^{-1} in conjunction with vermicompost at 2.5 t ha^{-1} and plastic mulch (F_3M_1) were higher due to the increased expenses of plastic mulch and vermicompost when compared to F_4M_4 and F_4M_2. Higher yield under paddy straw mulch may be attributed to improved soil moisture conservation, moderated soil temperature, enhanced microbial activity, addition of organic matter and nutrients through decomposition, and better root-zone conditions compared with plastic mulch. These factors collectively promoted plant growth and yield formation.

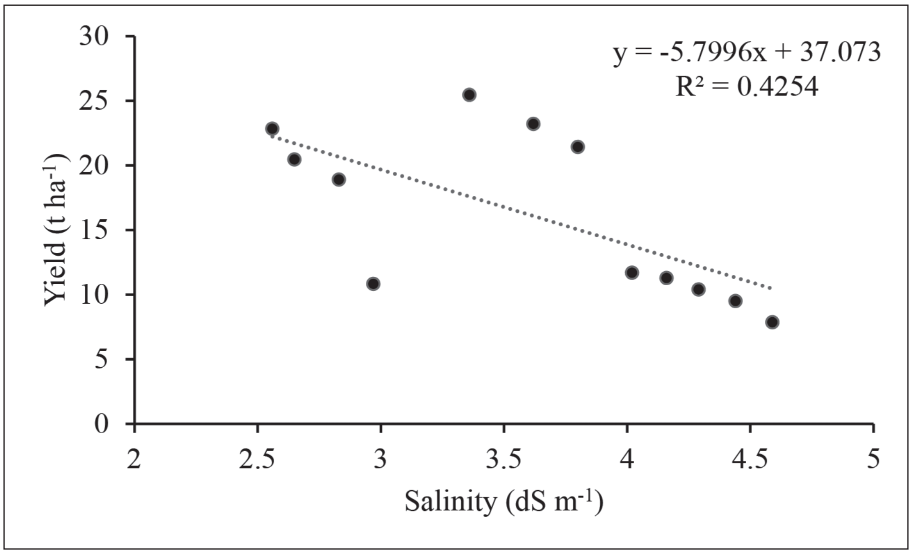

Fig. 1. *Relationship between soil salinity and tomato yield*

The results suggest that farmers should prefer tomato crop cultivation during the *Rabi* season under drip irrigation along with the integration of organic manure and mulch. In coastal regions, the use of mulching and salt-tolerant varieties of crops provides an opportunity for crop diversification. The higher net profit from tomatoes was observed with FYM at 7.5 t ha^{-1} + vermicompost at 2.5 t ha^{-1} under paddy straw mulch at 3.0 t ha^{-1} (F_3M_2), totalling ₹204676, followed closely by application of vermicompost at 5 ha^{-1} with paddy straw mulch (₹153401) across all treatments. A thorough analysis of the economics (Table 7) by assessing all investments and returns indicated that the

Table 7. *Economics of tomato as influenced by manure and mulching under saline soil (Pooled data of three years)*

Treatment combinations	Gross return (Rs. ha^{-1})	Total cost (Rs. ha^{-1})	Net returns on input cost (Rs. ha^{-1})	Net returns on total cost (Rs. ha^{-1})	B:C ratio (Input cost)	B:C ratio (Total cost)
M_1F_1	521425	609675	45336	-88250	1.09	0.85
M_1F_2	484175	514675	103086	-30500	1.27	0.94
M_1F_3	580575	562175	151986	18401	1.35	1.03
M_1F_4	299175	429675	3086	-130500	1.01	0.69
M_2F_1	595450	493675	235361	101776	1.65	1.20
M_2F_2	552075	398675	286986	153401	2.08	1.38
M_2F_3	650850	446175	338261	204676	2.08	1.45
M_2F_4	282575	313675	102486	-31100	1.56	0.90
M_3F_1	280075	484675	-71015	-204600	0.79	0.57
M_3F_2	260250	389675	4161	-129425	1.01	0.66
M_3F_3	289675	437175	-13915	-147500	0.95	0.66
M_3F_4	220050	304675	48961	-84625	1.28	0.72

best B:C ratio of 1.45 was recorded for FYM at 7.5 t ha^{-1} + vermicompost at 2.5 t ha^{-1} with paddy straw mulch at 3.0 t ha^{-1} (F_2M_3), followed by 1.38 in the vermicompost at 5 t ha^{-1} with paddy straw mulch at 3.0 t ha^{-1} (F_2M_2) treatment compared to all other treatments. This indicated that the combination of organic manure with mulch under drip irrigation increases productivity levels of tomato under saline conditions and the prevalent market rates made the tomato crop the most economical. It is convincingly clear that a tomato crop under saline conditions is an important crop to harness yield potential at an economic level. The variations in market selling rates can influence the B:C ratio. This benefit primarily stemmed from enhanced crop yield and improved access to water and nutrients and a reduction in salinity effects. It meant that the tomato crop should be given preference under coastal saline conditions.

CONCLUSION

It can be inferred that tomato is the most promising crop with the maximum return. The use of paddy straw mulch with drip irrigation proved to be the most effective method for lowering salinity, managing weeds, and achieving high yields. The use of mulches was demonstrated to be a more effective method for creating suitable soil conditions for tomato cultivation in the saline coastal soils of Maharashtra. Among the mulches, plastic mulch and paddy straw mulch retained greater moisture levels than the unmulched control. Decrease in weed competition alongside the crop and enhancement of soil organic carbon were clearly evident in optimizing the yield of tomato in the semi-arid coastal area of Maharashtra.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to ICAR, New Delhi, and the ICAR-Central Soil Salinity Research Institute based in Karnal for their essential financial and technical assistance in performing this research as part of the AICRP on Managing Salt-Affected Soils and Utilizing Saline Water in Agriculture at the Khar Land Research Station in Panvel, Maharashtra.

CONFLICTS OF INTEREST

There is no conflict of interest among the authors.

REFERENCES

Abd El-Mageed, T.A., Semida, W.M. and Abd El-Wahed, M.H. (2016). Effect of mulching on plant water status, soil salinity and yield of squash under summer-fall deficit irrigation in salt affected soil. *Agricultural Water Management* **173**: 1-12.

Ayana, D.T. and Olika, G.I. (2024). Effect of mulching practice as soil moisture conservation for tomato (*Lycopersicon esculentum* Mill.) production under supplemental irrigation in Yabello district of Borana zone, Ethiopia. *Acta Biology Forum* **3**(2): 43-47.

Bhattacharyya, R., Prakash, V., Kundu, S. and Gupta, H.S. (2015). Effect of conservation agriculture on soil aggregation and carbon sequestration in the Indian Himalayas. *Soil and Tillage Research,* **108**: 134-141.

Cantore, V., Pace, B., Todorović, M., Palma, E. De and Boari, F. (2012). Influence of salinity and water regime on tomato for processing. *Italian Journal of Agronomy* **7**: e10.

Das, S., Chatterjee, R. and Das, K. (2018). Effect of mulching on soil hydrothermal regimes, weed suppression and crop productivity: A review. *International Journal of Current Microbiology and Applied Sciences* **7**(11): 3219-3231.

Dodake, S.B., Khobragade, S.S., Borse, D.K., Vaidya, K.P., Kaledhonkar, M.J., Wahane, M.R. and Palkar, J.J. (2022). Effect of saline water irrigation on growth, yield and economics of spinach, radish and dill under coastal saline soils of North Konkan region of Maharashtra. *Journal of Soil Salinity and Water Quality* **14**(1): 76-83.

Dodake, S.B., Khobragade, S.S., Borse, D.K., Wahane, M.R., Vaidya, K.P., Kaledhonkar, M.J. and Meena, B.L. (2023). Effect of irrigation level and sowing date on yield of field bean in saline soils of Konkan region of Maharashtra. *Journal of Agricultural Engineering (India)* **60**(1): 100-107.

Hasan, G.N., Khan, Md. M.H., Faisal, A.H. Md. A., Islam, Md. M., Hussain, J., Islam, Md. M., Anik, Md. R.H., Akter, N. and Moriom, M. (2024). Mulching and drip irrigation to mitigate soil salinity on tomato (*Lycoperscon esculentum* L.) production in coastal area. *Trends in Horticulture* **7**(1): 3951.

Hou, M., Zhu, L. and Jin, Q. (2016). Surface drainage and mulching drip-irrigated tomatoes reduces soil salinity and improves fruit yield. *PLoS ONE* **11**(5): e0154799.

Iqbal, M., Iqbal, S., Ullah, A., Jahangeer, A., Akhtar, N., Tabassum, T., Zohaib, A. and Ramzan, N. (2024). Mulching for enhanced cotton production in saline soils. *Sarhad Journal of Agriculture* **40**(3): 877-894.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd. New Delhi, India. pp 69-182.

Khobragade, S.S., Vanave, P.B., Wahane, M.R., Bhangare, K.B., Kaledhonkar, M.L., Borse, D.K., Meena, R.L., Meena, B.L., Dodake, S.B. and Vaidya, K.P. (2025). Effect of manure and mulching under drip irrigation on salinity and yield of brinjal in coastal saline soils. *Journal of Soil Salinity and Water Quality* **17**(2): 288-296.

Li, F.M., Song, Q.H., Jjemba, P.K. and Shi, Y.C. (2013). Dynamics of soil microbial biomass C and soil fertility in cropland mulched with plastic film. *Soil Biology and Biochemistry* **39**: 1462-1468.

Li, J. Liu, S., Li, J., Feng, X. and Jia, S. (2024). Straw incorporation: A more effective coastal saline land reclamation approach to boost sunflower yield than straw mulching or burial. *Agricultural Water Management* **305**: 109140.

Mahanta, K.K., Burman, D., Sarangi, S.K., Mandal, U.K., Maji, B., Mandal, S., Digar, S. and Mainuddin, M. (2019). Drip irrigation for reducing soil salinity and increasing cropping intensity: Case studies in Indian Sundarbans. *Journal of Indian Society of Coastal Agricultural Research* **37**(2): 64-71.

Mahmoodabadi, M., Yazdanpanah, N. and Sinobas, L.R. (2013). Effects of organic amendments on soil physical and chemical properties under saline conditions. *Archives of Agronomy and Soil Science* **59**: 1-12.

Panse, V.G. and Sukhatme, P.V. (1961). *Statistical Methods for Agricultural Workers*, ICAR, New Delhi, India.

Patil, K.D., Khobragade, S.S., Palkar, J.J., Dodake, S.B., Wahane, M.R., Borse, D.K., Vaidya, K.P., Kaledhonkar, M.J. and Meena, B.L. (2024). Profitability of rainwater harvesting pond-based integrated farming systems in coastal plains of Western India: A case study. *Journal of Agricultural Engineering (India)* **61**(2): 219-231.

Raut, S., Burman, D., Sarangi, S.K. and Lama, T.D. (2021). Influence of ameliorants on physicochemical properties and salinity of a coastal soil of West Bengal. *Journal of Indian Society of Coastal Agricultural Research* **39**(1): 135-138.

Rakhonde, S.Y., Jondhale, D. G., Wahane, M. R., Borse, D. K., Dodake, S. B. and Prasad, J. (2026). Depth-wise distribution of potassium fractions and micronutrients and their relationship in coastal saline soils of Raigad, Maharashtra. *Journal of the Indian Society of Coastal Agricultural Research* **43**(2): 110-125.

Reta, B.G. and Habite W. (2025). Optimizing tomato yield in saline-sodic soils with gypsum and mulching techniques Near Lake Abaya, Ethiopia. *Applied and Environmental Soil Science* **2025**: 4199651.

Samui, I., Skalicky, M., Ray, K., Sarkar, S., Hossain, A., Brahmachari, K., Sau, S., Ghosh, A., Nanda, M.K., Bell, R.W., Mainuddin, M., Saneoka, H., Raza, M.A., Brestic, M., Liu, L., Erman, M. and Sabagh, A. EL. (2020). Yield response, nutritional quality and water productivity of tomato (*Solanum lycopersicum* L.) are influenced by drip irrigation and straw mulch in the coastal saline ecosystem of Ganges Delta, India. *Sustainability* **12**: 6779.

Sarangi, S.K., Mainuddin, M., Bell, R.W., Digar, S., Mahanta, K.K., Burman, D., Mandal, U. K. and Mandal, S. (2021). Low-cost pitcher irrigation system with paddy straw mulching for growing vegetables in coastal saline soils. *Journal of Indian Society of Coastal Agricultural Research* **42**(1): 165-174.

Sharma, P. and Singh, R. (2017). Effect of mulching on soil salinity and crop productivity under saline environments. *Journal of Soil Salinity and Water Quality* **9**(2): 135-142.

Singaravel, R., Balambigai, D. and Viswanathan, K. (2019). Effect of organic manures, micronutrients and growth regulators on growth and yield of sesame (*Sesamum indicum* L.) in coastal saline soil. *Journal of Indian Society of Coastal Agricultural Research* **37**(1): 46-50.

Singh, A.K., Meena, M.K. and Kumar, S. (2019). Influence of organic mulches on soil moisture conservation and productivity of vegetable crops. *Indian Journal of Agricultural Sciences* **89**(2): 275-280.

Song, Y., Sun, J., Cai, M., Li, J., Meizhen Bi. and Gao, M. (2025). Effects of management of plastic and straw mulching management on crop yield and soil salinity in saline-alkaline soils of China: A meta-analysis. *Agricultural Water Management* **308**: 109309.

Tejada, M., Garcia, C., Gonzalez, J.L. and Hernandez, M.T. (2006). Organic amendment based on fresh and composted beet vinasse: Influence on soil properties and wheat yield. *Soil Science Society of America Journal* **70**: 900-908.

Wang, X., Yang, J., Yao, R., Xie, W. and Zhang, X. (2022). Manure plus plastic film mulch reduces soil salinity and improves barley-maize growth and yield in newly reclaimed coastal land, Eastern China. *Water* **14**: 2944.

Zhang, P., Zhang, Z., Xiao, M., Chao, J., Dai, Y., Liu, G. and Senge, M. (2023). Effects of organic mulching on moisture and temperature of soil in greenhouse production of tomato under unheated greenhouse cultivation in the cold zone of China. *Food Science and Nutrition* **11**: 4829-4842.

Zhang, S., Lövdahl, L., Grip, H., Tong, Y., Yang, X. and Wang, Q. (2017). Effects of mulching and catch cropping on soil temperature, soil moisture and wheat yield. *Soil and Tillage Research* **102**: 78-86.