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Effect of Different Organic and Inorganic Manures on Growth and Yield of Bhendi (*Abelmoschus esculentus* L. Moench) under Coastal Saline Condition

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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

Bhendi (*Abelmoschus esculentus* L.) is one of the most familiar vegetables in India which is grown extensively throughout the year. The field experiment was conducted at the farmer's field Varagoorpetai, Chidambaram, Tamil Nadu, during the year 2022. To study the effect of different organic and inorganic manures on growth and yield of bhendi under coastal saline condition. The experiment was laid out in the randomized block design with three replications and thirteen treatments viz., T_1 (Control (No Fertilizer)),T_2 (FYM @25 t ha^{-1} + RDF (Through DAP, Urea and MOP),T_3 (VC @ 10t ha^{-1} + RDF (Through DAP, Urea and MOP), T_4 (FYM @25 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1},T_5 (VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1}), T_6 (FYM @25 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS),T_7 (VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS), T_8 (FYM @25 t ha^{-1} + RDF 50% (Through DAP, Urea and MOP), T_9 (VC @ 10t ha^{-1} + RDF 50% (Through DAP, Urea and MOP), T_{10} (FYM @25 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-}

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[1]),T_{11} (VC @ 10t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1}), T_{12} (FYM @25 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS), T_{13} (VC @ 10t ha^{-1} + RDF 50% + gypsum @200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS) were allocated randomly in each plot. Seed priming with coconut water 50% was done for all the treatments. From the present experimental findings it is found that the treatment combination T_7 (VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS) was found best in terms of growth and yield of okra, followed by treatment T_6 (FYM @25 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS) in all the parameters and lowest readings was observed in treatment T_1 (control).

Keywords: Coastal saline; organic; inorganic manures; bhendi.

1. INTRODUCTION

"Okra is an important annual, herbaceous vegetable crop in India, West Africa, South-East Asia, U.S.A., Brazil and Turkey. Okra (*Abelmoschus esculentus* (L.) Moench), belonging to the family Malvaceae, is extensively grown in the tropical and subtropical parts of the world. It is one of the most important nutritious vegetable crops grown around the year in India" [1]. "This crop is suitable for cultivation as a garden crop as well as on large commercial farms. Centre of origin of okra is Africa. It is commonly grown through the warmer parts of temperate Asia, Southern Europe, Northern Africa, the United States, and in all parts of the tropics. Bhendi plays an important role in the diet by supplying carbohydrate, protein, minerals, vitamins and fat that are usually deficient in the stable food. It has good nutritional value as 100 g consumable unripe fruit contains moisture 89.6 g, carbohydrates 6.4 g, protein 1.9 g, fat 0.2 g, fibre 1.2 g, minerals 0.7 g, vitamin A 88 IU, thiamine 0.07 mg, riboflavin 0.10 mg, nicotinic acid 0.60 mg and vitamin C 13 mg" [2].

"Organic manures are environmentally friendly, since they are from organic sources" [3-6]. "The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The organic manures provide nutritional requirements, suppress plant pest populations, and increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers" [7,8] "In addition to enhancing vegetable quality, organic manures are a dependable source of macro and micronutrients and can help improve the physical, chemical, and biological health of the soil. They can also decrease nutrient losses and increase nutrient availability and uptake, resulting in sustainable production free of harmful residues. The continuous and indiscriminate use of inorganic fertilizers has resulted in decreased nutrient uptake, poor quality of vegetables and deterioration of soil health" [9]. "The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. Gypsum is a relatively soluble supply of the important crop nutrients and can improve overall crop growth" [10]. "For instance, gypsum revealed excellent results when applied in saline soil and was used calcium fertilizer to enhance production" [11].

"Salinity is one of the important abiotic stresses that limit plants growth, development and improvement in several areas of the world and leads to excessive reduction in plant production" [12]. "Salinity is the main hurdle for the reduction in agricultural productivity" [13]. Worldwide, salinity led to the decline of crop production and plant growth in many cultivated areas [14], resulting in 65% loss of crop yield [15]. "Okra being sensitive to salinity is facing a severe loss in its yield and quality under increasing salinization in the arid and semi-arid environments". Ayub et al [16,17]. Keeping this in view, the present investigation was carried out to verify the effect of different organic and inorganic manures on growth and yield of bhendi under coastal saline condition.

2. MATERIALS AND METHODS

The present study was carried during January-May 2022 at farmer's field, Varagoorpetai, Chidambaram, Tamil Nadu, India. The experimental site is geographically located at 11° 24' N latitude, 79° 44' E longitude, at an altitude of +5.79 m above mean sea level and 15 km away from the Bay of Bengal East shore.

The experiment was conducted in a Randomized Block Design (RBD) replicated thrice with 13 treatments. The plot size for each treatment was 3.6x3.9 m^2. Ridges and furrows were formed and seeds were sown at a spacing of 45x30 cm. Arka Anamika was the variety used in this study. Treatment details were furnished in Table 1. Seed

Table 1. Treatments details

Treatments	Treatments
T_1	Control (No Fertilizer)
T_2	FYM @25 t ha^{-1} + RDF (Through DAP, Urea and MOP)
T_3	VC @ 10 t ha^{-1} + RDF (Through DAP, Urea and MOP)
T_4	FYM @25 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1}
T_5	VC @ 10 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1}
T_6	FYM @25 t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1}+ foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS
T_7	VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1}+ foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS
T_8	FYM @25 t ha^{-1} + RDF 50% (Through DAP, Urea and MOP)
T_9	VC @ 10 t ha^{-1} + RDF 50% (Through DAP, Urea and MOP)
T_{10}	FYM @25 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1}
T_{11}	VC @ 10 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1}
T_{12}	FYM @25 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1}+ foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS
T_{13}	VC @ 10 t ha^{-1} + RDF 50% + gypsum @ 200 kg ha^{-1}+ foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS

priming with coconut water- 50 % was done for all the treatments as which got the best treatment in previous experiment. The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were maintained properly. Direct sowing of the seeds was done in the field. Light irrigation was given after sowing. The organic manures were applied as basal dose before sowing, for proper decomposition, full dose of phosphorous and potassium and half dose of nitrogen as per treatment were applied just before the sowing. 30 days after sowing, the remaining half of the nitrogen dose was applied. All cultural practices were followed regularly during crop growth and observations were recorded on vegetative characters i.e., plant height, number of leaves, number of branches $plant^{-1}$, Flowering, fruiting and yield characters i.e., days to first flowering, fruit length, fruit diameter, no.of $fruits^{-1}$,fruit yield $plant^{-1}$ and analysis of variance was performed to determine the effect of organic and inorganic manures on growth and yield of Okra using Opstat. The interpretation of treatments effects was made on the basis of critical difference at 5 % probability level.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

The application of both organic and inorganic sources of nutrients together had a considerable impact on the growth-attributing features, including plant height, number of branches and number leaves (Table 2). The highest plant height (53.59, 88.48 and 108.82 cm at 30, 60 and 90 DAS respectively), number of leaves $plant^{-1}$ (12.94, 24.81 and 28.94 at 30, 60 and 90DAS, respectively), number of branches $plant^{-1}$ (3.04, 4.05 and 4.78 at 30, 60 and 90 days, respectively) were obtained using VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS and mimimum in T_1(control). “It has been discovered through the study of vegetative characteristics that a vermicompost with full dose of inorganic fertilizers with foliar application outperforms a farmyard manure with full dose of inorganic fertilizers with foliar application. In addition of ensuring correct soil aeration and enhancing the soil's ability to retain water, organic manures aid in enhancing soil health” [18,19]. “This could be further, confirmed by the facts that greater nutrient doses as RDF with organic supplements as vermicompost is responsible for improvement in soil and plant nutrient status which promotes greater metabolic activities resulting improvement in biomass production” [20,21].

Incorporation of gypsum either alone or in combination with other amendments had enhanced the performance of okra. The applied gypsum might have altered the soil structure, resulting in increased soil aeration and water infiltration, minimizing sodicity and enhanced the nutrient availability for better growth conditions. These results are in accordance with the findings of Uddain et al [22].

Foliar application of 19:19:19 along with the integration of inorganic and organic manures have created congenial environment that is favorable to the healthy growth and promoting the reproductive growth as well Narwariya et al [23].

3.2 Yield Related Attributes

Table 3 shows the findings of the study on the minimum number of days to first flowering, fruit length, fruit diameter and number of fruits plant^{-1} ,fruit yield plant^{-1} in okra. In terms of days to first flowering the treatment in T_7 recorded minimum number of days to first flowering (35.33 days), followed by T_6 with (38.00 days), whereas maximum number days to first flowering (51.33 days) was recorded in treatment T_1. "Early flowering may be due to interaction effect as vermicompost have soil microbes, nitrogen fixing bacteria, phosphate solubilizing bacteria and growth hormone auxin, gibberellins and cytokines which influence and enhance efficiency of nitrogen greater than that of chemical fertilizer which influence early flowering" [24]. "Earliness in day to flowering in okra was observed with integrated nutrient application" by Mal et al. [25].

Table 2. Effect of different organic and inorganic manures on growth parameters

Treatments	Plant height (cm)			No. of leaves plant^{-1}			No. of branches plant^{-1}		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	26.42	53..28	72.01	7.14	13.46	15.46	1.38	1.81	2.21
T_2	35.01	64.87	83.19	8.71	16.91	19.49	1.95	2.54	3.02
T_3	35.52	65.08	83.48	8.88	17.11	19.65	1.98	2.58	3.08
T_4	42.37	73.67	93.16	10.43	20.26	23.18	2.42	3.17	3.74
T_5	42.88	74.48	93.41	10.55	20.45	23.48	2.44	3.21	3.78
T_6	50.04	84.21	104.01	12.25	23.37	27.28	2.84	3.79	4.44
T_7	53.59	88.48	108.82	12.94	24.81	28.94	3.04	4.05	4.78
T_8	30.97	60.26	77.28	7.98	15.48	17.74	1.70	2.25	2.65
T_9	31.59	60.85	78.06	8.05	15.65	17.96	1.75	2.28	2.69
T_{10}	38.67	69.28	88.29	9.60	18.59	21.21	2.20	2.82	3.40
T_{11}	39.05	69.51	88.46	9.78	18.88	21.45	2.23	2.88	3.44
T12	46.44	79.22	98.22	11.23	21.87	25.24	2.62	3.48	4.09
T13	46.89	80.09	98.8	11.47	22.09	25.41	2.66	3.51	4.15
S.Ed	1.40	1.77	2.19	0.29	0.57	0.67	0.07	0.10	0.12
C.D(p=0.05)	2.89	3.65	4.52	0.59	1.17	1.39	0.15	0.21	0.25

Table 3. Effect of different organic and inorganic manures on yield parameters

Treatments	Days to first flowering	Fruit length (cm)	Fruit diameter (cm)	No. of fruits plant^{-1}	Fruit yield plant^{-1} (g)
T_1	51.33	9.17	1.21	7.89	63.99
T_2	47.33	11.03	1.46	10.98	105.63
T_3	47.33	11.14	1.48	11.10	109.67
T_4	42.33	13.01	1.72	13.36	149.77
T_5	42.33	13.09	1.73	13.48	153.94
T_6	38.00	14.82	1.96	15.95	200.17
T_7	35.33	15.64	2.07	16.91	221.52
T_8	49.00	10.11	1.32	9.72	85.92
T_9	49.00	10.20	1.34	9.98	89.92
T_{10}	44.33	12.02	1.59	12.08	126.12
T_{11}	44.00	12.09	1.61	12.17	128.52
T_{12}	40.33	13.92	1.84	14.60	174.47
T_{13}	40.00	14.00	1.86	14.88	178.71
S.Ed	0.90	0.39	0.05	0.44	0.74
C.D (p = 0.05)	1.86	0.81	0.10	0.90	1.52

In terms of number of fruits plant^{-1} the treatment in T_7 recorded maximum (16.91 fruits plant^{-1}), followed by T_6 with (15.95 fruit plant^{-1}) whereas minimum number of fruits plant^{-1} (7.89) was recorded in treatment T_1. Similar findings of significantly higher number of fruits plant^{-1} by the use of organic manure & inorganic fertilizers have also been reported by Prasad and Naik [26] in okra.

"In terms of fruit length the treatment T_7 recorded maximum (15.64cm) fruit length, followed by T_6 with (14.82cm) whereas minimum fruit length (9.17 cm) was recorded in treatment T_1. Maximum fruit length in best treatments is might be due to combined application of organic manures and inorganic fertilizers which might have acted complementary and supplementary to each other and resulted into adequate slow but steady supply of nutrients" Bairwa et al. [27].

In terms of fruit diameter the treatment T_7 recorded maximum (2.07cm) fruit diameter, followed by T_6 with (1.96 cm) whereas minimum Fruit diameter (1.21cm) was recorded in treatment T_1(control). High value in fruit diameter was observed in okra Kumar et al., [28].

In terms of fruit yield plant^{-1} the treatment T_7 recorded maximum (221.52g) fruit yield plant^{-1} followed by T_6 with (200.17) whereas minimum fruit yield (63.99) was recorded in treatment T_1(control). "Similar findings indicating the combined use of organic and inorganic manures enhanced greater growth and fruit yield of okra have also been reported by Tyagi et al. [29]. This might be attributed due to the increased availability of NPK, other minerals and water at critical stages of the crop resulting early establishment, vigorous growth, and larger fruits due to application of higher dose of nutrients through RDF" [30-32].

"The beneficial effect of application of organic manures along with inorganic increasing the vegetative growth and yield of plant can be attributed to the joint application of manures, chemical fertilizers that might have acted complementary and supplementary to each other and resulted into adequate slow but steady supply of nutrients. Moreover, the organic manures are also significant sources of major and micronutrients much needed by the plants" as reported by Rafi et al. [33]. This enhanced yield because of vermicompost might be due to the presence of more amount of available nitrogen, which is essential for the synthesis of structural proteins. This is found to be in accordance with findings of Pallavi and Anuja.[34] in moringa.

"The spraying of watersoluble fertilizers increases uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible parts. The probable reason for increase in yield might be due to easy assimilation of nutrients and balance in NPK ratio which affects the crop productivity" Batra et al. [35]. The present findings are found in agreement with Chaurasia et al.[36]; Narayanamma et al.[37]; Premsekhar and Rajashree. [38].

The application of gypsum, along with organic and inorganic fertilizers, has shown a significant effect on yield. This might be because, adding gypsum neutralized the water's sodicity impact. At the same time, vermicompost generally enhanced the physical characteristics of the soil, such as its structure, which promoted plant development, as seen by the yield shown in carrot Kumar et al.[39].

4. CONCLUSION

The present findings confirm that the okra cultivar Arka Anamika responded well to the application of seed priming with coconut water 50% with treatment (VC @ 10t ha^{-1} + RDF + gypsum @ 200 kg ha^{-1} + foliar application 19:19:19 @ 250 g ha^{-1} at 25 and 45 DAS) for good growth and higher yields. Thus, T_7 were reported as best approach for nutrients in okra to obtain better yield. The data analysis shows that the control treatment produced the minimum growth and yield. Therefore, combining the use of organic and inorganic fertilizers is the best strategy to increase production and efficiently manage the resources.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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