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Impact Assessment of in Organic Fertilizer, FYM and Sewage Sludge Application on Yield of Bhendi-Carrot Cropping System

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A B S T R A C T

Incorporation of manures improves soil health, soil fertility and restores degraded soils. The current study was carried out at the College of Agriculture, Rajendranagar, to know the effect of inorganic fertilizers along with manures and the residual effect of manures on the subsequent crop. The experimental design adopted for the study was split plot involving four inorganic fertilizer treatments (25%, 50%, 75% and 100%) in the main plot and 5 treatments in sub plots (control, 10 t ha^{-1} SS, 20 t ha^{-1} SS, 10 t ha^{-1} FYM, and 20 t ha^{-1} FYM). The increase in fresh fruit yield, plant dry matter and fruit dry matter of bhendi, fresh root yield, leaves dry matter and root dry matter of carrot was observed with increase in doses of inorganic fertilizers and manures. Above all the highest yield was recorded with the application of 20 t ha^{-1} SS and 100 per cent RDF. The residual effect of manures was significant in carrot. Hence, it is concluded that the application of inorganic fertilizers along with manures improves soil health and shows significant effect on the subsequent crop yield.

Introduction

Food is obligatory for the survival of human beings. Food security makes sure that humans have physical, economic and social access to enough, safe and nourishing food to fulfil bodies nutritional requirements and have a life of wellness (Papargyropoulou *et al.,* 2025). This was adopted in world food summit 1996. Food security has 4 dimensions: availability, access, utilization and stability (FAO, 2008). The food's availability and access to everyone reflects the agricultural production. The utilization and stability relates to the reach of food through the supply chain. Utilization is how the human body can intake and maximise the nutrients utilisation present in the food (Akinwande *et al.,* 2026). Stability refers to the constancy in the supply of food to everyone. But the exponentially increasing pattern of population growth is

laid immense pressure on agriculture to meet the food demand and supply (FAO, 2008).

Intensive cropping systems improve the agricultural output for the given area through the utilization of high-level inputs like labour, fertilizers, irrigation and pesticides (Ahvo *et al.,* 2023). Intensive cropping demands efficient crop management, which opts for the superfluous application of chemical inputs (Vaishali *et al.,* 2026). Intensive cropping puts pressure on the soil for the nutrient requirements, rendering the soil unfertile (Vaishali *et al.,* 2026). Intensive utilization of soil results in the fast degradation of soil health (Carswell *et al.,* 2025). As the world is moving towards the sustainable utilization of agricultural lands, intensive cropping becomes unsustainable in the long run due to the high level of inputs and resource intensiveness associated with it (Ahvo *et al.,* 2023; Carswell *et al.,* 2025).

Life on land (Sustainable Development Goal: 5). Healthy soil is essential for supporting biodiversity and protecting natural ecosystems for people, animals and plants (IPCC, 2022). Application of organic manure in the long run restores soil health and fertility (Rostaei *et al.,* 2024). Organic manures improve soil structure and aggregate stability by incorporating soil organic matter content (Gao *et al.,* 2023). The nutrient content of the organic manures also reduces the load on chemical fertilizer inputs (Zhao *et al.,* 2024). Organic manure improves soil microbial communities, which aids in maintaining and balancing nutrient cycles and chemical reactions, which are mandatory for the maintenance of soil health (Kumari *et al.,* 2024). Sewage sludge (SS) is the semi-solid byproduct of a sewage treatment plant. Apart from organic manures, sewage sludge is a rich source of organic matter and plant essential nutrients, N, P, K, Ca, Mg, S, Zn, Cu, Fe and Mn. The nutrient content of the sewage varies depending on the source of collection of waste and treatment process. Sewage sludge application improves soil fertility, porosity, aggregate stability and microbial activity (Głąb *et al.,* 2020; Wei *et al.,* 2020; Achkir *et al.,* 2023). SS enhances the crop growth and development (Koutroubas *et al.,* 2020; da Silva *et al.,* 2021; Muter *et al.,* 2022; Sowmya *et al.,* 2024). Application of SS involves unintentional application of heavy metals to the soil, A major limiting factor for agricultural use (Raheem *et al.,* 2018; Grobelak *et al.,* 2024). SS may have contaminants, including organic materials, pathogens and HMs, based on the source of sewerage collection. The research article evaluates the impact of the application of inorganic fertilizers, FYM and Sewage sludge in the Bhendi-Carrot cropping system.

Materials and Methods

Description of the study area and climate

The experiment was carried out at the college farm, College of Agriculture, Rajendranagar, Hyderabad, in *kharif-rabi*, 2008-09. The geographic coordinates of the farm are 17º19' N latitude and 78º28' E longitude and at an altitude of 535 m above MSL. In *Kharif*, the weekly maximum and minimum temperatures recorded during the experimental period were 33.6ºC and 26.6ºC, respectively. The weakly mean relative humidity during the crop growth period was 75 to 95 per cent. The mean weekly sunshine hours day^{-1} ranged from 0.9 to 7.9 with an average of 5 hours day^{-1}. The total rainfall recorded during the crop growth period was 726.1 mm with an average of 48.4 mm in 36 rainy days.

In *rabi*, the weekly mean maximum and minimum temperatures observed was 34.6ºC and 26.9ºC, respectively. The weekly mean relative humidity during the crop growth period was 81 to 93 per cent. The mean weekly sunshine hours ranged from 3.8 to 9.8 day^{-1}.

Initial soil characteristics

The experimental site, has sandy loam soil texture, and the soil reaction of the was slightly alkaline. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium.

Collection of manures

Sewage sludge was collected from sewage treatment plant, Amberpet, Hyderabad. FYM was collected from dairy farm, College of Veterinary Science, Rajendranagar, Hyderabad. The characteristics of manures were presented in Table 1.

Experimental design

The experiment was carried out with 20 treatments in split plot design with three replications. A total of four treatments in main plot and five treatments in sub plot were implemented. Treatment details were given below. The bhendi variety Arka Anamika was selected to carry out the experiment. Sowing of bhendi crop was done in

Kharif, 2008 with the spacing of 60 x 20-30 cm and recommended dose of fertilizer 120:50:50 kg N, P_2O_5 and K_2O ha^{-1}. Field preparation was carried out and the treatments were incorporated and the field operations were carried out accordingly. The succeeding crop was carrot (*Rabi*, 2008-09). The variety selected to carryout the experiment was Improved New Cauroda with 30 cm x 5 cm spacing, recommended doses of fertilizer is 50:40:50 kg N, P_2O_5 and K_2O ha^{-1} were implemented in main plots and manure application in sub plots was not followed.

Treatment details

Experimental design: Split plot

Main plot:

- ✓ Control (0:0:0 kg ha^{-1} NPK)
- ✓ 50% RDF
- ✓ 75% RDF
- ✓ 100% RDF

Sub plot:

- ✓ Control (no manure application)
- ✓ 10 t ha^{-1} SS
- ✓ 20 t ha^{-1} SS
- ✓ 10 t ha^{-1} FYM
- ✓ 20 t ha^{-1} FYM

Results and Discussion

In case of bhendi highest fresh fruit yield (180.53 q ha^{-1}), dry matter yield (1952 kg ha^{-1}) and fruit dry matter (1538 kg ha^{-1}) were recorded with the application of SS @ 20 t ha^{-1} in combination with the 100 per cent RDF (Fig. 1). In case of carrot, implication of manurial treatments in subplots was not followed to know the residual effect of manures applied in *kharif* (2008). The highest root fresh yield (194.34 q ha^{-1}), leaves dry matter (3033 kg ha^{-1}) and root dry matter (2805 kg ha^{-1}) of carrot were recorded with the application of SS @ 20 t ha^{-1} in combination with the 100 per cent RDF (Fig. 2). The residual effect of manures was significant in the case of carrots. The residual effect was maximum in the plots treated with sewage sludge over the control and the FYM-treated plots.

In main plots as the fertilizer doses increased from 0 to 100 per cent RDF and manure doses from 0 to 20 t ha^{-1}, fresh fruit yield, plant dry matter and fruit dry matter of bhendi, increased, similar pattern was observed in carrot as well. Maximum yield was recorded with the application of sewage sludge @ 20 t ha^{-1} in combination with 100 per cent RDF. Significant results for bhendi yield might be due to the increased nutrient availability from manure addition and the superior nutrient content of sewage sludge over FYM. Similar results were reported that the application of fertilizers along with FYM showed a significant increase in fresh fruit yield of tomato (Kannan, 2006).

As the bhendi-carrot cropping system demands more amounts of nutrients due to its intensiveness, which were made available through the strategic application of manure (Biswakarma *et al.,* 2025). Increased immediate availability of nutrients through inorganic fertilizers and slow release of nutrients over a long period of time through manures provides access to nutrients at various crop growth stages (Mageshen *et al.,* 2022). The residual effect of application of manures was significant on carrot with the maximum yields obtained with treatments involving manures over control (manure unamended) (Azuka and Idu, 2021; Dhaliwal *et al.,* 2023) which might be the result of release of nutrients by decomposition of organic matter (Agbede, 2021).

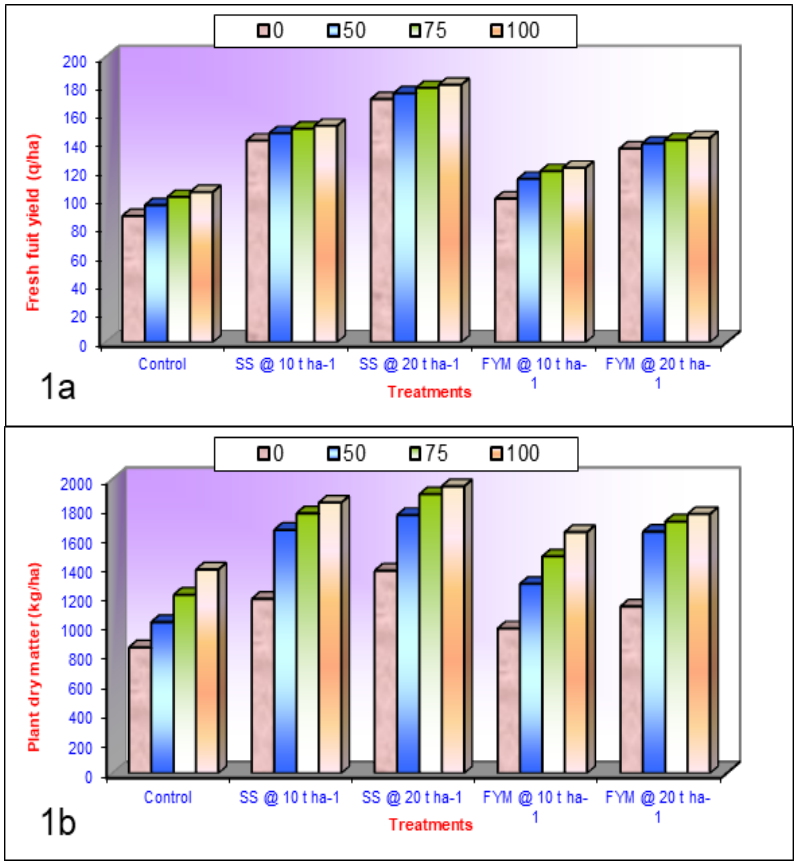
In conclusion, Application of manures along with inorganic fertilizers improved fresh weight and dry matter weights of the bhendi-carrot cropping system. The maximum results were observed with the application of 100 per cent inorganic fertilizer and 20 t ha^{-1} sewage sludge. The yield of crop increased with the increasing dosage of inorganic fertilizers and manure. Application of manures improves soil health and fertility in long term. The application of sewage sludge resulted in superior performance of crops over the treatments involving FYM and control. The direct application of inorganic fertilizers and manures resulted in increased yield of bhendi and carrot.

The residual effect of manure showed significant increase in carrot yield. The application of inorganic fertilizers in combination with manures improved crop yield of the subsequent crops. The integrated supply of nutrients through inorganic fertilizers for immediate nutrient need and manures for long-term fertility improves soil condition and restores soil through strategic application.

Table.1 Characteristics of manures

Parameter	Sewage sludge	FYM
pH	6.52	7.59
EC (dS m^{-1})	1.98	0.95
OC (%)	36.50	12.82
Humic acid (%)	12.68	8.90
Fulvic acid (%)	3.01	2.24
N (%)	1.81	0.54
P (%)	1.02	0.23
K (%)	0.59	0.49
Total Fe (mg kg^{-1})	64.43	1342
Total Mn (mg kg^{-1})	672	184
Total Cu (mg kg^{-1})	463	26.75
Total Zn (mg kg^{-1})	491	72.92
DTPA extractable Fe (mg kg^{-1})	172	49.72
DTPA extractable Mn (mg kg^{-1})	27.53	10.12
DTPA extractable Cu (mg kg^{-1})	26.31	9.42
DTPA extractable Zn (mg kg^{-1})	32.24	7.31

Fig.1 Direct effect of inorganic fertilizers, sewage sludge and FYM on fresh fruit yield (1a), plant dry matter (1b) and fruit dry matter (1c) of bhendi (*Kharif*, 2008)



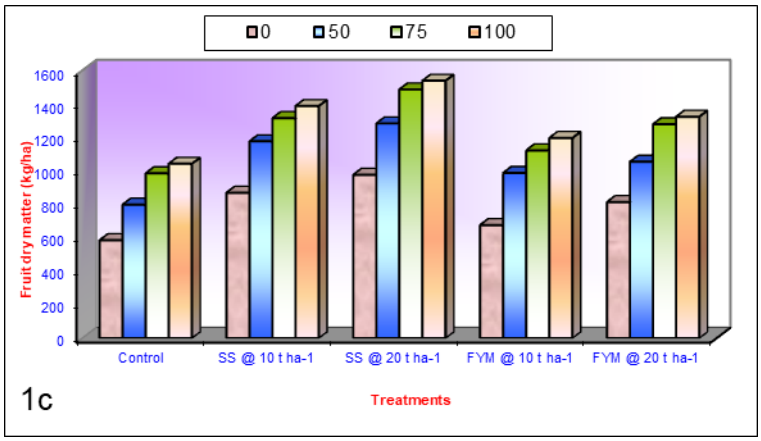
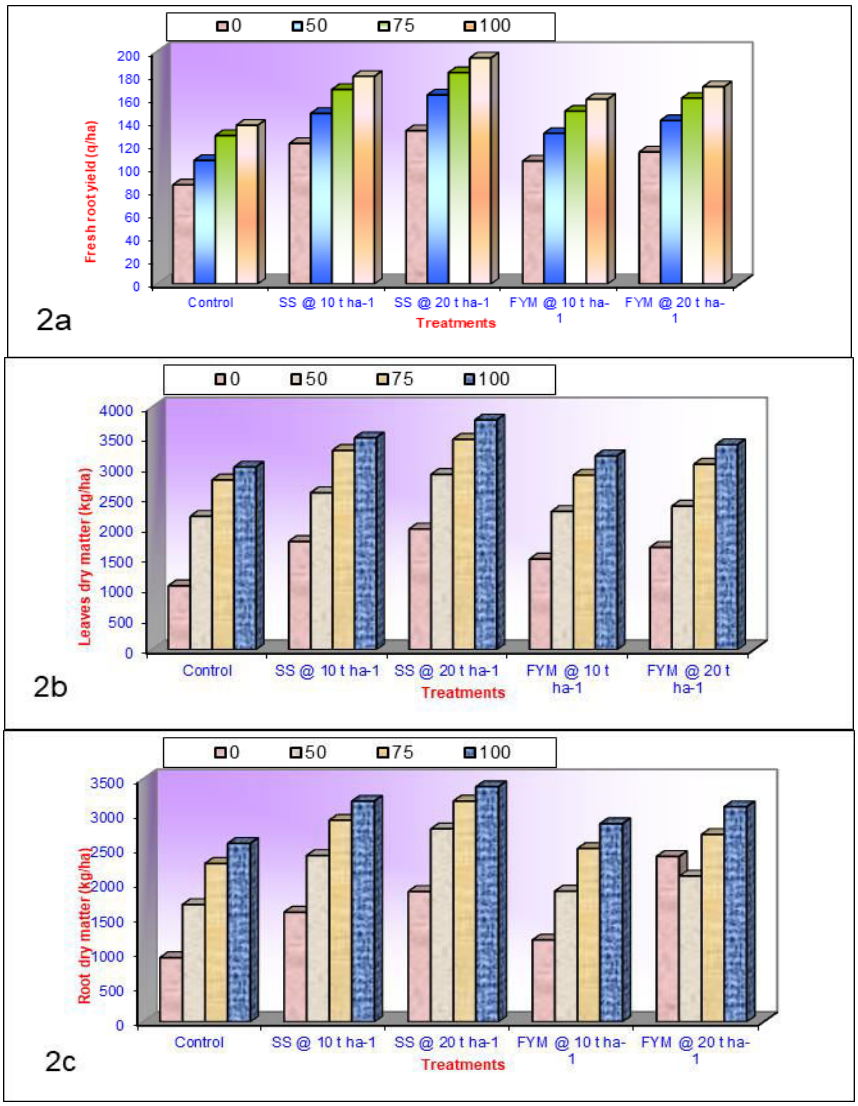


Fig.2 Direct effect of inorganic fertilizers, residual effect of sewage sludge and FYM on fresh root yield (2a), leaves dry mater (2b) and root dry matter (2c) of carrot at harvest (*Rabi*, 2008).



Future research direction

As the application of sewage sludge resulted in improved yield of the crops due to increased nutrient supply, the decomposition of sewage sludge and release of the nutrients from sewage sludge depend upon soil microbial dynamics, which remained unexplored. The crop production mainly revolves around B:C ratio, cost cut down of chemical fertilizers increases B:C ratio which favours adoption of practice by the farmers.

Author Contributions

K. Shailaja: Investigation, formal analysis, writing—original draft. K. Jeevan Rao: Validation, methodology, writing—reviewing. G. Sowmya:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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